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THE IMPACT OF IMMIGRATION ON THE EMPLOYMENT AND WAGES OF NATIVE WORKERS

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ABSTRACT

We analyze the impact of the immigration influx that took place during the years 2000-2007 in Greece on labor market outcomes. We employ a search and matching framework that allows for skill heterogeneity and differential unemployment income (search cost) between immigrants and natives. Within such a framework, we .find that skilled native workers, who complement immigrants in production, gain in terms of both wages and employment. The effects on unskilled native workers, who compete with immigrants, on the other hand, are ambiguous and depend first on the presence of a statutory minimum wage and second on the way that this minimum wage is determined.

Keywords: Immigration; Search and Matching; Unemployment; Skill-heterogeneity; Minimum Wage; Greek Economy.

JEL Classification: F22; J61; J64

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1 Introduction

Despite the ongoing effects of the recent economic crisis, in 2010 the total number of international migrants in the world was estimated at 214 million – up from 191 million in 2005 (World Migration Report 2011, p. 49). Roughly 1 in 32 of world's population is an immigrant. Movements at these high numbers do not go unnoticed. Today immigration is one of the most divisive issues. In 2011, on average 52% of Europeans[1] and 53% of Americans saw immigration as more of a problem than an opportunity (Transatlantic Trends 2011, p. 2). In the same year, the percentage of the respondents who think that there are "too many" immigrants was 47% in the U.S., 48% in Spain and in Italy and 57% in the U.K. (Transatlantic Trends 2011, Chart 3, p. 8). Responding to these attitudes towards immigration, almost every political party in the developed world has included this issue in its agenda.

This paper studies the effects of immigration on the host country and in particular on the labor market outcomes for native workers. For this purpose, it employs a search and matching model of the labor market (e.g., Diamond, 1982 and Mortensen and Pissarides, 1994) amended with immigration. Accordingly, unemployment exists due to frictions in the labor market and job entry responds endogenously to market incentives. Hence, this approach allows us to analyze the effects of immigration on unemployment and wages that result from the impact of changes in the availability of jobs on the bargaining position of workers.

Our basic model shares common elements with Chassamboulli and Palivos (2013). First, it allows for the presence of differential unemployment gains/costs between natives and immigrants, which serves to explain the equilibrium wage gap between otherwise identical native and immigrant workers. This feature generates also the possibility that immigration improves the employment and wage prospects of competing natives, since immigrants, who have a lower outside option, are willing to accept lower wages. Hence, an immigration influx lowers the average wage that firms expect to pay, leading to more job entry and consequently a better bargaining position for native workers. Second, we incorporate in the set-up skill heterogeneity among native workers as well as between natives and immigrants. Immigrants, who are all assumed to be unskilled, are perfect substitutes in production for unskilled and imperfect substitutes for skilled native workers. Thus, an increase in immigration, ceteris paribus, lowers the marginal product (price) of

[1] The countries that participated were France, Germany, Italy, Spain and the U.K.

the unskilled and raises that of the skilled native workers. In an important extension of the basic model we also allow for the presence of a minimum wage, which is binding and applies to a substantial percentage of the labor force. We analyze two cases: one in which the minimum wage is indexed to the wage of the skilled workers and one in which it is a fixed proportion of the average wage.

We calibrate the model to the Greek economy and find that the impact of the increase in immigration that took place between 2000 and 2007 is positive on the overall net income of natives. Moreover, as expected, it lowers the unemployment and raises the wage rate of skilled native workers. This occurs because unskilled immigration influx raises the marginal product of skilled labor; thus, it raises its wage and lowers its unemployment. As regards the unemployment rate of unskilled labor, the entrance of unskilled immigrants lowers the expected employment cost, owing to the lower wages paid to immigrants, and encourages unskilled job entry. This leads to a lower unemployment rate. As for the wage of unskilled native workers, on the one hand, the higher availability of unskilled jobs strengthens their bargaining position and pushes their wage up, but, on the other, the fall in their marginal product, due to the relatively higher quantity of unskilled labor, causes their wage to fall. In our baseline calibration we find the overall impact on the wage of unskilled natives to be negative. Nevertheless, the results change once we allow for a minimum wage. If the minimum wage is indexed to the wage of the skilled workers, then following an increase in immigration, both the skilled and the unskilled wage go up. If on the other hand, the minimum wage is a fixed percentage of the average wage, then the unskilled wage is lower. Also, in the first case the unemployment rate increases, while in the second it may go either up or down, depending on the relative size of two conflicting effects coming from the decrease in the price of unskilled labor and the higher number of immigrants.

There have been a large number of empirical studies that investigate the impact of unemployment on the labor market outcomes in the host country. Among the most recent are Borjas (2003) and Borjas, Grogger and Hanson (2008), who find a large negative wage effect on native workers, and Card (2009) and Ottaviano and Peri (2012), who find the same effect to be relatively small and often positive. Among the key issues behind this disagreement is the elasticity of substitution between native and immigrants in the same skill group. While the first set of studies assumes that it is infinity, i.e., natives and immigrants with the same education and experience characteristics are perfect substitutes, the second set finds this elasticity to be large but finite, e.g., Ottaviano and Peri estimate the elasticity between unskilled immigrant and native workers in the U.S. to be between 6.5 and 20; Manacorda, Manning, and Wadsworth (2012), using U.K. data, find it even smaller. Palivos, Xue and Yip (2011) and Chassamboulli and Palivos (2013) investigate the effects of this elasticity, in a neoclassical growth model and a "search and matching" framework of the labor market, respectively. Instead, throughout this study, we assume this elasticity of substitution to be infinite, i.e., unskilled immigrants and native workers are perfect substitutes, and concentrate on some of the other factors that seem to play a role, namely, the impact of immigration on the market incentives for job creation in different institutional settings.

Most of the theoretical studies that analyze the effects of immigration do so within the standard neoclassical growth model, where unemployment is often absent; examples include, but are not limited to, Ben-Gad (2004, 2008), Moy and Yip (2006), and Palivos and Yip (2010). To the best of our knowledge, the only other papers that analyze immigration within a search framework are those of Ortega (2000), Liu (2010) and Chassamboulli and Palivos (2013).

Ortega (2000) considers a two-country model where workers decide whether to search in their own country or immigrate and ranks the steady-state equilibria that emerge. In that sense, the scope of his paper is broader than ours. Ortega's analysis also takes into account the positive impact of immigration on job entry due to firms anticipating that they will pay lower wages to immigrants that have higher search costs. However, he assumes that worker productivity is constant and therefore independent of the immigration influx. Moreover, since he considers only one type of labor, his analysis overlooks both the negative effect on the marginal product of native workers and the across-skill externalities that arise when otherwise identical natives and immigrants compete for the same types of jobs.

Liu (2010) concentrates on the welfare effects of illegal immigration within a dynamic general equilibrium model with search frictions. The presence of search frictions allows him to identify a new channel through which immigration can alter domestic consumption: intensified job competition from illegal immigrants lowers the job finding rate of native workers and forces them to accept lower wages. Nevertheless, he does not consider the important case where different outside options (unemployment incomes or search costs) between natives and immigrants exist. Furthermore, in his model all wages are bargained and there is no minimum wage.

Finally, our previous work considers both of the channels that we mentioned above (differential unemployment gains and variable marginal products) through which immigration affects wages and unemployment. Nevertheless, apart for several other differences with this paper, e.g., different production function, data, type of immigration, etc., it does not consider the case where a minimum wage is present, which is a crucial feature of the current paper.

As mentioned above, we calibrate the model to Greek data for the period 1992-1999 and analyze the effects of the immigration influx that took place in the Greek economy during the period 2000-2007. Greece is a country that is suitable to run the simulation experiments performed in this study. Throughout most of its modern history, i.e., from 1828 and up until the 1980s, it was overwhelmingly an immigration sending country.

> During the last half of the 19th century, in fact, more Greeks lived outside of the country than inside its borders. Warfare and economic conditions had driven many Greeks into the Balkan Peninsula, into Turkey, as far south as Egypt, and to many other locations along the coast of the Mediterranean Sea. (Ingram 2005, p. 29)

> The 2000 census determined that the population of Greek Americans in the United States was 1,153,307 ... Although a large number of those who list themselves as Greek Americans came to the United States in the 1960s and 1970s, most are descended from immigrants who came in the early 20th century (Ingram 2005, p. 89).[2]

Starting with the 1990s and the collapse of the Soviet Union and other communist regimes in the region, this trend changed drastically. The official percentage of immigrants in the total population increased from 4% in 1990 to 10% in 2010 (the data are from the World Bank). During the 1990s the vast majority of them, close to 80%, came from former communist countries; in particular, more than 50% of immigrants were from Albania (see Cavounidis 2002a and Zografakis, Kontis and Mitrakos 2009).[3] Also, most of them were illegal. Indeed, the number of undocumented immigrants who applied during the first

[2]In 2001, there were 10,452,554 Greeks living inside the borders of Greece (Hellenic Statistical Authority).

[3]However, during the past decade, there has been a relatively big rise in the number of immigrants (mainly undocumented) from Asia, e.g., Afghanistan, Bangladesh, India, and Pakistan.

stage of Greece's first regularization program in 1998 was 371,641, "the largest number of applicants of all regularization programmes of undocumented immigrants carried out in Europe to date" (Cavounidis 2002b, p. 47). It is actually estimated that the total number of undocumented immigrants at the end of the 1990s represented approximately 12.5% of the labor force (see the discussion in Cavounidis 2002b and the references cited therein).

The rest of the paper is organized as follows. Section 2 presents the basic model and Section 3 characterizes its steady-state equilibrium. Section 4 analyzes the effects of immigration within the basic model. In doing so, it distinguishes two special cases. In the first, the two labor inputs (skilled and unskilled) are imperfect substitutes for each other, but otherwise identical native and immigrant workers have the same gains when unemployed. In the second, we assume differential unemployment gains, but let the two labor inputs be perfect substitutes for each other. Considering these two cases separately allows us to identify two different channels through which immigration affects labor market outcomes: one that comes from the impact on firms' expected cost of establishing an employment relation and one that comes from the impact on the prices of labor inputs. Since in the general case, when both of these channels are present, the effects are ambiguous, Section 5 calibrates the basic model to Greek data and presents simulation results regarding the effects of immigration on labor market outcomes. Section 6 revisits the previous results and presents the case where a minimum wage, determined in various ways, is present. Section 7 concludes the paper.

2 The Basic Model

The population comprises a continuum of workers who are either natives or immigrants. Both types are born and die at a constant rate n. The mass of natives is normalized to unity, while that of immigrants is denoted by I. A fraction λ of native workers are low-skilled and the remaining $1-\lambda$ are high-skilled.[4] Immigrants, on the other hand, are all low-skilled. All agents are risk neutral and discount the future at the world interest rate $r > 0$. There is also a continuum of jobs, whose mass is determined endogenously as shown below.

[4] Throughout the paper, we use the terms high-skilled, more-skilled and skilled interchangeably; the same applies for the terms low-skilled, less-skilled and unskilled.

2.1 The Production Technology

Three goods are produced: a final consumption good (Y) and two intermediate ones (H and L) that serve to produce Y. The intermediate goods H and L are produced using only skilled and unskilled labor, respectively. A skilled worker is capable of making one unit of intermediate good H and an unskilled worker one unit of intermediate good L per unit of time. The final good is the numeraire; its production function is

$$Y = AK^{\alpha}[\gamma H^{\sigma} + (1-\gamma)L^{\sigma}]^{\frac{1-\alpha}{\sigma}}, \qquad 0 < \alpha,\ \gamma < 1,\ \sigma \leq 1, \tag{1}$$

where A and K denote an efficiency parameter and the capital stock, α and γ govern income shares and σ drives the elasticity of substitution between skilled and unskilled labor. Chassamboulli and Palivos (2013), who use a similar framework, assume a production function that exhibits capital-skill complementarity, based primarily on the work of Krusell, Ohanian, Rios-Rull, and Violante (2000) for the US economy. However, a series of papers that use cross-country data sets (that include Greece) reject the capital-skill complementarity hypothesis (see, among others, Duffy, Papageorgiou, and Perez-Sebastian 2004, Papageorgiou and Chmelarova 2005, and Henderson 2009).

All three goods are sold in competitive markets. Therefore, the prices of the two intermediate goods, p_H and p_L, will be equal to their marginal products, that is, $p_i = \partial Y/\partial i$, $i = H, L$. Moreover, there exists a competitive capital market in which firms can buy and sell capital without delay. The marginal product of capital is equal to its rental price (p_K), which is in turn equal to the interest rate (r) plus the capital depreciation rate (δ), that is, $p_K = \partial Y/\partial K = r + \delta$.

2.2 Labor Markets

There are two labor markets, one for skilled and one for unskilled labor. The matching process in each of them is described by the function $M(U_i, V_i) = M_0 U_i^{\varepsilon} V_i^{1-\varepsilon}$, $\varepsilon \in (0,1)$, where M_0 is an efficiency parameter and U_i and V_i denote respectively unemployed workers and vacancies of skill type i, $i = H, L$. The flow rates of a match for a worker and for a vacancy is $M(U_i, V_i)/U_i = M_0\theta_i^{1-\varepsilon} = m(\theta_i)$ and $M(U_i, V_i)/V_i = M_0\theta_i^{-\varepsilon} = q(\theta_i)$, respectively, where $\theta_i = V_i/U_i = m(\theta_i)/q(\theta_i)$ is the number of vacancies per unemployed worker and serves as an indicator of the tightness in labor market i.

Firms post either high-skill vacancies, which are suited only for skilled workers, or low-skill vacancies, which are suited only for unskilled workers. Each firm posts at most one vacancy and the number of firms of each type is determined endogenously by free entry. Firms can choose to open either skilled or unskilled vacancies, but cannot open vacancies suited only for natives or only for immigrants. A vacant firm bears a recruitment cost c_i, $i = H, L$, specific to its type. On the other hand, an unemployed worker of type i and origin j receives a net flow of income b_{ij}, which can be considered as the instantaneous opportunity cost of employment and includes unemployment benefits, the value of leisure and the cost of searching for a job. In general, one expects that $b_{iN} > b_{iI}$, since all immigrants, but especially the illegal ones, have a higher search cost than natives and often do not qualify for unemployment insurance benefits. There is no cross-skill matching. Instead, the two markets are completely sealed off: high skill workers direct their search towards the high-skill sector and low-skill workers towards the low-skill sector. Also, for simplicity, we assume that creating a vacancy is costless.[5]

Once a vacancy and a worker meet, they bargain over the division of the surplus from a potential match. The skill level of the worker and hence the output that will result from the match are known to both parties. We follow the literature and assume that wages are determined by Nash bargaining, where the worker has relative power β. After an agreement has been reached, production begins. Nevertheless, matches dissolve at an exogenous rate s_i, specific to their type. Following a break-up, the worker and the vacancy enter the labor market and search for new trading partners. A comprehensive picture of the model is presented in Figure 1.

2.3 Asset Value Functions

It follows from the description above that all workers fall within the following three types of mutually exclusive pairs: skilled (H) and unskilled (L); natives (N) and immigrants (I); employed (E) and unemployed (U). Likewise, all vacancies are: suited for either skilled (H) or unskilled (L) workers; filled (F) or unfilled (V); and if filled, matched with either a native (N) or an immigrant (I). Let J_{ij}^{κ} denote the present discounted value associated with the state ijk, where $i = H, L$, $j = N, I$, and $\kappa = V, U, F, E$. Then, in steady state,

[5] Laing, Palivos and Wang (1995, 2003) analyze models where establishing a vacant position involves a cost. The introduction of such a cost facilitates, among others, the study of the effects of an investment subsidy.

the following equations must hold

$$
\begin{aligned}
rJ_i^V &= -c_i + q(\theta_i)\left[\phi_i J_{iN}^F + (1-\phi_i) J_{iI}^F - J_i^V\right], && (2)\\
rJ_{ij}^F &= p_i - w_{ij} - (s_i + n)\left[J_{ij}^F - J_i^V\right], && (3)\\
(r+n)J_{ij}^U &= b_{ij} + m(\theta_i)\left[J_{ij}^E - J_{ij}^U\right], && (4)\\
(r+n)J_{ij}^E &= w_{ij} - s_i\left[J_{ij}^E - J_{ij}^U\right], && (5)
\end{aligned}
$$

where ϕ_i is the fraction of unemployed workers of skill type i that are natives and w_{ij} denotes the wage rate for an employed worker of skill type $i = H, L$ and origin $j = N, I$. These equations have by now become standard textbook material. For example, consider equation (2). The term rJ_i^V is the flow value accrued to an unmatched vacancy of type i: it equals the loss from maintaining a vacant position plus the flow probability of becoming matched with a worker of the same type multiplied by the expected capital gain from such an event. The other asset value equations possess similar interpretation.

Free entry and exit on the firm side in each intermediate input market imply that, in equilibrium, an additional vacancy of skill type i should have an expected net profit equal to zero, i.e.,

$$J_i^V = 0. \tag{6}$$

On the other hand, the total surplus from a match S_{ij} is

$$S_{ij} = J_{ij}^F + J_{ij}^E - J_{ij}^U - J_i^V. \tag{7}$$

As mentioned above, firms and workers receive a share of this surplus equal to their bargaining power $1-\beta$ and β, respectively. Thus,

$$
\begin{aligned}
J_{ij}^F - J_i^V &= (1-\beta)S_{ij}, && (8)\\
J_{ij}^E - J_{ij}^U &= \beta S_{ij}. && (9)
\end{aligned}
$$

2.4 Unemployment

Recall that the total mass of skilled and unskilled workers is $1-\lambda$ and $\lambda + I$, respectively. By equating the flows out of unemployment to the sum of separations and new births, we can find the steady-state employment levels of each type of workers:[6]

[6] For example, the change in the level of skilled employment ($\dot{H}$) is given by $\dot{H} = m(\theta_H)(1-\lambda-H) - s_H H - nH$, where the first term on the right-hand side denotes the flow out of unemployment, the second the flow of separations and the third the flow of new births (=deaths) of skilled workers. Setting $\dot{H} = 0$ yields the steady-state level of H given in equation (10).

$$H = \frac{m(\theta_H)(1-\lambda)}{n + s_H + m(\theta_H)}, \quad L = \frac{m(\theta_L)(\lambda + I)}{n + s_L + m(\theta_L)}. \tag{10}$$

Similarly, the steady-state unemployment levels (U_{ij}) and rates (u_{ij}) of each skill type $i = H, L$ and origin $j = N, I$ are given by:

$$u_H = \frac{U_{HN}}{1-\lambda} = \frac{n + s_H}{n + s_H + m(\theta_H)}, \tag{11}$$

$$u_{LN} = \frac{U_{LN}}{\lambda} = u_{LI} = \frac{U_{LI}}{I} = \frac{n + s_L}{n + s_L + m(\theta_L)}. \tag{12}$$

Moreover, as mentioned above, the probability that a skill type i and unemployed worker is native is denoted by ϕ_i and is equal to

$$\phi_H = 1, \quad \phi_L = \frac{U_{LN}}{U_{LN} + U_{LI}} = \frac{\lambda}{\lambda + I}. \tag{13}$$

3 Characterization of the Steady-State Equilibrium

Definition. A steady-state equilibrium in this economy is a set $\{\theta_i^*, p_i^*, p_K^*, w_{ij}^*, H^*, L^*, K^*, u_{ij}^*, \}$, where $i = L, H$ and $j = N, I$, such that:

1. The intermediate input markets and the capital market clear.
2. The free entry condition (6) for each skill type i is satisfied.
3. The Nash bargaining optimality conditions (8) and (9) for each skill type i and origin j hold.
4. The numbers of employed and unemployed workers as well as of filled and unfilled vacancies of each type and origin remain constant.

Combining equations (3), (6) and (8) we have

$$S_{ij} = \frac{1}{1-\beta} \frac{p_i - w_{ij}}{n + r + s_i}. \tag{14}$$

Also, using equations (4), (5), (9) and (14), we get

$$w_{ij} = \beta p_i + (1-\beta)(r+n) J_{ij}^U, \tag{15}$$

that is, the wage rate is a convex combination of the value of production p_i and worker's reservation wage $(r+n)J^U_{ij}$.[7] Substituting away J^U_{ij} from (15), using (4) and (5), we obtain an expression for the negotiated wage rate in terms of the price p_i and the worker's net gain while being unemployed b_{ij}

$$w_{ij} = b_{ij} + (p_i - b_{ij})\frac{\beta[r+n+s_i+m(\theta_i)]}{r+n+s_i+\beta m(\theta_i)}. \tag{16}$$

Note that the worker's wage depends positively on the productivity p_i, unemployment income b_{ij} and market tightness θ_i. An increase in productivity increases the size of the pie that is to be divided between the worker and the firm. Thus, with bargaining power held constant, each party gets a bigger piece. Also, an increase in unemployment income raises the worker's reservation wage and hence pushes the negotiated wage upward. Finally, a rise in market tightness θ_i increases the probability of workers finding a job, which raises their reservation wage and puts upward pressure on the negotiated wage (it may be recalled that $\theta_i = V_i/U_i$).

Finally, using equations (2), (3), (6) (8) and (16), we obtain

$$p_i = B_i, \tag{17}$$

where

$$B_i \equiv \phi_i b_{iN} + (1-\phi_i)b_{iI} + \frac{c_i[n+r+s_i+\beta m(\theta_i)]}{(1-\beta)q(\theta_i)}, \quad i = L, H.$$

Each of equations (17) is a zero expected profit condition in the unskilled and skilled input market, respectively. The left-hand-side is the revenue, p_i, and the right-hand-side, B_i, the expected cost to an unfilled vacancy of skill type i from being matched randomly with a worker of the same type.

Using equations $p_i = \partial Y/\partial i$ and $p_K = \partial Y/\partial K = r+\delta$ and differentiating (1) we can express the prices of the two intermediate goods as functions of θ_H and θ_L:

$$p_H = (1-\alpha)\gamma A^{\frac{1}{1-\alpha}}\left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha}}\left[\gamma + (1-\gamma)\left(\frac{L}{H}\right)^{\sigma}\right]^{\frac{1-\sigma}{\sigma}} \tag{18}$$

$$p_L = (1-\alpha)(1-\gamma)A^{\frac{1}{1-\alpha}}\left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha}}\left[\gamma\left(\frac{L}{H}\right)^{-\sigma} + (1-\gamma)\right]^{\frac{1-\sigma}{\sigma}} \tag{19}$$

[7] Note from (15) that if workers do not have any bargaining power ($\beta = 0$), then they do not obtain any rent, i.e., $J^E_{ij} = J^U_{ij}$. If, on the other hand, they have all the bargaining power ($\beta = 1$), then they receive the entire value of production, i.e., $w_{ij} = p_i$.

where L and H follow from equations (10).

Equations (18) and (19) imply diminishing marginal products and Edgeworth complementarity between two different inputs, i.e., $\partial p_i/\partial_i < 0$ and $\partial p_i/\partial_j > 0$ for $i \neq j$, $i, j = H, L$. Moreover, equations (10) imply that $\partial_i/\partial\theta_i > 0$, $i = H, L$. Therefore, an increase in θ_i raises the employment and production of intermediate input i and decreases its price p_i (= marginal product). Also, an increase in θ_i raises both the time required to fill a vacant position of type i and the worker's probability of finding a job. Both of these changes drive up the expected cost B_i. Thus, if the left-hand-side of (17) is higher than its right-hand-side (i.e., $p_i > B_i$), then more firms of type i will enter, in which case θ_i will increase until the equilibrium is restored. Finally, an increase in θ_i raises the employment of input i and thus leads to a higher price of the other input j, $i \neq j$.

Having determined θ_H^* and θ_L^*, we can compute the equilibrium values for the other variables by substituting in the appropriate equations. In particular, the unemployment rates (u_{ij}) follow from equations (11) and (12) and the wage rates from equation (16). Notice that an increase in tightness θ_i and thus the matching rate $m(\theta_i)$ has two effects on the wage rate of a worker of type i: one negative through the price p_i - an increase in the matching rate raises employment and thus decreases the marginal product and price of input i - and one positive through the outside option - an increase in the matching rate raises the value of search and hence the outside option, which strengthens the worker's bargaining position.

It follows from equation (16) that the wage rate of a native unskilled worker is higher than that of an unskilled immigrant. This is so because the native unskilled worker has higher income while being unemployment ($b_{LN} > b_{LI}$) and hence higher outside option. Thus, firms extract higher surplus from immigrants. Therefore, we need to exclude the case where a firm that meets a native unskilled worker decides not to form a match and continues to search, i.e., we need to exclude the case where $J_{LN}^F \leq J_i^V = 0$. Combining equation (3) sequentially with equations (6), (16) and (17), we arrive at the following condition:

Condition 1 (Precluding the Option to Wait)

$$\frac{c_L}{q(\theta_L)} > \frac{(1-\beta)(1-\phi_L)(b_{LN} - b_{LI})}{n + r + s_L + \beta m(\theta_L)}.$$

The left-hand side is the average cost of a vacant low-skill position, while the right-hand side is the expected net benefit from hiring a low-skill immigrant. Obviously, if natives and immigrants have the same outside option, i.e., $b_{LN} = b_{LI}$, then this condition always holds. Also, given that a firm and a worker get a portion of the same surplus (see equations (8) and (9)), it follows that if Condition 1 holds, then $J_{LN}^{E} > J_{LN}^{U}$, i.e., an unemployment low-skilled worker will not turn down an employment opportunity in quest of a better offer.

4 The Effects of Immigration

The overall effect of a change in the number of unskilled immigrants I can be decomposed into two channels: i) an impact through the prices of intermediate goods p_i (see equations (10), (18) and (19), where it follows that a change in I affects L and through that both p_H and p_L) and ii) an impact through the expected employment cost of a low-skill vacancy B_L (see equation (13) and the definition of B_L given after equation (17), where it follows that a change in I affects the probability that an unemployed worker is native, ϕ_L, and through that the expected cost, B_L). Before analyzing the equilibrium in the general case, where a change in I is propagated through both of these channels, we analyze each case separately. Specifically, first, we set the immigrant's gain while in unemployment (b_{LI}) equal to that of an unskilled native (b_{LN}), so that there is no difference anymore between these two types of workers, i.e., $w_{LN} = w_{LI}$, and hence a firm is indifferent between hiring an immigrant and a native unskilled worker. Then, a change in I has no impact on the expected employment cost B_L; thus, it influences the equilibrium only through its impact on prices. The second special case that we analyze below is the one where natives have a higher gain while in unemployment, i.e., $b_{LN} > b_{LI}$, but the two intermediate inputs are perfect substitutes for each other ($\sigma = 1$). In this case the two input prices are always independent of I. Therefore, a change in I can affect the labor market outcomes only through its impact on the employment cost B_L.

4.1 Variable Prices and Equal Unemployment Incomes

Consider first the case where $\sigma < 1$ and the two types of unskilled workers receive the same gain while unemployed, that is, $b_{LN} = b_{LI} = b_L$. Among others this would be the case if immigrants and natives have the same value of leisure, including unemployment benefits, and the same search cost. As mentioned above, in this case there is no difference between a native worker and an immigrant of the same type; in particular, $w_{Lj} = w_L$

$\forall j = N, I$. Differentiating equations (17) for $i = L, H$ and making use of (10) we find that

$$\frac{d\theta_L}{dI} < 0 \quad \text{and} \quad \frac{d\theta_H}{dI} > 0.$$

An increase in the number of unskilled immigrants I lowers the price of unskilled labor, p_L, and raises that of skilled, p_H. This discourages the entry of unskilled jobs and lowers the tightness in the unskilled sector θ_L; at the same time, it induces entry of skilled jobs and drives up the tightness in the skilled sector θ_H. Moreover, the decrease in θ_L lowers the probability that an unskilled worker finds a match $m(\theta_L)$ and hence increases the unemployment rate u_{LN} (see equation 12). The opposite result holds for the unemployment rate among skilled workers, u_H (see equation 12). Finally, substituting $b_{LN} = b_{LI} = b_L$ in (17) and then in (16) yields

$$w_i = b_i + \frac{\beta}{1-\beta} \frac{c_i}{q(\theta_i)} [n + r + s_i + m(\theta_i)].$$

Obviously, a decrease in θ_L lowers worker's outside option and hence w_L. The opposite is true for w_H.

4.2 Fixed Prices and Differential Unemployment Gains

Next we analyze the other special case where $\sigma = 1$ but $b_{LN} > b_{LI}$. In this case, the marginal products of the two intermediate goods are independent of their quantities and hence of the number of immigrants I (see equations (18) and (19)). Thus, a change in the number of unskilled immigrants works only through the employment cost B_L. Given that immigrants earn a lower gain while unemployed, they are forced to accept lower wages. Consequently, an increase in the number of unskilled immigrants lowers the probability that that an unemployed and unskilled worker is native (ϕ_L) and thus lowers the expected employment cost in the low-skill sector B_L. This spurs entry of low-skill jobs with a concomitant increase in θ_L and in the matching rate for low-skill workers $m(\theta_L)$. As a result, the unemployment rate u_{LN} decreases while the wage rate w_{LN} goes up. On the other hand, the unemployment rate and the wage rate in the high-skill sector are not affected by the change in the number of immigrants, I, since the market tightness in that sector, θ_H, remains unaltered.

4.3 General Case

Let us now analyze the equilibrium in the general case, where $\sigma < 1$ and $b_{LN} > b_{LI}$, that is, the two intermediate inputs are imperfect substitutes for each other and the natives have a higher income (lower search cost) while unemployed than immigrants. It follows that a change in I can influence the equilibrium through both prices (p_H and p_L) and the expected employment cost for low-skill jobs (B_L).

From our analysis above, we can infer that in this general case the impact of an increase in the number of unskilled immigrants on the native skilled workers will be unambiguously positive, in terms of both wages and employment. Following an increase in I, the increase in the price of the intermediate good H (p_H) lowers the unemployment rate (u_H) and raises the wage (w_H) of skilled workers, while the change in the employment cost (B_L) leaves them unaffected. However, the impact on unskilled natives is in general ambiguous. This is so, because the price effect increases their unemployment (u_L) and lowers their wage rate (w_L), whereas the employment cost effect decreases their unemployment and raises their wage.

5 Quantitative Results

Below, we calibrate the model to Greek data in order to assess quantitatively the overall impact of immigration on the labor market outcomes (wages and unemployment rates) for natives of both skill groups. We further use this calibration exercise to provide insights on how immigration affects the total steady-state surplus of the economy, i.e., the total income to natives net of the flow cost of vacancies.

5.1 Welfare Measures

We make the assumption that all firms belong to natives, who therefore receive all the net profits. Thus, the measure of net income to natives (labeled as surplus 1) is given by

$$\widetilde{Y} = Y + b_H U_H + b_L U_{LN} - c_H V_H - c_L V_L - w_{LI}(I - U_{LI}), \tag{20}$$

i.e., it is equal to the total flow of output, Y, plus the output-equivalent flow to native workers who are not currently employed, $b_H U_H + b_L U_{LN}$, minus the flow costs of job creation for skilled and unskilled vacancies, $c_H V_H$ and $c_L V_L$, respectively, minus the wages paid to currently employed immigrants, given by the last term in equation (20). In the simulation exercises below, we also consider an alternative measure of the net income to natives (labeled as surplus 2) that does not include the income enjoyed by the unemployed; thus, it is equal to $\tilde{Y} - b_H U_H - b_L U_{LN}$. Finally, we compute the overall surpluses, which include the wages paid to immigrants, with and without the income of the unemployed; these are equal to $Y + b_H U_H + b_L U_{LN} - c_H V_H - c_L V_L$ and $Y - c_H V_H - c_L V_L$ and are labeled surplus 3 and surplus 4, respectively.

In the remaining of this section, we first describe the baseline calibration and then discuss the quantitative predictions of the general model.

5.2 Calibration

Our model economy is fully characterized by 19 parameters: the production parameters A, α, γ and σ, the parameters in the matching function, M_0 and ε, the interest rate, r, the workers' bargaining power, β, the job separation rates, s_L and s_H, the capital depreciation rate, δ, the normalized number of immigrants, I, the population birth rate, n, the share of the unskilled labor force, λ, the opportunity costs of employment, b_{LN}, b_{HN} and b_{LI}, and the vacancy costs, c_L and c_H. We choose the parameters of the model to match the Greek data during the period 1992-1999. We then simulate the effects of the increase in the number of immigrants that took place in Greece during the period 2000-2007. One period in the model economy represents one quarter, so all the parameters are interpreted quarterly. A summary of our calibration is given in Table 1.

First, we normalize the efficiency parameters in the production function, A, and in the matching function, M_0, to one. Second, following common practice, we set the unemployment elasticity of the matching function (ε) to 0.5, which is within the range of estimates reported in Petrongolo and Pissarides (2001). Third, following the literature, we postulate the worker's bargaining power (β) to be 0.5, so that the Hosios condition ($\beta = \varepsilon$) is met (Hosios, 1990). Regarding the value of σ, Autor, Katz and Krueger (1998) conclude that the elasticity of substitution between skilled and unskilled labor, which equals $1/(1-\sigma)$, is very unlikely to fall outside of the interval between 1 and 2. Moreover, Katz and Murphy (1992) estimate it to be about 1.41, Autor, Kerr and Kugler (2007) about 1.6, and Heckman, Lochner and Taber (1998) and Ciccone and Peri (2005) around 1.5. Based on these studies, we set the value of σ equal to $1/3$ so that the elasticity of substitution is 1.5.

Next, using data from Eurostat, we calculate the average yield to 10-year government bonds and the average growth rate of the Consumer Price Index over the period 1992-1999. The average annual real interest rate, which is approximated by the difference between these two figures, is 6.732%, implying a quarterly rate (r) 1.642%. Also, the average growth rate of the labor force is $n = 0.23\%$ (World Bank) and the share of unskilled labor force $\lambda = 0.864$ (Hellenic Statistical Authority).[8] The number of immigrants is taken from the series compiled in Zografakis, Kontis and Mitrakos (2009), the size of the native population from the World Bank and the labor force participation rates for immigrants and natives from the Hellenic Statistical Authority and the World Bank. Using all this information, we find the normalized number of immigrants $I = 0.0958$.[9]

Country specific estimates of the depreciation rate are not available with the exception of the U.S. According to the Bureau of Economic Analysis, the estimated depreciation rates for private capital in the U.S. were about 4.25% in 1960 and increased to 8.5% in 2001. We follow the literature (see, for example, Kamps 2006 and Arslanalp, Bornhorst, Gupta and Sze 2010) to construct the depreciation rate for Greece. More specifically, we assume a constant rate between the initial value of 4.25% in 1960 and the final value of 8.5% in 2001. The average rate over the period 1992-1999 is 7.77%, implying a quarterly rate of 1.94%.

We jointly calibrate the remaining nine parameters by matching nine calibration targets obtained from Greek data over the period of interest, namely, 1992-1999. More specifically, our first target is the capital to output ratio. The capital stock is defined to include nonresidential equipment and software as well as nonresidential structures. It is constructed using the perpetual inventory method following the formula $K_{t+1} = (1 - \delta)K_t + Inv_t$, where the depreciation rate δ is constructed as above and Inv_t is the level of investment in year t. We set the initial capital stock K_0 equal to $Inv_0/(g + \delta_0)$, where g is the average growth rate of investment over the period 1971-1990 and δ_0 is the depreciation rate in the initial year (for the details on this method see also Lowe, Papageorgiou and Perez-Sebastian 2012 and the references cited therein). This measure of capital is then divided by a measure of private output that is equal to GDP−Gross Housing Value Added−Compensation of Government Employees. This way, we find the value of 0.715 for the capital to output ratio.

[8] Data source inside the parentheses.

[9] Following our previous modeling choice, we assume that all immigrants are low-skilled. Given that many of them were illegal and did not have a working knowledge of the Greek language, we believe that this assumption is justified. See Lianos (2003), Chapter 7, and Zografakis, Kontis and Mitrakos (2009), p. 80, for empirical justification for this assumption.

Our second target is the overall average separation rate (s). We follow the method outlined in Shimer (2005). More specifically, the separation rate is calculated using the formula $s_t = U^s_{t+1}/[E_t(1-0.5f_t)]$, where U^s_t denotes the number of workers who are unemployed for less than a quarter in quarter t, E_t is the number of employed workers in quarter t and f is the job finding rate, given by $f_t = 1 - [(U_{t+1} - U^s_{t+1})/U_t]$. Using data from the Hellenic Statistical Authority we find the overall separation rate to be 0.0165.[10] In our analysis below, we experiment with different values regarding the separation rates in the skilled and the unskilled sector that result in this overall separation rate.[11]

For the skill premium we use the estimates of Prodromidis and Prodromidis (2008). They provide two sets of estimates for the premiums using 13 educational categories and two samples: the 1993-94 and the 1998-99 Household Surveys. Using their estimates and the number of workers that fall within each category we calculate the weighted average for the premium of those with a BA over those without a BA degree to be 1.482. Our fourth target is the native-immigrant wage gap. For this, we use the estimate of Lianos, Sarris and Katseli (1996), who find that immigrants earn 40% less than equally productive natives.[12]

Next we target the replacement ratios (ratio of unemployment to employment income) for the two skill groups. Data on net replacement ratios before the year 2001 do not exist. The average gross replacement ratio for two earnings levels, three family situations and three durations of unemployment over the period 1992-1999 was 15.25% (OECD 1998). In 2004 the net replacement ratio for those at the stage of initial unemployment was 65%, for long-term unemployment 17%, and the average over 5 years 33% (see Christoffel, Kuester and Linzert, 2009). In what follows, we use the value of 0.4 as the replacement ratio for each of the two groups. Our last two targets are the unemployment rates for both groups. Using data from the Hellenic Statistical Authority, we found the average unemployment rate for the skilled to be 7.71% and for the unskilled 10.6%.

[10] Hobijn and Sahin (2007) estimate the monthly separation rate for Greece over the period 1992-2004 to be 0.007, implying a quarterly rate of 0.0209.

[11] The existing data do not allow us to compute the separation rates for each skill group.

[12] Demoussis, Giannakopoulos and Zografakis (2010) find the same wage differential to be 48%, whereas Roupakias (2011) finds it 39% between natives and all immigrants and 45% between natives and non-EU immigrants.

5.3 Simulation Results

Using data from the World Bank over the period 2000-2007 we find the change in the number of immigrants to be $\Delta I = 0.052$, i.e., 5.2% of the native labor force. In Table 2 we summarize the effects of an immigration influx of the same magnitude as the one in the data. Since data that allow us to calculate the separation rate for skilled and unskilled workers separately do not exist, we analyze three different cases where the separation rate in the unskilled sector is equal, equal to one and a half times, and double the one in the skilled sector. As can be seen from Table 2, the differences in the impact on all variables are very small.

The increase in the number of unskilled immigrants raises job entry not only in the high- but also in the low-skill sector. Consequently, unemployment falls not only among skilled, but also among unskilled workers. These improvements come through the impact of search costs (more generally net gains while unemployed) on the wage of unskilled immigrants. As explained above, due to their higher search costs unskilled immigrants receive lower wages than unskilled natives. For this reason, as the immigrants' share of unskilled labor force increases, firms with low-skill vacancies anticipate that they will have to pay lower wages on average. This encourages low-skill job entry. The resulting increase in the unskilled labor input (L) causes the price of skilled labor input to rise (p_H), thereby also encouraging the creation of skilled jobs.

In addition, there is a negative impact on the wage of unskilled natives. To understand why recall that an increase in the number of immigrants, I, influences the equilibrium wage through two channels: 1) through its impact on the marginal product of labor and thus the price of the labor input; for example, an increase in the number of unskilled immigrants lowers the marginal product of unskilled labor, thereby lowering the unskilled worker's wage; 2) through its impact on the worker's value of outside option. An increase in I spurs job entry and raises the matching rate and the value of search, thereby strengthening the workers' position in wage setting, and in turn, causing their wage to rise. In the case of unskilled native workers, the first effect, which is negative, dominates the second, which is positive, causing a small decrease in the unskilled wage w_{LN}. As for the skilled workers, their wage goes up because both of the aforementioned effects are positive: first, their productivity goes up (an increase in L raises p_H) and second, their matching rate $m(\theta_H)$ and hence their outside option increases.

It is also worth commenting on the impact of the unskilled immigration influx on the welfare of previous unskilled immigrants. In the presence of differential unemployment gains the impact of immigration in terms of wages appears to be more positive on unskilled immigrants than on natives. Since search is much costlier for immigrants than for natives, the positive effect of higher job creation on the outside option of unskilled workers is much more important than the negative competitive effect on their marginal product, which explains why the impact of immigration on their wage is more positive. For these workers, a small increase in their chances of finding a job implies a much larger increase (in percentage terms) in their bargaining power and in turn on their wage. Finally, notice in Table 2 that all measures of unemployment decrease and all measures of output (surplus) go up.

6 The Presence of a Minimum Wage

Nearly all OECD countries have some form of a minimum wage-setting arrangement. In Greece minimum wage legislation was introduced in 1953 and it is still in effect although in a different form. For the period analyzed here (1992-1999) the minimum wage was set either as a daily rate for manual workers or as a monthly rate for non-manual workers by the National General Employment Collective Agreement and applied only to the private sector. Although this minimum wage was set through a national agreement between the social partners, it was legally binding. Also, while there was no automatic indexation, the rate was adjusted frequently, namely, twice or three times a year (see OECD 1998). Both the inflation rate and the wage movements were either explicitly or implicitly taken into consideration in annual reviews of the minimum wage.

To take into account this important labor institution, we analyze next the case where there exists a minimum or statutory wage received by unskilled workers. Accordingly, the wage of an unskilled worker is no longer the outcome of a bargaining process. Instead, unskilled native workers are paid the minimum wage and unskilled immigrant workers are paid less than that; i.e., $w_{LN} = w_m$, where w_m denotes the minimum or statutory wage and $w_{LI} = (1 - D)w_m$, where $1 > D \geq 0$ is the percentage difference between the wage of unskilled natives and that of immigrants. Obviously, if $D = 0$, then unskilled native and immigrant workers receive the same wage. The case where $D > 0$ is meant to capture either illegal immigration[13] or exploitation of immigrants in the sense that

[13] Palivos (2009) shows that illegal immigrants are paid a lower wage if there is a penalty imposed on firms that employ them.

identical workers are paid different wages.[14] As above, the wage of skilled workers is bargained over and satisfies the Nash bargaining solution in (9). Hence, the skilled wage and the zero expected profit condition in the skilled sector remain as given in equations (16) and (17), respectively.

Using equations (2), (3), and (6), we can write the zero expected profit condition in the unskilled market as

$$p_L = \phi_L w_{LN} + (1-\phi_L) w_{LI} + \frac{c_L(r+n+s_L)}{q(\theta_L)},$$

which gives

$$p_L = w_m \left[1-(1-\phi_L)D\right] + \frac{c_L(r+n+s_L)}{q(\theta_L)}. \tag{21}$$

Evidently, the higher the minimum wage, the higher the expected cost to an unskilled vacancy from being matched with an unskilled worker. On the other hand, an increase in the probability that an unemployed and unskilled worker is immigrant $(1-\phi_L)$ or an increase in the percentage native-immigrant wage gap D lowers the expected employment cost in the unskilled sector.

To analyze this issue further we must specify how the minimum wage is determined. We distinguish two cases. In the first case, the minium wage is indexed to the wage of skilled workers, w_{HN}, and in the second, it is a fixed proportion of the economy-wide average wage.

6.1 The Minimum Wage is Indexed to the Wage of Skilled Workers

Let us consider first the case where the minimum wage is indexed to the wage of skilled (native) workers so that

$$w_m = R_1 w_{HN}, \tag{22}$$

where R_1 is an exogenous parameter lying between 0 and 1. Using equations (2), (4), (6), (8), (9), and (15) we can write the equilibrium wage of skilled workers as

$$w_H = b_{HN} + \beta(p_H - b_{HN} + c_H\theta_H). \tag{23}$$

In the special case where $\sigma = 1$, i.e., skilled and unskilled labor are perfect substitutes for each other, an increase in the number of immigrants will leave the wage of skilled

[14] In this case, since wages are not negotiated, any differences in the unemployment incomes will be inconsequential.

workers and thus the minimum wage intact, because, in this case, the marginal product of the skilled intermediate input (p_H) is independent of the quantity of the unskilled (L). As a result, the increase in I will not affect the entry of high-skill jobs, but it will spur the entry of low-skill jobs, through its negative impact on ϕ_L, namely, the probability that a low-skilled and unemployed worker is an immigrant. As evidenced from (22) and discussed above, when the probability that an unskilled unemployed worker is an immigrant goes up, the expected employment cost in the unskilled sector decreases. Thus, the main difference between this case and the case where the unskilled wage is the outcome of Nash bargaining is that in the present case the entry of low-skill jobs, following the increase in I, leaves the wage of unskilled workers unchanged, whereas in the previous case it raises it. Hence, when $\sigma = 1$ the impact of an increase in I on unskilled workers, who receive the minimum wage, is less positive in terms of wages and more positive in terms of employment compared to the case where they bargain for their wage.

Consider now the case where all unskilled workers earn the minimum wage (i.e., $D = 0$) and $\sigma < 1$, so that the marginal products of the two intermediate inputs depend on their quantities. As discussed above, when the wage of unskilled workers is bargained over and the two types of unskilled workers have equal unemployment incomes, an increase in the number of immigrants has a negative impact on unskilled workers and a positive on skilled workers, in terms of both wages and employment. In the present case, however, the increase in the wage of skilled workers, following an increase in I, implies an increase in the wage of the unskilled workers as well, since skilled and unskilled wages are linked together. Hence, firms with low-skill vacancies will suffer from both the reduction in the price of the labor input that they produce and the increase in their expected employment cost, leading to a more severe negative impact on the entry of low-skill jobs. Thus, compared with the previous case where there was bargaining, the impact of the increase in I on unskilled workers is more positive in terms of wages and less positive in terms of employment.

In the general case, where $\sigma < 1$ and immigrants earn lower wages than natives, the impact of an increase in I will be unambiguously positive on skilled and ambiguous on unskilled workers. As before, the positive effect on skilled workers occurs because the increase in I raises the marginal product of skilled labor and therefore p_H. The profits of skilled firms and thus the entry of skilled jobs increase. The skilled unemployment rate falls and the skilled wage rises because of both the increase in p_H and the entry of skilled jobs, which raises the workers' outside option and bargaining position. As regards the unskilled workers, the fall in their marginal product due to the increase in I does not lower their wage, since this is now not bargained over. Hence, in this case unskilled firms cannot "pass" some of the reduction in the price p_L on to workers by reducing their wage. In contrast, the wage of unskilled workers rises, because the skilled wage rises. There are therefore two opposite effects on the expected employment cost in the unskilled sector (recall that in the bargained case there is an unambiguous reduction in the expected employment cost). First, the increase in the unskilled wage that raises it and second, the increase in the probability that an unemployed unskilled worker is an immigrant (who is willing to accept a lower wage) that lowers it (the composition effect).

The quantitative results in the general case and for different values of R_1, s_L and s_H appear in Tables 3 and 4. As expected, the effect on skilled workers is positive in terms of both employment and wages. Given the increase in the skilled wage, the unskilled (minimum) wage increases as well. This together with the fall in the marginal product of unskilled labor, p_L, dominate the composition effect and the low-skill job entry declines. Hence, unskilled workers gain in terms of wages but lose in terms of employment. It may be recalled that this is opposite to the result that we obtain in the case where the wage of unskilled workers is bargained: there i) the wage rate decreases because the lower marginal product of unskilled labor, p_L, dominates the lower employment cost and ii) there is entry of low-skill jobs because the composition effect dominates the fall in p_L. Therefore, unskilled workers lose in terms of wages but gain in terms of employment.

Finally, the surplus of natives rises for three reasons: 1) because Y increases (evidently because of the increase in the employment of the skilled labor input H and presumably the increase in the unskilled labor input that comes from immigrants – apparently the unskilled-native labor input falls); 2) the rise in capital (due to factor complementaries); and 3) the rise in wages.

6.2 The Minimum Wage is a Fixed Proportion of the Average Wage

Next we consider the case where the minimum wage is a fixed proportion of the average wage, namely,

$$w_m = R_2 \frac{w_{HN} H + w_m L_N + w_m (1 - D) L_I}{H + L_N + L_I}, \tag{24}$$

where H, L_N and L_I are the steady-state employment levels of skilled, unskilled-native and unskilled-immigrant workers, respectively. The fraction on the right-hand-side of equation (24) denotes the economy-wide average wage. As in the previous case, we assume that all native unskilled workers receive the minimum wage, i.e., $w_{LN} = w_m$, whereas the unskilled immigrants get $w_{LI} = (1 - D)w_m$.

Solving (24) for w_m gives:

$$w_m = R_2 \frac{w_{HN} H}{H + (1 - R_2)L_N + (1 - R_2(1 - D))L_I},$$

where $L_N = m(\theta_L)\lambda/(n + s_L + m(\theta_L))$ and $L_I = m(\theta_L)I/(n + s_L + m(\theta_L))$ (see equation 10).

Notice that in this case an increase in I has a "direct" negative effect on the minimum wage: since immigrants receive lower wages, given θ_L, an increase in the proportion of immigrants in the labor force will lower the average wage and therefore the minimum wage. Hence, compared to the case where the minimum wage is indexed to the skilled wage, and thus is independent of I, in this case an increase in I will raise L_I and therefore cause a reduction in the wage of unskilled workers, thereby lowering the expected employment cost of firms with low-skill vacancies and leading to a more positive impact on unskilled workers in terms of employment. Also, in this case, the overall impact of an increase in I on the wage of unskilled workers does not depend only on how the increase in I affects w_{HN} (through its impact on p_H and therefore θ_H); it also depends on how the increase in I affects the composition of the employed workers in terms of skills through its impact on θ_L and θ_H. Specifically, since the wage of unskilled workers is lower than that of skilled, an increase in L_N or L_I (H), due to an increase in θ_L (θ_H) will lower (raise) the average and therefore the minimum wage. It follows that even if prices are fixed (i.e., $\sigma = 1$), so that a change in I does not cause a decrease in p_L and thus has only positive effects on unskilled workers in terms of job creation, the impact of the increase in I on the wage of unskilled workers will be negative, since the impact of both the increase in I and the resulting increase in θ_L is negative on w_m. In fact, the wage of unskilled workers may rise, only if $\sigma < 1$, so that the increase in I causes p_H and therefore θ_H to rise.

The quantitative results in the general case, using Greek data and different values of R_2, s_L and s_H, appear in Tables 5 and 6. For the skilled workers the results are qualitatively the same as above. For the unskilled workers, however, there are now two opposite effects on their wage. On the one hand, the rise in w_{HN} and H (skilled employment) pushes their wage up and, on the other hand, the increase in I pushes their wage down. The results indicate that the second effect dominates; namely, the average wage falls and thus the minimum wage also falls. Despite the fall in the wage of unskilled workers and the positive composition effect, we do not always get an increase in low-skill job creation. At low values of R_2 the reduction in firms' profits, due to the fall in p_L, dominates the positive impact of the rise in I on the expected employment cost of low-skill firms and low-skill job entry falls. Nevertheless, at higher values of R_2 we get the opposite result. Also, the impact is again positive on the surplus, mainly because output increases (through the increase in skilled employment H and the capital stock K).

Finally, the results in this section are partly in contrast to those in Palivos (2009), who analyzes the effects of illegal unskilled immigration in the Ramsey-Cass-Koopmans model with an exogenously given minimum wage. He finds that unskilled native unemployment increases one-to-one, i.e., each immigrant, who is paid less, replaces an unskilled native worker. Our framework offers a much richer set of results.

7 Concluding Remarks

We have examined the effects of unskilled immigration on the native population in a search and matching model, where search frictions generate unemployment. The advantage of this framework, over a Walrasian market-clearing one, is that it takes into account the impact of immigration on the incentives for job creation and hence on wages and job availability. Similarly to the competitive model, we have shown that the impact of unskilled immigration on skilled native workers is positive in terms of both employment and wages, even though in our framework there are more channels through which these effects occur. In contrast, however, to the competitive model, we have shown that the effects of unskilled immigration are not necessarily negative on unskilled native workers, who compete with immigrants, in terms of both wages and employment. The results depend on how the wage of unskilled labor is determined. We have analyzed two cases: one in which the wage of unskilled labor is the outcome of a bargaining process and one in which it is equal to a statutory minimum wage that is linked either to the skilled wage or to the economy-wide average.

We have calibrated the model to the Greek economy and have quantitatively assessed the impact of the immigration influx that took place within the years 2000-2007. We have found that if the unskilled wage is bargained over, then the unskilled native workers lose in terms of wages but gain in terms of employment. On the contrary, if unskilled native workers receive a statutory minimum wage that is linked to the wage of skilled labor, then they gain in terms of wages but lose in terms of employment. Finally, in the case where the minimum wage is automatically set as percentage of the economy-wide average, then there is a negative effect on the unskilled wage and an ambiguous effect on unskilled employment. We have also used our calibrated model to provide insights into how immigration affects the total steady-state surplus of the economy.

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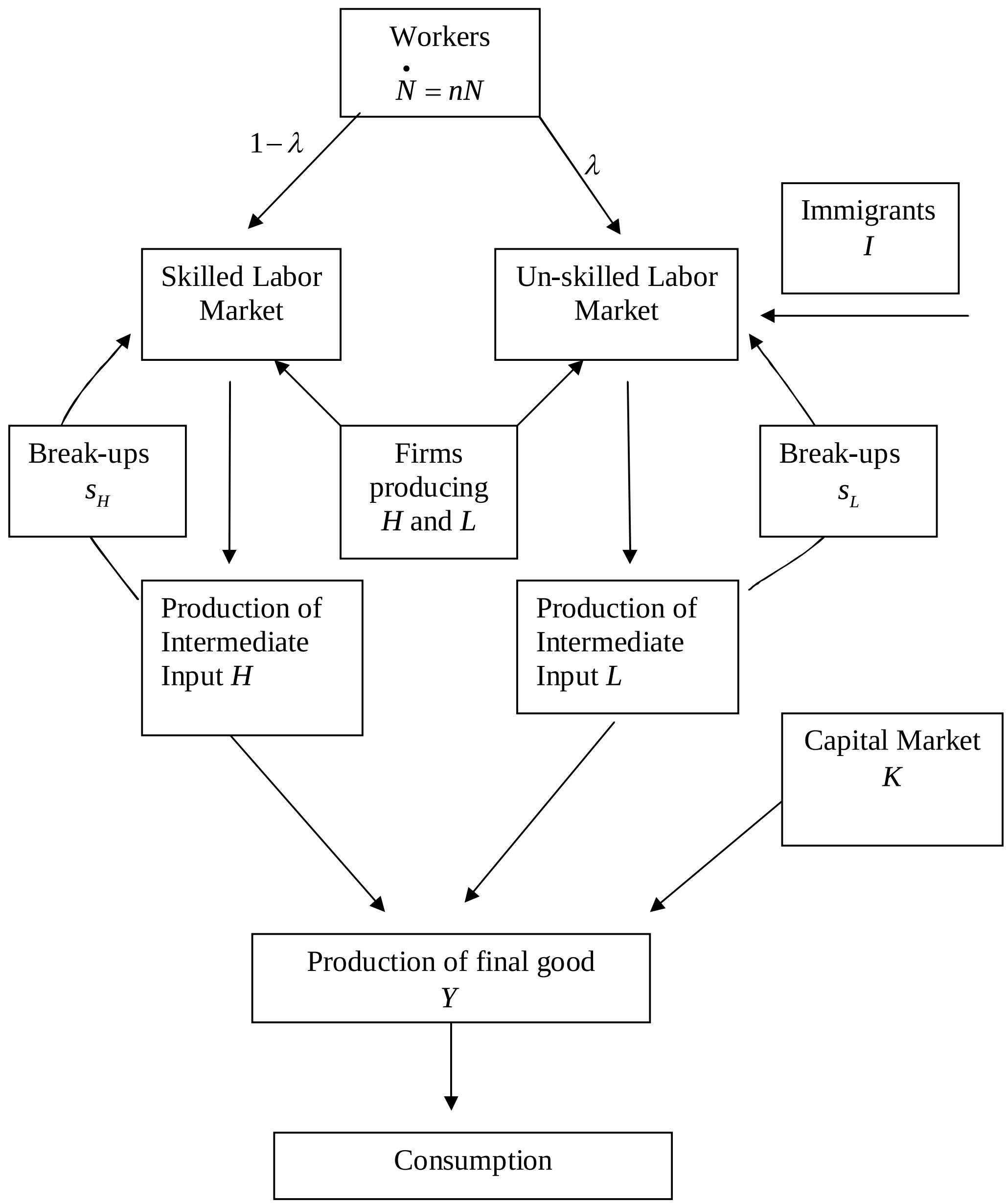

Figure 1. The Structure of the Model

Table 1. Parameterization of the Model

$A = 1$, $\xi = 1$	Normalization
$\varepsilon = 0.5$	Within the range of estimates in Petrongolo and Pissarides (2001)
$\beta = 0.5$	Satisfies the Hosios (1990) condition
$\sigma = 1/3$	Based on Autor et al. (1998) and several other empirical papers
Measured from the Data	
$r = 0.0164$	Real interest rate*
$n = 0.00228$	Growth rate of the native force**
$\delta = 0.0194$	Depreciation rate#
$\lambda = 0.864$	Share of unskilled labor force#
$I = 0.0958$	Normalized number of immigrants@#**
Jointly Calibrated to Match	
$\alpha = 0.104$	Capital-output ratio: 0.715#
$c_H = 19.860$	Average separation rate: 0.0165#
$c_L = 11.926$	Skill premium: 1.482†
$\gamma = 0.282$	Native-immigrant wage gap: -0.4‡
$s_H = 0.0088$, $s_L = 0.0176$	Replacement ratio for both groups: 0.4ǂ
$b_{HN} = 0.281$, $b_{LN} = 0.198$	Low-skill unemployment rate: 0.106#
$b_{LI} = -1.111$	High-skill unemployment rate: 0.0771#

Notes: All variables are quarterly.

* Eurostat

** World Bank

Hellenic Statistical Authority

@ Zografakis et al. (2009)

† Prodromidis and Prodromidis (1998)

‡ Lianos et al. (1996)

ǂ Christoffel, Kuester and Linzert (2009)

Table 2. The Effects of the 2000-2007 Immigration Influx

(Percentage Changes)

	$s_L = s_H$	$s_L = 1.5 s_H$	$s_L = 2 s_H$
Unskilled Natives			
w_{LN}	-0.12	-0.12	-0.13
u_{LN}	-5.84	-5.88	-5.90
θ_L	13.01	13.12	13.16
Skilled Natives			
w_{HN}	3.21	3.21	3.20
u_{HN}	-2.62	-2.64	-2.67
θ_H	5.67	5.73	5.77
Overall Natives			
w_N	0.49	0.48	0.48
u_N	-5.50	-5.55	-5.57
surplus 1	2.05	2.03	2.02
surplus 2	2.31	2.30	2.29
Immigrants			
w_{LI}	2.74	2.76	2.77
u_{LI}	-5.84	-5.88	-5.90
Overall			
w	-1.21	-1.21	-1.22
u	-5.39	-5.43	-5.45
Y	4.99	4.98	4.98
surplus 3	3.51	3.49	3.47
surplus 4	4.56	4.55	4.54

Notes: The variable w indicates the wage rate, u the unemployment rate, θ the tightness in the labor market, s is the separation rate and Y the output of the final good. The subscript L stands for unskilled, H for skilled, N for native and I for immigrant. The term "surplus" refers to total income net of the flow cost of vacancies. The measures "surplus 1" and "surplus 3" include income while unemployed, whereas the measures "surplus 2" and "surplus 4" do not.

Table 3. The Effects of the 2000-2007 Immigration Influx when the Minimum Wage is Indexed to the Skilled Wage and $s_L = s_H$

(Percentage Changes)

	$R_1 = 0.3$	$R_1 = 0.4$	$R_1 = 0.5$	$R_1 = 0.6$
	Unskilled Natives			
w_{LN}	2.81	2.81	2.80	2.80
u_{LN}	0.58	0.63	0.70	0.79
θ_L	-1.31	-1.41	-1.56	-1.77
	Skilled Natives			
w_{HN}	2.81	2.81	2.80	2.80
u_{HN}	-2.30	-2.29	-2.29	-2.29
θ_H	4.97	4.97	4.96	4.95
	Overall Natives			
w_N	2.97	2.95	2.93	2.90
u_N	0.29	0.34	0.39	0.48
surplus 1	3.97	3.88	3.77	3.63
surplus 2	4.03	3.94	3.84	3.70
	Immigrants			
w_{LI}	2.81	2.81	2.80	2.80
u_{LI}	0.58	0.63	0.70	0.79
	Overall			
w	-0.80	-0.54	-0.29	-0.03
u	0.49	0.53	0.59	0.68
Y	4.37	4.36	4.36	4.35
surplus 3	4.23	4.27	4.31	4.36
surplus 4	4.27	4.30	4.34	4.39

Notes: See Table 2. R_1 is the minimum wage as a percentage of the skilled wage.

Table 4. The Effects of the 2000-2007 Immigration Influx when the Minimum Wage is Indexed to the Skilled Wage and $s_L = 2s_H$

(Percentage Changes)

	$R_1 = 0.3$	$R_1 = 0.4$	$R_1 = 0.5$	$R_1 = 0.6$
Unskilled Natives				
w_{LN}	2.81	2.81	2.80	2.80
u_{LN}	0.58	0.63	0.69	0.78
θ_L	-1.30	-1.41	-1.55	-1.75
Skilled Natives				
w_{HN}	2.81	2.81	2.80	2.80
u_{HN}	-2.34	-2.34	-2.34	-2.33
θ_H	5.07	5.06	5.06	5.05
Overall Natives				
w_N	2.97	2.95	2.93	2.90
u_N	0.29	0.33	0.38	0.47
surplus 1	3.97	3.88	3.77	3.63
surplus 2	4.02	3.94	3.83	3.70
Immigrants				
w_{LI}	2.81	2.81	2.80	2.80
u_{LI}	0.58	0.63	0.69	0.78
Overall				
w	-0.80	-0.54	-0.28	-0.03
u	0.48	0.53	0.58	0.67
Y	4.37	4.36	4.36	4.35
surplus 3	4.23	4.26	4.30	4.36
surplus 4	4.27	4.30	4.34	4.38

Notes: See Table 2 and 3.

Table 5. The Effects of the 2000-2007 Immigration Influx when the Minimum Wage is Indexed to the Average Wage and $s_L = s_H$

(Percentage Changes)

	$R_2 = 0.3$	$R_2 = 0.4$	$R_2 = 0.5$	$R_2 = 0.6$
Unskilled Natives				
w_{LN}	-2.03	-2.25	-2.54	-2.92
u_{LN}	0.30	0.17	-0.03	-0.36
θ_L	-0.67	-0.39	0.06	0.81
Skilled Natives				
w_{HN}	2.83	2.84	2.85	2.87
u_{HN}	-2.31	-2.32	-2.33	-2.35
θ_H	5.01	5.02	5.04	5.08
Overall Natives				
w_N	1.83	1.35	0.80	0.15
u_N	0.04	-0.08	-0.26	-0.56
surplus 1	3.84	3.68	3.48	3.21
surplus 2	3.89	3.74	3.54	3.28
Immigrants				
w_{LI}	-2.03	-2.25	-2.54	-2.92
u_{LI}	0.30	0.17	-0.03	-0.36
Overall				
w	-2.03	-2.25	-2.54	-2.92
u	0.23	0.11	-0.07	-0.38
Y	4.40	4.41	4.43	4.46
surplus 3	4.07	4.01	3.94	3.84
surplus 4	4.11	4.05	3.98	3.87

Notes: See Table 2. R_2 is the minimum wage as a percentage of the average wage.

Table 6. The Effects of the 2000-2007 Immigration Influx when the Minimum Wage is Indexed to the Average Wage and $s_L = 2s_H$

(Percentage Changes)

	$R_2 = 0.3$	$R_2 = 0.4$	$R_2 = 0.5$	$R_2 = 0.6$
Unskilled Natives				
w_{LN}	-2.03	-2.25	-2.54	-2.92
u_{LN}	0.31	0.18	-0.02	-0.34
θ_L	-0.68	-0.40	0.04	0.76
Skilled Natives				
w_{HN}	2.83	2.83	2.85	2.87
u_{HN}	-2.36	-2.36	-2.37	-2.39
θ_H	5.10	5.12	5.14	5.18
Overall Natives				
w_N	1.83	1.35	0.80	0.16
u_N	0.04	-0.08	-0.25	-0.55
surplus 1	3.83	3.67	3.46	3.19
surplus 2	3.88	3.73	3.53	3.26
Immigrants				
w_{LI}	-2.03	-2.25	-2.54	-2.92
u_{LI}	0.31	0.18	-0.02	-0.34
Overall				
w	-2.03	-2.25	-2.54	-2.92
u	0.23	0.11	-0.06	-0.36
Y	4.40	4.41	4.43	4.46
surplus 3	4.06	4.00	3.93	3.82
surplus 4	4.10	4.04	3.96	3.85

Notes: See Tables 2 and 5.

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