Effects of immigration in frictional labor markets: theory and empirical evidence from EU countries

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Abstract

Immigrants are new comers in a labor market. As a consequence, they lack social networks and other country specific and not directly productive valuable assets affecting their relative bargaining position against employers. We introduce this simple observation into a two sector matching model of the labor market and find that immigrants increase employment prospects of competing natives. This result stands in sharp contrast to the predictions reached by the standard labor-supply labor-demand framework used in the literature to analyze the labor market impact of immigrants. To test the predictions of our model, we use yearly variations between 1998 and 2004 in the share of immigrants within occupations of 12 European countries. We identify the causal impact of immigrants on natives' employment rate using an instrumental variable strategy based on historical settlement patterns across host countries and occupations by origin countries. We find a small but positive causal impact of immigrants on natives' employment rate. However, our results also suggest that these employment gains diminish as immigrants assimilate to host country labor market.

Keywords: immigration, assimilation, labor market segmentation, on-the-job search

JEL: J61; J62; J64; E24

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1 Introduction

The consequences of immigration on labor market outcomes and welfare of the host country have been extensively discussed in the economic literature, both theoretically and empirically. This interest is justified by the implications in terms of inequality, fiscal stances or political positions of immigration. These consequences have been hotly debated in European countries who benefit from a relatively more generous welfare states. This paper analyzes the impact of the arrival of an immigrant wave on native's labor market opportunities.

Theoretically, the issue has been framed within a standard neoclassical labor supply, labor demand framework (see Borjas (2003), Card (2001), Card (2005), Card (2009), Ottaviano and Peri (2012)). In such a framework, a labor supply shock fostered by the arrival of an immigrant wave, yields a reduction in wages, which may discourage labor force participation. As a consequence, the crucial problem is to determine against which natives immigrants are competing, and then, analyze the distributional consequences of an immigration inflow (Friedberg and Hunt (1995)). Yet, this framework has somewhat been challenged by the empirical findings over the last two decades. Exploiting various experiences of immigration, in the US first and more recently in Europe, the literature has failed to find a consistent negative impact of immigrants on natives' labor market outcome[1].

A large literature has thus tried to explain this absence of negative impact on host labor market's outcomes. On the one hand, there exists an stream of literature which basically argues that natives and immigrants will never be perfectly substitutable. Notably, Ottaviano and Peri (2012) conclude that immigrants and natives, in spite of having similar skills, are not perfectly substitutable in production. According to their estimations, new immigrants are substitutes with old immigrants whereas they are imperfect substitutes of natives. Peri and Sparber (2011) or D'Amuri and Peri (2011) justify this finding by introducing different relative skill endowments between natives and immigrants. Whereas natives have a comparative advantage in language and communications skills, immigrants have a comparative advantage in manual skills. The

[1]Note that, an overwhelmingly majority of this literature has been focused on the impact over less-skilled natives, with the experience of the US following the 1965 Immigration Act that shifted the immigrants composition towards poorer countries and notably Mexicans; Card (1990); Altonji and Card (1991); Card (2001), Borjas (2003) are the most influential papers. For a literature review, see Borjas (1999). On Europe see Dustmann, Glitz, and Frattini (2008) for the UK, Glitz (2011) for Germany, Gonzalez and Ortega (2008) for Spain, and Ortega and Verdugo (2011) for France. Longhi, Nijkamp, and Poot (2006) offer a summary and perform a meta-analysis on the wage effect of immigrants.

arrival of the immigrant wave, yields natives to reallocate towards communication and language intensive tasks while immigrants specialize in manual intensive tasks. Again, they consider in this indirect way a complementary relation between observationally identical natives and immigrants.

On the other hand, there is a second stream of literature which focuses rather on the endogenous nature of technological progress. Lewis (2011), looks at labor demand side adjustment, and shows, as in the recent literature on inequality and technological changes (Acemoglu (2003)), that firms adjust to unskilled labor supply shocks by adopting less skilled biased technology : an increase in the share of immigrants among lower skilled workers makes the adoption of a technology complementary with low-skilled labor more profitable, dampening their initial negative impact on wages. However, all these contributions stick to the standard neoclassical framework and all the process of adjustment appeals to a form of "time consuming" adjustment coming from a complementary factor (capital, technology or natives' human capital).

Our paper proposes a third factor justifying the absence of a negative impact on native labor market outcomes, following the arrival of an immigrant wave. Whatever the labor market considered, immigrants are new comers. As a consequence, they lack of social networks, host country specific labor market knowledge and others, although non directly productive, valuable assets. For instance, one such an asset is the eligibility and amount of unemployment benefits which are conditional on past employment experience in host countries. These characteristics affect immigrants' outside option and put them in a lower bargaining position as compared to natives when they negotiate their wages with employers, making them more profitable employees. Therefore, even if immigrants are perfectly substitutable with natives in the production process (in terms of productivity or/and skills), they are more profitable workers for firms. The average expected profit obtained by firms located in the labor market receiving the immigrant wave increases following the arrival of the immigrants, which yields these firms to open more vacancies. Whatever their qualification, immigrants are always a source of a positive externality fostering an increase in the average profit by filled vacancy. While this impact mechanism has already been used in the theoretical papers of Ortega (2000) and Chassamboulli and Palivos (2012), our paper will the first one providing a numerical estimation of the gap between the value of outside opportunities.

The idea of a divergent reservation wage between natives and immigrants, yielding the last ones to accept a lower wage, is widely supported by the empirical evidence. In Algan et al. (2010), the

authors estimate that, for given characteristics (education, experience, region of residence, etc), first generation immigrant men from Maghreb earn 0.161 log point less than comparable native men in France. This divergence rises to 0.262 log points when considering immigrants from Africa. In Germany the gap between first generation immigrant men and comparable natives equals 0.205 log points when considering immigrants from Greece, 17.3 log points when considering immigrants from the former Yugoslavia and the gap falls to 0.076 log points for immigrants from Turkey. According to the estimations of Algan et al. (2010), in the UK, all first generation immigrant groups earn substantially less than their natives counterparts with the gap ranging from 0.207 log points for Black Caribbeans to 0.530 log points for Bangladeshis. Working with Dutch data, Kee (1995) finds that the offered wage differentials between native and immigrants equal 35.2% when considering Antilleans, 40.5% for Surinamese, 53.5% for Turks and 44.4% for Moroccans. When decomposing these differentials between the part justified by a divergence in objective characteristics and a part justified by discrimination, the author estimates that 11 percentage point of the log wage difference between natives and Antilleans is attributable to discrimination, this percentages decreases to 6 percentage points when considering Turks. Working with US data, Card (2005) estimates that, for identical characteristics, the wage gap between men immigrants and their natives' counterparts is about 11%. Finally, using UK data, Nanos and Schluter (2012) explores the role of unobservables (such as differences in search frictions or reservation wages) as determinants of wage differentials between natives and immigrants. They estimate that when controlling for the divergence in the reservation wage between natives and immigrants, the migrant effect of the wage differential between them is reduced by almost 55%. The divergence in the value of the outside options (reservation wage) plays thus a major role in observed wage inequalities, which corroborates the main hypothesis of our paper, according to which immigrants have a lower reservation wage with respect to natives due to their lower value of the outside option.

On the other hand, a common finding of the previous studies, is that this wage gap tends to diminish the longer the immigrant remains in the host country (actually for second generation immigrants, the gap is systematically lower and converges to zero in some cases). This result is found in previous studies by Chiswick (1978), Borjas (1994) or Borjas (1999) for the US, Chiswick, Lee, and Miller (2005) for Australia, Friedberg and Hunt (1995) for Israel or Lam and Liu (2002) for Hong Kong. All of them suggest then that with years of residence, the immigrant will tend to become an equal profitable worker as a native. The implicit idea in these papers is

that immigrant workers acquire language skills and other productive assets making them closer substitutes to natives. Our working hypothesis on the divergence of outside options (reservation wage) between natives and immigrants, provides also a rationale to this empirical finding. With years of residence in the host country, immigrants become eligible to the unemployment benefit, they develop their social networks and get a better knowledge of the labor market. Therefore, the value of their outside option converges to that of natives.

Our paper places the functioning of the labor market at the heart of the analysis. We propose to analyze the impact of an immigration wave within a search and matching framework in the style of Pissarides (1990). We believe this search friction approach is particularly relevant for the European case, where the presence of rigidities in the labor market prevents an adjustment of wages and all the adjustment is thus concentrated on the number of jobs. In a labor market characterized by the presence of generous institutions, most of the wage differentials between (eligible and protected) natives and (non-eligible and unprotected) immigrants must come from the value of the outside option (reservation wage). When comparing the results of wage disparities in US and European countries (see Card (2005) and Algan et al. (2010)), we realize that the gap is more important in European countries, which suggests that labor market institutions may play a role in increasing the relative reservation wage of natives with respect to immigrants. Particularly, since, afterwards, with years of residence in the host country (when immigrants become eligible), wage differentials tend to disappear in both the US and Europe.

Surprisingly enough, with the notable exception of Ortega (2000), Chassamboulli and Palivos (2012) or Liu (2010) we are not aware of any other study analyzing the labor market impact of immigrants on host countries using a search and matching model of equilibrium unemployment. Ortega (2000) is interested in the equilibrium distribution of workers in the host and origin countries and the employment consequences for natives in host countries. He shows, that provided they have higher search costs, immigrants can improve the employment prospect of natives. Liu (2010) analyzes the welfare effects of illegal immigration within a dynamic general equilibrium model with search frictions. He concludes that domestic consumption is affected by the arrival of the immigrant wave since the job finding rate for natives falls (increased job competition) and thus they are forced to accept lower wages. Chassamboulli and Palivos (2012) develop a model close to Liu (2010) but they consider both, skilled and unskilled immigration. Contrary to Liu (2010) who employs a Cobb-Douglas function, Chassamboulli and Palivos (2012) propose a nested CES aggregator, which allows skilled labor to be more complementary to capital than

to unskilled labor. The authors consider both the case where immigrants and natives are substitutes and the case where they are imperfect substitutes. The authors conclude that although the skill-biased immigration in US between 2000 and 2009 raised the overall net income to natives, it may have had distributional effects. Specifically, unskilled native workers gained in terms of both employment and wages. Skilled native workers, on the other hand, gained in terms of employment but may have lost in terms of wages.

We consider in this paper a local labor market (an occupation) segmented between two sectors. Natives and immigrants are perfectly substitutable since they have the same productivity when employed in the same sector. However, since immigrants have lower (less valuable) outside opportunities they are paid less and are thus not *equally profitable* from the firm's point of view. Firms respond to changes in labor market conditions by posting more or less vacancies so as to exploit all available profits: the number of jobs responds to changes in the expected profit of a filled vacancy. We allow then natives to move between sectors to take advantage of any changes in employment opportunities brought by immigrants. While most of the literature has considered outward displacement effect of immigration on natives we show that inward displacement is also a possibility. Finally, based on our empirical estimations, we numerically simulate the model in order to provide an estimation of the gap between the value of the outside opportunities of natives and immigrants.

To test the theoretical predictions of our model we use data from the European Labor Force surveys from 1998 to 2004 and define a labor market at a country and nine occupations level. To our knowledge, Angrist and Kugler (2003) and more recently D'Amuri and Peri (2011) are the only studies that exploit variations across European countries to identify the impact of immigrants on natives. For a large part, the literature has been focused on the US experience or a single country case. This is a concern as regard the external validity of the results. We believe our approach is particularly relevant given the peculiarity of European labor markets characterized by higher frictions than in the US. Moreover, if wages are sticky, as it is presumably the case in Europe, then most of labor market adjustments should happen along the quantity margin. This has been overlooked in the literature which has mainly focused on wage impact.

Defining a labor market at a national level, as in the seminal contribution of Borjas (2003), but in a multicountry context, has two key advantages. First mobility between countries is costly, therefore one can mitigate the spurious correlation introduced by the possibility for natives to "vote with their feet" by moving outside the labor market whose employment prospects worsen:

the so called *displacement effect*.

Second, we can use an identification strategy that has proven powerful in the spatial approach to deal with the non-random distribution of immigrants across local labor markets *i.e.* , the supply of immigrants in an occupation and a country responds to the relative employment rate, leading to a well known simultaneity problem. We identify the causal impact of immigrants on natives employment rate within an occupation using an instrumental variable strategy. In our case, not only do we need a variable which explains why immigrants are choosing a particular occupation, independently of any unobserved employment shocks, but also, why a particular country within that occupation is chosen. For this purpose, we extent the strategy originally developed by Altonji and Card (1991) to a multi-country-occupation setting and use historical settlement patterns in host countries and occupations by origin countries as an instrument for current inflows. Such instrument has proven to be a strong determinant of contemporaneous inflows in the single country case.[2] To date, D'Amuri and Peri (2011) are the only ones that use a similar instrument in a multicountry setting, although not in such a detail as ours as they do not instrument for occupational choices within countries.

Our main empirical findings are three. First, whether considering males or females, an increase by one percent in the proportion of immigrants workers in occupation o in a particular sector t increases the relative size of employment in that sector by more of one percent, pointing to employment creation for natives in the immigrant receiving sector within an occupation. Second, immigrants exert a small but positive impact on male natives employment rate. A doubling of the share of immigrants in an occupation increases native employment rate in that occupation by 1.9%. Third, the employment gains among natives are not long lasting. Distinguishing immigrants with more and less than 10 years of residence in host countries, we find a positive impact only for the later.

The rest of the paper is organized as follows. Next section presents our two sector matching model that allows us to compare changes in equilibrium natives employment rate before and after an immigration shock affecting one sector. Section 3 discusses data and gives some relevant descriptive statistics. Section 4 presents our empirical specification choices and discusses the identification strategy adopted. Empirical results are reported and discussed in section 5. Section 6 numerically estimates the gap between the value of the outside options of natives and immigrants that is consistent with the empirical estimations. Section 7 concludes.

[2]See Card (2001), Card (2009) for the US and Gonzalez and Ortega (2008) for Spain among others.

2 The model

The simple theoretical framework presented along these lines, allows us understand the economic mechanisms behind the empirical results presented in section 4. Finally, using reasonable parameter values, section 6 simulates the model in order to estimate the required divergence between the outside option of natives and immigrants so as to reproduce the empirical findings concerning the impact of immigrant on native employment.

Workers may be native or immigrants. The market is then composed by two labor suppliers whose source of difference is assumed to be the outside opportunities of employment. More precisely, immigrants arriving to the host country are likely to be non-eligible to the unemployment benefit, they are likely to have a lower value of domestic production or leisure than natives and they certainly lack of social networks and other valuable assets. As a result, when considering the immigrant population as a whole, we can claim that their average outside opportunity of employment will be lower than the average outside opportunity of employment for native workers.[3] We denote X_I all variables referring to immigrants workers and X_N those referring to old. Total population is denoted by P and is normalized to unity. It results from the addition of native and immigrant population, *i.e.* $P = P_I + P_N$. Native and immigrant individuals may be employed or unemployed, *i.e.* $P_j = n_j + u_j$ for $j = N, I$.

2.1 The matching process

In the empirical part of the paper we consider the effects of immigrants at the occupation level as well as at the sectoral level. The but of our theoretical model is just to provide an explanation on the economic mechanism behind our empirical results. Our objective is to underline the role of the reservation wage as source of a positive externality of immigrants on natives.

Let us denote by $j = N, I$ native and immigrant workers, v the number of vacancies, u_j the number of job seekers and n_j the number of employed. The matching function can be thus written as: $M = m(v, u_N + u_I)$. We assume a standard homogeneous matching function of the form $M = m_0(v)^{1/2}(u_N + u_I)^{1/2}$. Labor market opportunities are described by the market tightness variable $\theta = v/(u_N + u_I)$. The probability of filling an empty vacancy equals $q(\theta^t) = M/v$. The probability of finding a job is given by $p(\theta) = M/(u_N + u_I)$.

[3] Obviously we could also introduce productivity differences. However, since the main objective of the paper is to underline the role of the gap among reservation wages of natives and immigrants, we will consider that both types of workers are identical apart from the reservation wage.

2.2 The agents' behavior

2.2.1 Workers

Employed workers are paid a wage w_j. Jobs are destroyed at the exogenous probability s. Immigrants' outside opportunity of employment is below the outside opportunity of natives. This is captured by our theoretical framework. The asset value of employment is given by:

$$rE_N = w_N + s(U_N - E_N) \qquad \text{for natives} \tag{1}$$

$$rE_I = w_I + s(U_I - E_I) \qquad \text{for immigrants} \tag{2}$$

where U_N stands for the asset value of unemployment for natives (eligible to the unemployment benefit) and U_I for the asset value of unemployment for immigrants. As shown in section 2.3, due to their lower outside opportunity of employment, immigrants are ready to accept a lower wage, so that $w_I < w_N$.

The asset values of unemployed workers write as follows:

$$rU_N = b_N + p(\theta)(E_N - U_N) \qquad \text{for natives} \tag{3}$$

$$rU_I = b_I + p(\theta)(E_I - U_I) \qquad \text{for immigrants} \tag{4}$$

The value of the outside opportunities of employment is represented by b_j. The main difference between natives and immigrants is that the value of this outside opportunity is larger for natives, $b_N > b_I$.

2.2.2 Firms

From the firm's point of view, the asset value associated with an empty vacancy is given by minus the cost associated with the announcement of this vacancy, γ, plus the surplus obtained by the firm if it manages to fill the vacancy with a native worker or with an immigrant. The firm can only observe the worker's type at the time of the match and cannot discriminate between unemployed natives or unemployed immigrants. Firms cannot thus select their applicants. The possibility of rejecting an applicant that provides a positive surplus is not considered here. Actually, it is optimal for firms to fill the vacancy as far as the surplus associated with the match is positive rather than leaving the vacancy unfilled and bear a per period cost γ while waiting for a better worker to arrive. The value of an empty vacancy is given by:

$$rV = -\gamma + q(\theta)(\overline{J} - V) \tag{5}$$

where $\overline{J}$ represents the average value of a filled vacancy. The value of a filled vacancy is defined by the instantaneous profit $h - w_j$ associated with the job (productivity minus the wage) plus the expected loss if the vacancy becomes empty due to an exogenous job destruction shock :

$$rJ_N = h - w_N + s(V - J_N) \tag{6}$$

$$rJ_I = h - w_I + s(V - J_I) \tag{7}$$

The average value of a filled vacancy results from the weighted average $\overline{J} = \omega_1 J_I + (1 - \omega_1) J_N$, where $\omega_1 = \frac{u_I}{(u_N + u_I)}$.

Firms open vacancies until no more profit can be obtained so that, at the equilibrium, the free entry condition $V = 0$ applies, i.e.:

$$\frac{\gamma}{q(\theta)} = \overline{J} \tag{8}$$

The cost born by the firm while the vacancy remains empty must equal the value associated with the filled vacancy. At this equilibrium, the value of a filled job equals:

$$\overline{J} = \frac{h - \omega_1 w_I - (1 - \omega_1) w_N)}{r + s} \tag{9}$$

We can denote the average wage as $\overline{w} = \omega_1 w_I - (1 - \omega_1) w_N$.

2.3 Wages

There are two common concepts of wage bargaining. According to one concept, employers set wages and other terms and hire the most qualified applicant willing to work on those terms. The terms are offered to applicants on a strict take-it-or-leave-it basis. A second common concept, which forms the basis of extensive literature whose canon is Mortensen and Pissarides (1994), has wages and other terms of employment set by a Nash bargain. Models using this formula assume that the threat point for bargaining is the payoff pair that results when the job-seeker returns to the market and the employer waits for another applicant. One consequence is that the bargained wage is a weighted average of the applicant's productivity in the job and the value of unemployment. The latter value, in turn, depends largely on the wages offered for other jobs. This flexible-wage conclusion, however, hinges on unrealistic assumptions about bargaining threats, which are challenged by Hall and Milgrom (2008). Once a qualified worker meets an employer, threatening to walk away and permanently terminate the bargain is not credible. The bargainers have a joint surplus arising from search frictions that bind them together. Hall

and Milgrom (2008) use the bargaining theory proposed by Binmore, Rubinstein, and Wolinsky (1986) to invoke more realistic threats during bargaining. The threats are to extend bargaining (disagreement payoff) rather than terminate it (outside-option payoff). The result is to loosen the tight connection between wages and external conditions (market tightness).

In the Hall and Milgrom (2008) model, a job-seeker loses most of the connection with external conditions the moment she encounters a suitable employer, but before her wage bargain is made. The bargain is controlled by the job's productivity and by her patience as a bargainer in relation to that of the employer. In the alternating offer wage-bargaining environment, as long as reaching an agreement creates value, a bargainer who receives a poor offer continues to bargain, because that choice has a strictly higher payoff than taking the outside option. Threats to exercise the outside option are simply not credible. Since this is common knowledge, changes in the value of the outside option cannot affect the bargaining outcome.

Having found what appears to be a good match, the employer then makes a comprehensive job offer. The model assumes that the worker always accepts it at the equilibrium. The wage is higher than it would be if the employer had the power to make a take-it-or-leave-it offer that denied the worker any part of the surplus. The worker's right to respond to a low wage offer by counter-offering a higher wage -though never used in equilibrium- gives the worker part of the surplus. The authors assume the absence of any commitment technology that would enable the employer to ignore a counteroffer.

As in recent works by Pissarides and Vallanti (2007), Mortensen and Nagypal (2007) and Nagypal (2007) we adopt then the rigid wage definition proposed by Hall and Milgrom (2008). We suppose that the worker receives a payoff b_j in case negotiation breaks down but also when the agreement is delayed. For the firm, we assume that there is no cost while bargaining continues. Firms and workers renegotiate the division of the match product h, so that the outcome of the symmetric alternating-offers game is :

$$w_N = \eta h + (1-\eta) b_N \tag{10}$$

$$w_I = \eta h + (1-\eta) b_I \tag{11}$$

$$\tag{12}$$

where η can be interpreted as the bargaining power of each party and it is set to $1/2$. When outside opportunities of immigrants converge with those of natives, wages of natives and immigrants do not longer differ.

Note that $h > b_N > b_I$ (otherwise workers will prefer to remain unemployed rather than accepting a job), which implies that $w_N > w_I$.

2.4 Employment opportunities

Employment opportunities are measured by the labor market tightness which is determined by the free entry condition (8). Combining this equation with (9), yields:

$$\frac{\gamma}{q(\theta)} = \overline{J} = \frac{h - \overline{w}}{r + s} \tag{13}$$

Since $\frac{\gamma}{q(\theta)} = \frac{\gamma}{m_0}(\theta)^{1/2}$, we find:

$$\theta = \Big(\frac{m_0(h - \overline{w})}{\gamma(r + s)}\Big)^2 \tag{14}$$

Immigrants benefit from a lower wage than natives since the value of their outside option is lower. The presence of immigrants having a low outside option of employment in the labor market reduces then the average wage paid by firms with respect to the situation where all workers on the local labor would be natives. The market tightness is thus higher in the presence of immigrants (if $\overline{w}$ decreases, θ increases). The larger the importance of the immigrant share, the larger the reduction of the average wage and the larger the positive impact on employment opportunities.

2.5 The employment and unemployment rates

At the equilibrium inflows and outflows from the labor market must be equalized, so that the total population remains unchanged, *i.e.* $\dot{P} = \dot{P_I} = \dot{P_N} = 0$. Without loss of generality total population is normalized to 1, $P = P_I + P_N = 1$.

At the steady state, entries to unemployment must equal exits. Entries equal the proportion of employed people loosing their job, $s \cdot n$ where $n = n_I + n_N$. Exits from unemployment correspond to the proportion of unemployed workers finding a job, $p(\theta)u$. Equalizing entries and exits:

$$s(P - u) = p(\theta)u \qquad \Rightarrow \qquad \frac{u}{P} = \frac{s}{s + p(\theta)} \tag{15}$$

Applying the same reasoning but distinguishing between immigrants and natives yields the following unemployment rates:

$$u_I = \frac{s \cdot P_I}{p(\theta) + s} \qquad \Rightarrow \qquad \frac{u_I}{P_I} = \frac{s}{p(\theta) + s} \tag{16}$$

$$u_N = \frac{s \cdot P_N}{p(\theta) + s} \qquad \Rightarrow \qquad \frac{u_N}{P_N} = \frac{s}{p(\theta) + s} \tag{17}$$

Employed immigrants (natives) lose their job with probability s. Entries to immigrant unemployment come from the flow of employed immigrant (natives) loosing their job, $s \cdot n_I$ ($s \cdot n_N$). Exits are given by the proportion of unemployed immigrants (natives) that finds a job, $p(\theta)u_I$ ($p(\theta)u_N$).

Similarly, for the employment rate, entries to employment must equal exits. At the aggregate level, entries to employment are given by the share of unemployed finding a job while exits correspond to the proportion of employed loosing their job. Equalizing entries and exits yields:

$$n = \frac{p(\theta) \cdot P}{s + p(\theta)} \qquad \Rightarrow \qquad \frac{n}{P} = \frac{p(\theta)}{s + p(\theta)} \tag{18}$$

The number of immigrant and native employed is also computed equalizing entries and exits from employment. In both cases entries are given by the proportion of unemployed finding a job and exits by the share of employed loosing their job.

$$n_I = \frac{p(\theta) \cdot P_I}{s + p(\theta)} \qquad \Rightarrow \qquad \frac{n_I}{P_I} = \frac{p(\theta)}{s + p(\theta)} \tag{19}$$

$$n_N = \frac{p(\theta) \cdot P_N}{s + p(\theta)} \qquad \Rightarrow \qquad \frac{n_N}{P_N} = \frac{p(\theta)}{s + p(\theta)} \tag{20}$$

2.6 Testing the assumptions and predictions of the model

From the theoretical model we deduce that immigrants are the source of a positive externality since they are more profitable workers (for an equal productivity they are ready to accept a lower wage). This mechanism should be at work for any considered local labor market. In our empirical part we consider two levels of local labor market:

- First of all, we focus in occupations. We consider 9 local labor markets each corresponding to a particular occupation defined in large sense so that mobility across occupations is costly. We exploit variations in the share of immigrants across occupations (and countries) to test whether employment opportunities of natives are improved by immigrants.

- Secondly, within our local labor markets (occupations), there are different economic sectors. We then test whether the presence of immigrants in a particular sector within an occupation increases native employment in that sector. Contrary to the case where we consider the occupation, when focusing in a particular sector within an occupation, the improvement in employment opportunities favors both natives employed in other sectors within that occupation and unemployed natives. That is, within occupations we are likely

to observe an inward displacement towards the sector benefitting from the positive externality induced by the arrival of immigrants.

3 Data and descriptive statistics

The main dataset we use is the harmonized European Labour Force Survey (ELFS), which homogenizes and groups together country specific surveys at the European level (see EUROSTAT (2009)). Due to data availability, we restrict our analysis to the period 1998-2004. Our sample comprises the working age population (age 15-64) of Western European countries only. The data includes information on the occupation, working status (employed or inactive) and demographic characteristics of the individuals. Unluckily, the ELFS does not include any information on wages. We drop observations with missing data on country of birth, which are fundamental for our empirical analysis. In line with previous literature, we classify as immigrants all individuals born in any country (both EU or non-EU) outside the one of his current working residence. We categorize individuals into cells on the basis of different labor segments defined by occupations, which are used as proxy for skills and local labor markets. Occupations are broadly defined in 9 groups. These are (1) senior officials and managers, (2) professionals, (3) technicians and associate professionals, (4) clerks, (5) service workers and shop and market sales workers, (6) skilled agricultural and fishery workers, (7) craft and related trade workers, (8) plant and machine operators and assemblers, (9) elementary occupations.

We can easily understand that moving from one country to another or from one occupation to another, even within the same country, is very costly for natives in the short run. This should circumvent the criticism addressed to local labor market approaches, which point out the biases raised by the possibility for natives to leave labor markets receiving large immigration inflows (Peri and Sparber (2011)). Thus, individuals are grouped into cells defined by country-year and 1 digit occupation[4] (9 cells by country and year). Labor market outcomes for each cell are defined as the number of natives employed within that cell. We consider that non employed natives belong to the occupation of their last employment. We exclude those that have never

[4]It would be interesting to investigate possible heterogeneous effects across age groups (see Smith (2012)). However, with data in hand, it will be impossible to implement our instrumental variable approach since we do not have the age of immigrants at entry. As a robustness test, we distinguish among immigrants according to their years of residence in the host country, which should partially take into account the potential heterogeneous age effect.

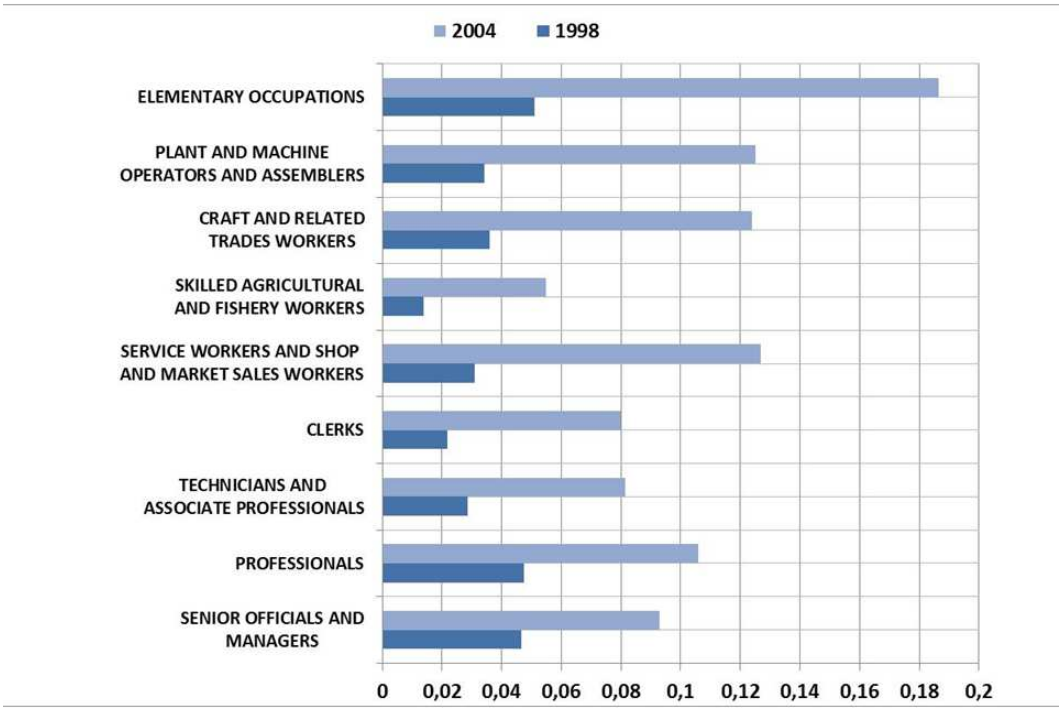

Figure 1: Contribution of immigrants to total labor force by occupation.

worked. Because last occupation of non employed natives is missing for Norway, France and Netherlands these countries are dropped from the analysis.

Considering the twelve European countries of our sample, from 1998 to 2004 the share of immigrants in the labor force has increased by 6 percentage points from 5.7% to 11.8% which is a large increase even compared with US. Comparatively in the US this share increased from 12.7% to 14.7% (Migration Policy Institute, 2006).

The European foreign labor force rise is even more impressive if one considers the heterogeneity across occupations as shown in Figure 1. While the rise is pervasive across all occupations, it is higher for the less skill occupations. However, contrary to conventional wisdom the contribution of immigrants to more skilled occupations is also rising and important. The rest of the paper will seek to exploit changes in this heterogeneity across occupations within countries which delimit our local labor markets to identify the causal impact of immigrants on natives employment rate.

4 Empirical specification issues and identification strategy

4.1 The impact at the occupation level

In the sake of simplicity, we start explaining the empirical specification and identification strategy working with grouped data at an *occupation-country-year* level. We define our outcome variable y_{oct} as the (log) share of employed natives in an occupation o in a country c at a time t. Let N_{oct} and P^N_{oct} denote respectively the number of employed natives and total native population in the corresponding cell, then y_{oct} is $\frac{N_{oct}}{P^N_{oct}}$. Our baseline estimating equation is:

$$\ln y_{oct} = \beta_0 + \beta_1 * \ln shim_{oct} + \delta_t + \delta_c + \delta_o + \mu_{ot} + \alpha_{oc} + + u_{ijt} \tag{21}$$

The key explanatory variable $shim_{oct}$, is the (log) ratio of immigrants (men or women) in labor cell *oct* to the total population of the cell, δ_c is a country fixed effect and δ_t, δ_o are year fixed effects and occupation fixed effects. These effects control for unobservable country, period and occupation specific determinants of native employment. Thus we achieve identification from variation of immigrants' share in an occupation across countries and through time. Lately we enrich our specification with country-occupation fixed effect (α_{oc}) and year-occupation fixed effect (μ_{ot}). In that case, our impact is identified by deviations across years from occupation specific mean within country, and deviation across countries from occupation specific mean within a period. This wide set of fixed effects distinguishes our approach from previous cross-area studies that could not control for such factors as they use a single cross-sectional data (see Card (2001)) or a single country aggregate times series data as in Borjas (2003).

Because serial correlation within cells is a concern, in all regressions we adjust standard errors for clustering of observations at the occupation-country level. We also use weighting least square, with weights equal to the native population size in each occupation[5]. It is important to note that the native labor force in a cell (P^N_{oct}) appears in the denominator of both sides of equation (21) which, as shown by Peri and Sparber (2011), may potentially create a spurious positive correlation between the immigrant share within an occupation and native employment share. For this reason in some specifications we fix the denominator of the share of immigrant in an occupation to its 1998 value, and in some others we also control directly for the size of native labor force in the cell. In this way, time variations of $shim_{oct}$ within a country stem only from changes in the number of immigrants within country-occupation cells and not from variation

[5]Unweighted regressions give similar results.

due to native inflow or outflow across occupations. The share specification adopted constraints the effect of immigrant variation and native variation within cell to be the same.

Despite our effort to control for unobservable determinants of natives' employment rate that are correlated with immigrants' share within an occupation, endogeneity bias still remains a concern[6]. This is the case for instance if changes in immigrants' share within a cell are correlated with changes in unobserved determinants of employment within the same cell. It is indeed plausible that immigrants sort into occupations whose demand is growing. In that case, occupation specific fixed effects are not enough since occupations specific employment rates are not fixed. We address this issue with two strategies. First, we control directly for estimated cell-specific productivity shocks. We motivate this by the fact that if an occupation is concentrated in an industry whose output has grown above average over the period, we expect labor demand for this occupation to have grown above average and to be potentially correlated with the inflow of immigrants within that occupation. To control for this possibility, we introduce in our estimated equation a occupation specific labor demand shift driven by sectoral composition of occupations at the national level. Thus we achieve identification from deviation through occupation specific trend driven by the initial sectorial composition of occupations. To be specific, we construct for each country the following occupation and year specific labor demand shift index (in the spirit of Katz and Murphy (1992) or Katz and Blanchard (1992)):

$$\hat{\eta}_{ot} = \sum_k \gamma_{ok,1998} Y_{kt}$$

where Y_{kt} is the real level of production of two-digit industry k at date t and $\gamma_{ok} = \frac{E_{ok}}{\sum_k E_{ok}}$ is the share of occupation o employed in industry k in 1998[7]. $\hat{\eta}_{ot}$ is interpreted as the predicted employment trend for workers belonging to occupation o (in a given country and period of time).

Our second approach to deal with endogeneity bias uses an instrumental variable strategy. This requires a variable correlated with influx of immigrants into a given labor market cell but uncorrelated with unobserved factors driving employment growth among natives. Our instrumental variable exploits the variation of the employment distribution of contemporaneous immigrants across occupations due to the past settlement patterns of their country peers across countries

[6]Because we are including country-occupation fixed effect endogeneity bias should arise from over time changing labor market conditions of an occupation in a given country.

[7]Industrial production data is obtained from the EUKlems consortium (http://www.euklems.net/). We have also constructed an index with the average level of occupation share over the whole period 1998-2004. This index gives similar result.

and occupations (see Altonji and Card (1991) or Card (2001)). Because of informational network, immigrants have a tendency to cluster into occupations having a higher share of their country peers (see Munshi (2003)). Our instrument, inspired from Card and Lewis (2007), is constructed as follows :

$$\phi_{cst} = \sum_{m} N_{cms,1990} * \frac{M_{OECD,m,t}}{N_{OECD,m,1990}},\ t = 1998, ..., 2004$$

where $M_{cm,t}$ is the flow of immigrants from country m in year t in the OECD, $N_{OECD,m,1990}$ is the stock of immigrants from country m in the OECD in 1990[8], and $N_{cms,1990}$ is the number of immigrants from country m in country c with educational group s. The instrument considers thus that the skill composition of the immigrant inflows between 1998 and 2004 to country c is the as the skill composition of the immigrant population in country c in 1990. Data on immigrants flows has been obtained from the OECD and those on stock are from Docquier, Lohest, and Marfouk (2007). We group immigrants in three educational levels: primary, secondary, and tertiary. Finally, we distribute this immigrants flows across occupations according to the native's skill distribution by occupations in 1998[9]. Our final instrument writes:

$$IV^{1}_{oct} = \sum_{s=1}^{3} \phi_{cst} * \gamma_{cso,1998} \tag{22}$$

where γ_{so} is the share of education level s employed in occupation o in country c in 1998. Our instrument is then built in two steps: we first consider that that the skill composition of the immigrant inflows to country c between 1998 and 2004 is the same as the skill composition of the immigrant population in 1990 in country c and, secondly, we distribute these immigrant inflows across occupations according to the native's skill composition by occupation. By defining our instrument in two steps we avoid all the potential problems associated with the fact that the immigrant's distribution across occupations in 1990 could already be endogenously determined or that native's distribution across occupations may be influenced by the presence of immigrants (even we have defined occupations in a large sense so that mobility across occupations is very costly).

[8]We consider the stock in the whole OECD which we believe is more exogenous than considering the stock of immigrants from country m in country c. This stock is more influenced by the economic conditions of the host country.

[9]The implicit assumption is that the skill distribution of natives across occupations is not affected by immigrants.

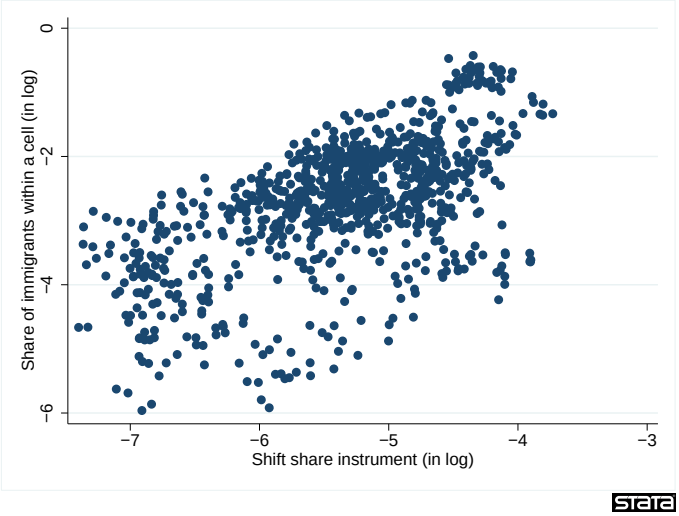

Figure 2: Immigrants predicted share based on 1990 settlement patterns across cells and immigrants yearly observed share within cells. The data are for male.

Thus we use the 1990 distribution of immigrants from a given country across occupations and OECD countries to allocate yearly new waves of immigrants from that country into OECD countries and occupations.

Figure 2 portrayed the scatter plot of the (log) share of immigrants against our (log) shift share variable. The figure illustrates the strong (unconditional) correlation between the two variables making, at a first glance, our shift share variable a good candidate to instrument the share of immigrants within cells. The first stage regression confirms that our instrument is a good predictor of immigrants' share within occupations with an F-stat above 50 in all cases.

4.1.1 The impact at the sectoral level

A noteworthy prediction of our search and matching model of labor market is that within occupations the share of the sector receiving more immigrants should expand since improved employment opportunities attract both, employed and unemployed native workers. The assessment of immigrants impact on local labor market has been blurred by the possibility for natives to leave the local labor market hosting more immigrants. In our context the local labor market is defined by broad occupation group, such that moving across these local labor markets is too costly. However and consistently with our model, workers in a given occupation can move across sectors within the occupation in response to changing employment opportunities.

While outward displacement has been the focus in the literature our theoretical model predicts inward displacement. To investigate whether this is the case in our sample data, we consider three occupations and nine sectors (1-digit industry) in each country. The three grouping of occupations are the following: the highly skilled which comprises "legislators, senior official managers" and "professionals"; the middle skill which comprises "technicians and associate professionals" and clerks ". Lately the low skill is composed of "service workers and shop and market sales workers", "agricultural and fishery workers", "craft and related trade workers", "plant and machine operators and assemblers" and "elementary occupations"[10]. We are obliged to aggregate occupations when implementing the analysis at the sectoral level, in order to ensure a sufficient number of observations per cell.

Given our broad definition of occupations, moving across occupations is prohibitively costly in short term, thus any labor mobility should occur within occupation across sectors. We consider this partitioning of the labor market as it best fits the conceptual framework of our model where we consider mobility across sectors within local labor markets therein defined by occupations. Generalizing the approach of Card (2005) to the specificity of our local labor market (occupations) we test for displacement of natives within occupation occurring across sectors by running the following simple regression:

$$\ln\left(\frac{\text{native and immigrant workers workers in occupation } o \text{ and sector } j}{\text{native and immigrant workers in occupation } o}\right)_{ct} \tag{23}$$

$$= \beta_0 + \beta_1 \ln\left(\frac{\text{immigrants in occupation } o \text{ and sector } j}{\text{native and immigrant workers workers in occupation } o}\right)_{ct} + \delta_c + \delta_t + \delta_o + \delta_j + \mu_{oc} + \alpha_{jc} + \varepsilon_{ojct} \tag{24}$$

We control for unobserved country, year, occupation and sector determinants of the native's employment rate. We also interact the country*occupation (μ_{oc}) and country*sector (α_{jc}) fixed effects, so as to identify the impact of immigration in deviation across years from the occupation (sector) specific mean within a country. Given that the number of workers (employed and unemployed) in an occupation and a sector is the sum of natives and immigrants workers, there is no displacement of natives if $\beta_1 = 1$. If the arrival of one immigrant triggers one native to leave the sector $\beta_1 = 0$. There is partial outward displacement (i.e. natives leave the sector hosting more immigrants) if $0 < \beta_1 < 1$, while as predicted by our model, there is inward displacement if $\beta_1 > 1$.

Again, because immigrants do not randomly locate across sectors within an occupation, the OLS

[10]Slightly different grouping of occupations into the middle and low skill group does not affect the results.

estimation of β_1 may suffer from endogeneity bias. We adopt an IV estimation strategy which generalizes the approach presented previously to the case where past immigrants' network are defined at the sector and occupation level, instead of occupation only. Specifically in (22) the parameter γ_{cso} is replaced by γ_{csoj}, where γ_{csoj} is the share of education level s employed in occupation o and sector j in country c in 1998.

4.2 The robustness test

4.2.1 Short-run *vs.* Long-run impact

The model outlined above suggests that certain conditions must hold in order for the impact of immigrants on native's employment to be positive. In particular, everything else equal, the higher the value of the outside option of immigrant with respect to natives, the lower the impact of immigrants on native employment. Equation (21) does not distinguish between recent and earlier immigrants which amounts to assume that all immigrants have the same outside options. As suggested by our model, this is unlikely to be the case. After a period of employment immigrants become eligible to unemployment benefits, they also develop their own knowledge of local labor market and their own social network, so their outside option will converge towards the outside option of natives as their number of years of residence in the country increases. To relax the assumption of identical outside options among immigrants we distinguish, within an occupation, immigrants with less than 10 years of residence (low outside option group) from those with more than 10 years (high outside option group). In a way, if immigrants outside option rises over time, their outside option should converge to that of natives and their positive impact should die out i.e. they become more substitutable with natives in what concerns their profitability for employers. Let $shim_{oct1}$ be the log ratio of immigrants (both men and women) with less than or equal to 10 years of residence, to the native population size of the cell oct and, let $shim_{oct2}$ be the ratio of immigrants with more than 10 years of residence[11]. The equation to be estimated becomes then:

$$\begin{aligned} \ln y_{oct} &= \gamma_0 + \gamma_1 * shim_{oct1} + \gamma_2 * shim_{oct2} + \\ &\quad + \delta_t + \delta_c + \delta_o + \mu_{ot} + \alpha_{oc} + u_{oct} \end{aligned} \tag{25}$$

[11]The choice of tenure spells in host countries is a trade-off between having a sufficient number of observations within each cell and sufficient variation to allow for identification. The ELS survey does not code residence levels above 10 years.

This specification assumes a piecewise linear impact of immigrants that depends on theirs years of residence within a host country labor market. Under the assimilation hypothesis, our testable assumption is $\gamma_1 > \gamma_2$. Since we face the same identification issues as in Eq.(21), we use both the labor demand shift index and a similar instrumental variable strategy. Equation 25 contains two endogenous variables, therefore we require two instruments. For individuals with less than 10 years of residence, we employ the same instrument as for equation 21. This instrument is associated with international flows so we believe that it is more correlated with immigrants having less than 10 years of residence in the host country. The share of immigrants with more than 10 years of residence by occupation, is more likely to be related with the internal economic structure and progression of a country. We define therefore as an additional instrument the distribution of immigrants within an occupation in 1990[12], crossed with occupation specific industry labor demand shift. Our justification, for this second instrumental variable is also the following: labor demand shifts within occupations will attract more immigrants towards occupations where immigrants were already relatively more concentrated in the past. In a way, our instrument is the predicted employment change of immigrants within occupations due to between-sector demand shifts and the past distribution of immigrants across occupations.

4.2.2 Immigrants from EU-15 *vs.* immigrants from outside EU-15

Equation (21) assumes that all immigrants have the same outside option. As a second robustness test we distinguish between immigrants coming from EU 15 and immigrants coming from outside EU 15. We expect immigrants from EU to have a closer outside option to natives than immigrants from outside EU. Therefore the positive impact on native employment should be larger when considering non EU 15 immigrants, who are likely to accept a lower wage than EU15 immigrants, and who are, thus, more profitable.

Within an occupation, we distinguish now between immigrants from EU15 and immigrants from outside EU15. Since some countries do not report this distinction, some obervations are lost. Let $shim_{octEU15}$ be the log ratio of immigrants (both men and women) coming from EU15 countries, to the native population size of the cell oct and, let $shim_{octNOEU15}$ be the ratio of

[12] As previously, this distribution is derived from the educational distribution of immigrants and the distribution of educational levels across occupations.

immigrants coming from outside EU15. The equation to be estimated becomes then:

$$\begin{aligned} \ln y_{oct} &= \gamma_0 + \gamma_1 * shim_{octNOEU15} + \gamma_2 * shim_{octEU15} + \\ &+\delta_t + \delta_c + \delta_o + \mu_{ot} + \alpha_{oc} + u_{oct} \end{aligned} \tag{26}$$

If our hypothesis holds and the outside option of immigrants from outside EU15 is lower than the outside option of EU15 immigrants, we should find $\gamma_1 > \gamma_2$. Since we face the same identification issues as in Eq.(21), we use both the labor demand shift index and a similar instrumental variable strategy but distinguishing between EU15 and no-EU15 immigrants.

4.2.3 Divergent generosity of the unemployment benefit system

5 Estimation results

We proceed sequentially in our estimation. First of all, we analyze the consequences of the immigration wave at the local labor market level. More precisely, we estimate the response of native employment in a local labor market (occupation) following the arrival of immigrants. In a second step, we test whether there is or not an inward displacement inside a local labor market (occupation) induced by the arrival of immigrants. That is, as predicted by our model, we would like to test if the arrival of immigrants into a particular sector or sectors, induces a reallocation of employed and unemployed workers towards these sectors. This would clearly suggest that the arrival of immigrants fosters an improvement in employment opportunities. In the last step we try to provide some evidence on the fact that the lower reservation wage of immigrants explains the positive impact of the immigrant wave on native employment. To do so, we first show that these positive consequences of the immigrant wave tend to die out with years of residence in the host country, which could suggest a progressive convergence of the reservation wave. Then, we distinguish between countries with generous unemployment benefits and countries with less generous unemployment benefits, and show that the positive impact of the immigration wave is larger in the presence of a generous unemployment benefit (since the gap between reservation wages will also be larger).

5.1 The impact at the local labor market level

Table 1 presents OLS estimates of the relationship between native's male employment rate and immigrants's share within a local labor market (occupation). Appendix 9 presents the

estimations without country and year occupation specific fixed effects (column 2) and then, we successively add occupation-country and occupation-year interactions (columns 3 and 4). Thus we are successively controlling for time, occupation and year invariant country determinants of employment, and occupation-level differences varying over time and across countries. We expect endogeneity bias to diminish as more controls are included in the regression.

To avoid a spurious interpretation of our result, in the first column of table 1 we fix the denominator of our independent variable to its 1998 value. The estimated coefficient remains unchanged compared to the specification provided in the appendix 9, table 6; furthermore, introducing the log number of natives in an occupation does not alter this result. We are therefore confident that bias due to displacement effects is negligible in our context, and does not confound our estimated impact.

A more serious concern is the unobserved time varying determinant of employment within a cell potentially correlated with the immigrants inflow within cell. To partially control for this possibility we introduce in the last column occupation specific industry labor demand shift $\hat{\eta}_{ot}$. The coefficient associated with the immigrants' share remains largely unaffected suggesting little correlation between changes in immigrant's labor force share within a cell and a cell specific labor demand shock driven by sectorial composition of employment.

In tables 2 and 6 columns (4), (5) and (6), we run the same set of regressions for our sample of female workers.

The coefficient for the share of immigrants remains statistically non different from zero. According to our model, this suggests that, compared with male, differences in outside opportunities between immigrants and native female are less relevant.

In spite of controlling for various occupation specific fixed effect and labor demand shift across occupation, OLS estimates may still be contaminated by cell specific unobservable demand-driven shocks correlated with immigrants' share. Thus, we turn to IV estimates. The three last columns of tables 1 and 2 provide the IV estimations[13]. Not surprisingly, given figure (2), the instruments turn out to be strong with an F-test above 25 in all specifications (males and females). Thus the initial origin country distribution of immigrants across occupation and the subsequent flows by origin are a strong predictor of immigrants changes within a cell. The 2SLS estimates suggests that our previous estimates are indeed consistent with a (small) but positive causal effect of immigration on male natives employment rate. This conclusion is robust

[13]First stage results are available upon request.

Table 1: The dependent variable is the log ratio of employed native over of the number of natives in the cell - Male sample -

dependent variable: log(employment rate of natives)

Specification sample	Males					
Estimation method	OLS			2SLS		
ln(IMoct/POP98oct)	0.015***	0.013***	0.012***	0.021***	0.020***	0.019***
	(0.004)	(0.004)	(0.004)	(0.007)	(0.008)	(0.007)
ln(NAoct)		0.041*	0.039*		0.035	0.031
		(0.024)	(0.021)		(0.027)	(0.023)
log of Industry labor demand shift			0.052**			0.049**
			(0.023)			(0.024)
Fixed effects						
country by occupation	yes	yes	yes	yes	yes	yes
year by occupation	yes	yes	yes	yes	yes	yes
F-stat of ex. instruments				57.99	56.25	53.76

The main explanatory variable is the log of the share of immigrants in the cell. In parenthesis we report the heteroskedaticity robust standard-errors clustered at the occupation-country level. All regressions include a full set of time, country and occupation dummies.

Table 2: The dependent variable is the log ratio of employed native over of the number of natives in the cell - Female sample

Dependent variable : log(employment rate of natives in the cell)						
Specification sample	Females					
Specification sample		OLS			2SLS	
ln(IMoct/POP98oct)	-0.001	0.001	0.001	0.008	0.013	0.009
	(0.009)	(0.006)	(0.006)	(0.012)	(0.015)	(0.014)
ln(Naoct)		-0.024	-0.027		-0.044	-0.037
		(0.026)	(0.018)		(0.034)	(0.026)
Industry labor						
demand shift			0.124***			0.125***
			(0.036)			(0.036)
Observations	683	683	683	683	683	683
Fixed effects						
country by occupation	yes	yes	yes	yes	yes	yes
year by occupation	yes	yes	yes	yes	yes	yes
F-stat of ex. instruments				39.49	27.91	27.25

The main explanatory variable is the log of the share of immigrants in the cell. In parenthesis we report the heteroskedaticity robust standard-errors clustered at the occupation-country level. All regressions include a full set of time, country and occupation dummies.

to the introduction of industry labor demand shift. Impact of immigrants on natives female employment remains non statistically different from zero.

5.2 The inward displacement effect within a local labor market

Results are presented in Table 3. The magnitude of the estimated coefficients in both OLS and IV suggests no outward displacement. More precisely, once we have controlled for the endogeneity bias (IV estimates) columns 2 and 5 clearly point towards an inward displacement for both, men and women. Both coefficients (1.347 for males and 1.483 for females) are significantly different from unity, suggesting that, when the share of immigrants in sector j in occupation o increases by one percent, the total share of sector j (natives plus immigrants) in occupation o increases by more than one percent. There has then be an inward displacement.

Columns 3 and 6 propose the most stringent version of our regression. We implement an IV estimation while controlling for a full set of country*occupation*sector fixed effects. Estimated coefficients (1.398 for males and 1.182 for females) are significantly different from zero but we cannot claim that they are significantly different from unity. This result reveals the absence of outward displacement but we cannot point towards an inward displacement in this case. The very stringent definition we use can justify why coefficients are not significantly different from unity.

These results provide some preliminary evidence on the fact that immigrants do not induce natives to reallocate towards other sectors (there is never an outward displacement). Furthermore, we can even claim the existence of an inward displacement since, as suggested by columns 2 and 5, the size of the receiving sector increases above one percent when the share of immigrants in the sector increases by one percent.

5.3 The reservation wage as a driving factor

We now present separate estimates for the impact of the share of veterans immigrants (more than 10 years of residence) and that of new immigrants (less than 10 years) in an occupation. The intuition behind this estimation is that, with years of residence in the host country, the reservation wage of natives and immigrants should converge and then, the positive effect of immigrants on employment opportunities of native should die out. Results for men are presented in table 4 for the OLS and the 2SLS, where we use as an additional instrumental variable the product of the 1990 distribution of immigrants across occupations in each country and the

Table 3: Displacement effects of immigration within occupation across sectors

Dependent variable: Ln(share of occupation o workforce employed in sector j)

	Male			Female		
	OLS	IV		OLS	IV	
	(1)	(2)	(3)	(4)	(5)	(6)
ln[(immigrants in occupation o and sector j)						
/(workers in occupation o)]	0.812***	1.347***	1.398***	0.851***	1.483***	1.182***
	(0.027)	(0.055)	(0.361)	(0.023)	(0.061)	(0.138)
Country*Occupation*Sector Fixed effects	NO	NO	YES	NO	NO	YES
Fstat of ex. instruments		444.06	19.19		339.12	61.34
Observations	2.368	2.354	2.354	2.374	2.348	2.348

All regressions include country, year, country*occupation and country*sector fixed effects. Standard errors clustered at the country, occupation and sector level are reported in parenthesis.

The instrumental variable is the share of immigrants predicted by the 1990 distribution of immigrants into sector and occupation by origin country.

$***\ p < 0.01$, $**\ p < 0.05$, $*\ p < 0.1$

Table 4: Robustness tests
Dependent variable: log(employment rate of natives)

Estimation method	OLS	2SLS	OLS	2SLS
ln(new immigrants IMoct /POP98oct)	0.012***	0.014***		
	(0.003)	(0.006)		
ln(Veterant immigrants IMoct /POP98oct)	0.005	-0.003		
	(0.003)	(0.016)		
ln(EU15/POP98oct)			-0.007**	-0.007
			(0.003)	(0.024)
ln(NOEU15/POP98oct)			0.021***	0.052***
			(0.005)	(0.014)
lnLDshift	0.022*	0.023**	0.112*	-0.007
	(0.013)	(0.014)	(0.047)	(0.058)
Observations	676	676	522	522
Fixed effects				
country by occupation	yes	yes	yes	yes
year by occupation	yes	yes	yes	yes
F-test of ex. instruments				
ln(New immigrants IMoct /POP98oct)		28.80		
ln(Veterant immigrants IMoct /POP98oct)		6.13		
ln(EU15/POP98oct)				11.24
ln(NOEU15/POP98oct)				8.90

In parenthesis we report the heteroskedaticity robust standard-errors clustered at the occupation-country level. All regressions include a full set of time, country and occupation dummies.

labor demand shift driven by the distribution of occupations across industries (Eq. 25).[14] For both estimation methods, OLS and 2SLS, and for all specifications adopted, only the share of recent immigrants exerts a small but positive impact on natives' employment rate. Results are consistent with a causal interpretation: doubling the share of new immigrants in an occupation increases the employment rate of natives by 1,7%. The fact that 2SLS estimates are higher than the OLS ones suggests that there is no tendency for immigrants to cluster in higher employment rate occupations. In the light of our model, these results suggest that new immigrants only have lower outside opportunities as compared to natives. Therefore, an inflow of new immigrants within an occupation decreases the average wages paid by firms in that occupation, triggering the opening of more vacancies and leading to higher employment rate for natives.

6 Numerical simulations

In this section, we propose numerical experiments in order to provide an estimation of the required gap between the value of the outside opportunities of natives and immigrants in order to be able to reproduce the empirical estimations provided in section 5. Two scenarios are actually considered in section 4: the impact at the local labor market level and the impact among sectors within the local labor market. In the former scenario, we analyze how native employment within an occupation is affected by the presence of immigrants. In the second scenario, we focus on sectors within an occupation. These experiments contribute to enriching the discussion on the capacity of the matching model to explain the impact of immigrants on native employment.

The numerical values of the parameters of our benchmark simulation are summarized in Table 5. The discount factor, the recruiting cost and the bargaining power are taken from Mortensen and Pissarides (1994). As already detailed before, a matching function of the Cobb-Douglas form is assumed, where α is the elasticity with respect to job seekers and it is assumed to be equal to 0.5 (see Petrongolo and Pissarides (2001)). Concerning the exogenous job destruction rate, we employ the estimations provided by Davis, Haltiwanger, and Schuh (1996) for US or OECD (1996) for other western countries and set s around 0.10. The outside option equals $b = 0.6$ when considering the scenario with a single sector within an occupation and 0.5 when considering the scenario with two sectors within an occupation. The replacement ratio is then around 66%.

[14] First stage results are available upon request.

Table 5: Baseline Parameters Values

	Employment in an Occupation	Employment in a Sector	
Job productivity	$h = 1$	$h_a = 1$	$h_b = 0.5$
Interest rate	$r = .04$	$r = .04$	
Matching elasticity	$\alpha = 0.5$	$\alpha = 0.5$	
Matching efficiency	$m_0 = 0.38$	$m_{0a} = 0.23$	$m_{0b} = 0.60$
Recruiting cost	$c = 0.3h$	$c_a = 0.3h_a$	$c_b = 0.3h_b$
Exogenous separation rate	$s = 0.10$	$s = 0.09$	
Bargaining power	$\eta = 0.5$	$\eta = 0.5$	
Outside option natives	$b = 0.6$	$b = 0.5$	

This corresponds well to the estimations made by the OECD for the net replacement ratio in European Countries (see OECD indicators on Benefits and Wages 2012).

In order to match our empirical estimates, we consider two alternative scenarios. In the first one, we take as a local labor market one occupation, without considering its internal composition by sectors. For simplicity, productivity is normalized to one. In the second scenario, we look inside our local labor market, that is, inside the occupation. We suppose that the occupation is composed by two large sectors[15]: the high productivity sector (good jobs) and the low productivity sector (bad jobs). We assume the former to be twice as productive as the low productivity sector. We simulate an exogenous increase in the immigrant population in the high productivity sector. This allows us to analyze flows across sectors within an occupation and thus the inward displacement effect.

When considering the first scenario, the scale parameter of the matching function m_0 is chosen so that the unemployment rates of immigrants and seniors are around 10-11%. The matching efficiency is set to 0.38. For the second scenario, where we distinguish good and bad jobs, the matching efficiencies are set to 0.23 for good jobs and to 0.60 for bad jobs. This yields an unemployment rate for natives and immigrants around 10% in good jobs, whereas for bad jobs unemployment rates attaint 20%.

Whether we consider the impact of immigration on employment in a given occupation or the

[15]This extension of our simplified theoretical framework is sketched in appendix 10

impact of immigration in a particular sector, the objective will be to determine the gap between the values of the outside option of natives and immigrants that allows us to reproduce the estimated elasticities of native employment when the immigrant share increases by 1%. Figures 3 and 4 reflect the impact of immigration depending on the gap between outside opportunities of natives and immigrants.

We start considering equation (21) whose non biased estimation is presented in columns (4)-(6) of tables 1 and 2. In this equation, the parameter β_1 tells us that, an increase by 1% in the proportion of immigrants in the total population of an occupation, fosters a rise in the employment rate of natives by 0.019-0.02% (see table 1). We define numerically our explicative variable as the ratio between the immigrant population in a particular occupation and the total population (native plus immigrant) in that occupation. We let this indicator to vary by 1% and analyze the impact on the employment rate of natives in that occupation depending on the gap between outside opportunities. Figure 3 displays the main results. As observed, we require the value of the outside opportunity of immigrants to represent around 20-30% of the value of the outside options of natives[16] to have an impact between 0.019-0.02%.

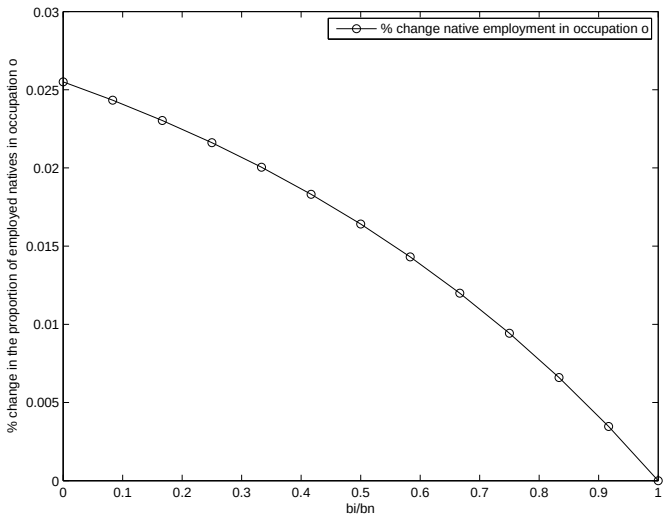

Figure 3: Percentage change in the proportion of employed natives in occupation o when the proportion of immigrants in the total population of an occupation increases by 1%.

In a second stage we focus on equation (24) whose estimation is provided in table 3. The

[16]Outside opportunities of natives equal 0.5 and we require b_i to equal 0.1 in order to reproduce the estimated elasticity.

explicative variable is the proportion of immigrants in a particular sector belonging to this occupation, over the total number of employed in the occupation. The dependent variable is the size of this sector receiving the immigrant wave over the total size of the local labor market (occupation). The coefficient β_1 in equation (24) inform us about the percentage change in the dependent variable, when the explanatory variable increases by 1%. More precisely, an increase of 1% in the contribution of immigrants to particular sector within an occupation increases the relative size of this sector by more of 1%, revealing that native employment is improved by 0.20-0.48% according to estimations in table 3. Figure 4 shows that, in order to reproduce an elasticity above unity we require the value of the outside option of immigrants to represent at most 30% of that of natives.

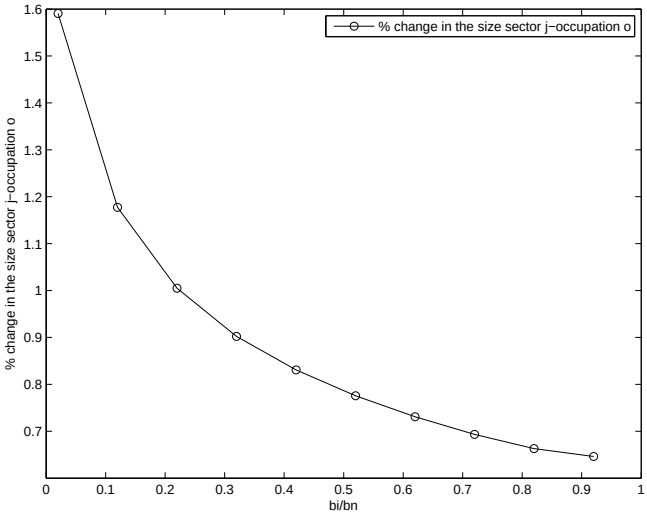

Figure 4: Percentage change in the share of employment in sector j-occupation o when the proportion of immigrants in sector j-occupation o increases by 1%.

7 Conclusion

The increasing contribution of immigrants to the labor force is among the most important comptemporaneous labor supply shocks facing most developed countries. To date, most of the literature has discussed the labor market consequences of this shock using a standard neoclassical labor-supply labor-demand framework. However, this approach does not allow to introduce important differences in non productive assets between immigrants and natives. We have shown

in this paper that, once introduced into a frictional labor market, differences in host country specific assets between immigrants and natives can revert the conclusions reached by the standard model: immigrants improve employment prospects of competing native workers. Thus, instead of crowding-out natives, immigrants may instead crowd-in natives in occupations in which they are landing. These predictions of the model are confirmed by exploiting variations of natives' employment rate and immigration across European countries, occupations and years. Occupations turn out to be an important dimension to analyze the labor market impact of immigrants on natives.

Our results have some direct implications that are worth pursuing further. First, regarding the design of an optimal immigration policy. On one hand, recent research indicates that skilled immigrants may crowd-out natives from skilled jobs (see Borjas (2009)). On the other hand, it has been argued that unskilled immigrants may improve incentives for natives to acquire human capital by rising the skill premium (see Hunt (2011)). In contrast, our conclusions suggest that host countries with more selective immigration policy could improve the employment rate of skilled workers and at the same time rise incentives for natives to acquire human capital. A welfare analysis of such policy is a natural extension of the model proposed in this paper.

Second, on the empirical side we highlight the importance of distinguishing immigrants according to their tenure in host countries. More generally, our more realistic approach to the functioning of the labor market stresses the importance of considering any heterogeneity between immigrants and natives that would affect their relative bargaining position with respect to employers.

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8 Appendix: The wage bargaining bargaining process

There are two common conceptions of wage bargaining. According to one conception, employers set wages and other terms and hire the most qualified applicant willing to work on those terms. The terms are offered to applicants on a strict take-it-or-leave-it basis. A second common conception, which forms the basis of a large literature whose canon is Mortensen and Pissarides (1994), has wages and other terms of employment set by a Nash bargain. Models using this formulation assume that the threat point for bargaining is the payoff pair that results when the job-seeker returns to the market and the employer waits for another applicant. A consequence is that the bargained wage is a weighted average of the applicant's productivity in the job and the value of unemployment. That latter value, in turn, depends in large part on the wages offered in other jobs. This flexible-wage conclusion, however, hinges on unrealistic assumptions about bargaining threats, which Hall and Milgrom (2008) challenge. Once a qualified worker meets an employer, a threat to walk away, permanently terminating the bargain, is not credible. The bargainers have a joint surplus, arising from search frictions, that glues them together. Hall and Milgrom (2008) make use of bargaining theory from Binmore, Rubinstein, and Wolinsky (1986) to invoke more realistic threats during bargaining. The threats are to extend bargaining (disagreement payoff) rather than to terminate it (outside-option payoff). The result is to loosen the tight connection between wages and outside conditions (market tightness). Hall and Milgrom (2008) model, a job-seeker loses most of the connection with outside conditions the moment she encounters a suitable employer, but before she makes her wage bargain. The bargain is controlled by the job's productivity and by her patience as a bargainer relative to the employer's.

In the alternating offer wage-bargaining environment, so long as reaching an agreement creates value, a bargainer who gets a poor offer continues to bargain, because that choice has a strictly higher payoff than taking the outside option. Threats to exercise the outside option simply are not credible. Since this is common knowledge, changes in the value of the outside option cannot affect the bargaining outcome.

Having found what appears to be a good match, the employer makes a comprehensive job offer, including pay, benefits, and duties. The authors believe that employers almost always make the

initial offer. The model assumes that the worker always accepts it at the equilibrium. The wage is higher than it would be if the employer had the power to make a take-it-or-leave-it offer that denied the worker any part of the surplus. The worker's right to respond to a low wage offer by counteroffering a higher wage (though never used in equilibrium) gives the worker part of the surplus. The authors assume the absence of any commitment technology that would enable the employer to ignore a counteroffer. In the Mortensen and Pissarides version of the Nash wage bargain, conditions in the labor market influence the agreed wage through U-V, which is the worker's opportunity cost or reservation wage. Better conditions in the market as represented by a higher value of U give the worker a higher wage. In the wage equation proposed by Hall and Milgrom (2008), the outside option (U) is relevant only when the worker is forced to return to search because of the ending of the opportunity. In the paper we retake the bargaining process proposed in Hall and Milgrom (2008). I suppose that the worker receives a payoff b_j in case negotiation breaks down (or w_j^{AB} if the worker is employed in sector B) but also when the agreement is delayed. For the firm, we assume that there is no cost while bargaining continues. Firms and workers renegotiate the division of the match product h^t for $t = A, B$, so that the outcome of the symmetric alternating-offers game is :

$$w_N^t = \eta h^t + (1-\eta) b_N \tag{27}$$

$$w_I^t = \eta h^t + (1-\eta) b_I^t \tag{28}$$

$$w_N^{AB} = \eta h^A + (1-\eta) w_N^B \tag{29}$$

$$w_I^{AB} = \eta h^A + (1-\eta) w_I^B \tag{30}$$

where η can be interpreted as the bargaining power of each party. The central result of this bargaining process is that the real wage does not depend on the labor market tightness. So, the real wage is rigid. As in the usual wage setting-rule, the real wage increases with the generosity of the unemployment benefits (b) and with the worker's productivity.

9 Appendix: Estimation results

Table 6: The dependent variable is the log ratio of employed native over of the number of natives in the cell - Male sample -

dependent variable: log(employment rate of natives)

Specification sample	Males			Females		
ln(IMoct/POPoct)	-0.009	0.016**	0.013***	-0.021*	0.006	0.001
	(0.146)	(0.012)	(0.008)	(0.065)	(0.472)	(0.889)
Observations	683	683	683	683	683	683
Fixed effects						
country by occupation	no	yes	yes	yes	yes	yes
year by occupation	no	no	yes	yes	yes	yes

The dependent variable is the logarithm of employment/population for natives in an occupation-country-year cell (Eq. 21). The main explanatory variable is the log of the share of immigrants in the corresponding cell. In parenthesis we report the heteroskedaticity robust p-values clustered at the occupation-country level. All regressions include a full set of time, country and occupation dummies.

10 Appendix: A two-sector model

10.1 The matching process

We consider a local labor market represented by occupation i. This occupation may cover several sectors. This allows us to consider both inward and outward displacements within a local labor market. For simplicity we consider here two sectors A and B. We assume that productivity in sector A is higher so wages earned by people employed in sector A are also higher. We assume that unemployed people in sector A have a per period probability λ of being depreciated to sector B. We allow workers employed in sector B to do on-the-job search in sector A where wages are higher. Since we are considering a single occupation, these flows between sectors within an occupation are perfectly reasonable.

Let us denote as $t = A, B$ the two existing sectors, $j = N, I$ native and immigrant workers, v^t the number of vacancies in sector t, u_j^t the number of job seekers, n_j^t the number of employed and eo_j the on-the-job search effort. The matching functions can be thus written as: $M^A = m^A(v^A, u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B)$ and $M^B = m^B(v^B, u_N^B + u_I^B)$, where we assume that initially $u_I^A = 0$ which necessarily implies that $u_I^B = 0$ since immigrants arrive in sector B in an indirect way, via depreciation from sector A. We assume a standard homogeneous matching function of

the form $M^A = m_0(v^A)^{1/2}(u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B)^{1/2}$ and $M^B = m_0(v^B)^{1/2}(u_N^B + u_I^B)^{1/2}$. Labor market opportunities are described by the market tightness variable $\theta^A = v^A/(u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B)$ and $\theta^B = v^B/(u_N^B + u_I^B)$. The probability of filling an empty vacancy equals $q(\theta^t) = M^t/v^t$. The probability of finding a job is given by $p(\theta^A) = M^A/(u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B)$ and $p(\theta^B) = M^B/(u_N^B + u_I^B)$. In sector A, a vacancy is filled by a native worker with probability $q(\theta^A)\frac{u_N^A + eo_N \cdot n_N^B}{u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B}$ and by an immigrant with probability $q(\theta^A)\frac{u_I^A + eo_I \cdot n_I^B}{u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B}$. In sector B, the probability equals $q(\theta^B)\frac{u_N^B}{u_N^B + u_I^B}$ for natives and $q(\theta^B)\frac{u_I^B}{u_N^B + u_I^B}$ for immigrants.

10.2 The agents' behavior

10.2.1 Workers

Employed workers coming from unemployed are paid w_j^t whereas workers in sector A that were previously employed in sector B earn w_j^{AB}, for $j = N, I$. Jobs are destroyed at the exogenous probability s. Workers employed in sector B have a probability $eo_j \cdot p(\theta^A)$ of finding a job in sector A but they bear a disutility cost linked to the search effort equal to $\tau(eo_j) = \phi_0 \cdot eo_j^{\phi_1}$, where $\phi_1 > 1$ so that $\tau'(eo_j) > 0$ and $\tau''(eo_j) > 0$.

The asset values of employment in sector A, B and in sector A but from someone coming from B, are respectively given by:

$$rE_j^A = w_j^A + s(U_j^A - E_j^A) \tag{31}$$

$$rE_j^B = w_j^B - \tau(eo_j) + s(U_j^B - E_j^B) + eo_j \cdot p(\theta^A)(E_j^{AB} - E_j^B) \tag{32}$$

$$rE_j^{AB} = w_j^{AB} + s(U_j^A - E_j^{AB}) \tag{33}$$

where U_j^t stands for the asset values of unemployment

The asset values of unemployment write as follows:

$$rU_j^A = b_j + p(\theta^A)(E_j^A - U_j^A) + \lambda(U_j^B - U_j^A) \tag{34}$$

$$rU_j^B = b_j + p(\theta^B)(E_j^B - U_j^B) \tag{35}$$

where $b_N > b_I$.

The individual employed in sector B, searches on-the-job until all possible rents are exhausted, that is, until the marginal cost of an additional unit of search effort equals the marginal expected benefit from on-the-job search:

$$\tau'(eo_j) = p(\theta^A)(E_j^{AB} - E_j^B) \tag{36}$$

Because $\tau''(eo_j) > 0$ we deduce that an increase in $p(\theta^A)$ should push up on-the-job-search effort. Intuitively, if employment opportunities are improved in sector A, while wages in both sectors remain unchanged, individuals will search more intensively in sector A.

10.2.2 Firms

From the firm's point of view, the asset value associated with an empty vacancy is given by minus the cost associated with the announcement of this vacancy, γ, plus the surplus obtained by the firm if it manages to fill the vacancy with a native worker or with an immigrant. The value of an empty vacancy in sector B is given by:

$$rV^B = -\gamma + q(\theta^B)(\overline{J^B} - V^B) \tag{37}$$

where $\overline{J^B}$ represents the average value of a filled vacancy. The value of a filled vacancy is defined by the instantaneous profit $h^B - w_j^B$ associated with the job (productivity minus the wage) plus the expected loss if the vacancy becomes empty, either because of an exogenous job destruction shock or because the worker finds a position in sector A:

$$rJ_N^B = h^B - w_N^B + s(V^B - J_N^B) + eo_N \cdot p(\theta^A)(V^B - J_N^B) \tag{38}$$

$$rJ_I^B = h^B - w_I^B + s(V^B - J_I^B) + eo_I \cdot p(\theta^A)(V^B - J_I^B) \tag{39}$$

The average value of a filled vacancy in sector B results from the weighted average $\overline{J^B} = \omega_1^B J_I^B + (1 - \omega_1^B) J_N^B$, where $\omega_1^B = \frac{u_I^B}{(u_N^B + u_I^B)}$.

In sector A, the vacancy may be filled by a native worker (unemployed or coming from sector B) or by an immigrant (unemployed or coming from sector B). The decision concerning the number of vacancies to open is then also based on the average expected profit. We denote V^A the value of an empty vacancy and J_N^A, J_N^{AB}, J_I^{AB} and J_I^A the values of a position filled, respectively, by a native worker previously unemployed, a native worker previously employed in sector B, an immigrant worker previously employed in sector B and an immigrant worker previously unemployed. These values are given by:

$$
\begin{aligned}
rV^A &= -\gamma + q(\theta^A)(\overline{J^A} - V^A) \qquad (40)\\
&= -\gamma + q(\theta^A)\Big(\frac{u_N^A}{u_N^A + u_I^A + eo_I \cdot n^B + eo_I \cdot n_I^B} J_N^A + \frac{eo_N \cdot n_N^B}{u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B} J_N^{AB}\\
&+ \frac{eo_I \cdot n_I^B}{u_N^A + u_I^A + eo_N \cdot n_N^B + eo_I \cdot n_I^B} J_I^{AB} + \frac{u_I^A}{u_N^z + u_I^z + eo_N \cdot n_N^B + eo_I \cdot n_I^B} J_I^A - V^B\Big)\\
&\text{where}
\end{aligned}
$$

$$rJ_N^A = h^A - w_N^A + s(V^A - J_N^A) \qquad (41)$$

$$rJ_N^{AB} = h^A - w_N^{AB} + s(V^A - J_N^{AB}) \qquad (42)$$

$$rJ_I^{AB} = h^A - w_I^{AB} + s(V^A - J_I^{AB}) \qquad (43)$$

$$rJ_I^A = h^A - w_I^A + s(V^A - J_I^A) \qquad (44)$$

where h^A corresponds to the productivity of the job and w_N^A, w_N^{AB}, w_I^{AB} and w_I^A stand, respectively, for the wage of a native previously unemployed, for the wage of a native coming from sector B, for the wage of an immigrant coming from sector B and for the wage of an immigrant coming from unemployed. We denote as $\omega_1^A = \frac{u_I^A}{u_N^A + u_I^A + eo \cdot n_N^B + eo \cdot n_I^B}$ the proportion of immigrants job-seekers in sector A that were previously unemployed, $\omega_2^A = \frac{eo \cdot n_I^B}{u_N^A + u_I^A + eo \cdot n_N^B + eo \cdot n_I^B}$ the proportion of immigrants in sector A that were previously employed in sector B, the share of native job seekers coming from sector B equals $\omega_3^A = \frac{eo \cdot n_N^B}{u_N^A + u_I^A + eo \cdot n_N^B + eo \cdot n_I^B}$ and the proportion of native job seekers coming from unemployed is given by $(1 - \omega_1^A - \omega_2^A - \omega_3^A) = \frac{u_N^A}{u_N^A + u_I^A + eo \cdot n_N^B + eo \cdot n_I^B}$.
Firms open vacancies until no more profit can be obtained so that, at the equilibrium, the free entry condition $V^t = 0$ applies, i.e.:

$$\frac{\gamma}{q(\theta^A)} = \overline{J^A} \qquad \text{and} \qquad \frac{\gamma}{q(\theta^B)} = \overline{J^B} \qquad (45)$$

The cost born by the firm while the vacancy remains empty must equal the value associated with the filled vacancy. At this equilibrium, the value of a filled job in sector A equals:

$$\overline{J^A} = \frac{h^A - \omega_1 w_I^A - \omega_2 w_N^{AB} - \omega_3 w_I^{AB} - (1 - \omega_1 - \omega_2 - \omega_3) w_N^A}{r + s} \qquad (46)$$

We can denote the average wage as $\overline{w^A} = \omega_1^A w_I^A + \omega_2^A w_I^{AB} + \omega_3^A w_N^{AB} + (1 - \omega_1^A - \omega_2^A - \omega_3^A) w_N^A$.
The average value of a filled position in sector B equals:

$$\overline{J^B} = \omega_1^B J_I^B + (1 - \omega_1^B) J_N^B = \omega_1^B \frac{h^B - w_I^B}{r + s + eo_I \cdot p(\theta^A)} + (1 - \omega_1^B) \frac{h^B - w_N^B}{r + s + eo_N \cdot p(\theta^A)} \qquad (47)$$

10.3 Wages

We consider a wage determination process in the style of Hall and Milgrom (2008) so that the outcome of the symmetric alternating-offers game is :

$$w_N^t = \eta h^t + (1-\eta) b_N \tag{48}$$

$$w_I^t = \eta h^t + (1-\eta) b_I^t \tag{49}$$

$$w_N^{AB} = \eta h^A + (1-\eta) w_N^B \tag{50}$$

$$w_I^{AB} = \eta h^A + (1-\eta) w_I^B \tag{51}$$

where η can be interpreted as the bargaining power of each party and it is set to 1/2.

10.4 Employment opportunities

Employment opportunities are measured by the labor market tightness which is determined by the free entry condition (45). Combining this equation with (46) and (47), yields:

$$\frac{\gamma}{q(\theta^A)} = \overline{J}^A = \frac{h^A - \overline{w^A}}{r+s} \qquad \text{and} \qquad \frac{\gamma}{q(\theta^B)} = \overline{J^B} = \omega_1^B \frac{h^B - w_I^B}{r+s+eo_I \cdot p(\theta^A)} + (1-\omega_1^B) \frac{h^B - w_N^B}{r+s+eo_N \cdot p(\theta^A)} \tag{52}$$

Since $\frac{\gamma}{q(\theta^t)} = \frac{\gamma}{m_0}(\theta^t)^{1/2}$ for $t = A, B$, we find:

$$\theta^A = \Big(\frac{m_0(h^A - \overline{w^A})}{\gamma(r+s)}\Big)^2 \qquad \text{and} \qquad \theta^B = \Big(\frac{m_0}{\gamma}\omega_1^B \frac{h^B - w_I^B}{r+s+eo_I \cdot p(\theta^A)} + \frac{m_0}{\gamma}(1-\omega_1^B) \frac{h^B - w_N^B}{r+s+eo_N \cdot p(\theta^A)}\Big)^2 \tag{53}$$