Winners and losers of immigration

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"... immigration has consequences, and these consequences generally imply that some people lose while others benefit."
— George Borjas (2014)

Abstract

In a general equilibrium search and matching model of immigration, we explore the price channel, based on the substitutability/complementarity between consumption goods, produced by low-skilled and high-skilled workers. Unemployment benefits and the provision of public goods are financed by a progressive taxation on wages and profits. For the case of Italy, winners of immigration are employees and employers in the high-skilled market (+ 8% real wages and +10% firms' value in the 2017 baseline scenario); while losers are employees and employers in the low-skilled market (-4% and -6%, respectively). At aggregate level, total GDP and government revenues are larger (+14% and +70 billions €, respectively) as well as the net fiscal benefit, as reflected by the increase in the per-capita provision of public goods (+4%). These findings are consistent across several robustness specifications.

Keywords: Search and matching model, heterogeneous workers, two-good economy, fiscal impact of immigration, price channel, method of simulated moments.
JEL classification: J61, J64, J21, J31.

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1 Introduction

In the last decade public sentiments towards immigration have been profoundly divided on the basis of party identification and political ideology (Gennaioli and Tabellini, 2019). Populist parties have gained momentum by leveraging on the widespread belief among the general public that immigration has adverse effects on the labour market. In Italy, where the share of the foreign workforce increased from 6% in 2004 to 15% in 2018, the share of the populist Northern League party grew from 17.4% in the 2018 national elections to 34.3% in the 2019 European elections, after a fierce campaign against immigration. The party consensus increased sharply mostly among blue collars (+29%) and people in the middle/lower tail of the income distribution (+18%), among whom the Northern League share reached almost 50% (SWG, 2019). The explanations of this electoral outcome swung between the cultural backlash against immigration and strictly economic motives (for Germany, Poutvaara and Steinhardt, 2018). Our estimates for Italy, by pointing out that the losers of immigration are mainly low-skilled, suggest that economic motives indeed played a role. However, we also find substantial aggregate gains from immigration, which could be used to counterbalance its negative impact on the poorest workers.

Traditionally, the literature on the economics of immigration has focused on three major issues: the determinants of the size and composition of immigrant flows, the integration of immigrants into the host country, and the impact of immigrants on the host country's economy (Borjas, 1989). Two different approaches have been used to address these issues, one based on the estimation/calibration of theoretical models (e.g., Borjas, 2003) and one based on the exploitation of exogenous shocks (e.g., Card, 2001). Theoretical studies on the effects of immigration on native labour market outcomes have populated the literature since the 1980s (Borjas and Tienda, 1987; Greenwood and McDowell, 1986; Borjas, 2003). The neoclassical theory suggests that a natural starting point for this type of analysis is the specification of a production technology, which describes how immigrants, natives and capital interact in the production process (Borjas, 1989).[1] A number of papers take a medium/long-run approach, by assuming that over time firms are able to adjust the composition of factors (capital/labour ratio) (Ottaviano and Peri, 2012), while another strand using a short-term approach represents immigration as an increase in labor supply for a given capital stock (Borjas, 2003). The large majority of papers discuss partial equilibrium models with a production technology that distinguishes between high-skilled and low-skilled labour and assume that immigrants are perfect substitutes with their corresponding native skill category. Within this framework, a sudden inflow of low-skilled migrants, changing the skill composition, leads to

[1] See Blau and Kahn (2012) for a survey of the literature.

an excess supply of low-skilled employees and therefore a downward pressure on wages of all low-skilled employees, at least in the short run (Dustmann et al., 2013; Moreno-Galbis and Tritah, 2016; Ortega, 2000). On the contrary, whenever immigrants and natives are only imperfect substitutes within the same (observable) skill group, the increase in immigration primarily affects the wages of immigrants already living in the host country (Manacorda et al., 2012; D'Amuri et al., 2010).

Scant is instead the literature on the use of a general equilibrium search and matching model to quantify the impact of immigration. Some papers concentrate only on the production side of the economy and assume perfect competition in the labour market (Ottaviano and Peri, 2012; Borjas, 2003). More recently, a number of papers have analysed the issue within a general equilibrium model with imperfect competition, but include only one sector and assume perfect substitutability between immigrants and natives (Albert and Monras, 2018; Amior et al., 2020). Generally, within these models consumption goods are produced by a nested CES production function, where employees of different skill levels enter as complementary factors, while less emphasis is placed on the equilibrium in the goods market (Chassamboulli and Palivos, 2014; Battisti et al., 2018; Iftikhar and Zaharieva, 2019; Monras, 2020). Another recent approach involves the inclusion of tradable and non-tradable activities (tasks), within a general equilibrium model, but with the assumption of perfect competition (Burstein et al., 2020).

We develop a novel general equilibrium search and matching model with imperfect competition where two non-tradable goods are produced using high-skilled and low-skilled labour (either native or non-native), respectively, and both goods are consumed by all employees and employers. The provision of public goods and unemployment benefits are financed by a progressive taxation on wages and profits. Two main features of the model deserve a deeper discussion: international trade of goods and the choice of the production function.

While in Section 3 we discuss an extension of the model to a small open economy where the high-skilled good is tradable, our analysis mainly focuses on the case of non-tradable goods for two reasons. First, non-tradable activities, typically services, are the ones which absorb the largest share of low-skilled immigrants (see Section I.1 for Italy). Moreover, on average the share of tradable activities in an economy is very small. Blinder and Krueger (2013) show that in the US only 25% of activities (tasks) are offshorable and offshorability does not have systematic effects on either wages or the probability of layoff. On the production side, we break the *complementarity channel* between employees of different skills by refraining from using a CES production function, which according to Borjas (2014), "greatly limits the structure of immigration wage effects". Our analysis offers an alternative to the 'CES production function approach', by exploring the *price channel*, i.e., adding the goods market to a search and matching framework and shifting the focus from factor ratios towards the elasticity of substitution between consumption goods, as discussed by Autor (2018, p.3). This alternative approach proves to be successful in the estimation of the Italian economy (see Section 5).

Within this framework a large inflow of low-skilled employees has two major effects on wages and prices. First, it changes the skill composition of the workforce with negative effects on the real wages of low-skilled employees. In addition, by increasing the supply of the low-skilled good produced by low-skilled employees, it leads to a drop in its price, causing an increase in the real wage of high-skilled employees. Interestingly, although the wage of low-skilled employees is lower, the adverse effect on the price of the low-skilled good can induce a loss for employers who operate in the low-skilled market. This inflow of low-skilled employees also increases total GDP and therefore government revenues and social contributions, while the impact on GDP per worker and the provision of the public goods is ambiguous, depending on the employment composition and the elasticity of the prices to the mass of low-skilled employees.

We estimate the model using data from Italy for each year in the period 2008-2017. We find that, compared to a counter-factual scenario with no non-natives, in 2017 total production was higher by approximately 14%. Both indirect and direct taxes, which are proportional to total production were 14% higher, and social security contributions were 12% higher, corresponding to an overall increase in the government revenues of approximately 88 billions €. GDP per worker and the per capita provision of public goods were both higher by approximately 4%. The wage of low-skilled employees was lower by approximately 4%, while the wage of high-skilled employees was higher by approximately 8%. On the other hand, the effect on unemployment rates was minimal. The overall effect of the presence of non-natives on the employees' lifetime utilities was positive for high-skilled employees (+8%) and negative for low-skilled employees (-2%). At the same time, the value of a filled vacancy, which we interpret as a proxy for the employers' expected profits, was 10% higher for firms operating in the high-skilled market and 6% lower for firms operating in the low-skilled market, due to the increased (decreased) real price of the high-skilled (low-skilled) good.

The contribution of this paper to the existing literature is multi-fold. First, while in most of the existing research the effects of immigration have been studied through the factor ratios within firms (Dustmann et al., 2013; Borjas, 2003; Ottaviano and Peri, 2012), in line with Monras (2020) this paper explores the *price channel* through the inclusion of two goods, whose equilibrium prices strongly depend on the skill composition of migrants, while maintaining some degree of socio-economic heterogeneity between native and non-native employees.[2] This is motivated by the

[2]For instance, the job finding and job exit rates of employees within the same labour market differ according to

evidence provided by Cortes (2008) who empirically shows that in the US an increase in the share of low-skilled immigrants in the labor force significantly decreased the price of immigrant-intensive services. Appendix A reports anecdotal evidence for Italy about the differential changes in the prices of high and low-skilled goods in the 2004-2017 period in which the percentage of foreign workforce increased from 6% to 15%.

Second, we provide a general equilibrium framework to assess the impact of immigration on public finances, which is crucial for formulating a comprehensive evaluation of the immigration phenomenon (National Academies of Sciences et al., 2017). As natives and non-natives have the same access to unemployment benefits and the provision of public goods (i.e., the fiscal costs are the same for all employees), under the assumption of a balanced budget we find for Italy a *net fiscal benefit* of immigration as measured by the increased per capita provision of public goods.

Third, we advance our understanding of the impact of immigration on profits and the welfare of employers, which are outcomes generally overlooked in the literature. This is particularly important as the mass of employers is on average not negligible; in 2019, it spanned from 6% of total employment in the USA to 23% in Italy and 32% in Greece (OECD). Our model points out that employers in the low-skilled market might be at risk of being negatively affected by low-skilled immigration as the benefit from the lower wage of low-skilled employees might be overtaken by the lower revenues deriving from the drop of the price of the low-skilled good. A similar risk is faced by employers in the high-skilled market due to the parallel increase in the wage of high-skilled employees and the higher price of the high-skilled good. Our empirical analysis for Italy suggests a loss for employers in the low-skilled market and a gain for employers in the high-skilled market.

Finally, we are the first to estimate the impact of immigration in Italy using a micro-founded general equilibrium model. Italy has experienced large immigration inflows in the last decade and several analysis on the fiscal consequences of immigration have been conducted by policy-focused groups (Moressa, 2019; INPS, 2017). This research however presents weaknesses typical of partial equilibrium analysis and the lack of micro-foundation of individual decisions. Not surprisingly, although we find qualitatively similar (but quantitatively different) results in terms of increased social security contributions (INPS, 2017), we offer a more balanced view on the costs of immigration, specifically for low-skilled workers.

An additional feature of our analysis is the matching of a much larger set of moments with respect to the estimated parameters with the aim of assessing the ability of the model to reproduce the dynamics of the most important variables, while in the literature the estimation of general

the country of origin, hence natives and non-natives are not perfect substitute, although their value added is the same.

equilibrium models is usually performed using perfect identification, i.e. the number of parameters estimated is equal to the number of moments (Flinn and Mullins, 2015).

This paper is organized as follows. In Section 2 we describe the search and matching model with non-tradable goods. In Section 3 we discuss a version of the model with one tradable good. In Section 4 we provide labour market statistics for Italy in the 2008-2017 period and illustrate the methodology used to estimate the model. Section 5 shows the results of the model estimation and presents two counter-factual scenarios. Section 6 concludes the paper.

2 The model

Consider the following continuous time infinite-horizon economy with constant stocks of physical and human capital and technology. There is a continuum of mass σ of employees. All employees supply labour inelastically, are risk neutral and discount the future at constant rate r. Employees differ according to their skill level and their country of origin. We distinguish between *natives* N, who are born in the home country and *non-natives* I, who are born in a foreign country. Each individual is either *high-skilled*, h, or *low-skilled*, l. Hence, the total measure of employees is the sum of the four different categories of employees, i.e. $\sigma = \sigma_{l,N} + \sigma_{l,I} + \sigma_{h,N} + \sigma_{h,I}$. *Employees* can be either employed or unemployed, hence $\sigma_{i,N} = e_{i,N} + u_{i,N}$ and $\sigma_{i,I} = e_{i,I} + u_{i,I}$, where $i \in \{l, h\}$. The economy is also populated by a measure χ of *employers*. Employers are ex-ante homogeneous and post skill-specific vacancies, which are open to both natives and non-natives. From the match between an employer and an employee two types of goods, h and l are produced, using labour as sole input, i.e., good h is produced using only high-skilled employees h, while good l is produced using only low-skilled employees l. x_h and x_l are the quantities of each good produced by each type of employee, which are sold at price p_h and p_l, respectively.

Employers and employees come together via a standard matching function $m(v_i, u_i)$, where u_i is the measure of unemployment (natives and non-natives, $u_i = u_{i,N} + u_{i,I}$) and v_i is the measure of vacancies, and $\theta_i \equiv v_i/u_i$ is defined as the labour market tightness. The function $m(v_i, u_i)$ is twice differentiable, increasing in its arguments, and exhibits constant returns to scale. Each vacancy is skill-specific, but open to both native and non-native employees. Hence, there are two labour markets, one for high-skilled and one for low-skilled employees. Within each market, the probability that an employer with an open vacancy meets either a native or an non-native employee may be defined as $q(\theta_i) \equiv m(u_i, v_i)/v_i$. The probability that an unemployed worker, either native or non-native, meets an employer may be defined as $\theta_i q(\theta_i) = m(u_i, v_i)/u_i$. It is assumed that $q(\theta_i) \to 1$ and $\theta_i q(\theta_i) \to 0$ as $\theta_i \to 0$, and $q(\theta_i) \to 0$ and $\theta_i q(\theta_i) \to 1$ as $\theta_i \to \infty$.

The probability that a vacancy is filled with a worker is equal to $\kappa_{i,j} q(\theta_i)$, which is the product of the probability that an employer meets an employee, $q(\theta_i)$, and the probability that the job offer is signed, $\kappa_{i,j}$. Similarly, the probability that an unemployed worker finds a job is equal to the product of the probability that an employee meets an employer $\theta_i q(\theta_i)$ and the probability that the job offer is signed $\kappa_{i,j}$, i.e., $\kappa_{i,j}\theta_i q(\theta_i)$. While the probability for an employee to meet an employer $q(\theta_i)$ and the probability for an employer to fill a vacancy $\theta_i q(\theta_i)$ are identical for all employers and employees searching in a given labour market (either high-skilled or low-skilled), the probability to sign a job offer $\kappa_{i,j}$ depends on both the country of origin and the skill level of the employee. This heterogeneity, which is discussed in the literature (Iftikhar and Zaharieva, 2019) and confirmed in the Italian data (Appendix I.5), can be explained by the *compatibility* factor: observable skills (i.e., language proficiency) and unobservable characteristics may favour the match formation of natives compared to non-natives once a contact happens. It is important to remark that this heterogeneity among employees is ex-ante and does not imply an ex-post heterogeneity in the new matches, as "non-compatible" matches are not formed (Rogerson et al., 2005). Also the exogenous destruction rate $\delta_{i,j}$ is specific to the type of worker as shown in the data (Appendix I.5): when the shock hits the match, the employee becomes unemployed and the employer is left with an open vacancy. In this circumstance, the employer is required to pay firing costs F, which include two components, as in Garibaldi and Violante (2005): a share ϕ of the cost is transferred to the employee as a severance payment, while the share $1-\phi$ is a dead-weight loss (red-tape cost).

Non-native employees coming from abroad join the labour market as unemployed at exogenous rate η. They also leave the labour market and go abroad at exogenous rate λ. Both λ and η are assumed to be the same among employees with different skill levels as they are influenced by socio-political phenomena, which affect all employees similarly.

2.1 Employees

All employees consume both goods x_h and x_l and benefit from the provision of public goods ν. As they consume all the income they earn and do not save, their utility function reads as follows:

$$Z_{i,j} = \left[\gamma d_{h,i,j}^{\rho} + (1-\gamma) d_{l,i,j}^{\rho}\right]^{1/\rho} + \iota\nu, \tag{1}$$

where $d_{h,i,j}$ and $d_{l,i,j}$ are the quantities demanded and consumed of product h and l, respectively, by an individual with skill level $i \in \{h, l\}$ and country of birth $j \in \{N, I\}$. The parameter ρ determines the *elasticity of substitution between the two goods* $\epsilon \geq 0$, in particular $\epsilon \equiv 1/(1-\rho)$. Whenever $\epsilon \to \infty$ ($\rho \to 1$) the two goods are perfect substitutes, whenever $\epsilon \to 0$ ($\rho \to -\infty$) the two goods are perfect complements, and, finally, whenever $\epsilon = 1$ ($\rho = 0$), we have the reference case of a Cobb-Douglas utility function.[3] The utility $\iota\nu$ comes from the *public goods* provided by the government, where ι is a proxy for the elasticity of substitution between private and public goods. We assume that $\gamma \in (0,1)$ and $\iota > 0$.[4]

Employees maximize their utility function, subject to the following budget constraint:

$$p_h d_{h,i,j} + p_l d_{l,i,j} = y_{i,j} = \begin{cases} (1-t)\,(w_{i,j}+\tau) & \text{if the worker } (i,j) \text{ is employed,} \\ b\,(1-t)\,(w_{i,j}+\tau) & \text{if the worker } (i,j) \text{ is unemployed.} \end{cases} \tag{2}$$

Employees earn a wage $w_{i,j}$, gross of social security contributions, which is taxed at proportional rate t.[5] In order to introduce the possibility of progressive taxation, we assume that all employees receive a *tax subsidy* τ.[6] Employees who are unemployed instead receive *unemployment benefits*, which are a proportion b of their net wage.

From the utility maximization, we get the optimal quantities of goods h and l demanded by each individual, depending on her skill level, country of origin and employment status. Specifically, if the worker is employed she will demand the following quantities of good h and good l:

$$d_{h,i,j} = \frac{\left(\frac{p_h}{\gamma}\right)^{1/(\rho-1)}}{p_l\left(\frac{p_l}{1-\gamma}\right)^{1/(\rho-1)} + p_h\left(\frac{p_h}{\gamma}\right)^{1/(\rho-1)}} y_{i,j}, \tag{3}$$

$$d_{l,i,j} = \frac{\left(\frac{p_l}{1-\gamma}\right)^{1/(\rho-1)}}{p_l\left(\frac{p_l}{1-\gamma}\right)^{1/(\rho-1)} + p_h\left(\frac{p_h}{\gamma}\right)^{1/(\rho-1)}} y_{i,j}, \tag{4}$$

where $y_{i,j}$ is the work income as defined in Equation (2). By plugging the optimal demands of the two goods (Equations (3) and (4)) into Equation (1), we can compute the indirect utility of employed and unemployed employees as:

$$Z_{i,j} = \frac{y_{i,j}}{P} + \iota\nu, \tag{5}$$

[3]See Appendix D for details.

[4]We include the term $\iota\nu$ as an additive factor, rather than multiplicative, for tractability purposes. Complementarity/substitution effects between public and private goods are captured by the parameter ι.

[5]In the model (and in real life), the wages paid by the firms ($w_{i,j}$) are gross of taxes and social security contributions, and are commonly defined as gross welfare wages; gross fiscal wages instead refer to the amount on which income taxes are computed (gross of taxes but net of social security contributions). Finally, in the data we observe net wages, i.e. wages net of income taxes and social security contributions (see Appendix I.4 for the Italian data on net wages).

[6]As in Pissarides (2000), employees receive a tax subsidy τ, and then are taxed on total labour earnings, including the subsidy, at the proportional tax rate t. Hence, the net taxation paid by the employee is $T(w_{i,j}) = tw_{i,j} - (1-t)\tau$.

where P is the *aggregate price index* defined as:

$$P = \left[p_h \left(\frac{p_h}{\gamma} \right)^{1/(\rho-1)} + p_l \left(\frac{p_l}{1-\gamma} \right)^{1/(\rho-1)} \right]^{(\rho-1)/\rho}. \tag{6}$$

Finally, we can express the demanded quantities of good h and good l as:

$$d_{h,i,j} = \left(\frac{\tilde{p}_h}{\gamma} \right)^{1/(\rho-1)} \tilde{y}_{i,j}, \tag{7}$$

$$d_{l,i,j} = \left(\frac{\tilde{p}_l}{1-\gamma} \right)^{1/(\rho-1)} \tilde{y}_{i,j}, \tag{8}$$

where $\tilde{p}_i \equiv p_i/P$ is the *real price* of good $i \in \{h, l\}$ and $\tilde{y}_{i,j} \equiv y_{i,j}/P$ is the *real income*. From Equations (7) and (8), we can then calculate the shares of expenditure per each good:

$$\frac{\tilde{p}_h d_{h,i,j}}{\tilde{y}_{i,j}} = \gamma^\epsilon \tilde{p}_h^{1-\epsilon}, \text{ and} \tag{9}$$

$$\frac{\tilde{p}_l d_{l,i,j}}{\tilde{y}_{i,j}} = (1-\gamma)^\epsilon \tilde{p}_l^{1-\epsilon}; \tag{10}$$

for $\epsilon = 1$ such shares are independent of the prices level, while for $\epsilon \neq 1$ the rate of change of the shares is equal to the rate of change of the prices multiplied by $1 - \epsilon$, suggesting that ϵ should be in a narrow range around 1.

Let $W^e_{i,j}$ be the present discounted value of the utility of an employee with skill level i and country of origin j who is currently employed. Following Pissarides (2000), the corresponding Bellman's equation reads:

$$rW^e_{i,j} = Z^e_{i,j} + \delta_{i,j} \left(W^u_{i,j} + \phi \tilde{p}_i x_i F - W^e_{i,j} \right). \tag{11}$$

Employees who are employed, both natives and non-natives, enjoy the indirect utility of being employed $Z^e_{i,j}$. At rate $\delta_{i,j}$ the match is exogenously destroyed and the employees become unemployed: in these circumstances, the employees receive a transfer, which is a share ϕ of the total firing costs $\tilde{p}_i x_i F$ paid by the employers.

The Bellman's equations for employees who are unemployed read:

$$rW^u_{i,N} = Z^u_{i,N} + \kappa_{i,N} \theta_i q(\theta_i) \left(W^e_{i,N} - W^u_{i,N} \right) \text{ and} \tag{12}$$

$$rW^u_{i,I} = Z^u_{i,I} + \kappa_{i,I} \theta_i q(\theta_i) \left(W^e_{i,I} - W^u_{i,I} \right) + \lambda \left(W_{i,FC} - W^u_{i,I} \right). \tag{13}$$

While both natives and non-native employees find a job with probability $\kappa_{i,j}\theta_i q(\theta_i)$, non-native employees have the additional outside option of leaving the country at rate λ,[7] and enjoying utility $W_{i,FC}$ elsewhere. We can interpret λ as either the individual decision to go back home or as a government policy, which forces non-native unemployed to be expelled.[8]

2.2 Employers

Employers may open a vacancy or manage a firm. They can be active on both markets and open multiple vacancies simultaneously. The utility of employer q reads as:

$$Z_q = \left[\gamma d_{h,q}^{\rho} + (1-\gamma) d_{l,q}^{\rho}\right]^{1/\rho} + \iota\nu. \tag{14}$$

Employers consume both goods and receive the provision of public goods ν, as the employees. We also assume that employers do not save. Employers maximize their utility subject to the following budget constraint:

$$p_h d_{h,q} + p_l d_{l,q} = \Pi_q, \tag{15}$$

where Π_q are the employer's q net profits. We can then express the demanded quantities of good h and good l in real terms, using the price index P (Equation (6)) as:

$$d_{h,i,j} = \left(\frac{\tilde{p}_h}{\gamma}\right)^{1/(\rho-1)} \tilde{\Pi}_q \text{ and} \tag{16}$$

$$d_{l,i,j} = \left(\frac{\tilde{p}_l}{1-\gamma}\right)^{1/(\rho-1)} \tilde{\Pi}_q, \tag{17}$$

where $\tilde{\Pi}_q \equiv \Pi_q/P$ is *real net profits.*

Let $J_{i,j}$ be the present discounted value of the utility of an employer hiring an employee with skill level i and of country of origin j. The employer's Bellman's equation for a filled position

[7] The model could be extended by allowing native employees to leave the country too. However, in Italy the share of native unemployed who emigrate is very low (about 2.5%, Appendix I.2)). Nevertheless, our main theoretical and empirical findings would be substantially unchanged.

[8] The rate at which non-natives exit the country λ is determined by socio-political factors in origin countries, by migration policies in host countries, and by the personal choice of non-natives. The first two factors appear to be the most important for several countries, suggesting that the rate at which non-natives exit the country is mainly independent of the skill level of non-natives. Nevertheless, introducing skill-specific λ would not change our main findings, while substantially increasing the algebraic computation.

reads:[9]

$$rJ_{i,j} \;=\; (1-t)(\tilde{p}_i x_i - \tilde{w}_{i,j}) + \delta_{i,j}\left(V_i - J_{i,j} - \tilde{p}_i x_i F\right), \tag{18}$$

where $i \in \{l, h\}$ and $\tilde{p}_i x_i$ is the real value added of each employee in the labour market i. The employer value function in Equation (18) takes into account the presence of *firing costs*. In particular, every time an exogenous shock $\delta_{i,j}$ destroys a match, the employer is required to pay firing costs F, which are proportional to the value added of the employee, as in Pissarides (2000). The firm's Bellman's equation for hiring an employee with skill level i, i.e. the value of a skill-specific vacancy, is given by:

$$rV_i = -c\tilde{p}_i x_i + \pi_{i,N}\kappa_{i,N} q\left(\theta_i\right)\left(J_{i,N} - V_i\right) + \left(1 - \pi_{i,N}\right)\kappa_{i,I} q\left(\theta_i\right)\left(J_{i,I} - V_i\right), \tag{19}$$

where $c\tilde{p}_i x_i$ is the vacancy cost which is proportional to the value added of the employee, $\kappa_{i,j} q\left(\theta_i\right)$ is the rate at which a vacancy is filled, and $\pi_{i,N} \equiv u_{i,N}/\left(u_{i,N} + u_{i,I}\right)$ is the probability for an employer operating in the good market i to meet a native employee, which is computed as the share of unemployed natives on the total number of unemployed.

2.3 Wage bargaining

The wages of native and non-native employees are chosen to maximize the surplus of the match between employer and employee:

$$\left(W^e_{i,j} - \phi\tilde{p}_i x_i F - W^u_{i,j}\right)^{\beta_j}\left(J_{i,j} + \tilde{p}_i x_i F - V_i\right)^{1-\beta_j}, \tag{20}$$

where β_j is the bargaining power of the employees and $1 - \beta_j$ is the bargaining power of the employers. The bargaining power β_j is different for employees with different country of origin, and specifically we expect $\beta_N \geq \beta_I$, for several reasons (Muthoo, 2001). First, a high degree of impatience adversely affects the worker's bargaining power, and non-natives may be more eager to close a deal compare to natives. Another source of friction in the bargaining process comes from the possibility that the negotiations might breakdown because of some exogenous and uncontrollable factors. Even if the possibility of such an occurrence is small, it nevertheless may provide appropriate incentives to the employees to compromise and reach an agreement. Finally, the different outside options on the outcome of the bargaining strongly affects the bargaining power of each

[9] See in particular Equation (9.9) in Pissarides (2000).

counterpart. The maximization with respect to wages amounts to maximize the Nash product with respect to $\tilde{w}_i$, being the price index P taken as given in competitive markets. Employers and employees also take V_i, $W^u_{i,N}$ and $W^u_{i,I}$ as given in the bargaining process. Firing costs F enter into the maximization as employers internalize the cost they will have to pay in case of match destruction. The share of the firing costs ϕ which is transferred to the employees enters into the maximization as it is part of the outside option of the employees. Hence, the first order condition for the maximization of the Nash product reads:

$$(1-\beta_j)(W^e_{i,j} - \phi\tilde{p}_i x_i F - W^u_{i,j}) = \beta_j \left(J_{i,j} + \tilde{p}_i x_i F - V_i\right). \tag{21}$$

2.4 The government

To conclude the description of the economy, we assume that the government expenditure in public goods is equal to the shares g_h and g_l of the aggregate real value added (GVA); however, the per capita provision of public goods is also subject to congestion, as measured by the parameter $\zeta \geq 0$ ($\zeta = 0$ is the case of pure public goods):

$$\nu = \frac{g_h\tilde{p}_h x_h(e_{h,N}+e_{h,I}) + g_l\tilde{p}_l x_l(e_{l,N}+e_{l,I})}{(\sigma_{h,N}+\sigma_{l,N}+\sigma_{h,I}+\sigma_{l,I}+\chi+IP)^{\zeta}}, \tag{22}$$

where the denominator of Equation (22) is the total population, which includes the labour force (employers and employees, employed and unemployed) and the rest of the population IP (inactive individuals and people who are not in the working age). The government collects the following amount of direct taxes (DT):

$$\begin{aligned} DT \equiv\ & t\left[\tilde{p}_h x_h\left(e_{h,N}+e_{h,I}\right) + \tilde{p}_l x_l\left(e_{l,N}+e_{l,I}\right) + \tilde{\tau}\left(e_{l,N}+e_{l,I}+e_{h,N}+e_{h,I}\right)\right] + \\ +\ & tb\left(\tilde{w}_{h,N}u_{h,N} + \tilde{w}_{h,I}u_{h,I} + \tilde{w}_{l,N}u_{l,N} + \tilde{w}_{l,I}u_{l,I}\right), \end{aligned} \tag{23}$$

where t_p is the indirect tax rate net of production subsidies, and the following amount of *indirect taxes* (IT):[10]

$$IT \equiv \left(\frac{t_p}{1-t_p}\right)\left[\tilde{p}_h x_h(e_{h,N}+e_{h,I}) + \tilde{p}_l x_l(e_{l,N}+e_{l,I})\right]. \tag{24}$$

[10] The amount of indirect taxes depends on the ratio between t_p and $1-t_p$ as $\tilde{p}_i x_i$ is the production *net* of the indirect tax and production subsidies.

Finally, the *total government expenditure* (TGE) amounts to the following:[11]

$$\begin{aligned} TGE &\equiv \tilde{\tau}\left(e_{l,N}+e_{l,I}+e_{h,N}+e_{h,I}+b(u_{l,N}+u_{l,I}+u_{h,N}+u_{h,I})\right)+ \\ &+ b\left[\tilde{w}_{h,N}u_{h,N}+\tilde{w}_{h,I}u_{h,I}+\tilde{w}_{l,N}u_{l,N}+\tilde{w}_{l,I}u_{l,I}\right]+g_h\tilde{p}_hx_h(e_{h,N}+e_{h,I})+g_l\tilde{p}_lx_l(e_{l,N}+e_{l,I}). \end{aligned} \tag{25}$$

In equilibrium, the government primary surplus is equal to zero, i.e., $TGE = DT + IT$ as in any closed economy with no investments and savings, independent on any fiscal parameter (Appendix E).

2.5 The equilibrium

A general equilibrium model requires that an equilibrium is reached in both labour markets (high-skilled and low-skilled) and in both goods markets (high-skilled and low-skilled).

2.5.1 The equilibrium in the labour markets

In this economy there are two separate labour markets, one for high-skilled and one for low-skilled employees, and each market is characterized by its specific market tightness $\theta_i \equiv (u_{i,N}+u_{i,I})/v_i$. The free-entry condition in each labour market implies that the value of a vacancy in each of the two markets is equal to zero, that is $V_i = 0$. Hence, in equilibrium employers are indifferent whether to open a low-skilled or a high-skilled vacancy.

We derive the job-creation curve, which is market-specific, by substituting Equation (18) in Equation (19) and applying the free-entry condition:

$$\begin{aligned} &\pi_{i,N}\kappa_{i,N}q(\theta_i)\left[\frac{(1-t)(\tilde{p}_ix_i-\tilde{w}_{i,N})-\delta_{i,N}\tilde{p}_ix_iF}{r+\delta_{i,N}}\right]+ \\ +\ &(1-\pi_{i,N})\kappa_{i,I}q(\theta_i)\left[\frac{(1-t)(\tilde{p}_ix_i-\tilde{w}_{i,I})-\delta_{i,I}\tilde{p}_ix_iF}{r+\delta_{i,I}}\right]=c\tilde{p}_ix_i. \end{aligned} \tag{26}$$

Equation (26) states that the expected benefit for an employer with a filled vacancy, which is given by the weighted average of the benefit received in case the employer hires a native or a non-native worker, appropriately discounted at rate $r+\delta_{i,j}$ must be equal to the cost of creating the vacancy (the right hand side of Equation (26)). The benefit is a positive function of the employee's value added $\tilde{p}_ix_i$ and a negative function of the wage paid $w_{i,j}$ and of the firing cost to be paid in case of dismissal $\delta_{ij}\tilde{p}_ix_iF$.

[11]With a slight stretch in the notation, we include the tax subsidy among the government expenditure.

To compute the equilibrium wages of native and non-native employees in each market we subtract Equation (12) from Equation (11) and Equation (13) from Equation (11):

$$W^e_{i,N} - W^u_{i,N} = \frac{(1-b)(1-t)(\tilde{w}_{i,j} + \tilde{\tau} + \delta_{i,N}\phi\tilde{p}_i x_i F)}{r + \delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)} \text{ and} \tag{27}$$

$$W^e_{i,I} - W^u_{i,I} = \frac{(1-b)(1-t)(\tilde{w}_{i,j} + \tilde{\tau}) - \lambda\left(W_{i,FC} - W^u_{i,I}\right) + \delta_{i,I}\phi\tilde{p}_i x_i F}{r + \delta_{i,I} + \kappa_{i,I}\theta_i q(\theta_i)}. \tag{28}$$

By plugging Equation (27) into the Nash bargaining Equation (21), we get an expression for the wages of native employees in each market, as a function of the parameters of the model:[12]

$$\tilde{w}_{i,N} = \underbrace{A_{i,N}(\theta_i)}_{>0}\tilde{p}_i x_i - \underbrace{B_{i,N}(\theta_i)}_{>0}\tilde{\tau} + \underbrace{C_{i,N}(\theta_i)}_{>0}\tilde{p}_i x_i F. \tag{29}$$

Similarly, by plugging Equation (28) into the Nash bargaining Equation (21), we get an expression for the wages of immigrant employees in each market, as a function of the parameters of the model:

$$\tilde{w}_{i,I} = \underbrace{D_{i,I}(\theta_i)}_{>0}\tilde{p}_i x_i - \underbrace{E_{i,I}(\theta_i)}_{>0}\tilde{\tau} + \underbrace{G_{i,I}(\theta_i)}_{>0}\tilde{p}_i x_i F + \underbrace{K_{i,I}(\theta_i)}_{>0}W_{i,FC} - \underbrace{H_{i,I}(\theta_i)}_{>0}\iota\nu. \tag{30}$$

Equations (29) and (30) show that the real wages of both native and non-native employees are positive functions of the employees' real value added $\tilde{p}_i x_i$ and of the firing cost $\tilde{p}_i x_i F$ paid by the employer in case of match destruction, as in the standard Diamond, Mortensen, Pissarides (DMP) model, because employers internalize the cost of dismissal. Instead, the real wages are negative functions of the real tax subsidy $\tilde{\tau}$ provided by the government to all employees. As the possibility of leaving the country at rate λ affects the outside option of non-native employees, their wage includes also additional factors. Specifically, their real wage is a positive function of the utility the employees would get if deciding to leave the country $W_{i,FC}$, and a negative function of public goods ν, which they will lose in case of emigration.

Employment and unemployment for native employees in equilibrium can be computed as:

$$e_{i,N} = \sigma_{i,N}\left[\frac{\kappa_{i,N}\theta_i q(\theta_i)}{\delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)}\right] \text{ and} \tag{31}$$

$$u_{i,N} = \sigma_{i,N}\left[\frac{\delta_{i,N}}{\delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)}\right], \tag{32}$$

[12] See Appendix F for the details of calculations.

while non-natives employed and unemployed in equilibrium are given by:

$$e_{i,I} = \sigma_{i,I}\left\{\frac{\eta\kappa_{i,I}\theta_i q\left(\theta_i\right)}{\lambda\delta_{i,I}+\eta\left[\kappa_{i,I}\theta_i q\left(\theta_i\right)+\delta_{i,I}\right]}\right\} \text{ and} \tag{33}$$

$$u_{i,I} = \sigma_{i,I}\left\{\frac{\eta\delta_{i,I}}{\lambda\delta_{i,I}+\eta\left[\kappa_{i,I}\theta_i q\left(\theta_i\right)+\delta_{i,I}\right]}\right\}. \tag{34}$$

Finally, the measure of non-natives in the foreign country in equilibrium is:

$$FC_{i,I}=\sigma_{i,I}\left\{\frac{\lambda\delta_{i,I}}{\lambda\delta_{i,I}+\eta\left[\kappa_{i,I}\theta_i q_{i,I}\left(\theta_i\right)+\delta_{i,I}\right]}\right\}. \tag{35}$$

2.5.2 The equilibrium in the goods markets

Using Equation (6), we can express the *real* price of good h as a function of the real price of good l as:

$$\tilde{p}_h=\left[\frac{1-\tilde{p}_l^{\rho/(\rho-1)}\left(1-\gamma\right)^{1/(1-\rho)}}{\gamma^{1/(1-\rho)}}\right]^{(\rho-1)/\rho}. \tag{36}$$

By equating demand and supply of good h and good l and using Equation (36), we get the following expressions for the equilibrium prices:

$$\tilde{p}_h = \left\{\gamma^{1/(1-\rho)}+(1-\gamma)\gamma^{\rho/(1-\rho)}\left[\frac{(1-g_l)x_l(e_{l,N}+e_{l,I})}{(1-g_h)x_h(e_{h,N}+e_{h,I})}\right]^{\rho}\right\}^{(1-\rho)/\rho} \text{ and} \tag{37}$$

$$\tilde{p}_l = \left\{(1-\gamma)^{1/(1-\rho)}+\gamma(1-\gamma)^{\rho/(1-\rho)}\left[\frac{(1-g_h)x_h(e_{h,N}+e_{h,I})}{(1-g_l)x_l(e_{l,N}+e_{l,I})}\right]^{\rho}\right\}^{(1-\rho)/\rho}. \tag{38}$$

2.5.3 General equilibrium effects of an immigration shock

A complete analytical study of the equilibrium properties appears as a difficult task; however, an intuition about the effects of an immigration shock on the labour and goods markets can help clarify the results of the counter-factual scenarios, discussed in Section 4.1. A sudden increase in the stock of low-skilled non-native employees produces a change in the equilibrium value of a firm (see Equation (18), setting $V_i=0$) which is operating in the low-skilled market equal to:

$$\frac{\partial J_{l,j}}{\partial\sigma_{l,j}}=\frac{(1-t-\delta_{l,j}F)x_l}{r+\delta_{l,j}}\frac{\partial\tilde{p}_l}{\partial\sigma_{l,j}}-\frac{1-t}{r+\delta_{l,j}}\frac{\partial\tilde{w}_{l,j}}{\partial\sigma_{l,j}}. \tag{39}$$

Given that both the wage of low-skilled employees and the price of the low-skilled good negatively depend on $\sigma_{l,j}$ (Equations (29) and (38)), we conclude that:

$$\frac{\partial J_{l,j}}{\partial \sigma_{l,j}} > 0 \iff \epsilon_{\tilde{w}_{l,j},\sigma_{l,j}} > \epsilon_{\tilde{p}_l,\sigma_{l,j}} \frac{(1-t-\delta_{l,j}F)\tilde{p}_l x_i}{(1-t)\tilde{w}_{l,j}}, \tag{40}$$

where $\epsilon_{\tilde{p}_l,\sigma_{l,j}}$ is the elasticity of the price of the low-skilled good with respect to the stock of low-skilled non-natives and $\epsilon_{\tilde{w}_{l,j},\sigma_{l,j}}$ is the elasticity of the wages of the low-skilled employees with respect to the stock of low-skilled non-natives. Hence, the sign of the impact of an immigration shock is undetermined a priori, depending on the magnitude of the two elasticities $\epsilon_{\tilde{w}_{l,j},\sigma_{l,j}}$ and $\epsilon_{\tilde{p}_l,\sigma_{l,j}}$, and can be only evaluated numerically. In other words, employers operating in the low-skilled market can be winners or losers depending on the functioning of the goods and labour markets.

In a similar fashion, given that the price of the high-skilled good positively depends on $\sigma_{l,j}$ (Equation (37)), and the wage of high-skilled employees and the price of the high-skilled good positively depend on $\sigma_{l,j}$, the change in the value of a firm which operates in the high-skilled sector following an immigration shock reads:

$$\frac{\partial J_{h,j}}{\partial \sigma_{l,j}} > 0 \iff \epsilon_{\tilde{w}_{h,j},\sigma_{l,j}} < \epsilon_{\tilde{p}_h,\sigma_{l,j}} \frac{(1-t-\delta_{h,j}F)\tilde{p}_h x_h}{(1-t)\tilde{w}_{h,j}}, \tag{41}$$

where $\epsilon_{\tilde{p}_h,\sigma_{l,j}}$ is the elasticity of the price of the high-skilled good with respect to the stock of low-skilled non-natives and $\epsilon_{\tilde{w}_{h,j},\sigma_{l,j}}$ is the elasticity of the wages of high-skilled employees with respect to the stock of low-skilled non-natives. Once again, the impact of an immigration shock on the value of a firm which operates in the high-skilled market cannot be determined analytically, but only numerically.

The change in the equilibrium lifetime utility of employed employees (Equation (11)) as a consequence of an increase in the stock of low-skilled non-natives reads:

$$\frac{\partial W^e_{i,j}}{\partial \sigma_{l,j}} = \frac{\partial W^e_{i,j}}{\partial \tilde{w}_{i,j}} \frac{\partial \tilde{w}_{i,j}}{\partial \sigma_{l,j}} + \frac{\partial W^e_{i,j}}{\partial \nu} \frac{\partial \nu}{\partial \sigma_{l,j}} + \frac{\partial W^e_{i,j}}{\partial \tilde{p}_i} \frac{\partial \tilde{p}_i}{\partial \sigma_{l,j}}. \tag{42}$$

Given that the price of the high (low)-skilled good positively (negatively) depends on $\sigma_{l,j}$ (Equation (37)), and the wage of high (low)-skilled employees positively (negatively) depend on $\sigma_{l,j}$, the first and the third terms are always positive (negative) for high (low)-skilled employees. On the contrary, the sign of the second term is undetermined depending on the degree of congestion in the provision of public goods (Equation (22)). Hence, also the impact of an immigration shock on the lifetime utility of employed employees can be calculated only numerically. Finally, an increase in the stock of non-natives raises total GDP as well as government revenues and social contributions. Instead, the impact on GDP per worker is analytically ambiguous, depending on the value of the elasticities of several variables with respect to the stock of non-natives. Among those, crucial is the magnitude of the elasticities of the goods prices. In Section 4.1 we will discuss the evidence for Italy for all the variables.

3 Small open economy

So far, we have considered a closed economy, i.e., an economy where both good h and good l are non-tradable, and hence produced and consumed internally. We now extend the model to assume that good h is tradable, while good l is non-tradable. The price of the non-tradable good l, will still be determined by equating demand and supply in the domestic market. The price of the tradable good h, instead is equal to the product of the price of the good h expressed in foreign currency in the international market $p_h^{\$}$ and the *nominal exchange rate* e, i.e.,

$$p_h = ep_h^{\$}. \tag{43}$$

The equilibrium in the goods markets h and l is defined as:

$$DD_h + NX = DS_h, \tag{44}$$

$$DD_l = DS_l, \tag{45}$$

where DD_i and DS_i are the domestic demand and supply of good $i \in \{h, l\}$, respectively, and NX is the *net export* of good h. If we define total consumption C, total demand D, total production Y and disposable income DY as:[13]

$$D = DD_h + NX + DD_l = C + I + G + NX, \tag{46}$$

$$DY = C + S = Y - T + TR, \text{and} \tag{47}$$

$$Y = DS_h + DS_l, \tag{48}$$

[13] We assume international transfers to be zero.

in equilibrium $D = Y$, from which

$$
\begin{aligned}
Y &= Y - T + TR - S + I + G + NX, \text{and} \quad (49) \\
S - I + PS &= NX, \quad (50)
\end{aligned}
$$

where $PS \equiv T - TR - G$ is the *primary surplus*. In our model, $S = I = 0$ and hence

$$
PS = NX. \quad (51)
$$

In a *flexible exchange rate regime* or a *fixed exchange rate regime* with flexible price of the non-tradable good p_l, in the absence of international financial markets, $NX = 0$ to guarantee the excess demand of national currency to be equal to zero in equilibrium. As a further consequence, in our economy with $S = I = 0$, the government runs a balanced primary budget, i.e. $PS = 0$. In other words, the *real* prices of the goods in equilibrium are not affected by the fact that the *nominal* price of good h is set in the international good market (Equation (43)); that is the price of the non-tradable good p_l adjusts to guarantee that the real prices of both goods satisfy Equation (51). As a consequence, in an economy with two goods, in equilibrium an immigration shock has exactly the same impact in a closed economy or in a small open economy with one tradable good.

An alternative assumption would be that, at a given *nominal* price of the tradable good, it is possible to produce any quantity of the tradable good, which is then absorbed by the international market (Iftikhar and Zaharieva, 2019). As such NX can get any value compatible with the decisions taken by the supply side of the economy. This assumption would imply that the equilibrium in the trade balance and in the government budget is not guaranteed.

4 Model estimation

In this section we bring the model to the data to quantify the impact of immigration in Italy.[14] Specifically, in Section 4.1 we discuss the calibration of some of the model's parameters, while in Section 4.2 we explain in detail the estimation method.[15]

[14] Appendix I contains some figures about the immigration and the labour market in Italy.

[15] Data (only the part publicly available) and codes are available at `https:/https://people.unipi.it/davide_fiaschi/ricerca/`.

4.1 Model's parameters

Table 1 reports the list of the model's parameters and describes their role. We take the value of three parameters, i.e. the discount rate, the share of firing costs transferred to employees and the elasticity of the matching function with respect to unemployment, from the literature. Specifically, Paserman (2008) discusses how the discount rate r is not identifiable, and needs to be set exogenously. In standard search models future choices are discounted exponentially, however according to the hyperbolic discounting theory (Laibson, 1997; Cohen et al., 2020), individual choices are time inconsistent, as people discount much more the close future rather the long run, i.e., r is generally set to a value which is too low. In our calibration, we set the discount rate r to a conservative level of 0.01, which corresponds to an annual discount rate of 12%, in line with the average annual discount rate estimated in the literature (Paserman, 2008; DellaVigna and Paserman, 2005). We also perform a sensitivity analysis with r equal to 0.005 and 0.015, which correspond respectively to annual discount rates of 5% and 18% (the lower and upper bounds suggested in the literature), and we get approximately the same quantitative results. The share of firing costs transferred to employees ϕ is taken from the literature (Garibaldi and Violante, 2005). As standard in the literature (Pissarides, 2000), we assume that the matching function is shaped as a Cobb-Douglas, $m(v_i, u_i) = u_i^{\alpha} v_i^{1-\alpha}$, with α defined as the elasticity with respect to unemployment. The parameter α is set to a conservative value of 0.4, which is in the range suggested in the literature and in line with the evidence reported by Petrongolo and Pissarides (2001).[16]

A large set of parameters are the result of our calculations. In particular, the vacancy cost c which is proportional to the employee's value added, is set equal to the estimated total start-up costs (as a percentage of per capita income) (Djankov et al., 2002), converted to a fraction of the value added as in Boeri and Burda (2009), using data from The World Bank (Appendix J.4). The firing cost, which is proportional to the employee's value added, is computed according to the Italian regulations, using data on trials as provided by the Ministry of Justice (Appendix J.3). The values of the job exit rates $\delta_{h,N}$, $\delta_{h,I}$, $\delta_{l,N}$, and $\delta_{l,I}$ are estimated following Shimer (2012) (Appendix I.5). The mass of different types of employees defined by their skill level and country of origin are taken from the Italian Labour Force Survey (*Rilevazione Continua sulle Forze di Lavoro*) and refer to the number of natives and non-natives individuals in the workforce with high or low skill levels, in line with the definition reported in Section 4. The mass of employers χ is also taken from the Italian Labour Force Survey (*Rilevazione Continua sulle Forze di Lavoro*) and corresponds

[16] In an alternative baseline specification, we set the parameter α free to match the moments described in Section 4.2, and as a result the value of α shows fluctuations around the value of 0.4.

Table 1. Description of model parameters and data sources.

Parameter	Description	Source	Time varying
r	Discount rate	DellaVigna and Paserman (2005)	no
ϕ	Share of firing costs transferred to employees	Garibaldi and Violante (2005)	no
α	Elasticity of matching function with respect to unemployment	Petrongolo and Pissarides (2001)	no
c	Vacancy cost	Our calculation (Appendix J.4)	yes
F	Firing cost	Our calculation (Appendix J.3)	yes
$\delta_{h,N}$	Job destruction rate of high-skilled native employees	Our calculation (Appendix G)	yes
$\delta_{l,N}$	Job destruction rate of low-skilled native employees	Our calculation (Appendix G)	yes
$\delta_{h,I}$	Job destruction rate of high-skilled non-native employees	Our calculation (Appendix G)	yes
$\delta_{l,I}$	Job destruction rate of low-skilled non-native employees	Our calculation (Appendix G)	yes
χ	Mass of employers	Italian Labour Force Survey (RCFL)	yes
$\sigma_{h,N}$	Mass of high-skilled native employees	Italian Labour Force Survey (RCFL)	yes
$\sigma_{l,N}$	Mass of low-skilled native employees	Italian Labour Force Survey (RCFL)	yes
$\sigma_{h,I}$	Mass of high-skilled non-native employees	Italian Labour Force Survey (RCFL)	yes
$\sigma_{l,I}$	Mass of low-skilled non-native employees	Italian Labour Force Survey (RCFL)	yes
g	government expenditure in public goods as percentage of GVA	Our calculation (Appendix M)	yes
b	Unemployment benefits	Our calculation (Appendix M)	yes
τ	Tax subsidy	Our calculation (Appendix J.2)	yes
t_p	Indirect tax rate	Our calculation (Appendix M)	yes
η	Rate at which non-natives enter the country	Our calculation (Appendix J.1)	yes
λ	Rate at which non-natives exit the country	Our calculation (Appendix J.1)	yes
β_N	Bargaining power of native employees	Estimated by matching moments	yes
β_I	Bargaining power of non-native employees	Estimated by matching moments	yes
γ	Share of income spent on the HS good	Estimated by matching moments	yes
x_h	Quantity of good h produced by high-skilled employees	Estimated by matching moments	yes
x_l	Quantity of good l produced by low-skilled employees	Estimated by matching moments	yes
t	Direct tax rate (income and profits)	Estimated by matching moments	yes
$\kappa_{h,N}$	Hiring chances of high-skilled native employees	Estimated by matching moments	yes
$\kappa_{l,N}$	Hiring chances of low-skilled native employees	Estimated by matching moments	yes
$\kappa_{h,I}$	Hiring chances of high-skilled non-native employees	Estimated by matching moments	yes
$\kappa_{l,I}$	Hiring chances of low-skilled non-native employees	Estimated by matching moments	yes
$W_{h,FC}$	Utility of high-skilled employees abroad	Estimated by matching moments	yes
$W_{l,FC}$	Utility of low-skilled employees abroad	Estimated by matching moments	yes
ι	Degree of substitutability between public and private goods	Set to 1 (neutral value)	no
ζ	Degree of congestion in accessing the public good	Set to 1 (neutral value)	no
ρ	Parameter of the CES utility function	Set to 0 (neutral value)	no

to the number of self-employed in the country. The government expenditure in public goods as percentage of GVA, g, is calculated using Eurostat data (Appendix M). The unemployment benefits are calculated as the ratio of total government expenditure for unemployment benefits and the number of unemployed in the economy, converted as a percentage of the employees' value added, using data from Eurostat (Appendix M). The tax subsidy τ is calculated using the marginal tax rate paid by employees who receive a salary which is 67% of the average salary (Appendix J.2), using data from the OECD statistics. The indirect tax rate t_p is set by dividing the total revenues from indirect taxation by the GDP at current prices, as reported by the Italian Ministry of Economics and Finance and the Italian Institute of Statistics (ISTAT) (Appendix M). The parameters η and λ, which refer to the rate at which non-native employees enter and leave the country, respectively, are set using inflow and outflow rates, as reported by the OECD statistics (Appendix J.1).[17]

[17] We use OECD statistics instead of data from the Italian Institute of Statistics as foreign employees in the OECD statistics are defined by country of birth and not by nationality.

Within this setup, and given the available set of information, we cannot identify the parameters ρ, ζ and ι, which define the parameter of the CES utility function, the congestion rate in the furniture of the public goods and the degree of substitutability between public and private goods, respectively; they are therefore set to their neutral level (Appendix M reports all the twenty calibrated parameters for each year of the analysis).

4.2 Estimation methodology

The remaining twelve model's parameters are estimated using the method of simulated moments (Gourieroux et al., 1996), year by year in the period 2008-2017, assuming that the bargaining power is the same for natives and non-natives, i.e $\beta = \beta_N = \beta_I$, since both βs cannot be identified simultaneously. In particular, the estimator is given by:

$$\hat{\boldsymbol{\omega}} = \arg\min_{\boldsymbol{\omega}\in\Omega}(\mathbf{M} - \mathbf{M}^s(\boldsymbol{\omega}))'\mathbf{W}(\mathbf{M} - \mathbf{M}^s(\boldsymbol{\omega})), \tag{52}$$

where $\hat{\boldsymbol{\omega}}$ is the vector of the estimated model's parameters, $\mathbf{M}$ the vector of moments used in the estimate, $\mathbf{M}^s(\boldsymbol{\omega})$ the vector of simulated moments calculated from the model taking the vector of parameters $\boldsymbol{\omega}$, $\mathbf{W}$ the weighting matrix, and Ω the parameter space. The weighting matrix $\mathbf{W}$ has to be positive-definite to guarantee that the moment-based estimator is consistent (Flinn and Mullins, 2015, p. 380). Given the comparable magnitude of the scale of each moment, in our estimation we set $\mathbf{W}$ to be an identity matrix.[18]

4.3 Matched moments and estimated parameters

We match seventeen moments of our theoretical model (Appendix K), which include four net wages, four job finding rates, four unemployment rates for the four different categories of employees plus the share of (non-adjusted) labour income on total gross value added, total real GDP, total real GDP per worker and the two shares of native unemployed (in the low-skilled and high-skilled labour markets). To minimize the impact of the business cycle fluctuations on the estimated parameters, we smooth the observed moments using the Hodrick-Prescott filter (Appendix N).

The model is able to match all observed moments well. Specifically, the net real wages, the GDP per worker, the shares of native unemployed employees and the share of labour income

[18] In Flinn and Mullins (2015) the diagonal elements of the matrix $\mathbf{W}$ are set equal to the inverse of the variance of the corresponding element of the matrix $\mathbf{M}$. However, in our analysis some moments to be matched have a negligible variance (they are taken from national accounts and from large national surveys), hence we take a conservative approach and use weights equal to one for all moments, while Flinn and Mullins (2015) deal with these cases by setting an "extremely large weight".

are estimated with an error smaller than 5%, the unemployment rates are estimated with an error smaller than 10%, and the job finding rates are estimated with an error smaller than 25% (Appendix O). This is a very satisfactory result considering that we only have 11 free parameters to match 17 moments. The estimated parameters are smooth over time and fluctuate in a range of plausible values (Appendix P). Specifically, the marginal tax rate on income (t) ranges between 0.50 to 0.51, which are values only slightly higher than the highest marginal income tax rate in Italy (which can vary between to 44.5% to 48.5%, as it includes additional regional and municipal rates on top of the national 43%). The hiring chances for all types of employees (κ) smoothly decrease over time, pointing to a declining matching efficiency. The preference parameter between high-skilled and low-skilled good (γ) lays in the range between 0.33 and 0.34. The non-native expected utilities of living abroad W_{FC} for high-skilled and low-skilled employees are decreasing over time, reflecting changes in the socio-economic conditions in foreign countries.[19] The bargaining power β is estimated to be in the range between 0.12 and 0.14, which is rather far from the level of 0.5 usually assumed in the literature (Pissarides, 2000). However, the accurate matching of the share of labour income on total gross value added supports the robustness of this finding. Finally, the quantities of goods produced by high-skilled and low-skilled employees (x) alone are scarcely informative; they need to be paired with the corresponding prices ($\tilde{p}$) to be able to evaluate the value added of firms ($\tilde{p}x$). The latter is estimated to be decreasing over time for both high-skilled and low-skilled firms, reflecting a declining GDP per worker (Appendix Q). Finally, the per-capita level of public goods ν has also been first declining and then increasing over time in the period considered.

5 Winners and losers of immigration

In this section, we run two counter-factual analyses to answer the main question raised in the paper about the multifaceted impact of immigration on the economy. First, we consider a scenario with no non-natives in the economy, and second we consider a scenario with a sudden inflow of 160 thousands low-skilled non-natives, which is the forecasted net migration for Italy in 2020, as provided by Eurostat. We perform these exercises by twisting the number of non-natives present in the economy and calculating the new equilibrium in the labour markets and in the goods markets, keeping the other parameters of the model at their original estimated values, while allowing all endogenous variables such as wages, prices, etc. to adjust to the new equilibrium conditions.

[19] This might reflect for instance, among others, the ongoing civil wars and persecutions in African and Middle Eastern countries, which are the sources of large immigration flows to Italy in the period of our analysis.

5.1 No non-natives

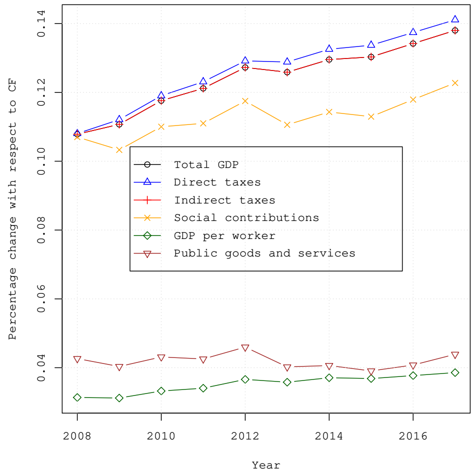
Figures 1 reports the changes in the main aggregated variables relative to the counter-factual scenario with no non-natives. The presence of non-natives, which peaked at 15% of the workforce in 2017, has lead to an increase in the gross domestic product (GDP) of 11% in 2008 (approximately 160 billions €) and of 14% in 2017 (approximately 210 billions €)(Figure 1a). Revenues from indirect taxes, which are proportional to the GDP, increased by 11% and 14% as well in 2008 and 2017, corresponding to an increase of approximately 25 billions €. Revenues from direct taxes increased by 11% and 14% as well in 2008 and 2017, corresponding to an increase of approximately 75 billions €. Social security contributions have steadily increased by approximately 12% over the period considered, which correspond to additional 25 billions € in the government revenues in 2017. The per-capita provision of public goods has increased in the presence of non-natives employees, by approximately 4% in 2017. Finally, GDP per worker has increased by about 4%, reflecting the considerable differential impact on the prices of the two goods.

Figure 1c reports the effect of the increased immigration on labour market variables. With the presence of non-natives, the real wage of low-skilled employees is lower by approximately 4% on average, while the real wage of high-skilled employees is higher on average by approximately 8%. This is the result of two complementary effects: the increased supply of non-native low-skilled employees has on one side pushed down the real wage of low-skilled employees, while also expanding the supply of the low-skilled good, driving its price down. In 2017 the real price of the high-skilled good $\tilde{p}_h$ has increased by approximately 10%, while the price of the low-skilled good $\tilde{p}_l$ has decreases by approximately 5% (Figure 1e). These findings are in line with our economic intuition that (real) wages and prices would be positively related and therefore would show similar patterns. In support of these results we provide in Appendix A anecdotal evidence (due to the very limited availability of data) that the prices of goods produced by low-skilled and high-skilled employees in Italy during the period considered show a divergent behavior.

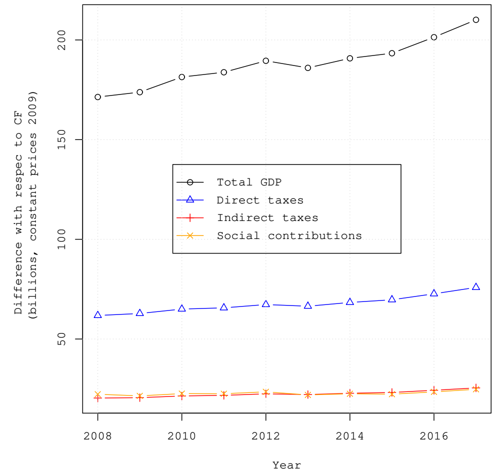
The effects on unemployment rates are minimal, with no effects on the unemployment rate of high-skilled employees, probably due to the very small number of high-skilled non-natives. On the other hand, we observe a slight decrease in the unemployment rate of low-skilled employees, ascribable to the asymmetries in the job finding and job exit rates between natives and non-natives. Specifically, both the job finding and the job exit rates are higher among non-natives, however the job finding rate effect seems to prevail leading to less unemployment in the presence of non-natives in the economy. Hence, when non-natives are not present, the labour market efficiency is worse and the number of vacancies is lower.

Figure 1d reports the impact of the presence of non-natives on the lifetime utility of (employed

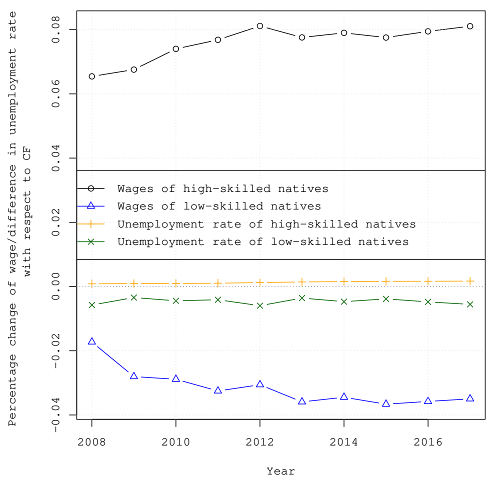
Figure 1. Counter-factual variables - no non-natives.



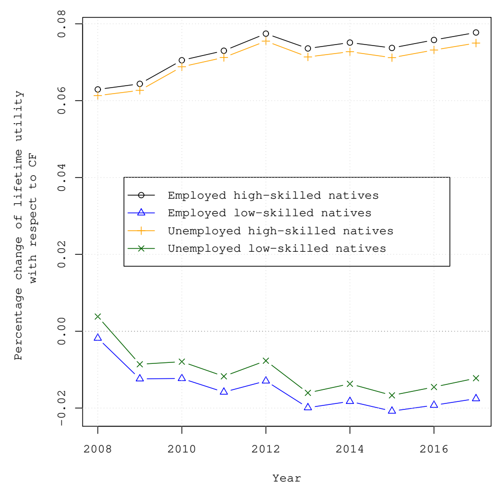
(a) Percentage changes of aggregate variables



(b) Changes of aggregate variables



(c) Wages and unemployment rates



(d) Employees' lifetime utility

(e) Employers' lifetime utility and real prices of goods

Note: The lines show the percentage/absolute change in the variables in the counter-factual scenario in which there are no non-natives compared to the equilibrium in each year between 2008 and 2017. Only for the case of unemployment, we report the difference between the unemployment rate in the counter-factual scenario and in equilibrium, by skill level and country of origin. We define by *CF* the counter-factual.

and unemployed) employees. We find that low-skilled employees are worse off compared to a scenario with no non-natives: their lifetime utility is lower by approximately 2%. This is due to the fact that their wage is lower and the higher per capita provision of public goods only partially balances this negative effect. High-skilled employees are instead better off when non-natives are present in the economy: their lifetime utility is higher by approximately 8%, due to their higher wage as well as the increased provision of public goods. When we compute the lifetime utility of unemployed employees, both high-skilled and low-skilled, we find a similar pattern: the lifetime utility is lower for low-skilled and higher for high-skilled unemployed employees. Figure 1e shows that employers in the low-skilled market are actually worse off in the presence of non-natives: while the salaries are lower, also the value added is lower due to the strong decline in the price of the low-skilled good. Their lifetime utility is therefore between 5% and 6% lower when non-natives are present. On the other hand, although the salaries of high-skilled employees are higher, employers in the high-skilled market are better off in the presence of non-natives, as they take advantage of the higher value added due to the increase in the price of the high-skilled good. Their lifetime utility is between 7% and 11% higher in the presence of non-natives.

As a robustness check, we consider results of the counter-factual scenario with no non-natives when we set ρ such that the elasticity of substitution between the two goods ϵ is equal to 0.9 and 1.1 (small perturbations) and to 0.5 and 2 (extreme cases) (Appendix C). In all scenarios, the results are consistent with the main findings discussed above. The magnitude of the impacts on GDP, GDP per worker, taxes, and social contributions is about the same as for the case with $\epsilon = 1$. Interestingly, whenever $\epsilon = 0.5$ or $\epsilon = 0.9$ (the goods are more complements), the outcome is more polarized. The real wage of high-skilled employees and the price of the high-skilled good are higher and the real wage of low-skilled employees and the price of the low-skilled good are lower in the presence of non-natives (compared the counter-factual scenario of no non-natives), with respect to the scenario with $\epsilon = 1$, and the degree of polarization is increasing with ϵ. This is then reflected in more polarized lifetime utilities for both employers and employees. The opposite is true for the scenario in which $\epsilon = 1.1$ or $\epsilon = 2$ (the goods are more substitutes): in this case the outcomes are less polarized. Interestingly, in the extreme case of $\epsilon = 2$, the wage of low-skilled employees is on average 1% higher in the presence of non-natives, while the wage of high-skilled employees is on average 3.5% higher. However, the lifetime utility of employers operating in the low-skilled market is still on average 4% lower, while the lifetime utility of employers operating in the high-skilled market is on average 5% higher.

Appendix B reports further support to our baseline specification. We discuss how the aggregate elasticity of substitution between employees of different skills levels calculated for our counter-factual scenario with $\epsilon = 1$, turns out to be very similar to the one estimated in the literature for the US (Katz and Murphy, 1992; Acemoglu and Autor, 2011).

5.2 Immigration shock

In this second counter-factual analysis, we investigate the impact of an increase in the stock of non-native individuals, using the net migration forecast for Italy in 2020, as published by Eurostat. While we expect the effects on native employees to be similar to the ones estimated within the previous counter-factual analysis, we are instead particularly interested in the effects on the outcomes of non-natives employees (Manacorda et al., 2012). Table 2 reports the impact of the counter-factual increase of 135,000 additional working age non-natives and 26,000 non-working age non-natives on aggregate variables, compared to the 2017 equilibrium. Increased immigration lead to a GDP increase of more than 0.55%, which corresponds to an increase of approximately 8.41 billions €. Revenues from indirect taxes and revenues from direct taxes increased by the same percentage, corresponding to an increase of approximately 1.02 and 3.02 billions €, respectively. Social security contributions increased by 0.50%, corresponding to 1.01 billions €increased revenues.

Table 2. Counter-factual - increase in non-natives stock (aggregate variables)

Variable	**% change**	**Absolute change (in billions of €)**
Monthly GDP	0.55	8.41
Direct taxes	0.56	3.02
Indirect taxes	0.55	1.02
Social security contributions	0.50	1.01

Looking at the effect of the increased stock of non-natives on individual variables (Table 3), GDP per worker is higher in the presence of an increased number of non-native people by 0.13% as well as the per-capita provision of public goods. The wage of low-skilled native and non-native employees is lower on average by approximately 0.2% when more non-natives are around. On the other hand, the wage of high-skilled native employees is higher on average by approximately 0.49%, while the wage of high-skilled non-native employees is higher on average by approximately 0.29%. Also in this scenario, the effects on unemployment rates are negligible. Accordingly, we find that both low-skilled native and non-native employees are worse off compared to a situation of fewer non-natives: their lifetime utility is lower by approximately 0.09% and 0.08%, respectively. This is due to the fact that their lower wage is only partially compensated by the higher provision of public goods. High-skilled native and non-native employees are instead better off with more non-natives in the economy: their lifetime utility is higher by 0.48% and 0.28%, respectively.

Table 3. Counter-factual - increase in non-natives stock (main variables)

Variable	**% change**
Real GDP per worker	0.13
Public goods	0.10
Wages of high-skilled natives	0.49
Wages of high-skilled non-natives	0.29
Wages of low-skilled natives	-0.20
Wages of low-skilled non-natives	-0.20
Unemployment rate of high-skilled natives (absolute change)	0.00001
Unemployment rate of high-skilled non-natives (absolute change)	0.00002
Unemployment rate of low-skilled natives (absolute change)	-0.00021
Unemployment rate of low-skilled non-natives (absolute change)	-0.00022
Lifetime utility of employed high-skilled natives	0.48
Lifetime utility of employed high-skilled non-natives	0.28
Lifetime utility of employed low-skilled natives	-0.09
Lifetime utility of employed low-skilled non-natives	-0.08
Lifetime utility of unemployed high-skilled natives	0.47
Lifetime utility of unemployed high-skilled non-natives	0.24
Lifetime utility of unemployed low-skilled natives	-0.07
Lifetime utility of unemployed low-skilled non-natives	-0.05
Lifetime utility of employers hiring high-skilled natives	0.55
Lifetime utility of employers hiring high-skilled non-natives	0.77
Lifetime utility of employers hiring low-skilled natives	-0.31
Lifetime utility of employers hiring low-skilled non-natives	-0.30
Price of high-skilled good	0.55
Price of low-skilled good	-0.28

In this case, native employees are the ones gaining the most, as the wage increase is higher for natives compared to non-natives. Finally, employers operating in the low-skilled market are worse off: while the salaries are lower, also the value added is lower due to the fall in the price of the low-skilled good. Their lifetime utility is lower by approximately 0.30%, independently on whether they hire a native or a non-native employee. On the other hand, although the salary of high-skilled employees is higher, employers in the high-skilled market are better off, as they take advantage of the higher value added of their production due to the increase in the price of the high-skilled good. Their lifetime utility is higher by 0.55% if they hire a non-native employee and 0.77% if they hire a native employee, due to the larger wage increase among native employees.

6 Conclusions

Our model has illustrated the distributive effects of low-skilled immigration, within a framework which includes key elements relevant for any policy maker aiming at developing an "effective, fair and robust migration policy" (European Parliament, 2019), such as the elasticity of substitution between goods produced by high-skilled and low-skilled workers, the opening to international trade, a frictional labour market, taxation of wages and profits and unemployment benefits.

Our analysis suggests that the effect of immigration in Italy has been sizeable and largely asymmetric and the net fiscal effect has been positive. The losers from the recent inflows of migrants are employees and employers who operate in the low-skilled market, while the winners are employers and employees in the high-skilled market. Among the winners we include also the Italian government, which has benefited from substantial additional direct and indirect taxes, and social security contributions. As a consequence, the opening of the Italian labour market to foreign workers has been a source of income inequality and likely of social conflicts between natives and non-natives (The Economist, 2018).

On the basis of our analysis we argue that when policy makers face the choice between a labour market with a limited participation of non-native low-skilled workers, e.g., the Brexit strategy, and a labour market open to non-native workers, the latter alternative is preferable, if it is implemented together with interventions to compensate the losers, i.e., additional provision of public goods, tax rebates and increased unemployment benefits. The effective implementation of these policies represents the direction of our future research.

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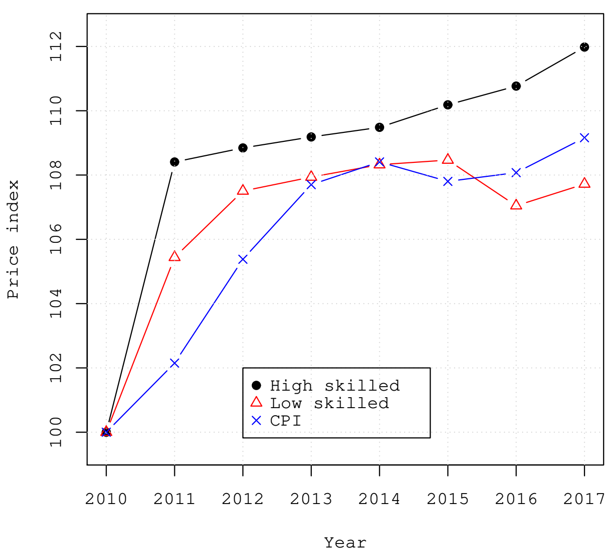
Appendix

A Prices of goods produced by high-skilled and low-skilled employees

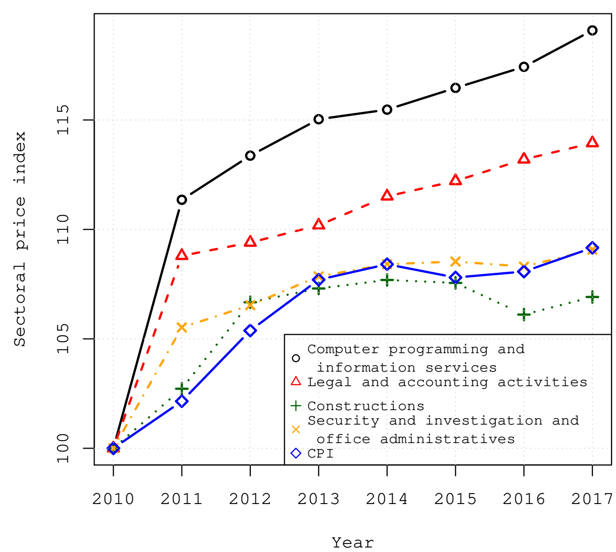
We document the evolution of the prices of goods in sectors in which mainly high-skilled or low-skilled employees are employed. Given that the availability of Italian data on production prices by sector is limited, we construct an index of prices for low-skilled and high-skilled goods (Figure 2a) by considering a number of sectors in which the share of high-skilled and low-skilled employees is higher than 50% and 85%, respectively. The index is built by weighting the price of each sector by the share of workers, either high-skilled or low-skilled, employed in the sector. This corresponds to the 29.3% of total high-skilled employees and 54.4% of total low-skilled employees in the Italian economy.

(a) Price index for high-skilled and low-skilled goods.



Note: We include among high-skilled sectors pharmaceuticals, computer programming and information services, legal and accounting activities, and architectural and engineering activities. Among low-skilled sectors we include textiles, wood, paper, glass, basic metals, constructions, transports, postal and courier activities, security and investigation and office administrative activities. The CPI index is reported for reference. *Source*: Italian Institute of Statistics.

(b) Price index of selected sectors.



Note: we include as high-skilled sectors computer programming and information services and legal and accounting activities. We include as low-skilled sectors constructions, and security and investigation and office administrative activities. The CPI index is reported for reference. *Source*: Italian Institute of Statistics.

In addition, we select four sectors for which the prices of goods and services should be less influenced by changes in technology (e.g., technological shocks), by external factors and import/export dynamics (e.g., oil shocks), and by the price of raw materials (e.g., commodities). For these four sectors, we report the producer prices (base year 2010) from 2010 to 2017 (Figure 2b). In sectors which are mainly high-skilled, the prices have been increasing much more relative to the prices in sectors which are mainly low-skilled. Employment in the two low-skilled sectors considered amounts to 28% of the total low-skilled employees, and the employment in the two high-skilled sectors considered amounts to 21% of the total high-skilled employees. Overall, this anecdotal evidence provides support to our findings that as a consequence of an increase in the supply of low-skilled labour in Italy in the period considered, prices in the low-skilled market have *relatively* declined with respect to prices in the high-skilled market.

B Computing the aggregate elasticity of substitution

We aim at evaluating the robustness of our counter-factual analysis from an aggregate perspective. In line with our model, we assume perfect substitutability between native and non-native workers. We can represent the aggregate output through a CES-type aggregate production function:

$$V = \Big[(A_l\sigma_l)^{\psi} + (A_h\sigma_h)^{\psi}\Big]^{1/\psi}, \tag{53}$$

where $\psi \in (-\infty, 1]$, A_l is the technological progress of low-skilled workers, and A_h is the technological progress of high-skilled workers. The elasticity of substitution between two types of workers is defined as:[20]

$$\xi \equiv \frac{1}{1-\psi}. \tag{54}$$

This production function admits three interpretations (Autor, 2018, p.3). First, there is only one good and high-skilled and low-skilled workers are imperfect substitutes. Second, the production function is equivalent to an economy where consumers have a utility function defined over two goods: $[V_l^{\psi} + V_h^{\psi}]^{1/\psi}$. Good h is produced with $V_h = A_h\sigma_h$ and good l is produced with $V_l = A_l\sigma_l$ (hence, they have linear, single-factor technology). The parameter ξ measures the elasticity of substitution between these consumption goods. Finally, a mix of the two whereby two different sectors produce goods that are imperfect substitutes, and high-skilled and low-skilled workers are employed in all sectors. Our model is in line with the second interpretation.

[20]Note that $\xi \in [0, \infty]$. When $\xi = 0$ ($\psi \to -\infty$), we get a Leontief production function, when $\xi = \infty$ ($\psi = 1$) we get perfect substitutability between the two types of workers, and when $\xi = 1$ ($\psi = 0$), we get a Cobb-Douglas production function.

Assuming that the wage is set equal to the marginal productivity of labour, we have:

$$\frac{w_h}{w_l} = \left(\frac{A_h}{A_l}\right)^{(\xi-1)/\xi} \left(\frac{\sigma_h}{\sigma_l}\right)^{-1/\xi}. \tag{55}$$

In our counter-factual scenarios there is no change in technological progress, but a change in the stock of high-skilled and low-skilled non-native workers, which we denote by $\Delta\sigma_h$ and $\Delta\sigma_l$, respectively. Using Equation (55), the difference in the percentage change of wages for the two types of workers can be expressed as:

$$\frac{\Delta w_h}{w_h} - \frac{\Delta w_l}{w_l} \approx -\left(\frac{1}{\xi}\right)\left(\frac{\Delta\sigma_h}{\sigma_h} - \frac{\Delta\sigma_l}{\sigma_l}\right). \tag{56}$$

Based on figures from our 2017 counter-factual experiment with no non-natives (Section 5.1), reported in Table 4, the robustness check with different value of the elasticity of substitution between the two goods (Section 5.1) and Equation (56), we compute the values of the aggregate elasticity of substitution between high-skilled and low-skilled workers. The estimates for the US economy of 1.41 (Katz and Murphy, 1992) and the range usually found in the literature (Autor, 2018), 1-2, suggests that our choice of the CES parameter equal to 1 can be considered a good baseline specification.

Table 4. 2017 counter-factual figures with no non-natives.

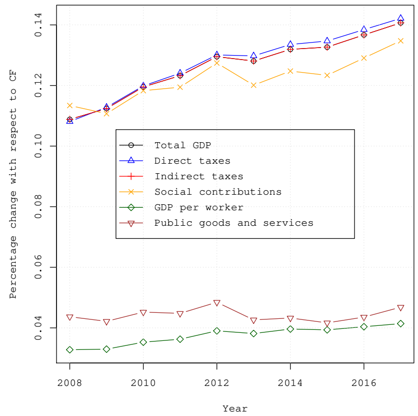
CES	$\frac{\Delta w_h}{w_h}$	$\frac{\Delta w_l}{w_l}$	$\frac{\Delta\sigma_h}{\sigma_h}$	$\frac{\Delta\sigma_l}{\sigma_l}$	ξ
1	8.11%	−3.50%	5%	21%	1.38
0.5	16.67%	−8.07%	5%	21%	0.64
0.9	9.07%	−4.02%	5%	21%	1.22
1.1	7.33%	−3.10%	5%	21%	1.53
2	3.66%	−1.13%	5%	21%	3.34

In the scenario in which native and non-native workers were not perfect substitutes, then our estimate of the aggregate elasticity of substitution would be a lower bound of the true parameter.

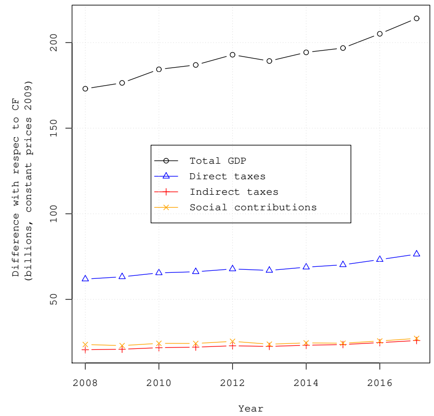
Appendix only for the referees

C Sensitivity analysis on the elasticity of substitution

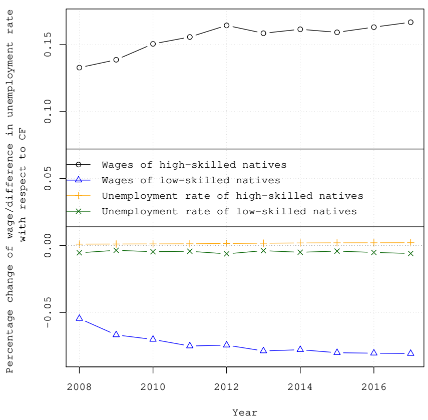
Figure 3. Counter-factual variables - no non-natives with CES parameter $\epsilon = 0.5$.



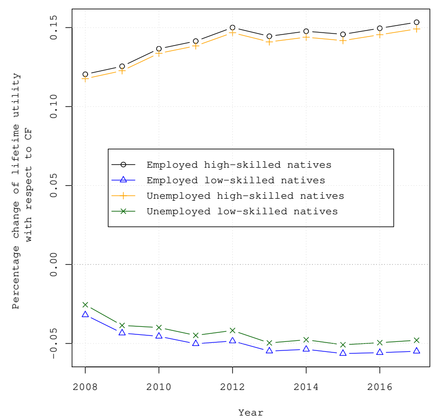
(a) Percentage changes of aggregate variables



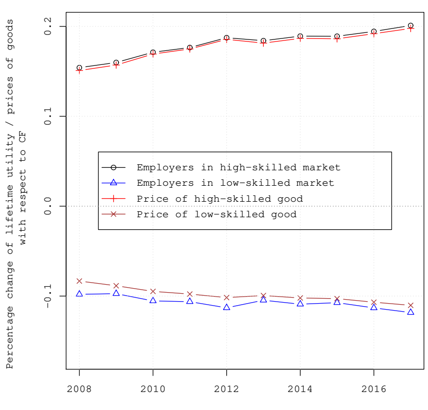
(b) Changes of aggregate variables



(c) Wages and unemployment rates



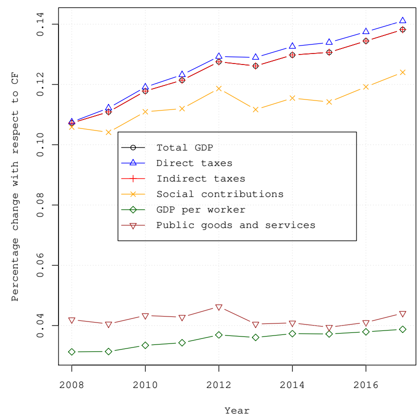
(d) Employees' lifetime utility



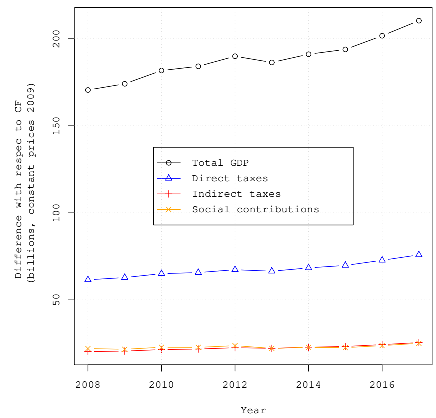
(e) Employers' lifetime utility and real prices of goods

Note: The lines show the percentage/absolute change in the variables in the counter-factual scenario in which there are no non-natives compared to the equilibrium in each year between 2008 and 2017. Only for the case of unemployment, we report the difference between the unemployment rate in the counter-factual scenario and in equilibrium, by skill level and country of origin. We define by CF the counter-factual.

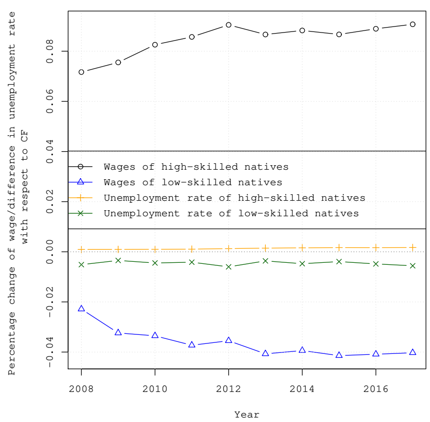
Figure 4. Counter-factual variables - no non-natives with CES parameter $\epsilon = 0.9$.



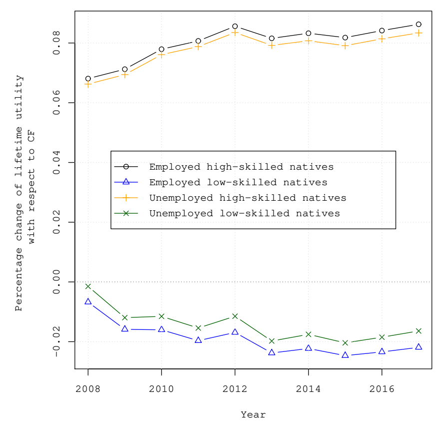
(a) Percentage changes of aggregate variables



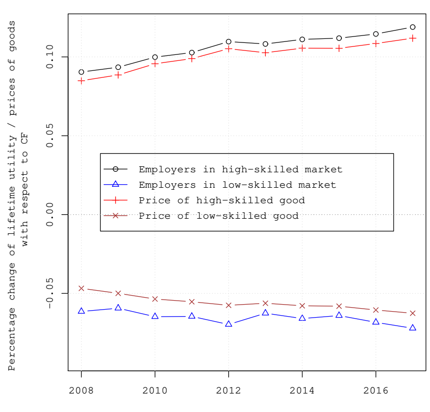
(b) Changes of aggregate variables



(c) Wages and unemployment rates



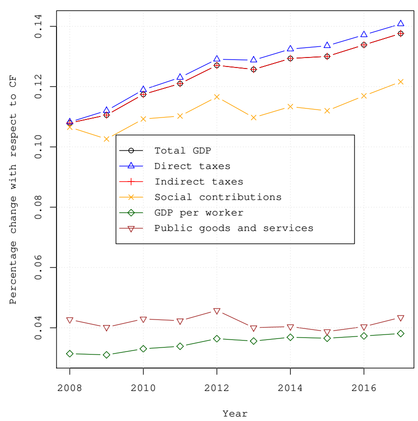
(d) Employees' lifetime utility



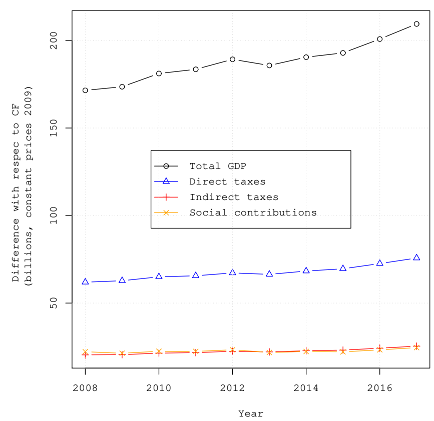
(e) Employers' lifetime utility and real prices of goods

Note: The lines show the percentage/absolute change in the variables in the counter-factual scenario in which there are no non-natives compared to the equilibrium in each year between 2008 and 2017. Only for the case of unemployment, we report the difference between the unemployment rate in the counter-factual scenario and in equilibrium, by skill level and country of origin. We define by CF the counter-factual.

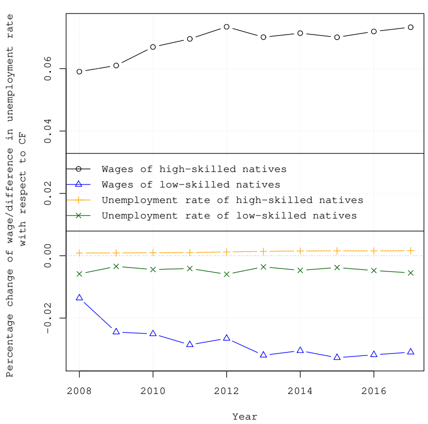
Figure 5. Counter-factual variables - no non-natives with CES parameter $\epsilon = 1.1$.



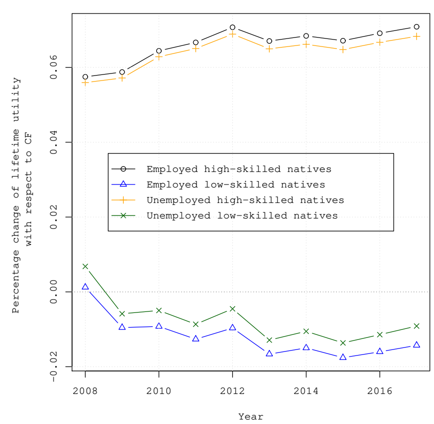
(a) Percentage changes of aggregate variables



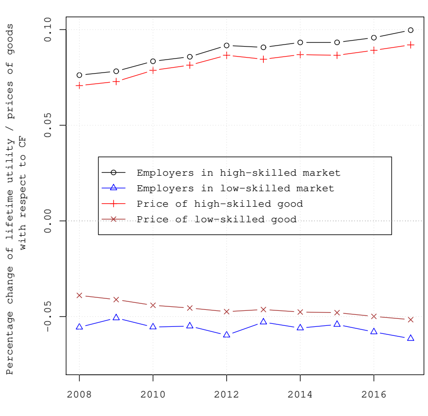
(b) Changes of aggregate variables



(c) Wages and unemployment rates



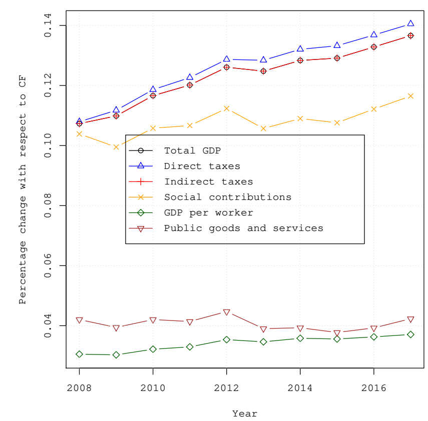
(d) Employees' lifetime utility



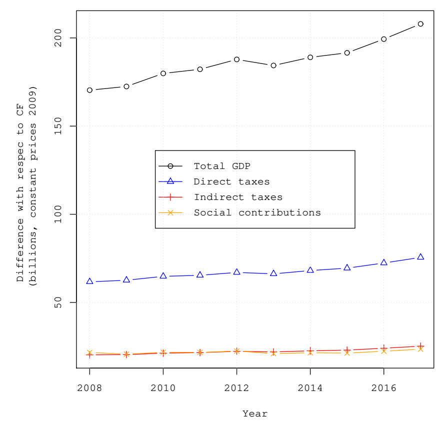
(e) Employers' lifetime utility and real prices of goods

Note: The lines show the percentage/absolute change in the variables in the counter-factual scenario in which there are no non-natives compared to the equilibrium in each year between 2008 and 2017. Only for the case of unemployment, we report the difference between the unemployment rate in the counter-factual scenario and in equilibrium, by skill level and country of origin. We define by CF the counter-factual.

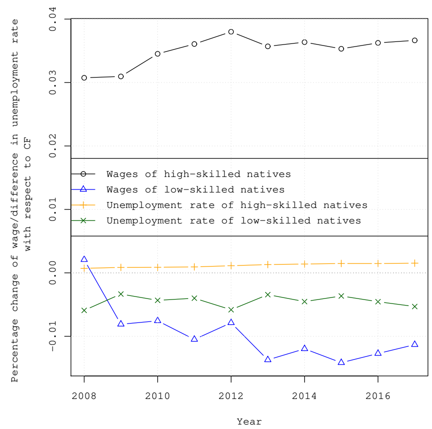
Figure 6. Counter-factual variables - no non-natives with CES parameter $\epsilon = 2$.



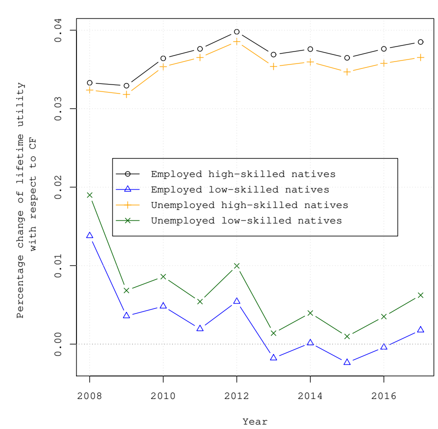
(a) Percentage changes of aggregate variables



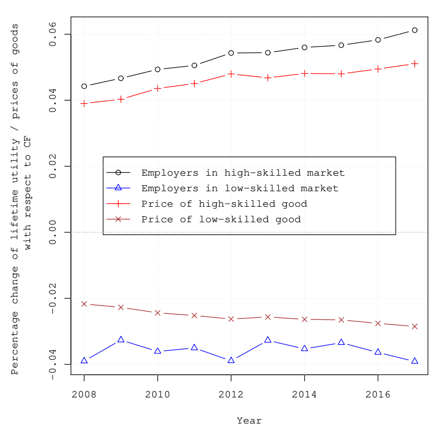
(b) Changes of aggregate variables



(c) Wages and unemployment rates



(d) Employees' lifetime utility



(e) Employers' lifetime utility and real prices of goods

Note: The lines show the percentage/absolute change in the variables in the counter-factual scenario in which there are no non-natives compared to the equilibrium in each year between 2008 and 2017. Only for the case of unemployment, we report the difference between the unemployment rate in the counter-factual scenario and in equilibrium, by skill level and country of origin. We define by *CF* the counter-factual.

D Cobb-Douglas preferences

Let's assume the utility function to be Cobb -Douglas. This would be a special case of the general CES utility function described in Section (2.1), when the parameter $\rho = 0$, i.e., the elasticity of substitution between good h and good l, $\epsilon = 1$. In this scenario, the utility function reads as:

$$Z_{i,j} = d_{h,i,j}^{\gamma} d_{l,i,j}^{1-\gamma} + \iota\nu. \tag{57}$$

Employees maximize their utility function, subject to the following budget constraint:

$$p_h d_{h,i,j} + p_l d_{l,i,j} = \begin{cases} (1-t)\left(w_{i,j}+\tau\right) & \text{if the worker } (i,j) \text{ is employed,} \\ b\,(1-t)\left(w_{i,j}+\tau\right) & \text{if the worker } (i,j) \text{ is unemployed.} \end{cases} \tag{58}$$

From the utility maximization, we get the optimal quantities of goods h and l demanded by each individual, depending on her skill level, country of origin and employment status. Specifically, if the worker is employed she will demand the following quantities of good h and good l:

$$\begin{aligned} d_{h,i,j}^{e} &= \frac{\gamma\,(1-t)\left(w_{i,j}+\tau\right)}{p_h} \text{ and} \\ d_{l,i,j}^{e} &= \frac{(1-\gamma)\,(1-t)\left(w_{i,j}+\tau\right)}{p_l}, \end{aligned} \tag{59}$$

while if the worker is unemployed, she will demand respectively:

$$\begin{aligned} d_{h,i,j}^{u} &= \frac{b\gamma\,(1-t)\left(w_{i,j}+\tau\right)}{p_h} \text{ and} \\ d_{l,i,j}^{u} &= \frac{b\,(1-\gamma)\,(1-t)\left(w_{i,j}+\tau\right)}{p_l}. \end{aligned} \tag{60}$$

We can also compute the indirect utility of employed and unemployed employees, which can be written as:

$$Z_{i,j}^{e} = (1-t)\left(\tilde{w}_{i,j}+\tilde{\tau}\right) + \iota\nu \text{ and} \tag{61}$$

$$Z_{i,j}^{u} = b\,(1-t)\left(\tilde{w}_{i,j}+\tilde{\tau}\right) + \iota\nu, \tag{62}$$

where the real tax subsidy $\tilde{\tau} \equiv \tau/p$ and the real wage $\tilde{w}_{i,j} \equiv w_{i,j}/p$ are computed using

$$P \equiv \frac{p_h^{\gamma} p_l^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}, \tag{63}$$

as the aggregate price index.

E The equilibrium in the goods market

Using Equation (6), we can express the real price of good h as a function of the real price of good l as:

$$\tilde{p}_h = \left[\frac{1 - \tilde{p}_l^{\rho/(\rho-1)} (1-\gamma)^{1/(1-\rho)}}{\gamma^{1/(1-\rho)}} \right]^{(\rho-1)/\rho}. \tag{64}$$

Moreover, by equating demand and supply of good h and good l and dividing member by member we get:

$$\frac{\tilde{p}_h}{\tilde{p}_l} = \left(\frac{\gamma}{1-\gamma} \right) \left[\frac{(1-g_l)x_l(e_{l,N}+e_{l,I})}{(1-g_h)x_h(e_{h,N}+e_{h,I})} \right]^{1-\rho}. \tag{65}$$

Solving the system of two equations (Equations (64) and (65)) in two unknowns ($\tilde{p}_h$ and $\tilde{p}_l$), we can derive the following equations for the two prices, as function of the parameters of the model:

$$\begin{aligned} \tilde{p}_h &= \left\{ \gamma^{1/(1-\rho)} + (1-\gamma)\gamma^{\rho/(1-\rho)} \left[\frac{(1-g_l)x_l(e_{l,N}+e_{l,I})}{(1-g_h)x_h(e_{h,N}+e_{h,I})} \right]^{\rho} \right\}^{(1-\rho)/\rho} && (66) \\ \tilde{p}_l &= \left\{ (1-\gamma)^{1/(1-\rho)} + \gamma(1-\gamma)^{\rho/(1-\rho)} \left[\frac{(1-g_h)x_h(e_{h,N}+e_{h,I})}{(1-g_l)x_l(e_{l,N}+e_{l,I})} \right]^{\rho} \right\}^{(1-\rho)/\rho} && (67) \end{aligned}$$

At aggregate level, by equating demand (left hand side) and supply (right hand side) of good h, we get:

$$\begin{aligned} & \tilde{p}_h \left(\frac{\tilde{p}_h}{\gamma} \right)^{1/(\rho-1)} (1-t) \{ b(\tilde{w}_{h,N}u_{h,N} + \tilde{w}_{h,I}u_{h,I} + \tilde{w}_{l,N}u_{l,N} + \tilde{w}_{l,I}u_{l,I}) + [e_{h,N} + e_{h,I} + e_{l,N} + e_{l,I} + \\ + \quad & b(u_{h,N} + u_{h,I} + u_{l,N} + u_{l,I})] \tilde{\tau} + \tilde{p}_l x_l(e_{l,N} + e_{l,I}) + \tilde{p}_h x_h(e_{h,N} + e_{h,I}) \} + \\ + \quad & g_h \frac{\tilde{p}_h x_h(e_{h,N} + e_{h,I})}{1-t_p} = \frac{\tilde{p}_h x_h(e_{h,N} + e_{h,I})}{1-t_p}, \end{aligned} \tag{68}$$

where g_h is the proportion of good h which is demanded by the government and $\frac{\tilde{p}_h x_h(e_{h,N}+e_{h,I})}{1-t_p}$ is the total production of good h before indirect taxes. Similarly, equating demand (left hand side) and supply (right hand side) of good l, we get:

$$\begin{aligned}
& \tilde{p}_l \left(\frac{\tilde{p}_l}{1-\gamma}\right)^{1/(\rho-1)} (1-t)\left\{b(\tilde{w}_{h,N}u_{h,N} + \tilde{w}_{h,I}u_{h,I} + \tilde{w}_{l,N}u_{l,N} + \tilde{w}_{l,I}u_{l,I}) + [e_{h,N} + e_{h,I} + e_{l,N} + e_{l,I} + \right. \\
+ \quad & \left. b(u_{h,N} + u_{h,I} + u_{l,N} + u_{l,I})]\,\tilde{\tau} + \tilde{p}_l x_l(e_{l,N} + e_{l,I}) + \tilde{p}_h x_h(e_{h,N} + e_{h,I})\right\} + \\
+ \quad & g_l \frac{\tilde{p}_l x_l(e_{l,N} + e_{l,I})}{1-t_p} = \frac{\tilde{p}_l x_l(e_{l,N} + e_{l,I})}{1-t_p}, \qquad (69)
\end{aligned}$$

where g_l is the proportion of good l which is demanded by the government and $\frac{\tilde{p}_l x_l(e_{h,N}+e_{h,I})}{1-t_p}$ is the total production of good l before indirect taxes.

Summing up side by side Equations (68) and (69), we get:

$$\begin{aligned}
& b(\tilde{w}_{h,N}u_{h,N} + \tilde{w}_{h,I}u_{h,I} + \tilde{w}_{l,N}u_{l,N} + \tilde{w}_{l,I}u_{l,I}) + [e_{h,N} + e_{h,I} + e_{l,N} + e_{l,I} + \\
+ \quad & b(u_{h,N} + u_{h,I} + u_{l,N} + u_{l,I})]\,\tilde{\tau} + \frac{g_l \tilde{p}_l x_l(e_{l,N} + e_{l,I}) + g_h \tilde{p}_h x_h(e_{h,N} + e_{h,I})}{1-t_p} = \\
= \quad & \frac{t_p}{1-t_p}[\tilde{p}_l x_l(e_{l,N} + e_{l,I}) + \tilde{p}_h x_h(e_{h,N} + e_{h,I})] + \qquad (70) \\
+ \quad & t\left\{b(\tilde{w}_{h,N}u_{h,N} + \tilde{w}_{h,I}u_{h,I} + \tilde{w}_{l,N}u_{l,N} + \tilde{w}_{l,I}u_{l,I}) + [e_{h,N} + e_{h,I} + e_{l,N} + e_{l,I} + \right. \\
+ \quad & \left. b(u_{h,N} + u_{h,I} + u_{l,N} + u_{l,I})]\,\tilde{\tau} + \tilde{p}_l x_l(e_{l,N} + e_{l,I}) + \tilde{p}_h x_h(e_{h,N} + e_{h,I})\right\}.
\end{aligned}$$

Equation (70) states that the sum of government expenditures on unemployment benefits, tax rebates and consumption of public goods is equal to the government revenues in the form of direct and indirect taxes, i.e. $TGE = IT + DT$. Hence, this equation implies that as in all closed economy macroeconomic models, the government primary surplus is equal to zero.

F Equilibrium wages

By plugging Equation (27) into the Nash bargaining Equation (21), we get an expression for the wages of native employees in each market, as a function of the parameters of the model:

$$\begin{aligned}
\tilde{w}_{i,N} \quad = \quad & \beta_N(1-t)\left\{\frac{r + \delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)}{(1-t)[(r+\delta_{i,N})[1-b(1-\beta_N)] + \beta_N\kappa_{i,N}\theta_i q(\theta_i)]}\right\}\tilde{p}_i x_i + \\
- \quad & \left\{\frac{(1-t)(1-\beta_N)(r+\delta_{i,N})(1-b)}{(1-t)[(r+\delta_{i,N})[1-b(1-\beta_N)] + \beta_j\kappa_{i,N}\theta_i q(\theta_i)]}\right\}\tilde{\tau} + \\
+ \quad & \left\{\frac{\beta_N r[r + \delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)] + \phi(r+\delta_{i,N})(1-\beta_N)[r + \kappa_{i,N}\theta_i q(\theta_i)]}{(1-t)[(r+\delta_{i,N})[1-b(1-\beta_N)] + \beta_N\kappa_{i,N}\theta_i q(\theta_i)]}\right\}\tilde{p}_i x_i F. \qquad (71)
\end{aligned}$$

Similarly, by plugging Equation (28) into the Nash bargaining Equation (21) and substituting into Equation (13), and reshuffling, we get an expression for the wages of non-native employees:

$$
\begin{aligned}
\tilde{w}_{i,I} &= \beta_I(1-t)\left\{\frac{(r+\lambda)(r+\delta_{i,I})+r\kappa_{i,I}\theta_i q(\theta_i)}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r)-rb(1-\beta)\right]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\tilde{p}_i x_i + \\
&- \left\{\frac{(1-\beta_I)(r+\delta_{i,I})(1-t)\left[(1-b)r+\lambda\right]}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r)-rb(1-\beta)\right]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\tilde{\tau} + \\
&+ \left\{\frac{\lambda r(1-\beta_I)(r+\delta_{i,I})}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r)-rb(1-\beta)\right]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}W_{i,FC} + \\
&+ \left\{\frac{\phi(r+\delta_{i,I})(1-\beta_I)(r+\lambda)(r+\kappa_{i,I}\theta_i q(\theta_i)-\lambda)}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r)-rb(1-\beta)\right]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right. + \\
&+ \left.\frac{\beta_I r\left[(r+\delta_{i,I})(r+\lambda)+r\kappa_{i,I}\theta_i q(\theta_i)\right]}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r)-rb(1-\beta)\right]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\tilde{p}_i x_i F + \\
&- \left\{\frac{\lambda(1-\beta_I)(r+\delta_{i,I})}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r)-rb(1-\beta)\right]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\iota\nu. \qquad (72)
\end{aligned}
$$

We can rewrite Equation (71) as:

$$
\tilde{w}_{i,N} = \underbrace{A_{i,N}(\theta_i)}_{>0}\tilde{p}_i x_i - \underbrace{B_{i,N}(\theta_i)}_{>0}\tilde{\tau} + \underbrace{C_{i,N}(\theta_i)}_{>0}\tilde{p}_i x_i F,
$$

where

$$
A_{i,N}(\theta_i) = \frac{\beta_N[r+\delta_{i,N}+\kappa_{i,N}\theta_i q(\theta_i)]}{[(r+\delta_{i,N})[1-b(1-\beta_N)]+\beta_N\kappa_{i,N}\theta_i q(\theta_i)]}, \qquad (73)
$$

$$
B_{i,N}(\theta_i) = \frac{(1-\beta_N)(r+\delta_{i,N})(1-b)}{[(r+\delta_{i,N})[1-b(1-\beta_N)]+\beta_N\kappa_{i,N}\theta_i q(\theta_i)]}, \qquad (74)
$$

$$
C_{i,N}(\theta_i) = \frac{\beta_N r[r+\delta_{i,N}+\kappa_{i,N}\theta_i q(\theta_i)]+\phi(r+\delta_{i,N})(1-\beta_N)[r+\kappa_{i,N}\theta_i q(\theta_i)]}{(1-t)[(r+\delta_{i,N})[1-b(1-\beta_N)]+\beta_N\kappa_{i,N}\theta_i q(\theta_i)]}. \qquad (75)
$$

Similarly, we can rewrite the equation for the wages of non-native employees (Equation (72)) as:

$$
\tilde{w}_{i,I} = \underbrace{D_{i,I}(\theta_i)}_{>0}\tilde{p}_i x_i - \underbrace{E_{i,I}(\theta_i)}_{>0}\tilde{\tau} + \underbrace{G_{i,I}(\theta_i)}_{>0}\tilde{p}_i x_i F + \underbrace{K_{i,I}(\theta_i)}_{>0}W_{i,FC} - \underbrace{H_{i,I}(\theta_i)}_{>0}\iota\nu, \qquad (76)
$$

where

$$D_{i,I}(\theta_i) = \frac{\beta_I\left[(r+\lambda)(r+\delta_{i,I}) + r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right]}{\left\{(r+\delta_{i,I})\left[(\lambda+r) - rb(1-\beta)\right] + \beta_I r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right\}}.$$

$$E_{i,I}(\theta_i) = \frac{(1-\beta_I)(r+\delta_{i,I})\left[(1-b)r+\lambda\right]}{(r+\delta_{i,I})\left[(\lambda+r) - rb(1-\beta)\right] + \beta_I r\kappa_{i,I}\theta_i q\left(\theta_i\right)}.$$

$$K_{i,I}(\theta_i) = \frac{\lambda r(1-\beta_I)(r+\delta_{i,I})}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r) - rb(1-\beta)\right] + \beta_I r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right\}}.$$

$$\begin{aligned} G_{i,I}(\theta_i) \quad &= \quad \frac{\phi(r+\delta_{i,I})(1-\beta_I)(r+\lambda)\left(r+\kappa_{i,I}\theta_i q\left(\theta_i\right)-\lambda\right)}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r) - rb(1-\beta)\right] + \beta_I r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right\}} + \\ &+ \quad \frac{\beta_I r\left[(r+\delta_{i,I})(r+\lambda) + r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right]}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r) - rb(1-\beta)\right] + \beta_I r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right\}}. \end{aligned}$$

$$H_{i,I}(\theta_i) = \frac{\lambda(1-\beta_I)(r+\delta_{i,I})}{(1-t)\left\{(r+\delta_{i,I})\left[(\lambda+r) - rb(1-\beta)\right] + \beta_I r\kappa_{i,I}\theta_i q\left(\theta_i\right)\right\}}.$$

G Calculation of job finding and job exit rates

To compute the probability for a worker to find a job as well as the probability for a worker to lose her job we follow Shimer (2012). Specifically, to calculate the job finding probability for the unemployed $Q_t \in [0,1]$ and the exit probability for the employed $\Delta_t \in [0,1]$ in Italy in the period 2004-2014 we use publicly available data from the Italian Labour Force Survey (LFS). We do not consider transitions in and out of the labour force, but we focus on the employees' transitions between employment and unemployment. We also assume that all the unemployed find a job with probability Q_t and all the employed lose a job with probability Δ_t during period t, ignoring any heterogeneity or duration dependence that makes some unemployed more likely to find and some employed less likely to lose a job within the period.

For $t \in \{0,1,2,...\}$, we refer to the interval $[t, t+1]$ as period t. We assume that during period t, all unemployed find a job according to a Poisson process with arrival rate $q_t \equiv -log(1-Q_t) > 0$ and all employed lose their job according to a Poisson process with arrival rate $\delta_t \equiv -log(1-\Delta_t) > 0$. Hence, q_t and δ_t represent the job finding and employment exit rates and Q_t and Δ_t are the corresponding probabilities. By fixing $t \in \{0,1,2,...\}$ and letting $\tau \in [0,1]$ be the time elapsed since the last measurement date, we can define $e_{t+\tau}$ as the number of employed at time $t+\tau$, $u_{t+\tau}$ as the number of unemployed at time $t+\tau$, and $u_t^s(\tau)$ denote "short term unemployment", that is employees who are unemployed at time $t+\tau$, but were employed at some time $t' \in [t, t+\tau]$. Note that $u_t^s(0) = 0$ for all t. Therefore, the law of motion for unemployment at time $t+\tau$ reads:

$$\dot{u}_{t+\tau} = e_{t+\tau}\delta_t - u_{t+\tau}q_t. \tag{77}$$

The number of unemployed at date $[t+1]$ is then equal to the number of unemployed at date t who do not find a job (a fraction $1 - Q_t = e^{-qt}$) plus the u_{t+1}^s short-term unemployed, i.e., those who are unemployed at date $[t+1]$ but held a job at some point during period t:

$$u_{t+1} = (1 - Q_t)u_t + u_{t+1}^s. \tag{78}$$

By inverting Equation 78, we find an expression for the job finding probability as a function of unemployment and short term unemployment:

$$Q_t = 1 - \frac{u_{t+1} - u_{t+1}^s}{u_t}. \tag{79}$$

As in (Shimer, 2005, p.130), an implicit equation for the employment exit rate can be obtained by solving Equation 77 :

$$u_{t+1} = \frac{[1 - \exp(-q_t - \delta_t)]\,\delta_t l_t}{q_t + \delta_t} + \exp(-q_t - \delta_t)u_t, \tag{80}$$

where $l_t \equiv u_t + e_t$ is the size of the labour force during period t, which we assume to be constant since entries or exits from the labour force are not allowed.

G.1 Robustness check for the calculation of job finding and job exit rates

From Equations (31)-(34), we derive the following equality:

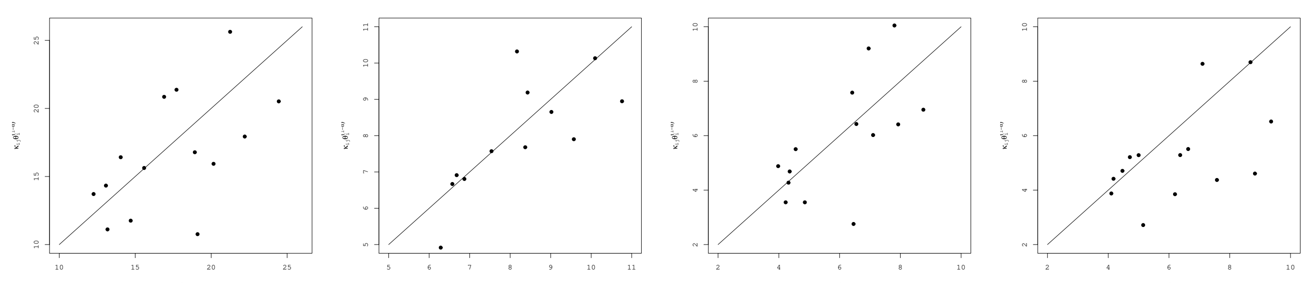
$$\frac{e_{i,j}}{u_{i,j}} = \frac{\kappa_{i,j}\theta_i^{1-\alpha}}{\delta_{i,j}}, \tag{81}$$

where $i \in \{h, l\}$ and $j \in \{N, I\}$. The right hand side of Equation (81) reports the ratio between the job finding rate and the job exit rate per each worker type, while the left hand side is the ratio between employed and unemployed. If our estimates of the job finding rates and the job exit rates for employees by skill level and country of origin were approximatively correct, then their ratio should be equal to the ratio of employed and unemployed employees by skill level and country of origin. Hence, we regress the computed ratio of job finding rate and job exit rate per worker type on the ratio of employed and unemployed by skill level and country of origin for Italy for the period 2004-2017 (Figure 7a-7d). The coefficients are very close to 1, confirming the validity of our calculations (Table 5).

Table 5. Check for the estimate of the job finding and exit rate for different skills and country of origin. Source: our calculations using ELFS data.

	Estimate	Std. Error	t value	Pr(>|t|)
$e_{h,N}/u_{h,N}$	1.0302	0.0739	13.93	0.0000
$e_{l,N}/u_{l,N}$	0.9753	0.0857	11.39	0.0000
$e_{h,I}/u_{h,I}$	1.0949	0.0862	12.69	0.0000
$e_{l,I}/u_{l,I}$	1.1940	0.1246	9.58	0.0000

Figure 7. Correlation between the ratio of the estimated job finding rates and the job exit rates and the ration between employed and unemployed per worker type.



(a) High-skilled natives. (b) High-skilled non-natives. (c) Low-skilled natives. (d) Low-skilled non-natives.

H The classification of employees by skill level

To classify employees according to their skill level is a hard task. This is because it is not clear what is a good proxy to be used to capture the skills of an individual. Possible alternatives which have been used in the literature include educational attainment (Altonji and Card, 1991; Dustmann et al., 2001), occupation (Card, 2001), or experience and education (Borjas, 2003). All of those have pros and cons. The benefit of using the education level is that it is in general available for all employees; however, it is a rather imprecise measure of the individual skills. One of the main problems is the issue of mismatch, particularly over-education, as often employees are hired to perform a job which requires skills associated with an education level which is lower compared to the one of the individual. This phenomenon is specifically relevant for immigrants, as investigated by Dustmann et al. (2013) and Eckstein and Weiss (2004), who show that immigrants downgrade considerably upon arrival and therefore the allocation of immigrants according to their measured skills, such as education, would place them at different locations across the native wage distribution than where we actually find them. Alternatively, we could use as a proxy the individual's occupation, which is still an imperfect measure of the skill level, but is probably more accurate than education.

The International Labor Organization (ILO) maps the the International Standard Classification of Occupations (ISCO) in skill levels (Table 6). While the definition of *skill* refers to the ability to carry out the tasks and duties of a given job (ILO, 2012), the definition of *skill level* relates to a function of the complexity and range of tasks and duties to be performed in an occupation. The skill level is measured operationally by considering one or more of the following elements:

- the nature of the work performed in an occupation in relation to the characteristic tasks and duties defined for each ISCO-88 skill level;
- the level of formal education defined in terms of the International Standard Classification of Education (ISCED-97) required for competent performance of the tasks and duties involved; and
- the amount of informal on-the-job training and /or previous experience in a related occupation required for competent performance of these tasks and duties.

In addition, ILO provides a mapping between skill levels and education levels, following the International Standard Classification of Education ISCED-97, as developed by UNESCO (Table 7).

Occupations at Skill Level 1 typically require the performance of simple and routine physical or manual tasks. They may require the use of hand held tools, such as shovels, or of simple electrical equipment, such as vacuum cleaners. They involve tasks such as cleaning; digging; lifting and carrying materials by hand; sorting, storing or assembling goods by hand (sometimes in the context of mechanised operations); operating non-motorised vehicles; and picking fruit and vegetables. Many occupations at Skill Level 1 may require physical strength and/or endurance. For some jobs basic skills in literacy and numeracy may be required. If required, these skills would not be a major part of the job. For competent performance in some occupations at Skill Level 1, completion of primary education or the first stage of basic education (ISCED Level 1) may be required. Occupations classified at Skill Level 1 include office cleaners, freight handlers, garden labourers and kitchen assistants.

Table 6. Mapping of ISCO-08 major groups to skill levels.

ISCO-08 major groups	Skill Level
1 - Managers, senior officials and legislators	3 + 4
2 - Professionals	4
3 - Technicians and associate professionals	3
4 - Clerks	
5 - Service and sales employees	
6 - Skilled agricultural and fishery employees	
7 - Craft and related trades employees	
8 - Plant and machine operators, and assemblers	2
9 - Elementary occupations	1
0 - Military occupations	1 + 4

Source: International Labor Organization (ILO).

Occupations at Skill Level 2 typically involve the performance of tasks such as operating machinery and electronic equipment; driving vehicles; maintenance and repair of electrical and mechanical equipment; and manipulation, ordering and storage of information. For almost all occupations at Skill Level 2 the ability to read information such as safety instructions, to make written records of work completed, and to accurately perform simple arithmetical calculations is essential. Many occupations at this skill level require relatively advanced literacy and numeracy skills and good interpersonal communication skills. In some occupations these skills are required for a major part of the work. Many occupations at this skill level require a high level of manual dexterity. Occupations classified at Skill Level 2 include butchers, bus drivers, secretaries, accounts clerks, sewing machinists, dressmakers, shop sales assistants, police officers, hairdressers, building electricians and motor vehicle mechanics.

Occupations at Skill Level 3 typically involve the performance of complex technical and practical tasks which require an extensive body of factual, technical and procedural knowledge in a specialised field. Occupations at this skill level generally require a high level of literacy and numeracy and well developed interpersonal communication skills. These skills may include the ability to understand complex written material, prepare factual reports and communicate with people who are distressed. The knowledge and skills required at Skill Level 3 are usually obtained as the result of study at a higher educational institution following completion of secondary education for a period of 1-3 years (ISCED Level 5b). In some cases extensive relevant work experience and prolonged on the job training may substitute for the formal education. Occupations classified at Skill Level 3 include shop managers, medical laboratory technicians, legal secretaries, commercial sales representatives, computer support technicians, and broadcasting and recording technicians.

Table 7. Mapping of ISCO-08 major groups to education level (ISCED-97) groups.

ISCO-08 Skill Level	ISCED-97 groups Education Level
4	6 - Second stage of tertiary education (leading to an advanced research qualification)
	5a - First stage of tertiary education, 1st degree (medium duration)
3	5b - First stage of tertiary education (short or medium duration)
2	4 - Post-secondary, non-tertiary education
	3 - Upper secondary level of education
	2 - Lower secondary level of education
1	1 - Primary level of education

Source: International Labor Organization (ILO).

Occupations at Skill Level 4 typically involve the performance of tasks which require complex problem solving and decision making based on an extensive body of theoretical and factual knowledge in a specialised field. The tasks performed typically include analysis and research to extend the body of human knowledge in a particular field, diagnosis and treatment of disease, imparting knowledge to others, design of structures or machinery and of processes for construction and production. Occupations at this skill level generally require extended levels of literacy and numeracy, sometimes at a very high level, and excellent interpersonal communication skills. These skills generally include the ability to understand complex written material and communicate complex ideas in media such as books, reports and oral presentations. The knowledge and skills required at Skill Level 4 are usually obtained as the result of study at a higher educational institution for a period of 3-6 years leading to the award of a first degree or higher qualification (ISCED Level 5a or higher). In some cases experience and on the job training may substitute for the formal education. In many cases appropriate formal qualifications are an essential requirement for entry to the occupation.

We classify individuals in two categories, high-skilled and low-skilled. To do so, we follow the ILO classification, and we refer to high-skilled employees (with skill levels 3 or 4) as those individuals who work as managers, professionals or technicians. Moreover, we refer to low-skilled employees (with skill levels 1 or 2) as those individuals who work as clerks, sales employees, craft employees, plant and machine operators and in elementary occupations. For those for whom, we do not observe the occupation as they are currently unemployed, we use the occupation in their last job. For those for whom no information is available, either because they are stepping for the first time in the labour market or because they have not worked before in Italy or because they did not report the information, we use the education level. The majority of unemployed without information on previous occupation are young and their average age is below 40, both among natives and non-natives. In order to correct for the issue of mismatch, we look at the probability for high educated employees (with a tertiary level of education) and low educated employees (primary or secondary levels) under the age of 40 to work in a high-skilled occupation (with skill levels 3 or 4, as classified by ILO) versus a low skill occupation (with skill levels 1 or 2, as classified by ILO) for both natives and immigrants. We then randomly assign the unemployed into high-skilled and low-skilled according to their education level, taking into account the probabilities of falling in the different categories reported in Table 8.

Table 8. Employed employees by country of origin, occupation and education levels.

		ISCED-97 Education level			
		Non-natives		Natives	
		Low	High	Low	High
Occupation level	Low	0.825	0.335	0.685	0.1127
	High	0.175	0.665	0.315	0.8873

Note: These statistics refer to employees below the age of 40, as this is the category which is most exposed to the issue of downgrading. *Source*: Our own calculations based on the Italian Labour Force Statistics (RCFL) data.

I Italian labor market

I.1 The size and type of immigration in Italy

The size of non-natives in Italy becoming larger and larger, reaching approximately 15% of the total workforce in 2017 (from approximately 6% in 2004). Low-skilled employees are the strong majority (about 90%) of the non-native workforce in 2017, and there exists a strong heterogeneity in wages, job creation and job exit rates among high-skilled, low-skilled, native and non-native employees.

The increase in the Italian population in the past two decades is due exclusively to the increase in the number of non-natives present on the territory (Figure 8). The stock of non-natives in the workforce in Italy increased from less than 2 millions in 2004 to approximately 4 millions in 2018, corresponding to a surge in the share in the labour force from approximately 6% in 2004 to 15%

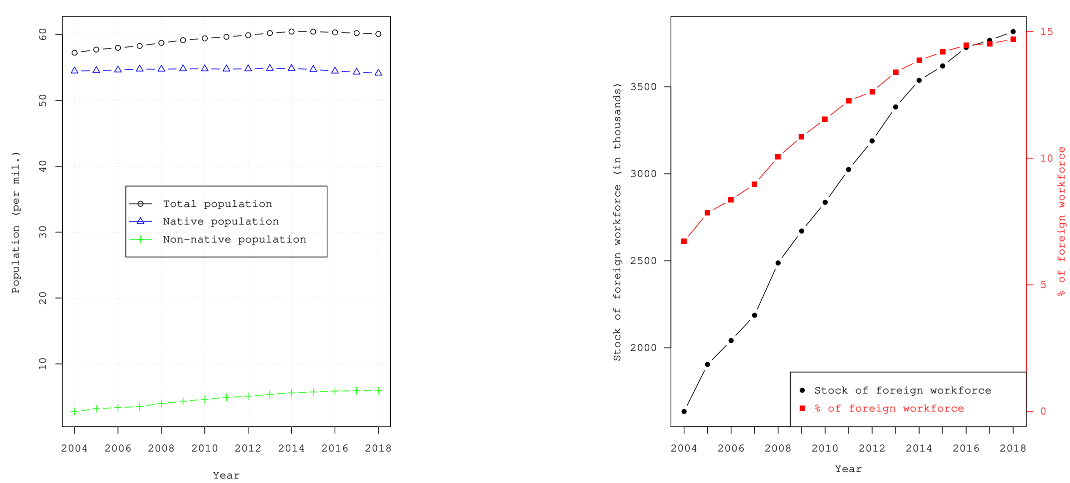
Table 9. Immigration dynamics (in thousands).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inflow															
Total	373.1	267.6	242.1	490.4	462.3	392.5	419.6	354.3	321.3	279.0	248.4	250.0	262.9	301.1	285.5
Non EU	178.4	128.9	115.8	112.7	168.3	179.0	205.6	175.2	168.6	155.8	145.2	152.8	166.3	204.4	190.0
Romania	63.4	43.9	38.2	261.3	162.3	100.7	90.9	90.1	81.7	58.2	50.7	46.4	45.2	43.5	40.1
Bulgaria	3.8	2.3	2.1	12.7	7.8	6.1	5.8	5.1	4.8	3.7	2.9	2.8	2.8	2.6	2.5
Outflow															
Total	10.8	11.9	12.1	14.8	22.1	25.9	28.0	32.4	38.2	43.6	47.5	44.7	42.5	40.5	40.2
% Unempl.	10.2	8.9	9.8	11.3	14.1	11.5	11.2	11.7	11.0	9.6	10.2	9.8	9.7	9.9	10.0

Source: Italian Institute of Statistics (ISTAT).

in 2018.

Figure 8. Stocks of native and non-native population and workforce.



(a) Stock of native and non-native population.

(b) Stock and share of foreign-born workforce.

Source: Own calculations based on the Italian Labour Force Statistics (RCFL) data.

Table 9 shows that there were approximately 270.000 new entries in 2005, but this number almost doubled in 2007, when the pick of the inflow was reached. Since 2008, the total number of entries slowed down, and went back to an average of 270,000 in the period 2013-2018. The total number of inflows, which shows a pick in 2007, was almost entirely ascribable to the entry of Romania and Bulgaria in the EU in 2007. The total number of outflows as a percentage of unemployed (both EU and non-EU nationals) has been quite stable around 10% over time, with a single pick of 14% in 2008.[21]

The activity rate and the employment rate are much higher for non-natives than for natives (Table 10). The 2008-2009 economic crisis drove the employment rate of non-native employees

[21]For natives inflow and outflow rates, please refer to Table 11 in the Appendix I.6.

down by more than 8 percentage points between 2004 and 2012, while the activity rate went down by 3 percentage points. The employment rate of Italian employees dropped by 2 percentage points between 2004 and 2014, and raised back in 2018, while the activity rate remained constant, with an increasing trend after 2013. The unemployment rate is higher among non-natives than among natives. The gap was of approximately 2 percentage points in the period 2004-2008, went up to 6 percentage points in 2013 and down again to 4 percentage points in 2018.

Table 10. Labour force (in thousands).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-natives															
Labour force	1070	1291	1422	1578	1847	2017	2162	2308	2456	2638	2760	2815	2838	2 829	2 855
Employed	965	1158	1299	1447	1690	1790	1912	2030	2110	2183	2294	2359	2 401	2 423	2 455
Activity rate	74.2	73.4	73.6	73.2	73.2	72.5	71.3	70.9	70.5	70.5	70.4	70.3	70.4	70.8	71.2
Empl. rate	66.9	65.8	67.2	67.1	67.0	64.3	63.1	62.3	60.6	58.3	58.5	58.9	59.5	60.6	61.2
Unempl. rate	9.8	10.3	8.6	8.3	8.5	11.2	11.6	12.0	14.1	17.2	16.8	16.2	15.4	14.3	14.0
Italians															
Labour force	23237	22993	22990	22797	22908	22589	22420	22351	22801	22622	22755	22683	22932	23101	23 116
Employed	21398	21249	21459	21447	21400	20909	20615	20568	20456	20008	19985	20106	20 357	20600	20 760
Activity rate	62.2	61.8	62.1	61.8	62.2	61.5	61.2	61.3	62.8	62.6	63.2	63.3	64.3	64.8	65.0
Empl. rate	57.2	57.1	57.9	58.1	58.1	56.8	56.2	56.3	56.3	55.2	55.4	56.0	57.0	57.7	58.2
Unempl. rate	7.9	7.6	6.7	5.9	6.6	7.4	8.1	8.0	10.3	11.6	12.2	11.4	11.2	10.8	10.2

Source: Italian Institute of Statistics (ISTAT).

I.2 Inflow and outflow of natives

Table 11 reports the inflow and outflow of natives (in thousands). The outflow rate is also reported as percentage of unemployed natives.

Table 11. Dynamics of natives.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inflow - Total	41.8	37.3	37.7	36.7	32 .1	29.3	28.2	31.5	29.5	28.4	29.3	30.1	37.9	42.4	46.8
Outflow - Total	39.2	41.9	46.3	36.3	39.5	39.0	39.5	50.1	68.0	82.1	88.9	102.3	114.5	114.5	116.7
Outflow (% unemployed)	2.1	2.4	3.0	2.8	2.6	2.3	2.2	2.8	2.9	3.1	3.2	3.9	4.4	4.6	4.9

Source: Italian Institute of statistics (ISTAT).

I.3 Employees' occupation, composition and unemployment

Table 12 provides data on the distribution of non-native (Panel A) and native (Panel B) employees by occupation in Italy from 2004 to 2018. More than 90% of non-natives are hired either as clerks and sales employees, craft employees and machine operators or in elementary occupations, which are occupations which require lower skill levels (1 or 2 according to the ILO classification). Looking at the trend, the share of non-natives hired in elementary occupations is roughly stable over time. However, we observe a shift away from occupations such as craft employees and machine operators and managers towards occupations such as clerks and sales employees. Among natives, approximately two third of employees are hired in occupations which require lower skill levels (levels 1 or 2 of the ILO classification), while one third of employees are hired as managers and professionals, which are occupations which require higher skill levels (levels 3 or 4 of ILO classification). Over time, we observe fewer employees who work as craft employees or machine operators and more who are employed in occupations such as clerks and sales employees and managers.

Table 12. Distribution of native and non-native employees by occupation.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-natives															
Managers, etc.[1]	10.9	9.2	9.4	10.1	8.5	7.3	7.2	6.7	5.9	6.0	7.0	6.8	6.7	7.1	7.6
Clerks and sales employees[2]	16.4	17.0	18.4	18.8	18.3	17.3	16.4	23.6	25.6	26.7	26.9	27.2	28.3	30.0	29.4
Craft employees and machine operators[3]	39.8	40.4	42.7	42.8	41.2	39.3	38.2	36.4	33.8	0.318	30.3	30.1	29.3	28.3	29.6
Elementary occupations	33.0	33.3	29.5	28.3	31.9	36.1	38.1	33.2	34.7	35.4	35.6	35.9	35.7	34.4	33.3
Natives															
Managers, etc.[1]	35.5	35.5	37.8	38.8	38.5	37.5	36.9	36.4	36.5	37.4	37.4	37.6	37.8	38.0	38.5
Clerks and sales employees[2]	27.5	27.7	26.8	26.7	27.5	28.4	29.3	30.0	30.5	30.5	30.6	30.7	30.8	30.7	30.6
Craft employees and machine operators[3]	27.6	27.5	26.5	26.0	25.7	25.5	25.0	24.7	23.7	22.9	22.7	22.4	22.0	21.9	21.6
Elementary occupations	8.3	8.2	7.8	7.4	7.2	7.3	7.5	7.7	7.9	8.1	8.1	8.1	8.2	8.2	8.2
Military service	1.2	1.2	1.2	1.2	1.1	1.2	1.3	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.1

Source: Italian Institute if Statistics (ISTAT) and OECD.
[1] It includes also professionals, technicians and associate professionals.
[2] It includes also service employees.
[3] It includes also skilled agricultural and fishery employees, plant and machine operators and assemblers.

To have a better understanding of the distribution of non-natives across occupations, in Table 13 we report the number of non-natives as a share of the total number of employees by occupation. In 2005, approximately 4.3% of all employees were non-natives. Specifically, among employees employed in elementary occupations, approximately 15% were non-natives, among craft employees approximately 6% and among clerks or sale employees less than 3%. Among managers the percentage of non-natives was just 1.4%. In 2018, the number of non-natives as a share of the whole pool of employees is up to 10.6%, while in elementary occupations, the share of non-natives is up to 32%; among all craft employees 14% and among clerks and sales employees approximately 10%. The share of non-natives in managerial positions is still low (approximately 2%). Evidence on the share of non-natives in 3 digit occupations (129 categories) provides further support against the hypothesis of occupational segregation of non-natives. In the large majority of low-skilled occupations (85 categories) we observe the coexistence of a large share of both natives and non-natives. If we consider occupations with at least 10,000 employees (62 categories), there is no occupation with less than 20% non-natives.[22] This is the case also in occupations which are perceived as dominated by non-natives (Di Belgiojoso and Ortensi, 2015): approximately 24% of natives and 76% of non-natives are employed in domestic services and 20% of natives and 80% of non-natives are employed as blue-collars performing manual (routine) jobs.

We classify individuals in two categories, high-skilled and low-skilled, following the ILO classification, and we refer to high-skilled employees (with skill levels 3 or 4) as those individuals who work as managers or professionals. Moreover, we refer to low-skilled employees (with skill levels 1 or 2) as those individuals who work as clerks, sales employees, craft employees, plant and machine operators and in elementary occupations. For those for whom we do not observe the occupation, we use the occupation in their last job. For those for whom no information is available, we use the education level and correct for the issue of mismatch.[23]

Table 13. Share of non-natives by occupation.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Managers, etc.[1]	1.4	1.4	1.5	1.7	1.7	1.6	1.8	1.8	1.6	1.7	2.1	2.1	2.0	2.2	2.3
Clerks and sales employees[2]	2.6	3.2	4.0	4.5	5.0	5.0	4.9	7.2	8.0	8.7	9.2	9.4	9.8	10.3	10.2
Craft employees and machine operators[3]	6.1	7.4	8.9	10.0	11.3	0.116	12.4	12.7	12.8	13.2	13.3	13.7	13.6	13.2	14.0
Elementary occupations	15.2	18.2	18.7	20.5	25.9	29.7	31.9	29.9	31.0	32.6	33.6	34.2	33.9	33.1	32.4
Total	4.3	5.2	5.7	6.3	7.3	7.9	8.5	9.0	9.3	9.8	10.3	10.5	10.6	10.5	10.6

Source: Italian Institute if Statistics (ISTAT).
[1] It includes also professionals, technicians and associate professionals.
[2] It includes also service employees.
[3] It includes also skilled agricultural and fishery employees, plant and machine operators and assemblers.

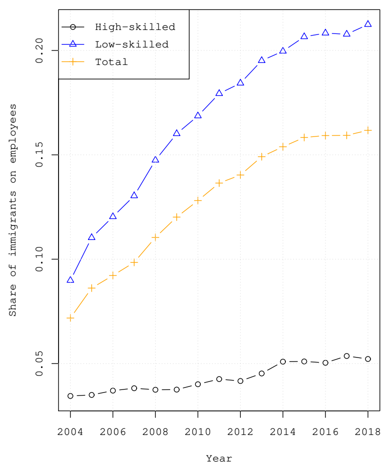
We use data from the Labour Force Survey as provided by the National Institute of Statistics (ISTAT) to compute the share of non-natives in the workforce and the unemployment rates by skill level, according to our classification. The great majority of non-natives is low-skilled, and their share in the workforce has increased by approximately 15% in the period 2004-2018. The share of non-native high-skilled employees has increased by 2% only in the period considered (Figure 9a). Among natives and non-natives (Figure 9b), the unemployment rate of low-skilled employees is higher compared to the unemployment rate of high-skilled employees. Among low-skilled employees, the unemployment rate is similar between natives and non-natives, while among high-skilled employees the unemployment rate of non-natives is much higher compared to the

[22]On the other hand, there are 5 low-skilled occupations in which the share of non-natives is below 5%.

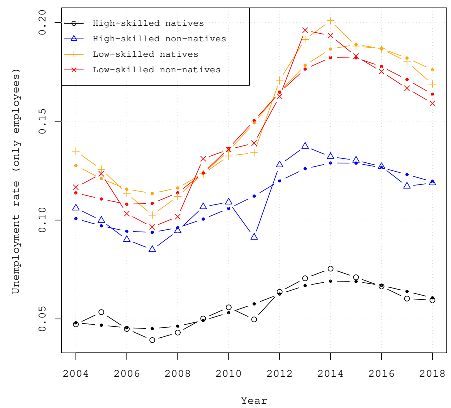
[23]Details are reported in Appendix H. The classification by education level is in line with a group of studies (Card and Lemieux, 2001; Card, 2009; Goldin and Katz, 2009) which has argued that the most relevant partition across employees by education groups is between people with at least some college education and people with a high school degree or less, i.e., "college-educated" and "non-college-educated" (Peri, 2016).

unemployment rate of natives. After the 2008/2009 crisis, the unemployment rates of low-skilled employees have increased relatively more compared to the unemployment rates of high-skilled employees, both among natives and non-natives.

Figure 9. Share of non-natives in the workforce and unemployment rates by skill level.



(a) Share of non-natives in the workforce by skill level.



(b) Unemployment rate by country of origin and skill level.

Source: Italian Labour Force Survey (RCFL).

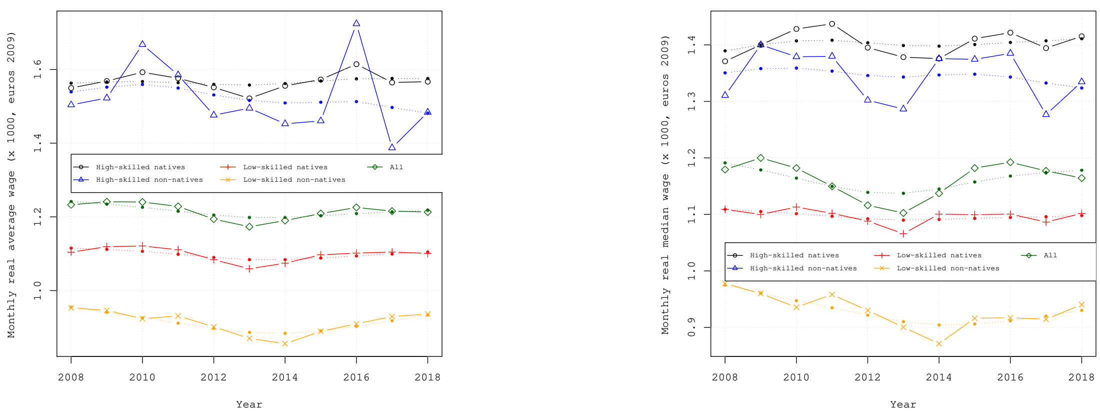
I.4 Wages

Figures 10a and 10b report the mean and median (net) real wages of employees by skill level and country of origin (natives and non-natives) for the years 2008-2018 calculated using data from the Labour Force Survey as provided by the National Institute of Statistics (ISTAT).[24] The real mean and median wages of both high-skilled and low-skilled native employees are higher than those of non-native employees, although the gap between the two is much larger among low-skilled employees. Specifically, employees with a low skill level who are non-natives earn 20% less than natives. Employees with a high skill level who are non-natives earn 10% less than natives. Native high-skilled employees earn 40% more than native low-skilled employees. Non-native high-skilled employees earn 55% more than non-native low-skilled employees. While the real wages of high-skilled employees both natives and non-natives, has been approximately constant during the period

[24] Few caveats need to be mentioned here in relation to the data used. First, the information on the individual wage is not released by ISTAT before 2008. Second, the wages reported are *nominal* monthly net wages, which are then converted into real monthly net wages using the price consumer index provided by ISTAT. The net wages refer to the wages earned by the employees the month before the interview, excluding additional monthly payments and thirteen and fourteen salaries. Finally, the wage distribution is left and right truncated as wages are capped in the range between 250€ and 3000€; mean wages are therefore calculated by fitting a beta distribution using the available data.

considered, from 2009 to 2014 the wage level of low-skilled employees has decreased in absolute terms. The wage of non-native employees has decreased more than the wage of native employees, and although it increased after 2014 it did not reach the pre-crisis level.[25] In the analysis, we use median wages (instead of mean wages) as we believe them to be more robust for the categories of employees we are considering.

Figure 10. Monthly real mean and median net wages (in thousands).



(a) Monthly real average net wages. (b) Monthly real median net wages.

Note: The monthly nominal net wages have been divided by the CPI index with 2009 used as base year. *Source*: Italian Labour Force Survey (RCFL).

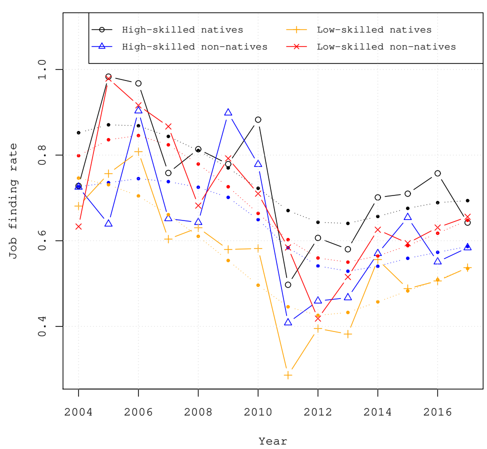
I.5 Job creation and job exit rates

Figure 11 reports the probability for a worker to find a job and the probability to lose a job, using the methodology proposed by Shimer (2012) and data on unemployment rates by skill level, as computed in Section I.3 (see Appendix G). High-skilled employees exhibit higher job finding rates and lower job exit rates compared to low-skilled employees, in agreement with the literature which provide evidence of low educated employees having the highest gross mobility (turnover) compared to middle and high educated employees (Landesmann et al., 2015). As in Dustmann et al. (2010), we find that among high-skilled, natives exhibit higher job finding rates, particularly after 2011, while among low-skilled employees the opposite is true. Over time, job finding rates across all types of employees have crashed in 2011 as a result of the crisis and while they have increased afterwards, as of 2018 they have not reached the level pre-crisis. Non-native employees tend to

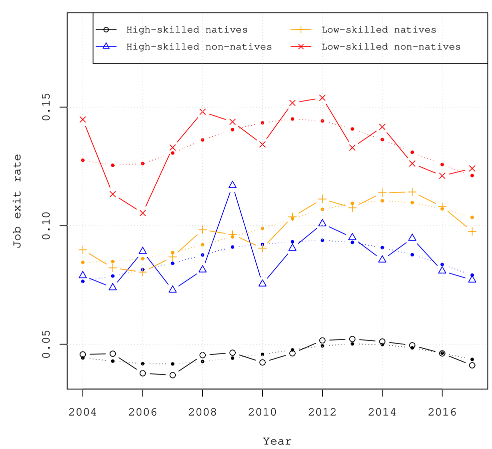
[25] It is noteworthy mentioning that the wage of high-skilled non-natives may not be accurate due to their small number in the sample.

have higher exit rates. This is in line with the literature, which shows that non-native employees lose their jobs more often than natives but once being unemployed they have more probabilities of finding a job than natives (Barth et al., 2012; Fullin, 2011). Heterogeneity between natives and non-natives may be due to the difference in the job tenure and the higher likelihood to be hired on temporary contracts.[26] The availability of financial support may also make a job search different for non-natives and natives, as poor support pushes unemployed into finding a job as soon as possible.[27] Finally, non-native employees tend to be concentrated in industries which are more vulnerable to economic slowdowns and in low-skilled occupations.[28]

Figure 11. Annual job finding and job exit rates 2004-2017.



(a) Job finding rates.



(b) Job exit rates.

Source: our calculations using data from the Italian Labour Force Survey (RCFL).

[26]The concentration of non-natives in the secondary labour market is the most important factor explaining their disadvantage in terms of risk of losing a job (Piore, 1979; OECD, 2007). In Italy, the share of non-natives hired on temporary contracts is only slightly higher than the share of natives (Table 14 in Appendix I.6), however, many non-natives hired on a permanent job are working in small firms in which the risk of losing a job is higher. Moreover, a large secondary labour market provides a great deal of poorly qualified jobs that are more suitable for non-natives, who have lower reservation wages than natives since they take the wages in their home country as a reference (Dustmann, 2000; Kalter and Kogan, 2002; Kogan, 2007).

[27]In Italy, non-natives are formally entitled to get unemployment benefits, but in practice they have less access, because their work history includes more spells of temporary and non-registered jobs (Fullin, 2011) and most non-natives cannot rely on family support (Uhlendorff and Zimmermann, 2014).

[28]In Italy, male non-natives are mainly employed in the construction and manufacturing sectors, which are either seasonal or very sensitive to business cycle fluctuations, whereas females non-natives are mainly employed as housekeepers and elderly caregivers, which are less sensitive to the business cycle (Fullin and Reyneri, 2011).

I.6 Temporary jobs among natives and non-natives

In most countries the probability of being hired on a temporary job is significantly higher for non-natives than for natives and the more temporary work is utilized as a form of employment, the greater is be the gap between non-natives and natives (OECD, 2007). In Italy, surprisingly, the share of non-natives hired on temporary contracts is only slightly higher than the share of natives, as shown in Table 14.

Table 14. Share of employees in temporary contracts among natives and non-natives.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Non-natives	0.145	0.147	0.153	0.147	0.156	0.143	0.151	0.158	0.163	0.152	0.158	0.164
Natives	0.118	0.121	0.129	0.130	0.131	0.123	0.124	0.130	0.135	0.129	0.133	0.140

Note: in this classification non-natives are defined not by country of birth, but by nationality.
Source: Italian Institute of Statistics (ISTAT).

J Details on the calibration of the model's parameters

In this section we describe in detail the steps followed to calibrate the levels of non-native inflow rate, tax subsidy, firing cost, and vacancy cost (and some robustness checks on these).

J.1 The inflow rate of non-natives

In our model the total inflow of non-natives (TII) is given by:

$$TII = \eta\left(\sigma_{h,I} + \sigma_{l,I}\right), \tag{82}$$

which is the product between the rate η at which non-native employees arrive in the country and the stock of all non-native employees in the country $\sigma_{h,I} + \sigma_{l,I}$. Using the stock of employed non-native employees (Equations (33)) and (82)), we can derive an expression for the rate at which non-native employees join the country η:

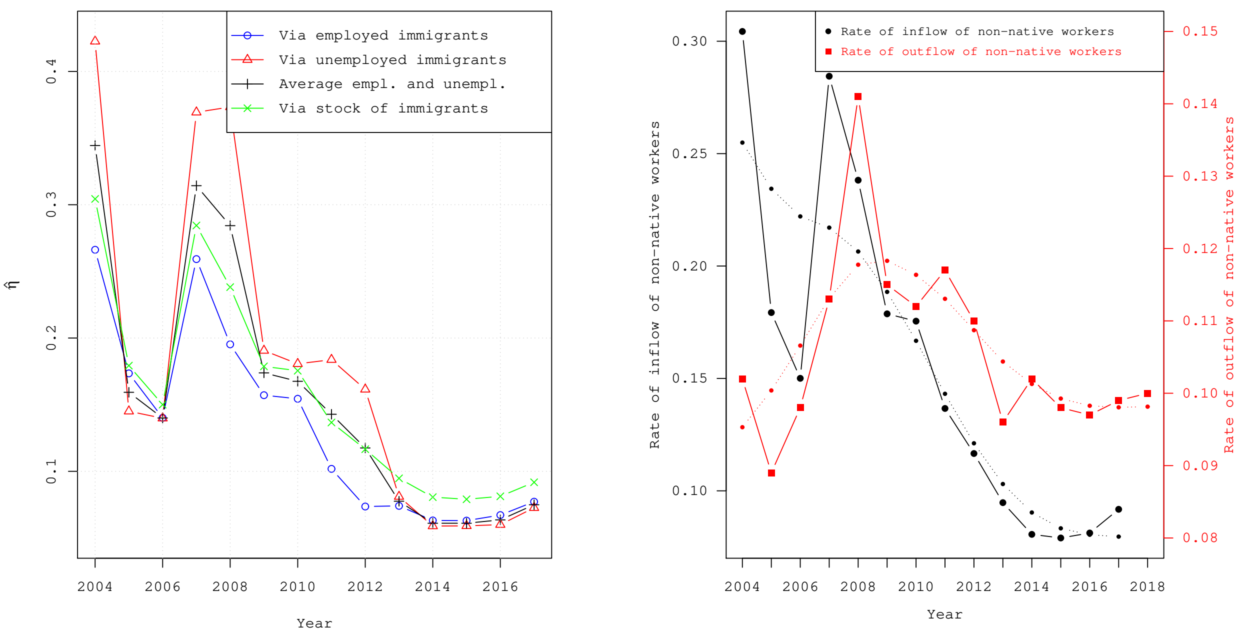
$$\eta = \frac{TII - \lambda\left[e_{h,I}\delta_{h,I}/\kappa_{h,I}\theta_h q\left(\theta_h\right) + e_{l,I}\delta_{l,I}/\kappa_{l,I}\theta_l q\left(\theta_l\right)\right]}{e_{h,I}\left[\kappa_{h,I}\theta_h q\left(\theta_h\right) + \delta_{h,I}\right]/\kappa_{h,I}\theta_h q\left(\theta_h\right) + e_{l,I}\left[\kappa_{l,I}\theta_l q\left(\theta_l\right) + \delta_{l,I}\right]/\kappa_{l,I}\theta_l q\left(\theta_l\right)}. \tag{83}$$

The same rate can be computed using the stock of unemployed non-native employees (Equations (34) and (82):

$$\eta = \frac{TII - \lambda\left(u_{h,I} + u_{l,I}\right)}{u_{h,I}\left[\kappa_{h,I}\theta_h q\left(\theta_h\right) + \delta_{h,I}\right]/\delta_{h,I} + u_{l,I}\left[\kappa_{l,I}\theta_l q\left(\theta_l\right) + \delta_{l,I}\right]/\delta_{l,I}}. \tag{84}$$

Figure 12 reports the estimates of η based on Equations (34), (83) and (84) using data as provided by the OECD statistics.

Figure 12. Non-native inflow and outflow rates



(a) Non-native inflow rate (different approaches compared)

(b) Inflow and outflow rates of non-native employees

Source: Own calculations based on the model.

J.2 The tax subsidy

OECD provides data on the average and marginal tax rates for individuals earning 67, 100, 133 and 167 percent of the average annual gross labour income, as reported in Table 15.

Table 15. Average and marginal personal income tax rate on gross labour income.

	67	100	133	167
Average	0.129	0.221	0.272	0.300
Marginal	0.309	0.401	0.411	0.407

Source: OECD.

We use these rates to compute the parameter τ, which is a tax subsidy for all employees, which makes the taxation progressive. We focus on low-skilled employees, who enjoy 67% of the average wage, for whom we assume their income lay within the first tax bracket (i.e., there is only one marginal tax rate). For them the average tax is equal to $[t_l w_l - \tau(1-t_l)]/w_l$. The average tax rate is then given by:

$$\bar{t} = \frac{t^m w - \tau(1 - t^m)}{w}, \tag{85}$$

where $\bar{t}$ is the average tax rate and t^m is the marginal tax rate. The numerator includes the total taxes paid by each employee and the denominator is the individual wage. Since we have data on $\bar{t}$ and t^m, we can compute τ as:

$$\tau = 0.67\bar{w}\left[\frac{t^m - \bar{t}}{1 - t^m}\right]. \tag{86}$$

To calculate the no-tax area we compute the wage $\underline{w}$ by which the average tax rate (Equation (85)) is equal to zero:

$$t^m(1 - t^m)\left(\frac{\tau}{\underline{w}}\right) = 0, \tag{87}$$

which leads to:

$$\underline{w} = \frac{(1 - t^m)\tau}{t^m}. \tag{88}$$

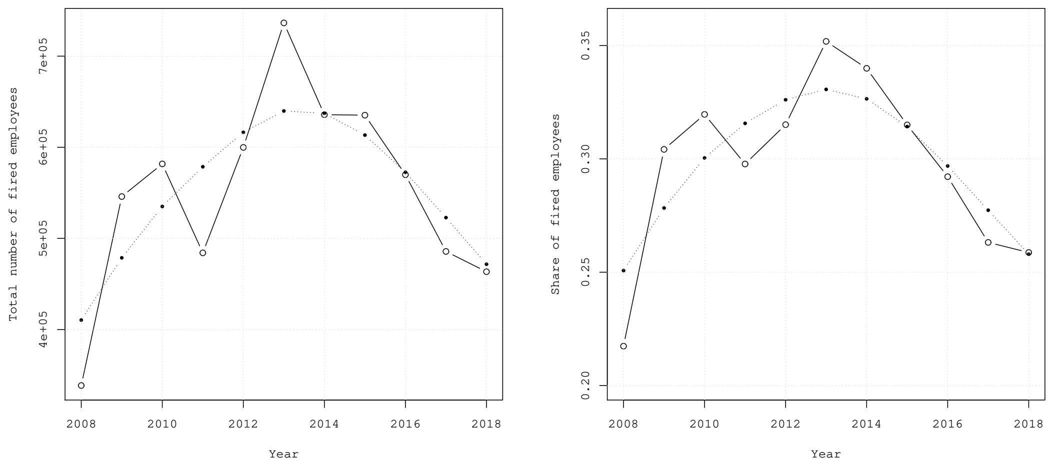
J.3 The firing cost

In the Italian legislation, a firing cost is not due in case of quitting, hence in this case F is equal to zero. Moreover, an employer-initiated separation is legitimate only when it satisfies a "just clause". The Italian civil law (st. n 604/1966, sect. 3) foresees that individual dismissal is legal only under the two headings: justified objective motive, i.e. "justified reasons concerning the production activity, the organization of labor in the firm and its regular functioning", and justified subjective motives, i.e. "a significantly inadequate fulfilment of the employee's tasks specified by the court". The first heading involves events which are outside the employee's control, while the second case requires misconduct on the part of the worker. The worker has always the right to appeal the firm's decision, and the final judgment ultimately depends on the court's interpretation of the case. If the separation is ruled fair, or if the worker does not appeal the firing decision, the legislation does not impose any firing cost to the firm. Conversely, when the separation is ruled unfair and illegitimate, the court imposes a specific set of transfers and "taxes" to the firm.

In Figure 13, we report the number of fired employees as the share of the total number of employees, who lost their job.

With the so called "Fornero Law" implemented in 2013 (Law n.92 del 2012), all employers who fire employees are required to contribute to the payment of the unemployment benefits, the worker is entitled to. This is also a form of firing costs. Specifically, employers need to pay 41% of the maximum monthly unemployment benefit, per each 12 month of tenure in the previous 3 years. For instance, in 2013 the maximum monthly unemployment benefit amounted to 483,80 €, hence

Figure 13. Number and share of fired employees.



(a) Total number of fired employees (b) The share of fired employees on total job losses

Source: Own calculation based on the Italian Labour Force Survey (RCFL).

the employer is required to pay approximately 1.451,00 €, to the social security institute, which is approximately equal to an average monthly salary. Moreover, the law introduced a fast-track to try to accelerate the trials in case of dismissal. The main purpose was to create greater and faster legal certainty in the dismissal system, especially with regard to the financial consequences of an unfair dismissal. The proceedings in first instance were split into two phases. The first phase was initiated by means of a complaint lodged at the Labour Court, followed by a judge's order to schedule a summary hearing within forty days of the complaint, and ended with a preliminary, but enforceable, court order upholding or rejecting the claim. The second, optional, phase offered both parties the opportunity to oppose the preliminary rulings within thirty days of the initial judgment being notified; this culminated in a final, first-instance verdict. Afterwards, as under the old procedure, the parties could appeal the judgment at the *Corte di Appello* (second degree) (de Vaate, 2017).

Specifically, we consider a situation where an employer-initiated individual separation against a blue-collar worker with average tenure in a firm with more than 15 employees is ruled unfair by the judge after a trial. The computation is based on the ex-post firing cost, once the case has been taken to court and the judge has reached the verdict. Obviously, ex-ante the firm does not know with certainty whether any given individual dismissal will be appealed by the worker, and whether the separation will be ruled legitimate.

First of all, the worker should be granted the foregone wages from the separation's day up to the court ruling, while the firm should pay the foregone social insurance contributions augmented by a penalty for delayed payment. In addition, the worker may choose between a severance payments of 15 months or the right of being reinstated by the firm that unlawfully fired him. Finally, all the legal costs should be paid by the firm.

Thus, if we let n be the number of months that it took to reach a court decision, w the gross monthly wage, ss the social security contributions, pp the penalty rate on foregone contributions, sp the mandatory severance payments for unfair dismissal and lc the total legal cost, the expected firing costs (EFC) when the worker opts for the severance payment over reinstatement (this happens in over 95% of the cases), which in our model corresponds to $F\tilde{p}_i x_i$, is

$$EFC = [n + (ss + pp)n + sp + lc]\, w. \tag{89}$$

The pure transfer component paid by the firm to the worker is

$$S = (n + \backepsilon\, ssn + sp)w. \tag{90}$$

where $\backepsilon$ is the share of the social security contributions that is rebated to the worker in the form of increased future pensions. The tax component is

$$T = [(1 - \backepsilon)ssn + ppn + lc]w. \tag{91}$$

We allow the number of months that it took to reach a court decision to be different whether it is a first degree trial or an appeal: n_{fd} defines the number of months in first degree trials and n_a the number of months in case of appeal. If we ignore discounting, and we denote as p_f the probability of being fired, p_s the probability of suing the company, p_w the probability that the firing is ruled unfair and, p_a be the probability of appeal,the ex-ante expected firing cost is:

$$\begin{aligned} EFC &= p_f \{(1 - p_s)C_{NA} + p_s [(1 - p_w)C_L + p_w [n_{fd} + (ss + pp)n_{fd} + sp + lc]\, w] + \\ &+ p_s(1 - p_w)p_a p_w [n_a + (ss + pp)n_a + sp + lc]\, w + p_s(1 - p_w)p_a(1 - p_w)C_{SD}\}\,, \end{aligned} \tag{92}$$

where C_L is the firing costs incurred by the firm when the judge rules the firing legitimate, C_{NA} is cost incurred when the worker does not appeal the firm decision, and C_{SD} is the firing costs incurred by the firm when the judge rules the firing legitimate after an appeal. Since, in the Italian legislation $C_L = C_{NA} = C_{SD} = 0$, the ex-ante expected firing cost is

$$\begin{aligned} EFC &= p_f p_s p_w \left[n_{fd} + (ss+pp)n_{fd} + sp + lc \right] w + \\ &+ p_f p_s (1-p_w) p_a p_w \left[n_a + (ss+pp)n_a + sp + lc \right] w. \end{aligned} \tag{93}$$

We can then compute the firing cost F as a proportion of the value added of the employees (as in the model) as:

$$\begin{aligned} F &= p_f \Big\{ \mathbb{1}^F + p_s p_w \left[n_{fd} + (ss+pp)n_{fd} + sp + lc \right] + \\ &+ p_s (1-p_w) p_a p_w \left[n_a + (ss+pp)n_a + sp + lc \right] \Big\} \left(\frac{w}{\tilde{p}x} \right), \end{aligned} \tag{94}$$

where $\mathbb{1}^F$ is the additional cost introduced by the Fornero reform in 2013.

Finally, one should recall that most employer-initiated separations do not end up in court since employers and employees may well find a satisfactory settlement before the full trial is over. In the case of an off-court agreement, the parties can save any court penalties that may eventually be imposed by a judge, and all the legal costs linked to the trial.

Table 16. Firing cost components.

	Symbol	First Degree	Appeal
Social Security Contributions	ss	4/12	4/12
Sanctions for Delayed Payments	pp	3/12	3/12
Legal Costs	lc	3	3
Severance Payments	sp	15	-

Following Garibaldi and Violante (2002), we set the legal cost and the sanctions for delayed payments equal to three gross monthly salaries (Table 16), in line with the evidence provided by (Ichino, 1996). The severance payments are set by law equal to 15 monthly salaries. Given the large uncertainty about the judges' decisions (Ichino, 1996; Ichino et al., 2003), we assume symmetry in the probability that the judges rule in favor of the worker, i.e., $p_w = 0.5$. Using Equation (94) and the data reported in Table 16, we are able to compute the estimated firing costs (Table 14).

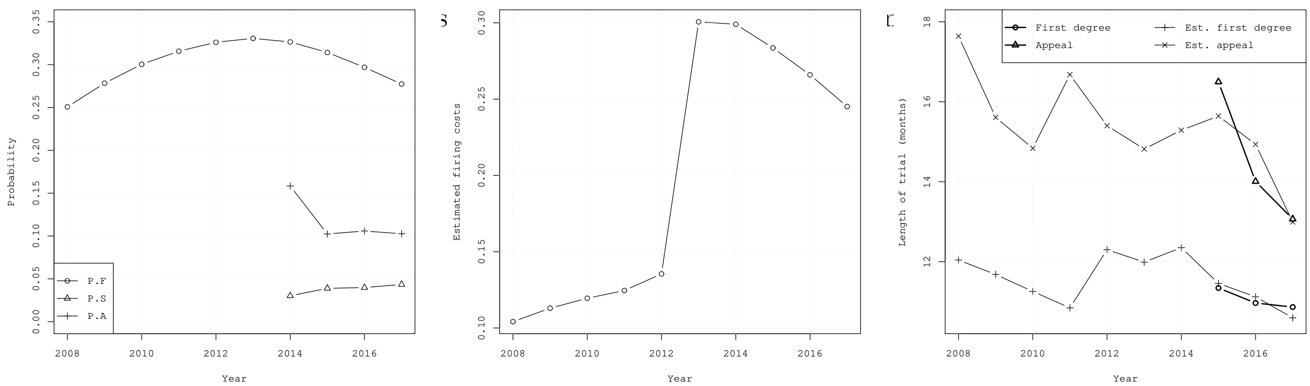
The average trail length is calculated using data from the Italian Ministry of Justice on ensued, pending and settled trials fro the years 2014-2017 (Figure 14). Specifically, we compute the monthly probability of closing a trial (P^m_{ct}) assuming a uniform distribution of ensued and settled trials over the months, as

$$P^m_{ct} = \frac{ST_m}{PT_{t-1} + ET_m}, \tag{95}$$

where ST_m is the flow of settled trials in month 1 (January), PT_{t-1} is the stock of pending trials at time $t-1$ and ET_m is the flow of ensued trials in month 1 (January). The average length of trials is therefore computed as

$$ATL = \frac{1}{P_{ct}^{m}}, \tag{96}$$

assuming that the trials are distributing according to a Poisson process (Figure 14).



(a) Probabilities to be fired, to sue and to appeal.

(b) Estimated firing costs (F).

(c) Trial length first degree and appeal (in months).

Source: Own calculation based on data from the Italian Department of Justice.

Finally, in 2015 the government implement a new reform to create incentives for firms to hire employees on a permanent basis, the *Jobs Act*. The reform introduced a new form of open-ended contract with firing cost increasing with tenure, reducing *de facto* the firing costs to be paid by the employer in case of unfair dismissal. As part of the reform, employers and employees can also opt for negotiations right after the firing to avoid the legal route, which could be costly, long and uncertain for both parties. These negotiations allow employers to pay within two months from the event (firing of the employee) half the amount it would have had to pay in case of a judicial ruling in favor of the employee. However, these new rules apply only to the new open-ended contract and hence we believe that for the years 2015-2017 the change in the average aggregate firing cost has been minimal.

J.4 The vacancy cost

The vacancy cost in the model is equal to:

$$cp_i x_i = \kappa_{i,j} q(\theta) TC, \tag{97}$$

where TC is the total cost of opening a vacancy, $q(\theta)$ is the probability to fill a vacancy and $cp_i x_i$ is the instantaneous cost of vacancy, which is paid by the employer in each instant of time and it is proportional to the real value added. Rearranging, we that the instantaneous vacancy cost c is equal to:

$$c = \frac{\kappa_{i,j} q(\theta) TC}{p_i x_i}. \tag{98}$$

The next step is to move away from an instantaneous cost to a monthly cost, as per our calibration. To achieve this goal, we compute the monthly job finding rate ($\kappa_{i,j} q(\theta)^m$) and the monthly real value added ($p_i x_i^m$), to get:

$$c^m = \frac{\kappa_{i,j} q(\theta)^m TC}{p_i x_i^m}. \tag{99}$$

Since $TC = DC + OC$, where DC is the direct cost and OC is the opportunity cost, we can the previous equation as:

$$c^m = \kappa_{i,j} q(\theta)^m \left(\frac{DC}{p_i x_i^m} + \frac{OC}{p_i x_i^m} \right). \tag{100}$$

To compute the monthly cost we use the job finding rate as calculated in Appendix G and data on direct cost and opportunity cost per person from The World Bank 'Doing Business', which we converted into the per worker variables.

K The system of equations defining the model's equilibrium

The equilibrium is the solution of the following system of 17 nonlinear equations in 17 variables ($i \in \{h, l\}$).

$$e_{i,N} = \sigma_{i,N} \left[\frac{\kappa_{i,N} \theta_i q(\theta_i)}{\delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i)} \right]; \tag{101}$$

$$u_{i,N} = \sigma_{i,N} \left[\frac{\delta_{i,N}}{\delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i)} \right]; \tag{102}$$

$$e_{i,I} = \sigma_{i,I} \left\{ \frac{\eta \kappa_{i,I} \theta_i q(\theta_i)}{\lambda \delta_{i,I} + \eta \left[\kappa_{i,I} \theta_i q(\theta_i) + \delta_{i,I} \right]} \right\}; \tag{103}$$

$$u_{i,I} = \sigma_{i,I} \left\{ \frac{\eta \delta_{i,I}}{\lambda \delta_{i,I} + \eta \left[\kappa_{i,I} \theta_i q(\theta_i) + \delta_{i,I} \right]} \right\}; \tag{104}$$

$$
\begin{aligned}
\tilde{w}_{i,N} &= \beta_j(1-t)\left\{\frac{(r+\delta_{i,N}+\kappa_{i,N}\theta_i q(\theta_i))}{(1-t)[(r+\delta_{i,N})(1-b(1-\beta_j))+\beta_j\kappa_{i,N}\theta_i q(\theta_i)]}\right\}\tilde{p}_i x_i + \\
&- \frac{(1-\beta_j)(r+\delta_{i,N})(1-t)(1-b)}{(1-t)[(r+\delta_{i,N})(1-b(1-\beta_j))+\beta_j\kappa_{i,N}\theta_i q(\theta_i)]}\tilde{\tau} + \\
&+ \left\{\frac{\beta_j r(r+\delta_{i,N}+\kappa_{i,N}\theta_i q(\theta_i))+\phi(r+\delta_{i,N})(1-\beta_j)[(r+\kappa_{i,N}\theta_i q(\theta_i))]}{(1-t)[(r+\delta_{i,N})(1-b(1-\beta_j))+\beta_j\kappa_{i,N}\theta_i q(\theta_i)]}\right\}\tilde{p}_i x_i F; \qquad (105)
\end{aligned}
$$

$$
\begin{aligned}
\tilde{w}_{i,I} &= \beta_I(1-t)\left\{\frac{(r+\lambda)(r+\delta_{i,I})+r\kappa_{i,I}\theta_i q(\theta_i)}{(1-t)\left\{(r+\delta_{i,I})[(\lambda+r)-rb(1-\beta)]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\tilde{p}_i x_i + \\
&- \left\{\frac{(1-\beta_I)(r+\delta_{i,I})(1-t)[(1-b)r+\lambda]}{(1-t)\left\{(r+\delta_{i,I})[(\lambda+r)-rb(1-\beta)]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\tilde{\tau} + \\
&+ \left\{\frac{\lambda r(1-\beta_I)(r+\delta_{i,I})}{(1-t)\left\{(r+\delta_{i,I})[(\lambda+r)-rb(1-\beta)]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}W_{i,FC} + \\
&+ \left\{\frac{\phi(r+\delta_{i,I})(1-\beta_I)(r+\lambda)\left(r+\kappa_{i,I}\theta_i q(\theta_i)-\lambda\right)}{(1-t)\left\{(r+\delta_{i,I})[(\lambda+r)-rb(1-\beta)]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}} + \right. \\
&+ \left.\frac{\beta_I r\left[(r+\delta_{i,I})(r+\lambda)+r\kappa_{i,I}\theta_i q(\theta_i)\right]}{(1-t)\left\{(r+\delta_{i,I})[(\lambda+r)-rb(1-\beta)]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\tilde{p}_i x_i F + \\
&- \left\{\frac{\lambda(1-\beta_I)(r+\delta_{i,I})}{(1-t)\left\{(r+\delta_{i,I})[(\lambda+r)-rb(1-\beta)]+\beta_I r\kappa_{i,I}\theta_i q(\theta_i)\right\}}\right\}\iota\nu. \qquad (106)
\end{aligned}
$$

$$
\begin{aligned}
\tilde{p}_i &= \frac{q(\theta_i)\pi_{i,N}\kappa_{i,N}(r+\delta_{i,I})(1-t)\tilde{w}_{i,N}}{x_i\left\{q(\theta_i)\left[\pi_{i,N}\kappa_{i,N}(r+\delta_{i,I})(1-t-\delta_{i,N}F)+(1-\pi_{i,N})\kappa_{i,I}(r+\delta_{i,N})(1-t-\delta_{i,I}F)\right]-c(r+\delta_{i,N})(r+\delta_{i,I})\right\}} + \\
&+ \frac{q(\theta_i)(1-\pi_{i,N})\kappa_{i,I}(r+\delta_{i,N})(1-t)\tilde{w}_{i,I}}{x_i\left\{q(\theta_i)\left[\pi_{i,N}\kappa_{i,N}(r+\delta_{i,I})(1-t-\delta_{i,N}F)+(1-\pi_{i,N})\kappa_{i,I}(r+\delta_{i,N})(1-t-\delta_{i,I}F)\right]-c(r+\delta_{i,N})(r+\delta_{i,I})\right\}}; \qquad (107)
\end{aligned}
$$

$$
\tilde{p}_h = \left\{\gamma^{1/(1-\rho)}+(1-\gamma)\gamma^{\rho/(1-\rho)}\left[\frac{(1-g_l)x_l(e_{l,N}+e_{l,I})}{(1-g_h)x_h(e_{h,N}+e_{h,I})}\right]^{\rho}\right\}^{(1-\rho)/\rho} \qquad (108)
$$

$$
\tilde{p}_l = \left\{(1-\gamma)^{1/(1-\rho)}+\gamma(1-\gamma)^{\rho/(1-\rho)}\left[\frac{(1-g_h)x_h(e_{h,N}+e_{h,I})}{(1-g_l)x_l(e_{l,N}+e_{l,I})}\right]^{\rho}\right\}^{(1-\rho)/\rho} \qquad (109)
$$

$$
\iota\nu = \frac{\iota g[\tilde{p}_h x_h(e_{h,N}+e_{h,I})+\tilde{p}_l x_l(e_{l,N}+e_{l,I})]}{\left(\sigma_{h,N}+\sigma_{l,N}+e_{h,I}+e_{l,I}+u_{h,I}+u_{l,I}+\chi+z\right)^{\rho}}. \qquad (110)
$$

L Welfare equations of employers and employees

$$W^u_{i,N} = \frac{Z^u_{i,N}}{r} + \left(\frac{\kappa_{i,N}\theta_i q\left(\theta_i\right)}{r}\right)\left\{\left(\frac{\beta_N}{1-\beta_N}\right)\left[\frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,N})}{r+\delta_{i,N}} - \frac{\delta_{i,N}\tilde{p}_i x_i F}{r+\delta_{i,N}} + \tilde{p}_i x_i F\right] + \right.$$
$$\left. + \phi\tilde{p}_i x_i F\right\}; \tag{111}$$

$$W^u_{i,I} = \frac{Z^u_{i,I} + \lambda W_{i,FC}}{(r+\lambda)} + \left(\frac{\kappa_{i,I}\theta_i q\left(\theta_i\right)}{r+\lambda}\right)\left\{\left(\frac{\beta_I}{1-\beta_I}\right)\left[\frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,I})}{r+\delta_{i,I}} - \frac{\delta_{i,I}\tilde{p}_i x_i F}{r+\delta_{i,I}} + \tilde{p}_i x_i F\right] + \right.$$
$$\left. + \phi\tilde{p}_i x_i F\right\}; \tag{112}$$

$$W^e_{i,N} = W^u_{i,N} + \frac{(1-b)\left(1-t\right)\left(\tilde{w}_{i,j} + \tilde{\tau} + \delta_{i,N}\phi\tilde{p}_i x_i F\right)}{r+\delta_{i,N}+\kappa_{i,N}\theta_i q\left(\theta_i\right)}; \tag{113}$$

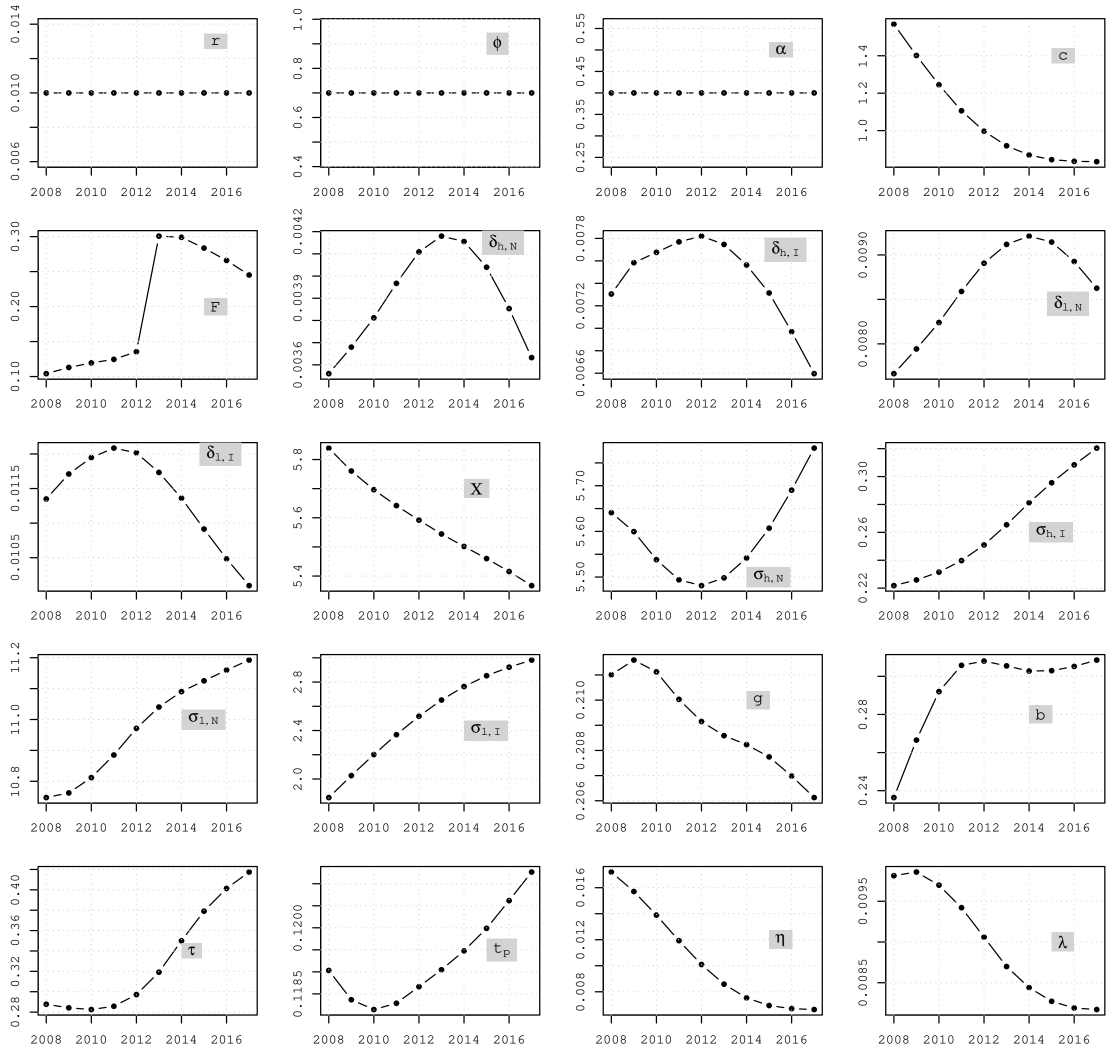
$$W^e_{i,I} = W^u_{i,I} + \frac{(1-b)\left(1-t\right)\left(\tilde{w}_{i,j} + \tilde{\tau}\right) - \lambda\left(W_{i,FC} - W^u_{i,I}\right) + \delta_{i,I}\phi\tilde{p}_i x_i F}{r+\delta_{i,I}+\kappa_{i,I}\theta_i q\left(\theta_i\right)}; \tag{114}$$

$$J_{i,N} = \frac{(1-t)\left(\tilde{p}_i x_i - \tilde{w}_{i,N}\right) - \delta_{i,N}\tilde{p}_i x_i F}{r+\delta_{i,N}}; \tag{115}$$

$$J_{i,I} = \frac{(1-t)\left(\tilde{p}_i x_i - \tilde{w}_{i,I}\right) - \delta_{i,I}\tilde{p}_i x_i F}{r+\delta_{i,I}}. \tag{116}$$

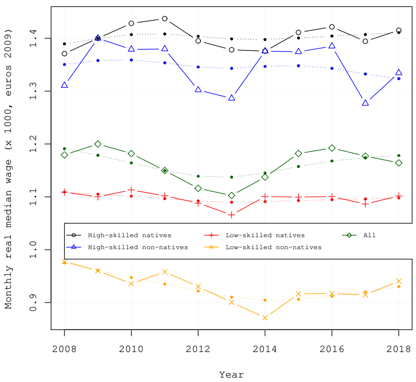
M Calibrated parameters

Figure 15. The twenty calibrated parameters of the model.

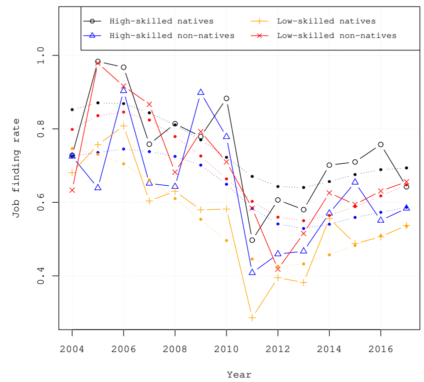


N Moments (smoothed) to be matched

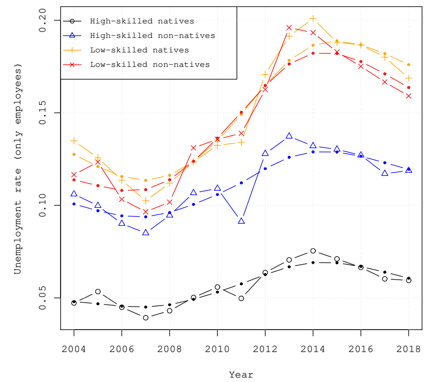
Figure 16. Seventeen moments to be matched.



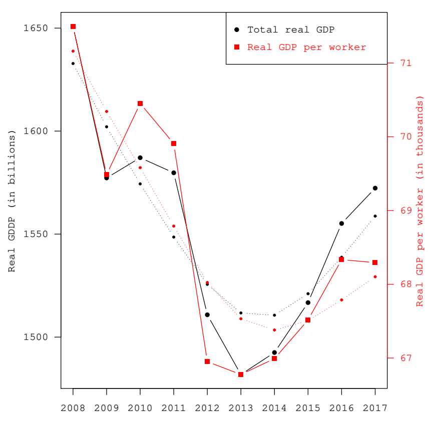
(a) Monthly real median wages.



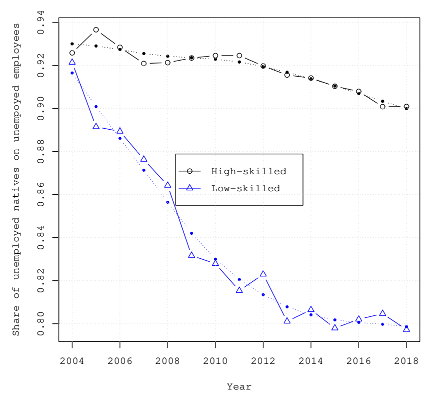
(b) Job finding rates.



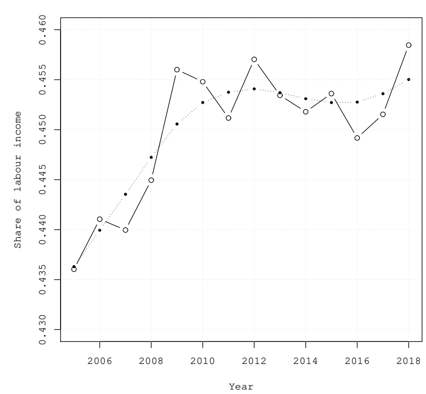
(c) Unemployment rates.



(d) Total real GDP (in billions) and real GDP per worker (in thousands).



(e) Composition of unemployment (high-skilled versus low-skilled)

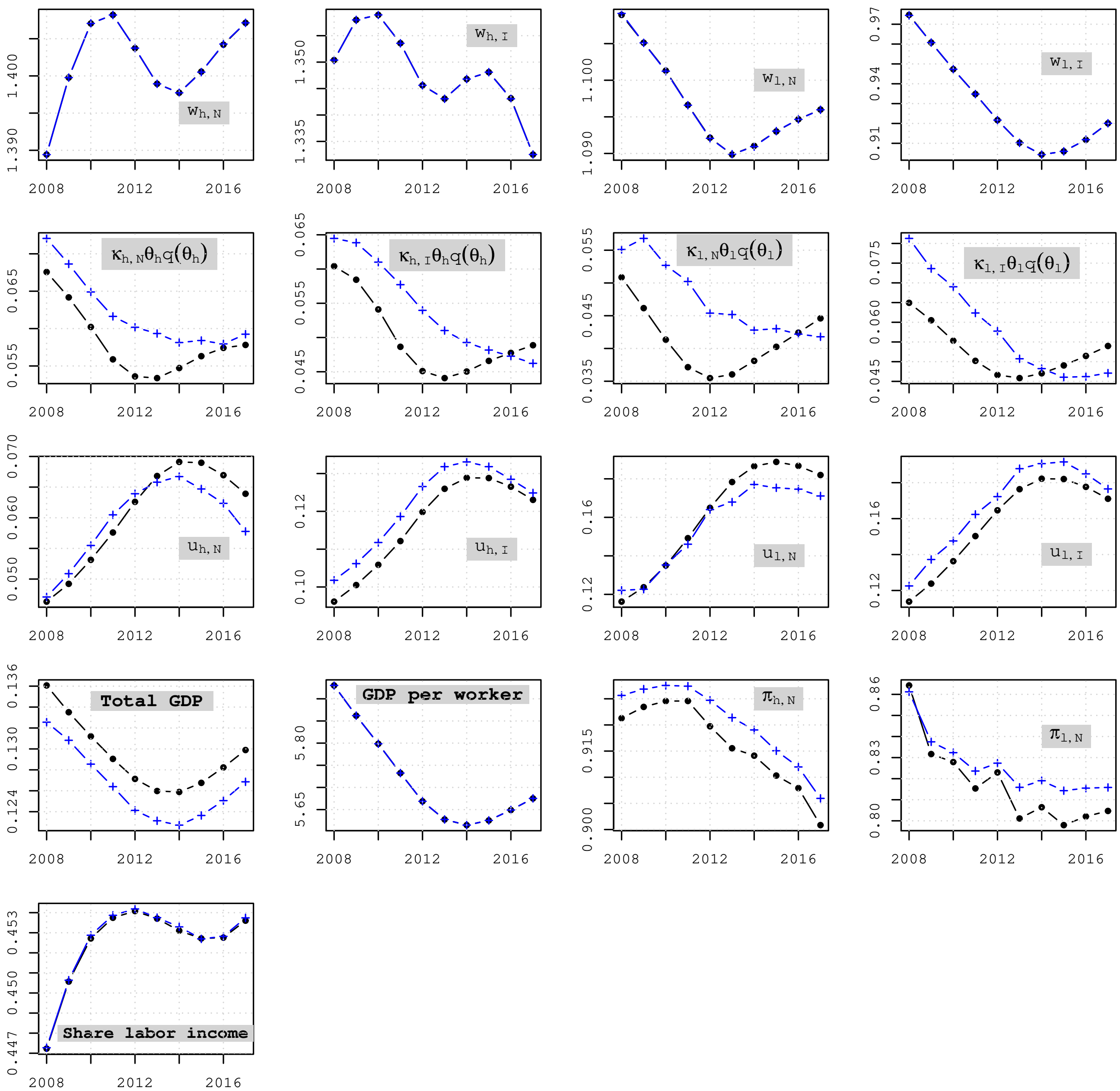


(f) Share of (non-adjusted) labour income on total GVA

Note: The labour income share is computed as the ratio between the total (non adjusted) labour income and the gross domestic product (GVA), both provided in nominal terms. The real GDP and the real median wages are computed using the CPI index (base year 2009). *Source*: The labour income share and the real GDP are based on our own calculations based on data from the Italian Institute of Statistics (ISTAT). The median real wages, the job finding rates and the unemployment rates are based on our own calculations based on data from the Italian Labour Force Survey (RCFL).

O Observed versus matched moments

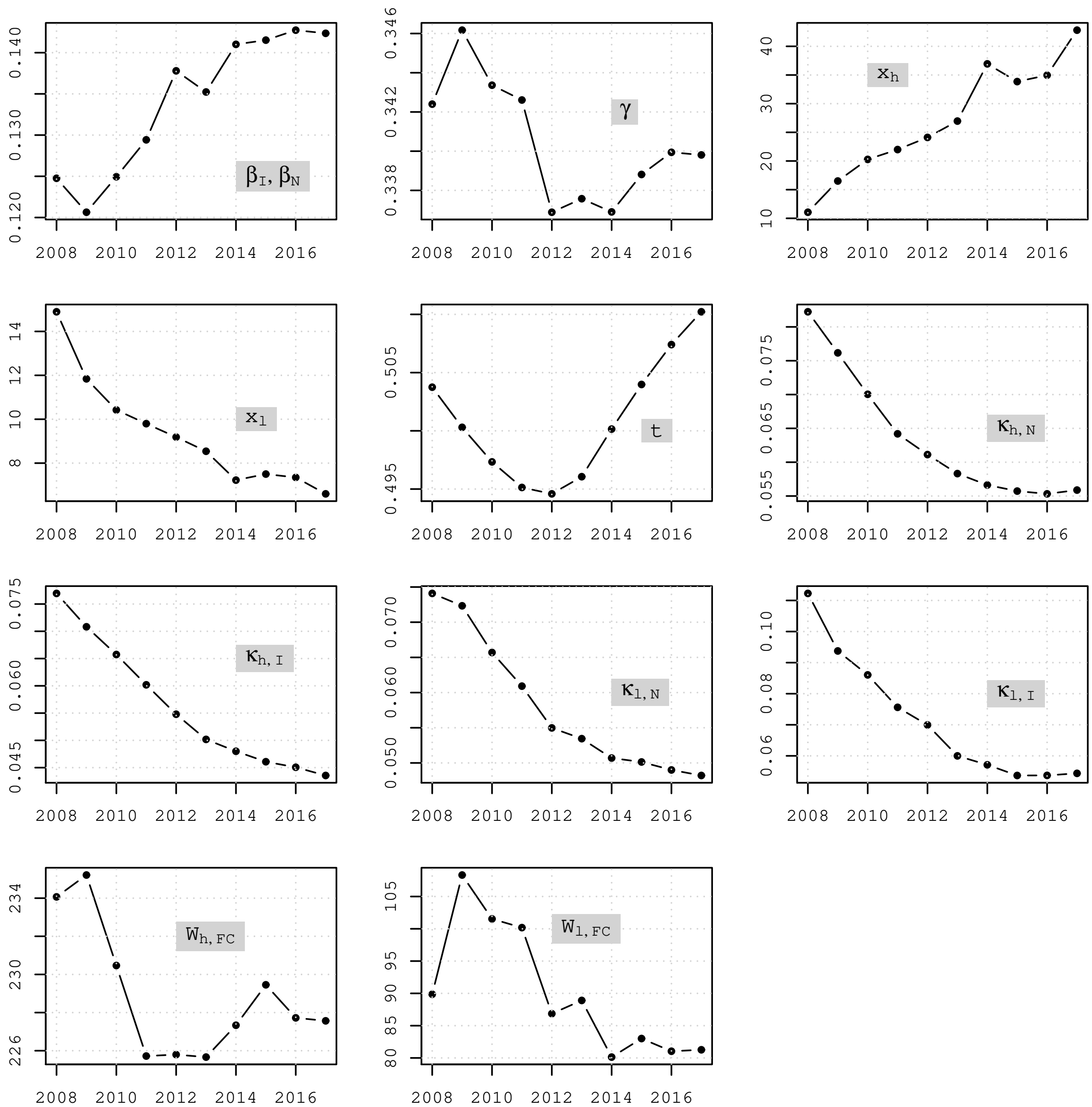
Figure 17. The seventeen observed versus matched moments.



Note: The observed moments are in black with solid circles, while the matched moments are in blue with plus symbols. We indicate with N native employees, I non-native employees, h high-skilled employees and l low-skilled employees. The moments include net real wages (w), job finding rates ($\kappa\theta q(\theta)$) and unemployment rates (u) for the four categories of employees, total real GDP, real GDP per worker, the shares of native unemployed employees in the low-skilled and high-skilled markets (π), and the (non adjusted) share of labour income.

P Matched parameters

Figure 18. The twelve matched parameters.



Note: we indicate with N native employees, I non-native employees, h high-skilled employees and l low-skilled employees. The matched parameters include the bargaining power of the employees (β) (which is assumed to be the same for natives and non-natives), the elasticity of substitution between high-skilled and low-skilled goods (γ), the value added of high-skilled and low-skilled employees (x), the direct tax rate (t), the hiring chances of four types of employees (κ) and the lifetime utility of high-skilled and low-skilled employees abroad (W_{FC}).

Q Other endogenous variables

Figure 19. Gross value added of firms in the high-skilled and low-skilled markets (px) and the per-capita value of the provision of public goods (ν).