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ABSTRACT

Winners and Losers of Immigration

We aim to identify winners and losers of a sudden inflow of low-skilled immigrants using a general equilibrium search and matching model in which employees, either native or nonnative, are heterogeneous with respect to their skill level and produce different types of goods. We estimate the short-term impact of this shock for Italy in the period 2008-2017 to be sizeable and highly asymmetric. In 2017, the real wages of low-skilled and high-skilled employees were 8% lower and 4% higher, respectively, compared to a counter-factual scenario with no non-natives. Similarly, employers working in the low-skilled market experienced a drop in profits of comparable magnitude, while the opposite happened to employers operating in the high-skilled market. Finally, the presence of non-natives led to a 10% increase in GDP and to an increment of approximately 70 billions € in Government revenues and 18 billions € in social security contributions. We argue that these results help rationalise the recent surge of anti-immigrant sentiments among the low-income segment of the Italian population.

JEL Classification: J61, J64, J21, J31

Keywords: immigration, welfare, search and matching

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1 Introduction

In many countries in the last decade public sentiments towards immigration have been profoundly divided on the basis of party identification and political ideology (Tabellini and Gennaioli, 2019). National-populist parties have gained momentum by leveraging on the widespread belief among the general public that immigration has adverse effects on the labour market and by elevating the protection of the national culture to be their main mission. The growth of these movements is echoed online, as populist parties make large use of social media creating *de facto* a medley of virtual and real-world political activity, which has become the way millions of people relate to politics in the twenty-first century (Bartlett et al., 2011). After a fierce campaign against immigration, the vote share of the Italian populist Northern League party grew from 17.4% in the 2018 national elections to 34.3% in the 2019 European elections. 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 of votes reached almost 50% (SWG, 2019). Is this simply the result of a mass media cultural backlash against liberalism and immigration or is it also motivated by economic factors? The results of our analysis point to strong economic motives behind this recent shift of Italian voters toward no-immigration parties, being the new voters of these parties mainly the losers from immigration as identified in our model. However, we also estimate substantial aggregate gains from immigration, suggesting that redistribution policies could be effective in contrasting this shift.

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). Theoretical studies on the effects of immigration on native labour market outcomes have populated the literature since the 1980s (Borjas, 2003; Borjas and Tienda, 1987; Greenwood and McDowell, 1986). The neoclassical economic 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

¹See, e.g., Blau and Kahn (2012) for recent surveys of the literature on the topic.

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 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 (D'Amuri et al., 2010; Manacorda et al., 2012; Ottaviano and Peri, 2012). Scant is instead the literature on the use of a general equilibrium search and matching model to quantify the impact of immigration. 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 (Battisti et al., 2018; Chassamboulli and Palivos, 2014; Iftikhar and Zaharieva, 2019; Monras, 2020).²

We develop a novel general equilibrium search and matching model where two 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. 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". In an economy characterized by the presence of two goods which are produced by employees with different skill levels, a large inflow of low-skilled employees has two major effects. 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 induces a loss for employers who operate in the low-skilled market. Our framework also includes a Government which collects revenues by taxing production, wages and profits and redistributes the income through the provision of public goods, unemployment benefits and a tax subsidy.

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 10%. Indirect taxes and direct taxes, which are proportional to total production were also 10% higher, and social security contributions were 7% higher, corresponding to an overall

²To be mentioned Liu (2010), who develops a dynamic general equilibrium model with imperfect substitution between domestic and illegal immigrants to quantify the welfare effects of illegal immigration.

increase in the Government revenues of approximately 90 billions €. However, gross value added (GVA) per worker and the per capita provision of public goods were lower by approximately 2% and 1%, respectively. Among employees, the wage of low-skilled employees was lower by approximately 8%, while the wage of high-skilled employees was higher by approximately 4%. 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 (+3%) and negative for low-skilled employees (-6%). At the same time, the value of a filled vacancy, which we interpret as a proxy for the employers' expected profits, was 6% higher for firms operating in the high-skilled market and 12% 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 (CES imposed) complementarity between native and non-native employees (Borjas, 2003; Dustmann et al., 2013; 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.³ Second, while the few search and matching general equilibrium models in the literature which study the immigration phenomenon (Battisti et al., 2018; Chassamboulli and Palivos, 2013) focus on labour market outcomes, our approach provides a more comprehensive picture of the impact on immigration not only on wages, unemployment and the welfare of employees, but also on prices, output mix, expected profits, Government revenues and social security contributions. Third, while in the literature the estimation of general 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), in this paper we match a much larger set of moments with respect to the estimated parameters in order to assess the ability of the model to reproduce the dynamics of the most important variables. Fourth, we are the first to provide evidence on the impact of immigration in Italy, which has experienced large immigration inflows in the last decade.

This paper is organized as follows. In Section 2 we describe the search and matching model and the steady-state equilibrium. In Section 3 we provide detailed labour market statistics by types of employees in Italy during the period 2008-2017, describe the empirical analysis and illustrate the methodology used to estimate the model. Section 4 shows the results, compared to a counter-

³For instance, the job finding and job exit rates of employees within the same labour market differ according to the country of origin, hence natives and non-natives are not perfect substitute, although their value added is the same.

factual scenario in which there are no non-natives. Section 5 concludes the paper with some policy recommendations.

2 The Model

Consider the following continuous time infinite-horizon economy. 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 a 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 $q(\theta_i) \rightarrow 1$ and $\theta_i q(\theta_i) \rightarrow 0$ as $\theta_i \rightarrow 0$, and $q(\theta_i) \rightarrow 0$ and $\theta_i q(\theta_i) \rightarrow 1$ as $\theta_i \rightarrow \infty$.

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 data (see Section 3.1.4), 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 (see Section 3.1.4): 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.⁴

2.1 Employees

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

$$Y_i = d_{h,i,j}^\gamma d_{l,i,j}^{1-\gamma} + \nu, \quad (1)$$

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 utility ν comes from the public goods provided by the Government, where ν is a proxy for the elasticity of substitution between private and public goods. Finally, γ is the elasticity of substitution between high-skilled and low-skilled goods. Both parameters $\gamma \in (0, 1)$ and $\nu > 0$ represent individuals' preferences.⁵

⁴In particular, differences in inflow and outflow rates between high-skilled and low-skilled employees are determined by long-term forces, such as the change in physical capital endowments, which are outside the scope of this paper.

⁵We include the term ν as an additive factor, rather than multiplicative, for tractability purposes and to avoid complementarity/substitution effects with the private goods, which are already captured by the parameter ν .

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

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

Employees earn a wage $w_{i,j}$, gross of social security contributions, which is taxed at proportional rate t .⁶ In order to introduce the possibility of progressive taxation, we assume that employees receive a tax subsidy τ .⁷ 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 :

$$\begin{aligned} d_{h,i,j}^e &= \frac{\gamma(1-t)(w_{i,j} + \tau)}{p_h} \text{ and} \\ d_{l,i,j}^e &= \frac{(1-\gamma)(1-t)(w_{i,j} + \tau)}{p_l}, \end{aligned} \quad (3)$$

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

$$\begin{aligned} d_{h,i,j}^u &= \frac{b\gamma(1-t)(w_{i,j} + \tau)}{p_h} \text{ and} \\ d_{l,i,j}^u &= \frac{b(1-\gamma)(1-t)(w_{i,j} + \tau)}{p_l}. \end{aligned} \quad (4)$$

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

$$Y_{i,j}^e = \psi(1-t)(\tilde{w}_{i,j} + \tilde{\tau}) + \iota\nu \text{ and} \quad (5)$$

$$Y_{i,j}^u = b\psi(1-t)(\tilde{w}_{i,j} + \tilde{\tau}) + \iota\nu, \quad (6)$$

where $\psi \equiv \gamma^\gamma(1-\gamma)^{1-\gamma}$. 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 $p \equiv p_h^\gamma p_l^{1-\gamma}$ as the economy price index. Let $W_{i,N}^e$ be the present discounted value

⁶In 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 Section 3.1.3 for the Italian data on net wages).

⁷As 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 $T(w_{i,j}) = tw_{i,j} - (1-t)\tau$.

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 equations read:

$$rW_{i,N}^e = Y_{i,N}^e + \delta_{i,N} (W_{i,N}^u + \phi \tilde{p}_i x_i F - W_{i,N}^e) \text{ and} \quad (7)$$

$$rW_{i,I}^e = Y_{i,I}^e + \delta_{i,I} (W_{i,I}^u + \phi \tilde{p}_i x_i F - W_{i,I}^e). \quad (8)$$

Employees who are employed, both natives and non-natives, enjoy the indirect utility of being employed $Y_{i,j}^e$. At rate $\delta_{i,j}$ the match is exogenously destroyed and they become unemployed: in these circumstances, 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:

$$rW_{i,N}^u = Y_{i,N}^u + \kappa_{i,N} \theta_i q(\theta_i) (W_{i,N}^e - W_{i,N}^u) \text{ and} \quad (9)$$

$$rW_{i,I}^u = Y_{i,I}^u + \lambda (W_{i,FC} - W_{i,I}^u) + \kappa_{i,I} \theta_i q(\theta_i) (W_{i,I}^e - W_{i,I}^u). \quad (10)$$

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 ,⁸ 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. As λ is likely to be influenced by socio-political factors which have similar effects across the population, we set it constant for all employees independent of their skill level.

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 preferences of employer q read as:

$$Y_q = d_{h,q}^\gamma d_{l,q}^{(1-\gamma)} + \nu. \quad (11)$$

Employers consume quantities d of 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

⁸The model could be extended by allowing native employees to leave the country too. However, as reported in the Appendix A, the share of native unemployed who emigrate is very low (about 2.5%). Nevertheless, our main theoretical and empirical findings would be substantially unchanged.

to the following budget constraint:

$$p_h d_{hq} + p_l d_{lq} = P_q, \quad (12)$$

where P_q are the employer's q net profits. The optimal quantities of goods h and l demanded by employer q are:

$$\begin{aligned} d_{h,q} &= \frac{\gamma P_q}{p_h} \text{ and} \\ d_{l,q} &= \frac{(1 - \gamma) P_q}{p_l}. \end{aligned} \quad (13)$$

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 equations for a filled position read:⁹

$$rJ_{i,N} = (1 - t)(\tilde{p}_i x_i - \tilde{w}_{i,N}) + \delta_{i,N} (V_i - J_{i,N} - \tilde{p}_i x_i F) \text{ and} \quad (14)$$

$$rJ_{i,I} = (1 - t)(\tilde{p}_i x_i - \tilde{w}_{i,I}) + \delta_{i,I} (V_i - J_{i,I} - \tilde{p}_i x_i F), \quad (15)$$

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 functions in Equations (14) and (15) take 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:

$$rV_i = -c\tilde{p}_i x_i + \pi_{i,N} \kappa_{i,N} q(\theta_i) (J_{i,N} - V_i) + (1 - \pi_{i,N}) \kappa_{i,I} q(\theta_i) (J_{i,I} - V_i), \quad (16)$$

where $c\tilde{p}_i x_i$ is the vacancy cost which is proportional to the value added of the employee, $\kappa_{i,j} q(\theta_i)$ is the rate at which a vacancy is filled, and $\pi_{i,N} \equiv u_{i,N} / (u_{i,N} + u_{i,I})$ 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.

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

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:

$$\left(W_{i,j}^e - \phi \tilde{p}_i x_i F - W_{i,j}^u\right)^{\beta_j} (J_{i,j} + \tilde{p}_i x_i F - V_i)^{1-\beta_j}, \quad (17)$$

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 $\beta_N \geq \beta_I$, due to a number of factors (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 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 , $W_{i,N}^u$ and $W_{i,I}^u$ 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:

$$(1 - \beta_j)(W_{i,j}^e - \phi \tilde{p}_i x_i F - W_{i,j}^u) = \beta_j \psi (J_{i,j} + \tilde{p}_i x_i F - V_i). \quad (18)$$

2.4 The Government

To conclude the presentation of the model, we assume that the Government expenditure in public goods is equal to the share g of aggregate real value added (GVA); however, the per capita provision of public goods is also subject to congestion, as measured by the parameter $\rho \geq 0$ ($\rho = 0$ is the case of pure public goods):

$$\nu = \frac{g[\tilde{p}_h x_h (e_{h,N} + e_{h,I}) + \tilde{p}_l x_l (e_{l,N} + e_{l,I})]}{(\sigma_{h,N} + \sigma_{l,N} + e_{h,I} + e_{l,I} + u_{h,I} + u_{l,I} + \chi + z)^\rho}, \quad (19)$$

where the denominator of Equation (19) is the total population, which includes both the labour force and the rest of the population z (inactive individuals and people who are not in the working age). The Government collects the following amount of direct taxes:

$$DT \equiv t [\tilde{p}_h x_h (e_{h,N} + e_{h,I}) + \tilde{p}_l x_l (e_{l,N} + e_{l,I}) + \tilde{\tau} (e_{l,N} + e_{l,I} + e_{h,N} + e_{h,I})] + tb [\tilde{w}_{h,N} u_{h,N} + \tilde{w}_{h,I} u_{h,I} + \tilde{w}_{l,N} u_{l,N} + \tilde{w}_{l,I} u_{l,I}], \quad (20)$$

where t_p is the indirect tax rate net of production subsidies, and the following amount of indirect taxes:¹⁰

$$IT \equiv \left(\frac{t_p}{1 - t_p} \right) [\tilde{p}_h x_h (e_{h,N} + e_{h,I}) + \tilde{p}_l x_l (e_{l,N} + e_{l,I})]. \quad (21)$$

Finally, the total Government expenditure amount to the following:¹¹

$$TGE \equiv \tilde{\tau} (e_{l,N} + e_{l,I} + e_{h,N} + e_{h,I}) + b [\tilde{w}_{h,N} u_{h,N} + \tilde{w}_{h,I} u_{h,I} + \tilde{w}_{l,N} u_{l,N} + \tilde{w}_{l,I} u_{l,I}] + g [\tilde{p}_h x_h (e_{h,N} + e_{h,I}) + \tilde{p}_l x_l (e_{l,N} + e_{l,I})]. \quad (22)$$

Given the scope of our paper, we do not impose any type of budget constraint to the Government, but we separately consider in the empirical analysis direct and indirect taxes.

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 economic agents, 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 Equations (14) and

¹⁰The 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.

¹¹With a slight stretch we include the tax subsidy among the Government expenditure.

(15) in Equation (16) and applying the free-entry condition:

$$\begin{aligned} & \pi_{i,N} \kappa_{i,N} q(\theta_i) \left[\frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,N}) - \delta_{i,N} \tilde{p}_i x_i F}{r + \delta_{i,N}} \right] + \\ & + (1 - \pi_{i,N}) \kappa_{i,I} q(\theta_i) \left[\frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,I}) - \delta_{i,I} \tilde{p}_i x_i F}{r + \delta_{i,I}} \right] = c \tilde{p}_i x_i. \end{aligned} \quad (23)$$

Equation (23) 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 (23)). The benefit is a positive function of the employee's value added $\tilde{p}_i x_i$ and a negative function of the wage paid $w_{i,j}$ and of the firing cost to be paid in case of dismissal $\delta_{ij} \tilde{p}_i x_i F$.

To compute the equilibrium wages of native and non-native employees in each market we subtract Equation (9) from Equation (7) and Equation (10) from Equation (8):

$$W_{i,N}^e - W_{i,N}^u = \frac{(1-b)\psi(1-t)(\tilde{w}_{i,j} + \tilde{\tau} + \delta_{i,N} \phi \tilde{p}_i x_i F)}{r + \delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i)} \text{ and} \quad (24)$$

$$W_{i,I}^e - W_{i,I}^u = \frac{(1-b)\psi(1-t)(\tilde{w}_{i,j} + \tilde{\tau}) - \lambda(W_{i,FC} - W_{i,I}^u) + \delta_{i,I} \phi \tilde{p}_i x_i F}{r + \delta_{i,I} + \kappa_{i,I} \theta_i q(\theta_i)}. \quad (25)$$

By plugging Equation (24) into the Nash bargaining Equation (18), we get an expression for the wages of native employees in each market, which is a function of the parameters of the model:

$$\begin{aligned} \tilde{w}_{i,N} &= \beta_N \psi(1-t) \left\{ \frac{r + \delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i)}{\psi(1-t)[(r + \delta_{i,N})[1 - b(1 - \beta_N)] + \beta_N \kappa_{i,N} \theta_i q(\theta_i)]} \right\} \tilde{p}_i x_i + \\ &- \left\{ \frac{\psi(1-t)(1 - \beta_N)(r + \delta_{i,N})(1 - b)}{\psi(1-t)[(r + \delta_{i,N})[1 - b(1 - \beta_N)] + \beta_j \kappa_{i,N} \theta_i q(\theta_i)]} \right\} \tilde{\tau} + \\ &+ \left\{ \frac{\beta_N \psi r [r + \delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i)] + \phi(r + \delta_{i,N})(1 - \beta_N)[r + \kappa_{i,N} \theta_i q(\theta_i)]}{\psi(1-t)[(r + \delta_{i,N})[1 - b(1 - \beta_N)] + \beta_N \kappa_{i,N} \theta_i q(\theta_i)]} \right\} \tilde{p}_i x_i F. \end{aligned} \quad (26)$$

Similarly, by plugging Equation (25) into the Nash bargaining Equation (18) and substituting

into Equation (10), and reshuffling, we get an expression for the wages of non-native employees:

$$\begin{aligned}
\tilde{w}_{i,I} = & \beta_I \psi(1-t) \left\{ \frac{(r+\lambda)(r+\delta_{i,I}) + r\kappa_{i,I}\theta_i q(\theta_i)}{\psi(1-t) \{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r \kappa_{i,I} \theta_i q(\theta_i) \}} \right\} \tilde{p}_i x_i + \\
& - \left\{ \frac{(1-\beta_I)(r+\delta_{i,I})\psi(1-t) [(1-b)r + \lambda]}{\psi(1-t) \{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r \kappa_{i,I} \theta_i q(\theta_i) \}} \right\} \tilde{\tau} + \\
& + \left\{ \frac{\lambda r(1-\beta_I)(r+\delta_{i,I})}{\psi(1-t) \{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r \kappa_{i,I} \theta_i q(\theta_i) \}} \right\} W_{i,FC} + \\
& + \left\{ \frac{\phi(r+\delta_{i,I})(1-\beta_I)(r+\lambda) (r+\kappa_{i,I}\theta_i q(\theta_i) - \lambda)}{\psi(1-t) \{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r \kappa_{i,I} \theta_i q(\theta_i) \}} \right\} + \\
& + \left. \frac{\beta_I \psi r [(r+\delta_{i,I})(r+\lambda) + r\kappa_{i,I}\theta_i q(\theta_i)]}{\psi(1-t) \{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r \kappa_{i,I} \theta_i q(\theta_i) \}} \right\} \tilde{p}_i x_i F + \\
& - \left\{ \frac{\lambda(1-\beta_I)(r+\delta_{i,I})}{\psi(1-t) \{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r \kappa_{i,I} \theta_i q(\theta_i) \}} \right\} \nu. \tag{27}
\end{aligned}$$

Equations (26) and (27) show that the real wage both of 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.

Employees can be employed or unemployed in the home country or residing in a foreign country (FC). We assume that the measure of high-skilled natives in the labour force is equal to $\sigma_{h,N}$ and the measure of low-skilled natives in the labour force is equal to $\sigma_{l,N}$. Hence, employment and unemployment for native employees of different skill levels can be computed as:

$$e_{i,N} = \sigma_{i,N} \left[\frac{\kappa_{i,N}\theta_i q(\theta_i)}{\delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)} \right] \text{ and} \tag{28}$$

$$u_{i,N} = \sigma_{i,N} \left[\frac{\delta_{i,N}}{\delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)} \right]. \tag{29}$$

Assuming that the measure of high-skilled and low-skilled non-natives is equal to $\sigma_{h,I}$ and $\sigma_{l,I}$,

respectively, the measures of employed and unemployed non-natives are given by:

$$e_{i,I} = \sigma_{i,I} \left\{ \frac{\eta \kappa_{i,I} \theta_i q(\theta_i)}{\lambda \delta_{i,I} + \eta [\kappa_{i,I} \theta_i q(\theta_i) + \delta_{i,I}]} \right\} \text{ and} \quad (30)$$

$$u_{i,I} = \sigma_{i,I} \left\{ \frac{\eta \delta_{i,I}}{\lambda \delta_{i,I} + \eta [\kappa_{i,I} \theta_i q(\theta_i) + \delta_{i,I}]} \right\}. \quad (31)$$

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

$$FC_{i,I} = \sigma_{i,I} \left\{ \frac{\lambda \delta_{i,I}}{\lambda \delta_{i,I} + \eta [\kappa_{i,I} \theta_i q_{i,I}(\theta_i) + \delta_{i,I}]} \right\}. \quad (32)$$

2.5.2 The Equilibrium in the Goods Markets

Prices are endogenously determined by equating the demand and supply of the high-skilled and low-skilled goods. By definition, the real prices \tilde{p}_h and \tilde{p}_l are equal to the nominal prices divided by the price index $p_h^\gamma p_l^{1-\gamma}$, and hence they can be written as:

$$\tilde{p}_h = \tilde{p}_l^{(\gamma-1)/\gamma}. \quad (33)$$

By equating demand and supply of good h , using Equation 33 for \tilde{p}_l , we implicitly get the real price \tilde{p}_h as:

$$\begin{aligned} & b(\tilde{w}_{h,N} u_{h,N} + \tilde{w}_{h,I} u_{h,I} + \tilde{w}_{l,N} u_{l,N} + \tilde{w}_{l,I} u_{l,I}) + [(e_{l,N} + e_{l,I}) + b(u_{l,N} + u_{l,I})] \tilde{\tau} + \\ & + \tilde{p}_h^{\gamma/(\gamma-1)} x_l (e_{l,N} + e_{l,I}) = \tilde{p}_h x_h (e_{h,N} + e_{h,I}) \left[\frac{1 - \gamma(1-t)}{\gamma(1-t)} \right], \end{aligned} \quad (34)$$

from which we can derive \tilde{p}_l , using Equation (33).

3 Empirical Analysis

In this section we bring the model to the data to quantify the impact of an immigration shock. Specifically, in Section 3.1 we present some figures about the Italian labour market in the period 2004-2017 which illustrate why Italy represents a good case study to evaluate the effects of immigration. In Section 3.2 we discuss the calibration of some of the model's parameters, while in Section 3.3 we explain in detail the estimation method.¹²

¹²Data and codes are available at <https://owncloud.ec.unipi.it/index.php/s/enr2SvuXmErit8p>.

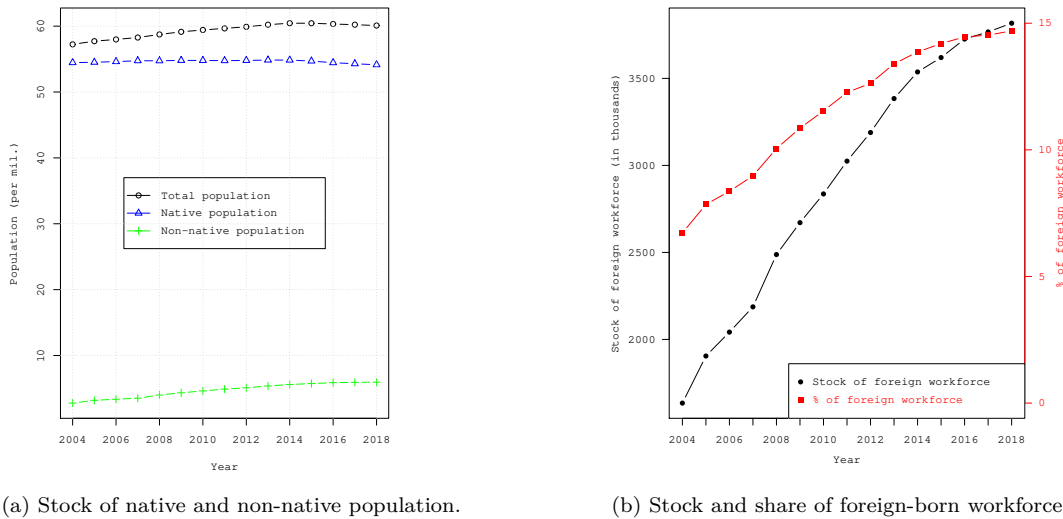
3.1 The Italian labour market

To objective of this section is to provide evidence about i) the size of non-natives in Italy becoming larger and larger, reaching approximately 15% of the total workforce in 2017; ii) low-skilled employees being the strong majority (about 90%) of the non-native workforce; and iii) the strong heterogeneity in wages, job creation and job exit rates among high-skilled, low-skilled, native and non-native employees.

3.1.1 The size of immigration

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 1). 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% in 2018.

Figure 1. Stocks of native and non-native population and workforce.



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

Table 1 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

Table 1. 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).

single pick of 14% in 2008.¹³

The activity rate and the employment rate are much higher for non-natives than for natives (Table 2). The 2008-2009 economic crisis drove the employment rate of non-native employees 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 2. 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).

¹³For natives inflow and outflow rates, please refer to Table 8 in the Appendix D.

3.1.2 Employees' occupation, composition and unemployment

Table 3 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 3. 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 of 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 4 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%).

We therefore 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.¹⁴

Table 4. 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 of Statistics (ISTAT).

¹ It includes also professionals, technicians and associate professionals.

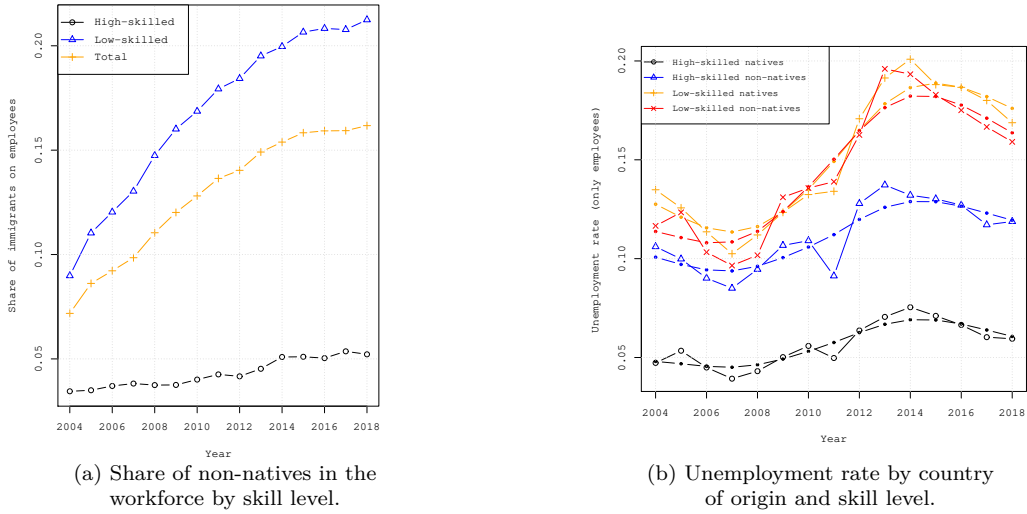
² It includes also service employees.

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 2a). Among natives and non-natives (Figure 2b), 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 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.

¹⁴Details are reported in Appendix B. The classification by education level is in line with a group of studies (Card, 2009; Card and Lemieux, 2001; 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).

Figure 2. Share of non-natives in the workforce and unemployment rates by skill level.



Source: Italian Labour Force Survey (RCFL).

3.1.3 Wages

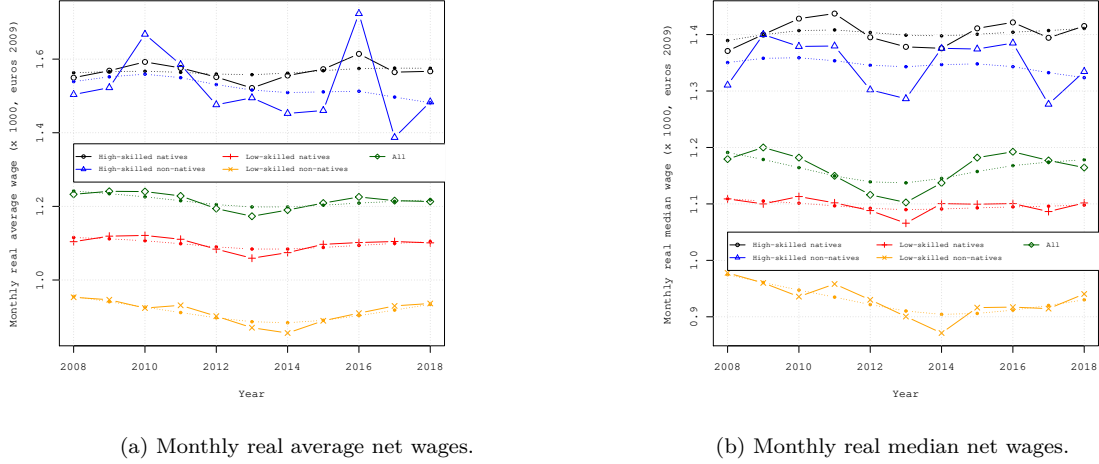
Figures 3a and 3b) report the mean and median (net) real wages of employees by skill level and country of origin (natives and non-natives) for the years 2008-2018 calculated using data from the Labour Force Survey as provided by the National Institute of Statistics (ISTAT).¹⁵ The real mean and median 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 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 didn't reach the pre-crisis level.¹⁶ In the analysis, we use

¹⁵Few 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.

¹⁶It is noteworthy mentioning that the wage of high-skilled non-natives may not be accurate due to their small number in the sample.

median wages (instead of mean wages) as we believe them to be more robust for the categories of employees we are considering.

Figure 3. Monthly real mean and median net wages (in thousands).



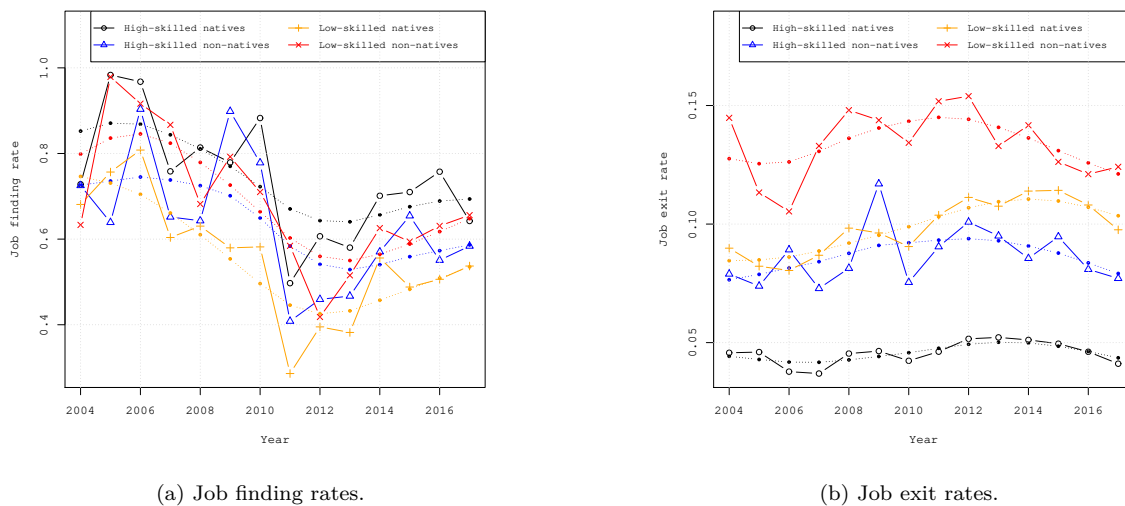
Note: The monthly nominal net wages have been divided by the CPI index with 2009 used as base year. *Source:* Italian Labour Force Survey (RCFL).

3.1.4 Job Creation and Job Exit Rates

Figure 4 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 3.1.2 (see Appendix C). 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 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.¹⁷ 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.¹⁸ Finally, non-native employees tend to be concentrated in industries which are more vulnerable to economic slowdowns and in low-skilled occupations.¹⁹

Figure 4. Annual job finding and job exit rates 2004-2017.



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

3.2 Calibration of parameters

Table 5 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

¹⁷The 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 (OECD, 2007; Piore, 1979). In Italy, the share of non-natives hired on temporary contracts is only slightly higher than the share of natives (Table 13 in Appendix D), 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).

¹⁸In 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).

¹⁹In 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).

Table 5. Description of model parameters and data sources.

Parameter	Description	Source
r	Discount rate	DellaVigna and Paserman (2005)
ϕ	Share of firing costs transferred to employees	Garibaldi and Violante (2005)
α	Elasticity of matching function with respect to unemployment	Petrongolo and Pissarides (2001)
c	Vacancy cost	Our calculation (Appendix E.4)
F	Firing cost	Our calculation (Appendix E.3)
$\delta_{h,N}$	Job destruction rate of high-skilled native employees	Our calculation (Appendix C)
$\delta_{l,N}$	Job destruction rate of low-skilled native employees	Our calculation (Appendix C)
$\delta_{h,I}$	Job destruction rate of high-skilled non-native employees	Our calculation (Appendix C)
$\delta_{l,I}$	Job destruction rate of low-skilled non-native employees	Our calculation (Appendix C)
χ	Mass of employers	Italian Labour Force Survey (RCFL)
$\sigma_{h,N}$	Mass of high-skilled native employees	Italian Labour Force Survey (RCFL)
$\sigma_{l,N}$	Mass of low-skilled native employees	Italian Labour Force Survey (RCFL)
$\sigma_{h,I}$	Mass of high-skilled non-native employees	Italian Labour Force Survey (RCFL)
$\sigma_{l,I}$	Mass of low-skilled non-native employees	Italian Labour Force Survey (RCFL)
g	Government expenditure in public goods as percentage of GVA	Our calculation (Appendix H)
b	Unemployment benefits	Our calculation (Appendix H)
τ	Tax subsidy	Our calculation (Appendix E.2)
t_p	Indirect tax rate	Our calculation (Appendix H)
η	Rate at which non-natives enter the country	Our calculation (Appendix E.1)
λ	Rate at which non-natives exit the country	Our calculation (Appendix E.1)
β_N	Bargaining power of native employees	Estimated by matching moments
β_I	Bargaining power of non-native employees	Estimated by matching moments
γ	Elasticity of substitution between HS and LS goods	Estimated by matching moments
x_h	Quantity of good h produced by high-skilled employees	Estimated by matching moments
x_l	Quantity of good l produced by low-skilled employees	Estimated by matching moments
t	Direct tax rate (income and profits)	Estimated by matching moments
$\kappa_{h,N}$	Hiring chances of high-skilled native employees	Estimated by matching moments
$\kappa_{l,N}$	Hiring chances of low-skilled native employees	Estimated by matching moments
$\kappa_{h,I}$	Hiring chances of high-skilled non-native employees	Estimated by matching moments
$\kappa_{l,I}$	Hiring chances of low-skilled non-native employees	Estimated by matching moments
$W_{h,FC}$	Utility of high-skilled employees abroad	Estimated by matching moments
$W_{l,FC}$	Utility of low-skilled employees abroad	Estimated by matching moments
ι	Elasticity of substitution between private and public goods	Set to 1 (neutral value)
ρ	Degree of congestion in accessing the public good	Set to 1 (neutral value)

needs to be set exogenously. In standard search models future choices are discounted exponentially, however according to the hyperbolic discounting theory (Cohen et al., 2020; Laibson, 1997), 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 (DellaVigna and Paserman, 2005; Paserman, 2008). 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).²⁰

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 E.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, as described in detail in Appendix E.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), as described in detail in Section 3.1.4. 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 3. The mass of employers χ is also taken from the Italian Labour Force Survey (*Rilevazione Continua sulle Forze di Lavoro*) and corresponds 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 H). 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 H). 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 E.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 H). 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, using the procedure described in Appendix E.1.²¹

Within this setup and given the available set of information, we cannot identify the parameters ρ and ι , which define 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 of one. Figure 10 in Appendix H reports all the twenty calibrated parameters for each year of the analysis.

²⁰In an alternative baseline specification, we set the parameter α free to match the moments described in Section 3.3, and as a result the value of α shows strong fluctuations around the value of 0.4.

²¹We 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.

3.3 Estimation methodology

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

$$\hat{\omega}_{N,W_N} = \arg \min_{\omega \in \Omega} (M_N - \tilde{M}(\omega))' W_N (M_N - \tilde{M}(\omega)), \quad (35)$$

where $\hat{\omega}_{N,W_N}$ are the estimated model’s parameters, N the number of observations, M_N the vector of moments used in the estimate calculated on the base of N observations, $\tilde{M}(\omega)$ the vector of simulated moments calculated taking the vector of all identified parameters ω , W_N the weighting matrix, and Ω the parameter space. The weighting matrix W_N has to be positive-definite to guarantee that the moment-based estimator is consistent (Flinn and Mullins, 2015, p. 380). In our estimation, we set W_N to be an identity matrix.²²

3.4 Matched Moments and Estimated Parameters

We match seventeen moments, which are the outcomes of our theoretical model (Appendix F), 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 values, we smooth the observed moments using the Hodrick-Prescott filter (Figure 11 in Appendix I).

The model is able to match all observed moments quite well. Specifically, the net real wages, the GDP per worker, the shares of native unemployed employees and the share of labour income 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% (Figure 12 in Appendix J). This is a very satisfactory result considering that we only have 11 free parameters to match 17 moments.

The estimated parameters (Figure 10 in Appendix H) are smooth over time and fluctuate in

²²In Flinn and Mullins (2015) the diagonal elements of the matrix W_N are set equal to the inverse of the variance of the corresponding element of the matrix M_N . 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”.

a range of plausible values. 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 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 elasticity of substitution between high-skilled and low-skilled good (γ) lays in the range between 0.63 and 0.66. 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.²³ The bargaining power β is estimated to be in the range between 0.12 and 0.135, 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 real value added of firms ($\tilde{p}x$). The latter is estimated to be decreasing over time for both high-skilled and low-skilled firms (Figure 14 in Appendix L), reflecting a declining GDP per worker. Finally, the per-capita level of public goods ν has also been declining over time in the period considered.

4 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.

4.1 No non-natives

Figure 5 reports the changes in the main aggregated variables relative to the counter-factual scenario with no non-natives. The presence of non-natives, which has increased from 10% to 15% of the workforce from 2008 to 2017, has led to an increase in the gross domestic product (GDP)

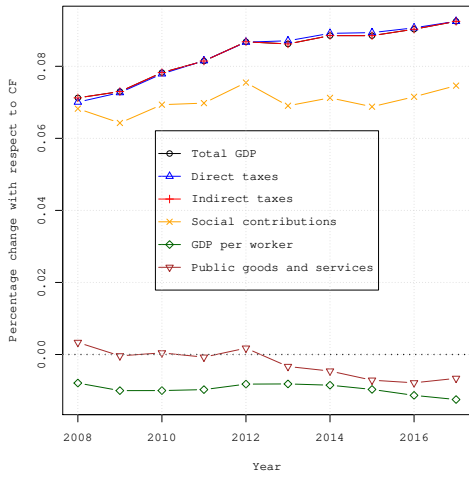
²³This might reflect for instance, among others, the ongoing civil wars and persecutions in African and Middle Eastern countries.

of 7% in 2008 (approximately 110 billions €) and of 10% in 2017 (approximately 140 billions €)(Figure 5a). Revenues from indirect taxes, which are proportional to the GDP, increased by 7% and 10% as well in 2008 and 2017, corresponding to an increase of approximately 20 billions €. Revenues from direct taxes increased by 7% and 10% as well in 2008 and 2017, corresponding to an increase of approximately 50 billions €. Social security contributions have steadily increased by approximately 7% over the period considered, which correspond to additional 18 billions € in the Government revenues in 2017. The per-capita provision of public goods has instead decreased in the presence of non-natives employees, by approximately 1% in 2017, due to the larger pool of people accessing them. Finally, GDP per worker has decreased by more than 1% due to a composition effect, i.e. non-natives employees are mainly low-skilled.

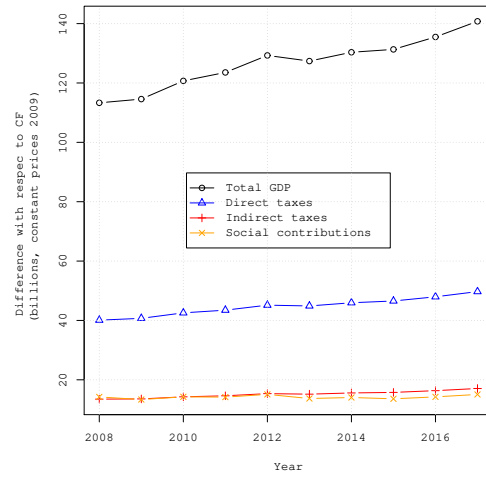
We then report the effect of the increased immigration on labour market variables (Figure 5c). With the presence of non-natives, the real wage of low-skilled employees is lower by approximately 8% on average, while the real wage of high-skilled employees is higher on average by approximately 4%. This 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 6%, while the price of the low-skilled good \tilde{p}_l has decreases by approximately 11% (Figure 5e). The effects on unemployment rates are minimal: we observe 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 rate 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 present, the labour market efficiency is worse and the number of vacancies is lower.

Combining the general equilibrium effects, we can compute the impact of the presence of non-natives on the lifetime utility of (employed and unemployed) employees (Figure 5d). We find that low-skilled employees are worse off compared to a scenario with no non-natives: their lifetime utility is lower by approximately 4%. This is due to the fact that both their wage and the per capita provision of public goods are lower. High-skilled employees are instead better off when non-natives are present in the economy: their lifetime utility is higher by approximately 6%, due to the fact that their wage is higher, although the provision of public goods is lower. 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

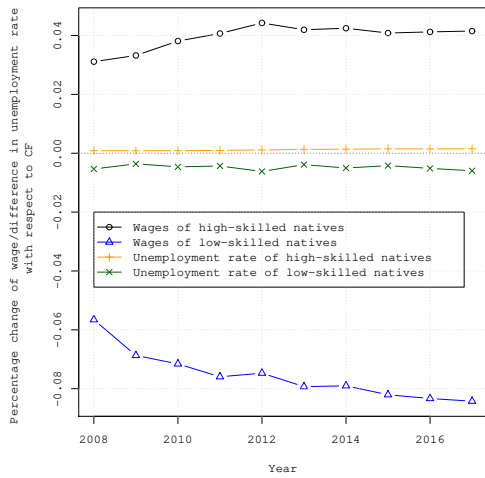
Figure 5. Counter-factual variables - no non-natives.



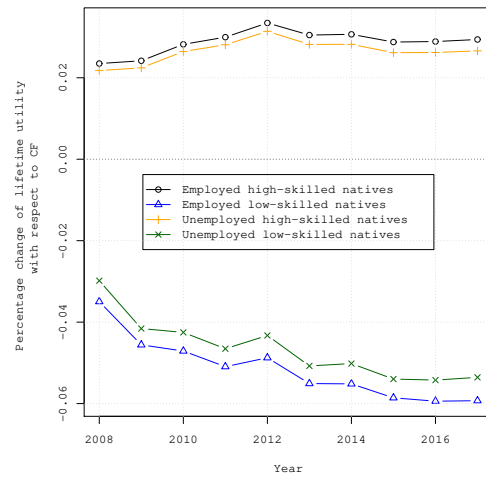
(a) Percentage changes of aggregate variables



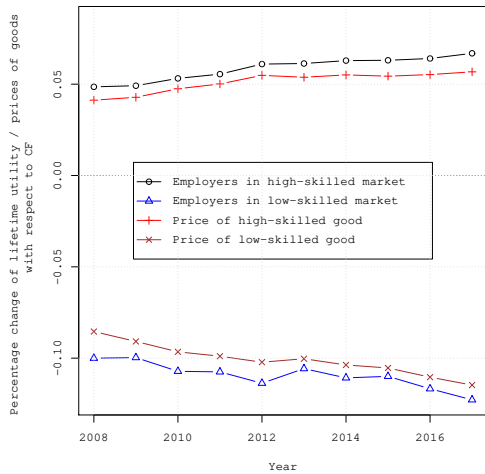
(b) Changes of aggregate variables



(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.

employees. Finally, we compute the impact of the presence of non-natives on the lifetime utility of employers (Figure 5e), which is a rather interesting outcome to look at. We find 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 fall in the price of the low-skilled good. Their lifetime utility is therefore between 10% and 12% 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 5% and 6% higher in the presence of non-natives.

4.2 Immigration shock

While we expect the effects on native employees to be similar to the ones estimated within the previous counter-factual analysis, we are particularly interested in the effects on the outcomes of non-natives employees (Manacorda et al., 2012). Hence, in a 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. Table 6 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 0.28%, which corresponds to an increase of approximately 4.3 billions €. Revenues from indirect taxes and revenues from direct taxes increased by the same percentage, corresponding to an increase of approximately 0.5 and 1.5 billions €, respectively. Social security contributions increased by 0.23%, corresponding to 0.46 billions € increased revenues.

Table 6. Counter-factual - increase in non-natives stock (aggregate variables)

Variable	% change	Absolute change (in billions of €)
Monthly GDP	0.28	4.32
Direct taxes	0.27	1.47
Indirect taxes	0.28	0.52
Social security contributions	0.23	0.46

Looking at the effect of the increased stock of non-natives on individual variables (Table 7), GDP per worker is slightly lower in the presence of an increased number of non-native people by 0.1%, while the change in the per-capita provision of public goods is negligible. The wage of low-skilled native employees is lower on average by approximately 0.4% when more non-natives are around, while the wage of low-skilled non-native employees is lower on average by approximately 0.17%. On the other hand, the wage of high-skilled native employees is higher on average by

Table 7. Counter-factual - increase in non-natives stock (main variables)

Variable	% change
Real GDP per worker	-0.14
Public goods	0.00006
Wages of high-skilled natives	0.27
Wages of high-skilled non-natives	0.17
Wages of low-skilled natives	-0.44
Wages of low-skilled non-natives	-0.38
Unemployment rate of high-skilled natives (absolute change)	0.00005
Unemployment rate of high-skilled non-natives (absolute change)	0.00001
Unemployment rate of low-skilled natives (absolute change)	-0.00022
Unemployment rate of low-skilled non-natives (absolute change)	-0.00022
Lifetime utility of employed high-skilled natives	0.21
Lifetime utility of employed high-skilled non-natives	0.12
Lifetime utility of employed low-skilled natives	-0.29
Lifetime utility of employed low-skilled non-natives	-0.23
Lifetime utility of unemployed high-skilled natives	0.20
Lifetime utility of unemployed high-skilled non-natives	0.10
Lifetime utility of unemployed low-skilled natives	-0.27
Lifetime utility of unemployed low-skilled non-natives	-0.18
Lifetime utility of employers hiring high-skilled natives	0.29
Lifetime utility of employers hiring high-skilled non-natives	0.41
Lifetime utility of employers hiring low-skilled natives	-0.58
Lifetime utility of employers hiring low-skilled non-natives	-0.60
Price of high-skilled good	0.30
Price of low-skilled good	-0.56

approximately 0.27%, while the wage of high-skilled non-native employees is higher on average by approximately 0.17%. 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 0.29% and 0.22%, respectively. This is due to the fact that both their wage and the provision of public goods are lower, but the decrease in wages is larger among natives. High-skilled native and non-native employees are instead better off with more non-natives in the economy: their lifetime utility is higher by 0.21% and 0.12%, respectively. In this case, native employees are the ones gaining the most, as the wage increase is higher for natives compared to non-natives. Finally, we compute the impact of the increased presence of non-natives on the lifetime utility of employers. 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 0.58%, independently on whether they hire a native or a non-native employee. On the other hand, although the salaries of high-skilled employees are 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 0.42% if they hire a non-native employee and 0.28% if they hire a native employee, due to the larger increase in wage among native employees.

5 Conclusions and discussion

In this paper we develop a general equilibrium search and matching model, which is the estimated using data from Italy for each year in the period 2008-2017. Our counter-factual analysis suggests that the effect of immigration has been sizable and largely asymmetric. At aggregate level, the presence of a large number of non-natives had positive effects on total production, social security contributions and tax revenues (both direct and indirect), although it increased the pressure on the provision of public goods. From a micro-economic perspective, we can precisely identify winners and losers. The losers are employees and employers who operate in the low-skilled market. In this segment, the real price of the low-skilled good is lower, salaries are lower and value added of production is lower. Hence the lifetime utility is lower among all economic agents (employers and employees). The winners are employers and employees in the high-skilled market: higher prices, value added and salaries lead to a higher lifetime utility among all economic agents in the high-skilled market. Among the winner we can include also the Government, which benefits from substantial additional direct and indirect taxes, and social security contributions. In this respect, we can classify as winners also all categories of people who benefit from the social welfare which is financed by tax revenues, such as retired people. We argue that these findings help rationalize the dynamics of the recent elections in Italy, which saw a massive increase in the consensus towards the Northern League party, which focused its electoral campaign on the harm caused by immigration. The voters who switched away from other parties are mostly blue collars and individuals in the low/medium tail of the income distribution, who according to our estimates, are those who were most severely and negatively affected by the increased presence of non-natives on the territory. Although the nationalist populism spreading all over the world could be partly ascribable to a mass media reaction against liberalism and immigration, we provide evidence that it is also deeply motivated by economic factors. A set of Pareto-efficient redistribution policies put in place to transfer resources from the winners to the losers could therefore be effective in reducing anti-immigrant sentiments. These policies could channel the increased Government revenues towards additional provision of public goods to avoid congestion effects. Tax rebates and unemployment benefits could be also used as instruments to increase the lifetime utility of employees operating in the low-skilled market, who have been asymmetrically and severely hit by the increased low-skilled immigration flows.

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Appendix

A Inflow and outflow of natives

Table 8 reports the inflow and outflow of natives (in thousands). The outflow rate is also reported as percentage of unemployed natives.

Table 8. 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).

B 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 9). 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 10).

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 9. 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 10. 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 11.

C 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

Table 11. 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.

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 $t \in \{0, 1, 2, \dots\}$, 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 $t \in \{0, 1, 2, \dots\}$ 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:

$$\dot{u}_{t+\tau} = e_{t+\tau}\delta_t - u_{t+\tau}q_t. \quad (36)$$

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 $1 - Q_t = e^{-q_t}$) 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 :

$$u_{t+1} = (1 - Q_t)u_t + u_{t+1}^s. \quad (37)$$

By inverting Equation 37, we find an expression for the job finding probability as a function of unemployment and short term unemployment:

$$Q_t = 1 - \frac{u_{t+1} - u_{t+1}^s}{u_t}. \quad (38)$$

As in (Shimer, 2005, p.130), an implicit equation for the employment exit rate can be obtained by solving Equation 36 :

$$u_{t+1} = \frac{[1 - \exp(-q_t - \delta_t)] \delta_t l_t}{q_t + \delta_t} + \exp(-q_t - \delta_t) u_t, \quad (39)$$

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.

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

From Equations (28)-(31) in the model, we derive the following equality:

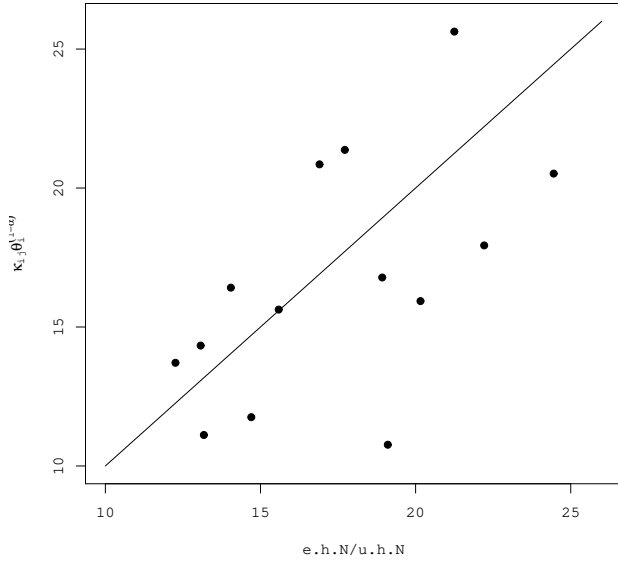
$$\frac{e_{i,j}}{u_{i,j}} = \frac{\kappa_{i,j} \theta_i^{1-\alpha}}{\delta_{i,j}}, \quad (40)$$

where $i \in \{h, l\}$ and $j \in \{N, I\}$. The right hand side of Equation 40 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 6a-6d). The coefficients are very close to 1, confirming the validity of our calculations (Table 12).

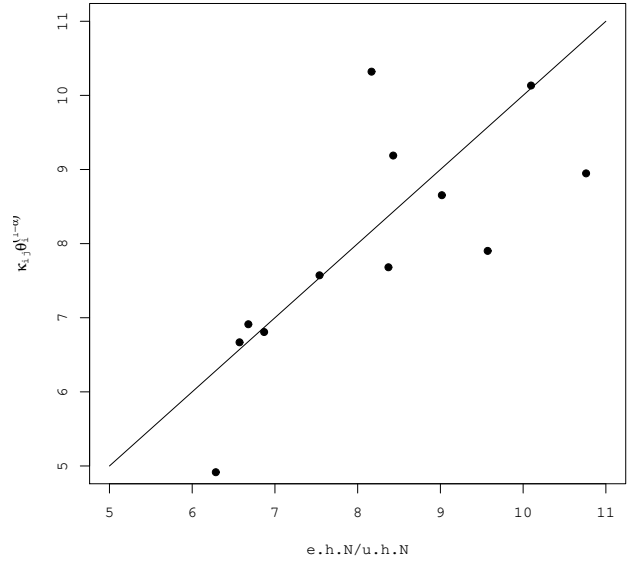
Table 12. Check for the estimate of the job finding and exit rate for different skills and country of origin. Source: our calculations using ELFS data.

	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

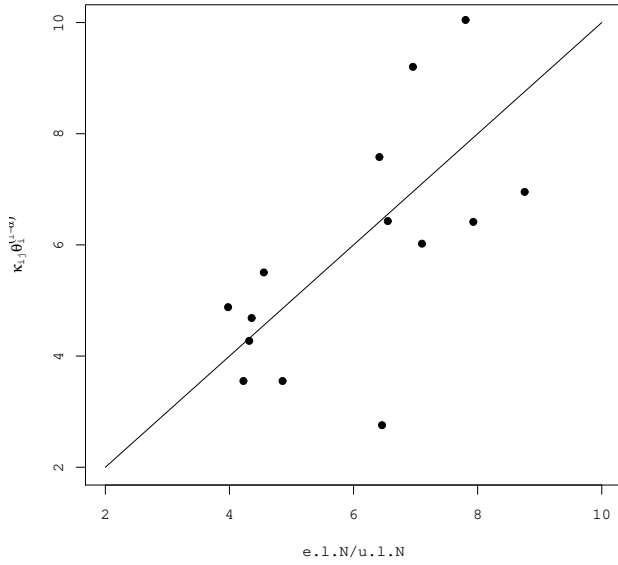
Figure 6. Correlation between the ratio of the estimated job finding rates and the job exit rates and the ration between employed and unemployed per worker type.



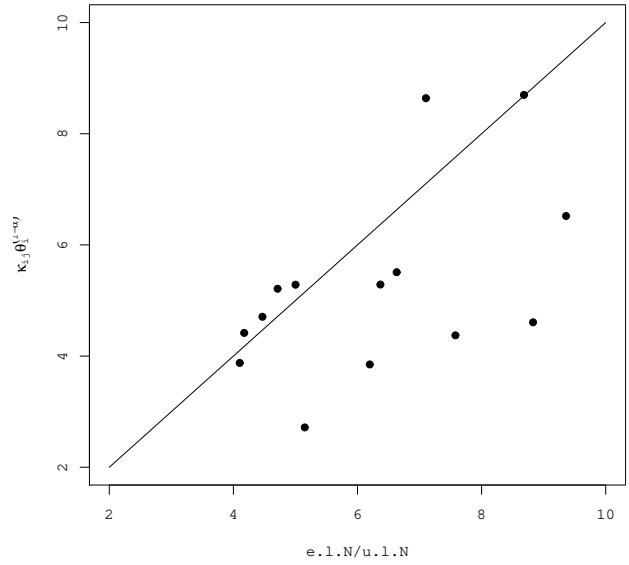
(a) High-skilled natives.



(b) High-skilled non-natives.



(c) Low-skilled natives.



(d) Low-skilled non-natives.

D 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 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 13.

Table 13. 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).

E 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).

E.1 The inflow rate of non-natives

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

$$TII = \eta (\sigma_{h,I} + \sigma_{l,I}), \quad (41)$$

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 30) and (41)), we can derive an expression for the rate at which non-native employees join the country η :

$$\eta = \frac{TII - \lambda [e_{h,I} \delta_{h,I} / \kappa_{h,I} \theta_h q(\theta_h) + e_{l,I} \delta_{l,I} / \kappa_{l,I} \theta_l q(\theta_l)]}{e_{h,I} [\kappa_{h,I} \theta_h q(\theta_h) + \delta_{h,I}] / \kappa_{h,I} \theta_h q(\theta_h) + e_{l,I} [\kappa_{l,I} \theta_l q(\theta_l) + \delta_{l,I}] / \kappa_{l,I} \theta_l q(\theta_l)}. \quad (42)$$

The same rate can be computed using the stock of unemployed non-native employees (Equations (31) and (41)):

$$\eta = \frac{TII - \lambda (u_{h,I} + u_{l,I})}{u_{h,I} [\kappa_{h,I} \theta_h q(\theta_h) + \delta_{h,I}] / \delta_{h,I} + u_{l,I} [\kappa_{l,I} \theta_l q(\theta_l) + \delta_{l,I}] / \delta_{l,I}}. \quad (43)$$

Figure 7 reports the estimates of η based on Equations (31), (42) and (43) using data as provided by the OECD statistics.

E.2 The tax subsidy

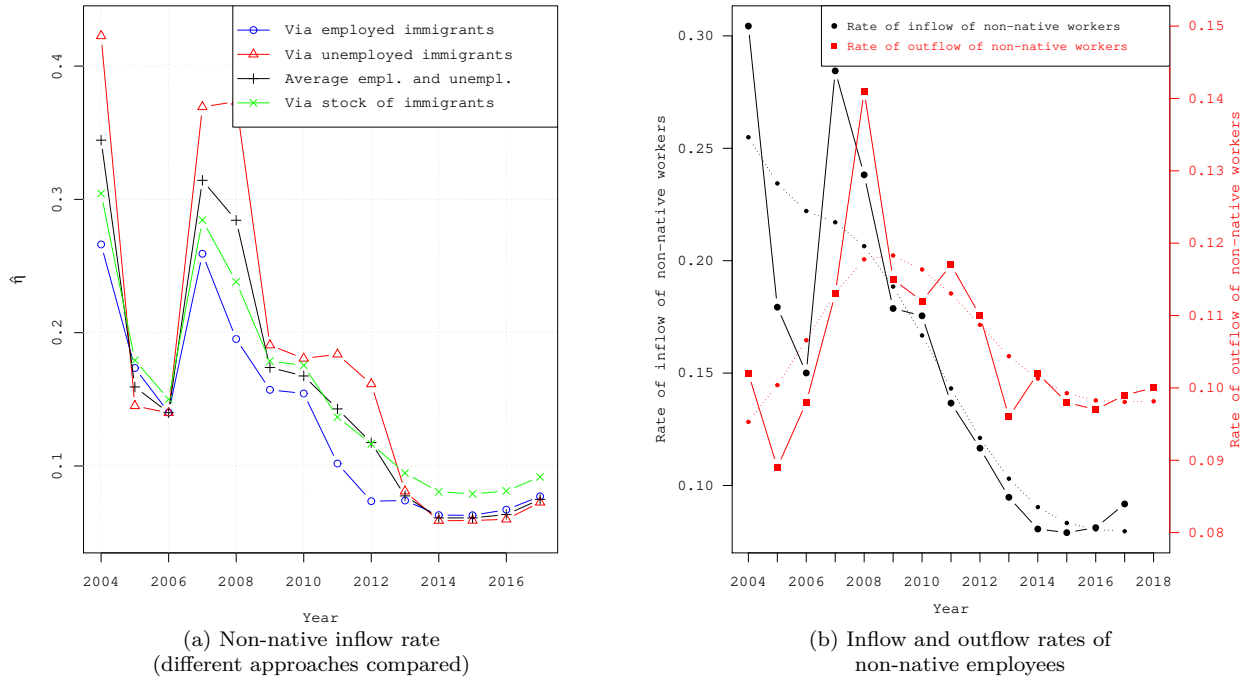
OECD provides data on the average and marginal tax rates for individuals earning 67, 100, 133 and 167 percent of the average annual gross labour income, as reported in Table 14.

Table 14. 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.

Figure 7. Non-native inflow and outflow rates



Source: Own calculations based on the model.

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:

$$\bar{t} = \frac{t^m w - \tau(1 - t^m)}{w}, \quad (44)$$

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:

$$\tau = 0.67\bar{w} \left[\frac{t^m - \bar{t}}{1 - t^m} \right]. \quad (45)$$

To calculate the no-tax area we compute the wage \underline{w} by which the average tax rate (Equation (44)) is equal to zero:

$$t^m(1 - t^m) \left(\frac{\tau}{\underline{w}} \right) = 0, \quad (46)$$

which leads to:

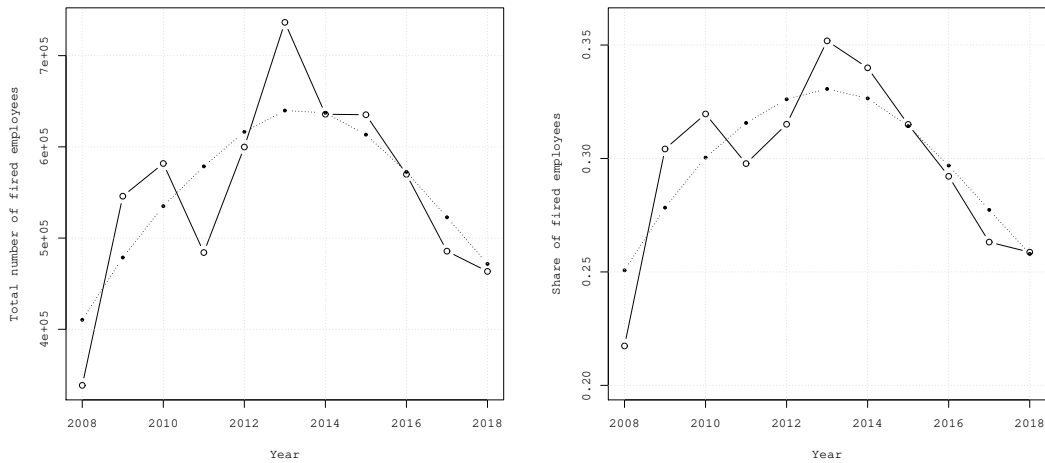
$$\underline{w} = \frac{(1 - t^m)\tau}{t^m}. \quad (47)$$

E.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 fulfillment 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 8, we report the number of fired employees as the share of the total number of employees, who lost their job.

Figure 8. 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).

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 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 percent of the cases), which in our model corresponds to $F\tilde{p}_i x_i$, is

$$EFC = [n + (ss + pp)n + sp + lc] w. \quad (48)$$

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

$$S = (n + \varepsilon ssn + sp)w. \quad (49)$$

where ε 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

$$T = [(1 - \varepsilon)ssn + ppn + lc]w. \quad (50)$$

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:

$$\begin{aligned} EFC &= p_f \{ (1 - p_s)C_{NA} + p_s [(1 - p_w)C_L + p_w [n_{fd} + (ss + pp)n_{fd} + sp + lc]w] + \\ &+ p_s(1 - p_w)p_ap_w [n_a + (ss + pp)n_a + sp + lc]w + p_s(1 - p_w)p_a(1 - p_w)C_{SD} \}, \end{aligned} \quad (51)$$

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

$$\begin{aligned} EFC &= p_f p_s p_w [n_{fd} + (ss + pp)n_{fd} + sp + lc]w + \\ &+ p_f p_s (1 - p_w) p_a p_w [n_a + (ss + pp)n_a + sp + lc]w. \end{aligned} \quad (52)$$

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

$$\begin{aligned} F &= p_f \left\{ \mathbb{1}^F + p_s p_w [n_{fd} + (ss + pp)n_{fd} + sp + lc] + \right. \\ &\left. + p_s (1 - p_w) p_a p_w [n_a + (ss + pp)n_a + sp + lc] \right\} \left(\frac{w}{\tilde{p}x} \right), \end{aligned} \quad (53)$$

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 15. 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 15), 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 et al., 2003; Ichino, 1996), we assume symmetry in the probability that the judges rule in favor of the worker, i.e., $p_w = 0.5$. Using Equation (53) and the data reported in Table 15, we are able to compute the estimated firing costs (Table 9).

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 9). Specifically, we compute the monthly probability of closing a trial (P_{ct}^m) assuming a uniform distribution of ensued and settled trials over the months, as

$$P_{ct}^m = \frac{ST_m}{PT_{t-1} + ET_m}, \quad (54)$$

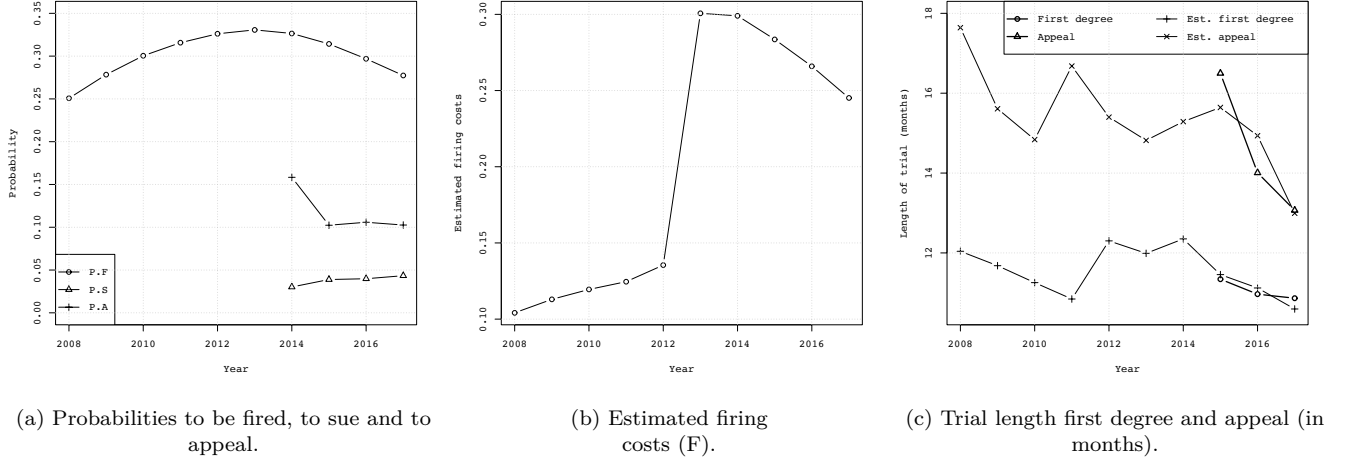
where ST_m is the flow of settled trials in month 1 (January), PT_{t-1} is the stock of pending trials at time $t - 1$ and ET_m is the flow of ensued trials in month 1 (January). The average length of trials is therefore computed as

$$ATL = \frac{1}{P_{ct}^m}, \quad (55)$$

assuming that the trials are distributing according to a Poisson process (Figure 9).

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

Figure 9. Trial length, probabilities to sue and appeal, and estimated firing costs.



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

hence we believe that for the years 2015-2017 the change in the average aggregate firing cost has been minimal.

E.4 The vacancy cost

The vacancy cost in the model is equal to:

$$cp_i x_i = \kappa_{i,j} q(\theta) TC, \quad (56)$$

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:

$$c = \frac{\kappa_{i,j} q(\theta) TC}{p_i x_i}. \quad (57)$$

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:

$$c^m = \frac{\kappa_{i,j} q(\theta)^m TC}{p_i x_i^m}. \quad (58)$$

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

$$c^m = \kappa_{i,j}q(\theta)^m \left(\frac{DC}{p_i x_i^m} + \frac{OC}{p_i x_i^m} \right). \quad (59)$$

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

F 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 ($i \in \{h, l\}$).

$$e_{i,N} = \sigma_{i,N} \left[\frac{\kappa_{i,N}\theta_i q(\theta_i)}{\delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)} \right]; \quad (60)$$

$$u_{i,N} = \sigma_{i,N} \left[\frac{\delta_{i,N}}{\delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)} \right]; \quad (61)$$

$$e_{i,I} = \sigma_{i,I} \left\{ \frac{\eta \kappa_{i,I} \theta_i q(\theta_i)}{\lambda \delta_{i,I} + \eta [\kappa_{i,I} \theta_i q(\theta_i) + \delta_{i,I}]} \right\}; \quad (62)$$

$$u_{i,I} = \sigma_{i,I} \left\{ \frac{\eta \delta_{i,I}}{\lambda \delta_{i,I} + \eta [\kappa_{i,I} \theta_i q(\theta_i) + \delta_{i,I}]} \right\}; \quad (63)$$

$$\begin{aligned} \tilde{w}_{i,N} &= \beta_j \psi (1-t) \left\{ \frac{(r + \delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i))}{\psi (1-t) [(r + \delta_{i,N})(1-b(1-\beta_j)) + \beta_j \kappa_{i,N} \theta_i q(\theta_i)]} \right\} \tilde{p}_i x_i + \\ &- \frac{(1-\beta_j)(r + \delta_{i,N})\psi(1-t)(1-b)}{\psi(1-t)[(r + \delta_{i,N})(1-b(1-\beta_j)) + \beta_j \kappa_{i,N} \theta_i q(\theta_i)]} \tilde{\tau} + \\ &+ \left\{ \frac{\beta_j \psi r (r + \delta_{i,N} + \kappa_{i,N} \theta_i q(\theta_i)) + \phi (r + \delta_{i,N})(1-\beta_j)[(r + \kappa_{i,N} \theta_i q(\theta_i))]}{\psi(1-t)[(r + \delta_{i,N})(1-b(1-\beta_j)) + \beta_j \kappa_{i,N} \theta_i q(\theta_i)]} \right\} \tilde{p}_i x_i F; \end{aligned} \quad (64)$$

$$\begin{aligned}
\tilde{w}_{i,I} &= \beta_I \psi(1-t) \left\{ \frac{(r+\lambda)(r+\delta_{i,I}) + r\kappa_{i,I}\theta_i q(\theta_i)}{\psi(1-t) \left\{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r\kappa_{i,I}\theta_i q(\theta_i) \right\}} \right\} \tilde{p}_i x_i + \\
&- \frac{(1-\beta_I)(r+\delta_{i,I})\psi(1-t) [(1-b)r+\lambda]}{\psi(1-t) \left\{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r\kappa_{i,I}\theta_i q(\theta_i) \right\}} \tilde{\tau} + \\
&+ \frac{(1-\beta_I)\lambda r(r+\delta_{i,I})}{\psi(1-t) \left\{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r\kappa_{i,I}\theta_i q(\theta_i) \right\}} W_{i,FC} + \\
&+ \left\{ \frac{\phi(r+\delta_{i,I})(1-\beta_I)(r+\lambda) (r+\kappa_{i,I}\theta_i q(\theta_i) - \lambda)}{\psi(1-t) \left\{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r\kappa_{i,I}\theta_i q(\theta_i) \right\}} \right\} + \\
&+ \left. \frac{\beta_I \psi r [(r+\delta_{i,I})(r+\lambda) + r\kappa_{i,I}\theta_i q(\theta_i)]}{\psi(1-t) \left\{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r\kappa_{i,I}\theta_i q(\theta_i) \right\}} \right\} \tilde{p}_i x_i F + \\
&- \frac{(1-\beta_I)(r+\delta_{i,I})\lambda}{\psi(1-t) \left\{ (r+\delta_{i,I}) [(\lambda+r) - rb(1-\beta)] + \beta_I r\kappa_{i,I}\theta_i q(\theta_i) \right\}} \nu; \tag{65}
\end{aligned}$$

$$\begin{aligned}
\tilde{p}_i &= \frac{q(\theta_i)\pi_{i,N}\kappa_{i,N}(r+\delta_{i,I})(1-t)\tilde{w}_{i,N}}{x_i \left\{ q(\theta_i) \left[\pi_{i,N}\kappa_{i,N}(r+\delta_{i,I})(1-t-\delta_{i,N}F) + (1-\pi_{i,N})\kappa_{i,I}(r+\delta_{i,N})(1-t-\delta_{i,I}F) \right] - c(r+\delta_{i,N})(r+\delta_{i,I}) \right\}} + \\
&+ \frac{q(\theta_i)(1-\pi_{i,N})\kappa_{i,I}(r+\delta_{i,N})(1-t)\tilde{w}_{i,I}}{x_i \left\{ q(\theta_i) \left[\pi_{i,N}\kappa_{i,N}(r+\delta_{i,I})(1-t-\delta_{i,N}F) + (1-\pi_{i,N})\kappa_{i,I}(r+\delta_{i,N})(1-t-\delta_{i,I}F) \right] - c(r+\delta_{i,N})(r+\delta_{i,I}) \right\}}; \tag{66}
\end{aligned}$$

$$\begin{aligned}
&b(\tilde{w}_{h,N}u_{h,N} + \tilde{w}_{h,I}u_{h,I} + \tilde{w}_{l,N}u_{l,N} + \tilde{w}_{l,I}u_{l,I}) + [(e_{l,N} + e_{l,I}) + b(u_{l,N} + u_{l,I})] \tilde{\tau} + \\
&+ \tilde{p}_h^{\gamma/(\gamma-1)} x_l (e_{l,N} + e_{l,I}) - \tilde{p}_h x_h (e_{h,N} + e_{h,I}) \left(\frac{1-\gamma(1-t)}{\gamma(1-t)} \right) = 0; \tag{67}
\end{aligned}$$

$$\tilde{p}_l = \tilde{p}_h^{\gamma/\gamma-1}; \tag{68}$$

$$\nu = \frac{\iota g[\tilde{p}_h x_h (e_{h,N} + e_{h,I}) + \tilde{p}_l x_l (e_{l,N} + e_{l,I})]}{(\sigma_{h,N} + \sigma_{l,N} + e_{h,I} + e_{l,I} + u_{h,I} + u_{l,I} + \chi + z)^\rho}. \tag{69}$$

G Welfare equations of employers and employees

$$\begin{aligned}
 W_{i,N}^u &= \frac{Y_{i,N}^u}{r} + \left(\frac{\kappa_{i,N}\theta_i q(\theta_i)}{r} \right) \left\{ \frac{\beta_N \psi}{(1-\beta_N)} \left[\frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,N})}{r + \delta_{i,N}} - \frac{\delta_{i,N} \tilde{p}_i x_i F}{r + \delta_{i,N}} + \tilde{p}_i x_i F \right] + \right. \\
 &\quad \left. + \phi \tilde{p}_i x_i F \right\}; \tag{70}
 \end{aligned}$$

$$\begin{aligned}
 W_{i,I}^u &= \frac{Y_{i,I}^u + \lambda W_{i,FC}}{(r + \lambda)} + \left(\frac{\kappa_{i,I}\theta_i q(\theta_i)}{(r + \lambda)} \right) \left\{ \frac{\beta_I \psi}{(1-\beta_I)} \left[\frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,I})}{r + \delta_{i,I}} - \frac{\delta_{i,I} \tilde{p}_i x_i F}{r + \delta_{i,I}} + \tilde{p}_i x_i F \right] + \right. \\
 &\quad \left. + \phi \tilde{p}_i x_i F \right\}; \tag{71}
 \end{aligned}$$

$$W_{i,N}^e = W_{i,N}^u + \frac{(1-b)\psi(1-t)(\tilde{w}_{i,j} + \tilde{\tau} + \delta_{i,N}\phi\tilde{p}_i x_i F)}{r + \delta_{i,N} + \kappa_{i,N}\theta_i q(\theta_i)}; \tag{72}$$

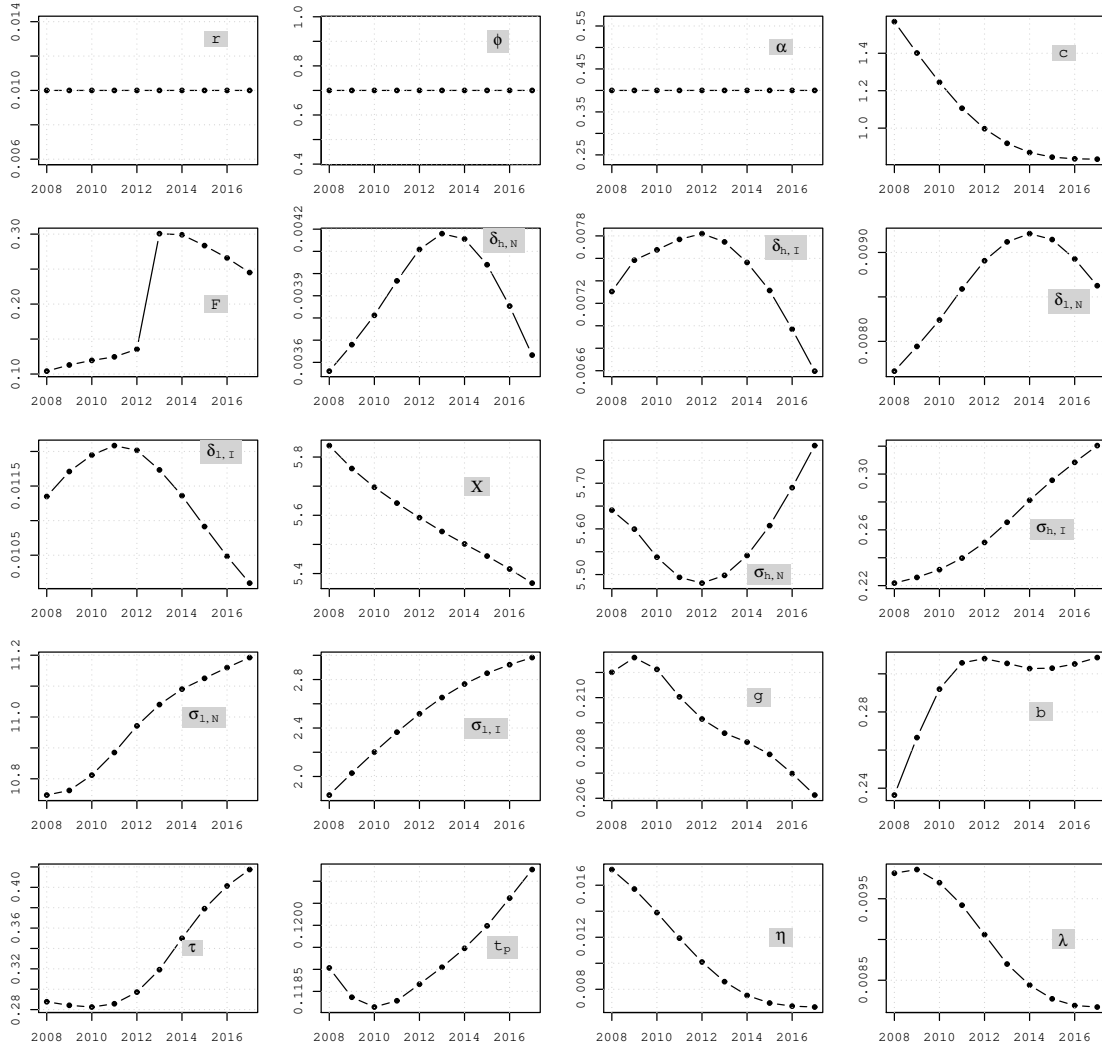
$$W_{i,I}^e = W_{i,I}^u + \frac{(1-b)\psi(1-t)(\tilde{w}_{i,j} + \tilde{\tau}) - \lambda(W_{i,FC} - W_{i,I}^u) + \delta_{i,I}\phi\tilde{p}_i x_i F}{r + \delta_{i,I} + \kappa_{i,I}\theta_i q(\theta_i)}; \tag{73}$$

$$J_{i,N} = \frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,N}) - \delta_{i,N}\tilde{p}_i x_i F}{r + \delta_{i,N}}; \tag{74}$$

$$J_{i,I} = \frac{(1-t)(\tilde{p}_i x_i - \tilde{w}_{i,I}) - \delta_{i,I}\tilde{p}_i x_i F}{r + \delta_{i,I}}. \tag{75}$$

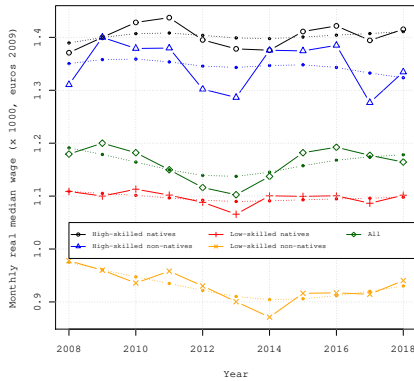
H Calibrated parameters

Figure 10. The twenty calibrated parameters of the model.

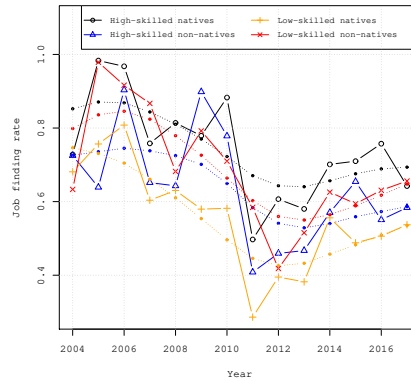


I Moments (smoothed) to be matched

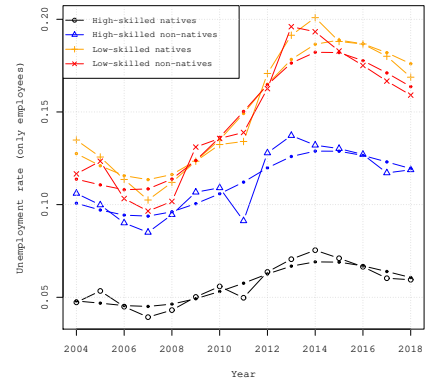
Figure 11. Seventeen moments to be matched.



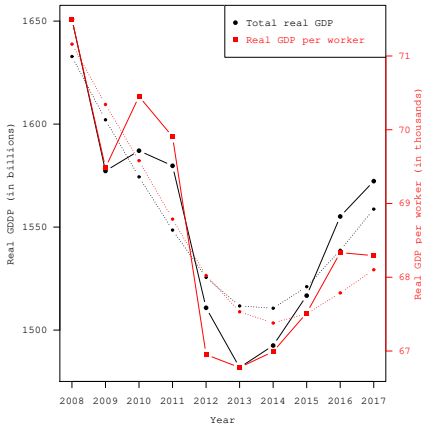
(a) Monthly real median wages.



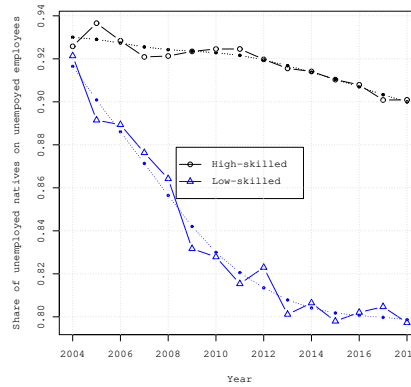
(b) Job finding rates.



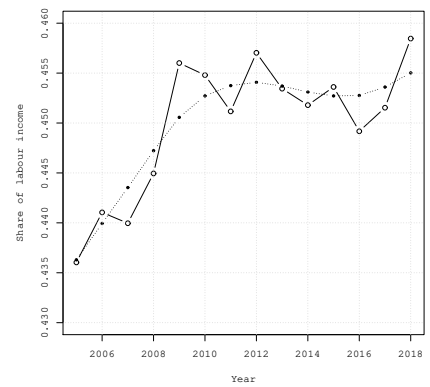
(c) Unemployment rates.



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



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

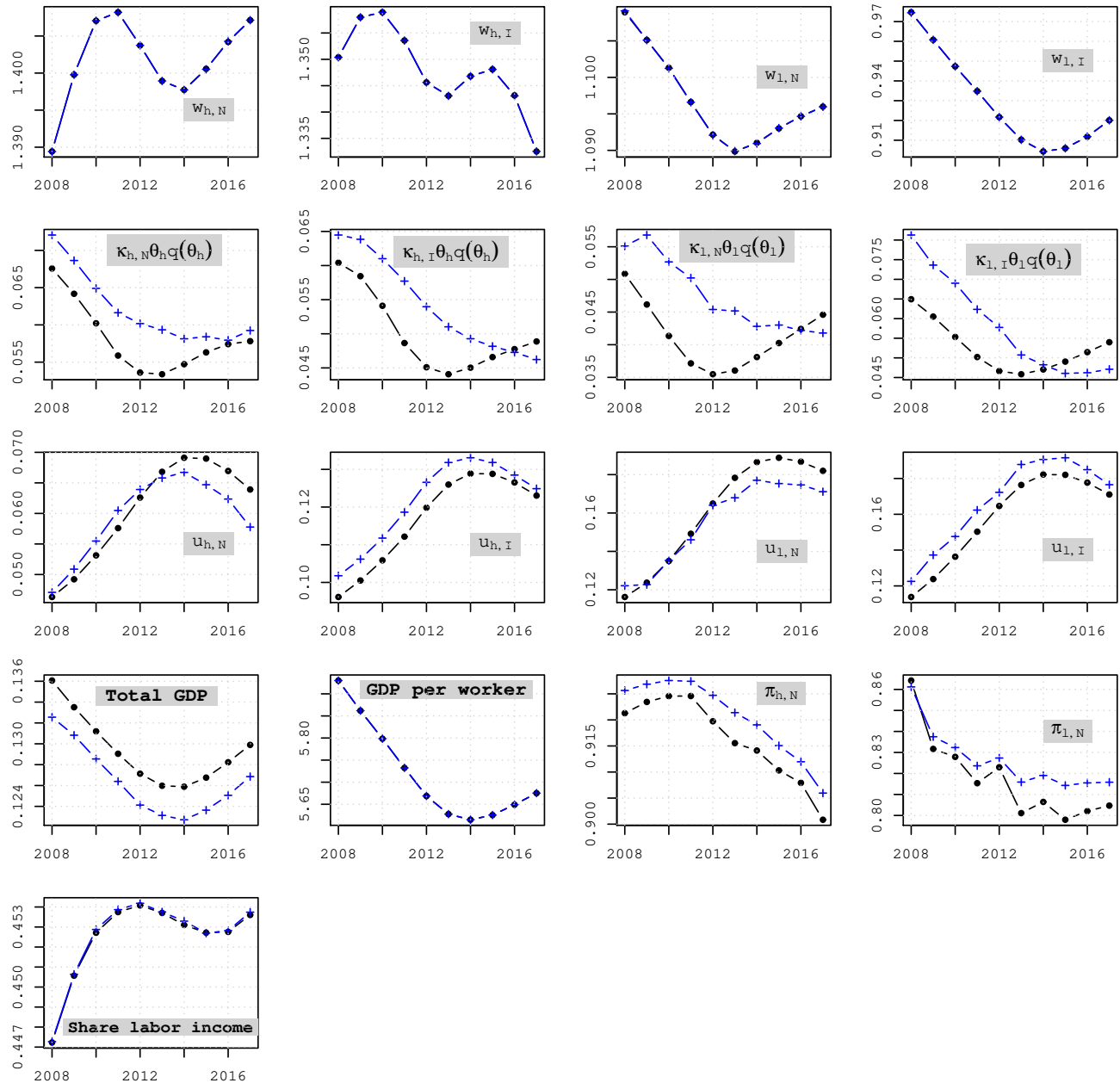


(f) Share of (non-adjusted) labour income on total GVA

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).

J Observed versus matched moments

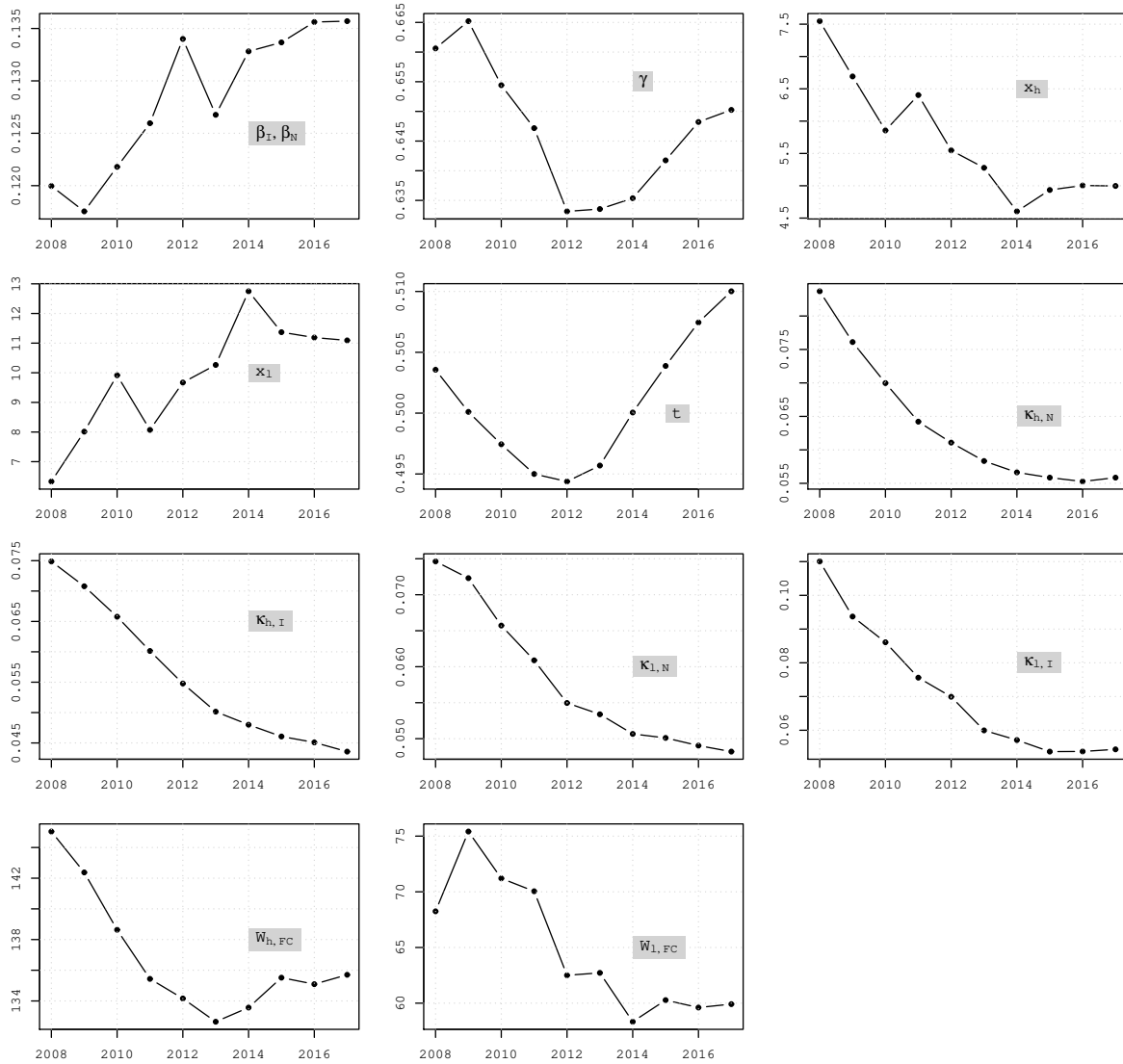
Figure 12. The seventeen observed versus matched moments.



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.

K Matched parameters

Figure 13. 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}).

L Other endogenous variables

Figure 14. Gross value added of firms in the high-skilled and low-skilled markets (px) and the per-capita value of the furniture of public goods (ν).

