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International immigration and mobility across sectors: an exploration of alternative scenarios for Spain

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Abstract

This paper explores the economic effects of international immigration in Spain by constructing a CGE model. We are mainly concerned about the issue of labor mobility across sectors. In our simulations, we first restrict immigrants to work in a small set of industries receiving wages that are below the native ones, a situation that we call the short run. Then, we consider that immigrants can move freely among all the industries in the economy earning wages on a par with local workers. This we call the long run situation. The results suggest that short run economic performance can be improved by choosing strategic sectors to receive immigrants. We also find evidence that the wage regime is an important parameter to explain the impact both in the short and in the long run.

Key words: immigration, sector-specific factor, computable general equilibrium.
JEL classification: F22, D58

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1 Introduction

One of the topics related to international population movements that has been attracting ever growing attention over the last number of years, both in political debates and in scientific research, is that of illegal immigration.[1] From the host countries perspective, the basic role of immigration is probably to complete the native labor supply. Thus, immigrants are welcome as long as they intend to get a job in those activities where more workers are needed. Apparently, there is no way of controlling the extent to which illegal immigration fulfills this objective. However, the fact that undocumented workers tend to concentrate in a select number of activities has often been adduced as characteristic of illegal immigration.[2] Despite these activities varying from country to country, the fact that illegal immigrants do not freely move across sectors remains. There are a number of studies devoted to explaining this evidence: Hill and Pearce (1990), for instance, showed for the United States that a high number of undocumented workers concentrates in services and construction. These authors concluded that the low concentration at the establishment level of firms operating in these activities, as opposed to manufacturing, makes them less likely to be inspected and, consequently, sanctioned for hiring undocumented workers. Similarly, Taylor (1992) presents econometric evidence that legal status influences the mobility of foreign workers in agricultural activities. Hillman and Weiss (1999) suggest that the visibility of concentrations of unauthorized workers implies the existence of permissible illegal immigration. In other words, taking the presence of illegal immigrants in the host country as given, owners of domestic factors may be interested in holding the situation constant as long as illegal immigrants are locked in selective sectors. An interesting conclusion stemming from all these studies is that this sector-specific enforcement, in fact, transforms illegal workers into specific productive factors.

A key point, however, is whether this concentration in a small number of sectors is specific to undocumented workers or whether it also applies to legal immigrants. According to OECD,[3] about 40% of legal immigrants in Germany work in manufacturing, about 50% of legal immigrants are employed in transport and storage and communications in Portugal, and in Spain it is in services (mostly tourism activities) that more than 50% of work permits are granted. Despite the broad definition of these activities, the figures illustrate that high concentration also occurs in the case of legal immigrants. In this case, the sector-specific enforcement argument does not work as well as in the former case. A useful way of explaining this evidence is to think of the concentration of immigrants as a short-run effect of a change in factor endowments, as opposed to the long-run effect where legal immigrants can move across sectors.[4] In the short run, immigrants enter the host

[1] See, for instance, Djajić (1997), Sarris and Zografakis (1999), Venturini (1999) or Hillman and Weiss (1999).

[2] See Hillman and Weiss (1999) for a review of the empirical evidence.

[3] See *Trends in International Migration* (1999).

[4] See Mayer (1974).

country to work in selective sectors, as a consequence of links with previous immigrants, or, for instance, because of the existence of network effects, and they are temporarily stuck there. Later, in the long run, as they become more integrated in the host country,[5] they are able to get a job in different sectors.

The purpose of the present research is to compare the economic effects of immigrants being a specific factor fixed in certain sectors or being perfectly mobile across sectors. However, from the paragraphs above it seems clear that the causes of the different mobility of immigrants could be related to their legal status. Therefore, legal status should be taken into account, as it will play a crucial role in determining the economic effects on the host country. To deal with the legal status of immigrants, we will focus on wage discrimination, as usually illegal immigrants earn lower wages than legal ones, or native workers, even when they have the same qualifications. Likely the main reason is that national firms hiring illegal immigrants face possible sanctioning by the authorities; thus, they minimize costs by taking advantage of their bargaining position with regard to the undocumented workers (see Ethier (1986), Bond and Chen (1987) or Sarris and Zografakis (1999)). In fact, evidence shows significant rises in the wages of workers after achieving legal status.[6]

We approach the problem by constructing a computable general equilibrium model for the Spanish economy. Spain, as other Southern countries in the European Union, has only become a net receiver of immigrants in recent years. Although global migration flows have been steadily increasing, the rate of growth seems to be stronger in those countries that have traditionally been a source of migratory flows and, therefore, have not traditionally dealt with mass immigration. This change of pattern explains why the debate about immigration has been particularly strong in Spain, concerning topics such as the number of immigrants that should be allowed to enter the country, and under what conditions. Thus, the effects of immigrants displaying different levels of mobility in the economy under alternative legal status constitute interesting topics for the Spanish case. In order to analyze the effects of immigration, specially illegal immigration, computable general equilibrium models provide a useful tool. First, immigration implies a change in the relative factor endowments of both the host and the origin country, affecting suctorial production and employment, relative prices and, therefore, income distribution. Thus, a general equilibrium framework seems to naturally suit the study of this subject. Second, simulation techniques represent a good alternative to econometric analysis, given the lack of statistical coverage that is inherent in clandestine immigration.

The paper is organized as follows: in section 2 we introduce the main features of the model. Section 3 explains the calibration procedure while results are discussed in section 4. Finally, section 5 concludes.

[5]Because they increase their knowledge of the language and institutions, or they acquire new skills in the host country, they eventually become more competitive with regard to native workers.

[6]See OECD's *Trends in International Migration (1999).*

2 The model

The model that we use to evaluate the impact of immigration is static and deals with a single open economy disaggregated in eleven production sectors, with eleven consumption goods, twelve households, and a public sector. In this section, we simply provide a description of the essence of the model. Notation for variables and parameters is in appendix 1, while all the equations that make up the model are displayed in appendix 2. A more complete representation including mathematical derivations can be found in Ferri *et al.* (2001).

The model is solved through Rutherford's (1999) method who considers the solution of general equilibrium models as a mixed complementarity problem (see Mathiesen, 1985). Hence, there are three types of equations in the applied general equilibrium model: those representing firms just breaking even, those representing goods and factors markets clearing, and some additional ones referring to system restrictions.

2.1 Production

We consider different specifications for the production side of the model according to the presence or absence of a specific factor in the production function. In fact, the unskilled labor is introduced in some scenarios as a factor that can not move freely among all the sectors.

Producers are subject to technology characterized by a three-nesting level and constant returns to scale. The first nesting level is a Leontief production function[7] integrated by a composite of primary inputs and intermediate inputs. The second nest divides the primary inputs composite, which is considered as a CES function of labor and capital.

The third nesting level is a Cobb-Douglas composite[8] of labor inputs integrated by skilled and unskilled labor. At this point, we introduce some alternatives depending on the assumption on factor specificity. In some cases, all the unskilled workers are considered homogeneous and perfect mobility exists among sectors. But in other cases, we assume that certain unskilled labor is in some sense locked up in very few sectors so immigrants are not free to choose the sector of destination. Therefore, we use two kinds of unskilled labor in the model: specific and non-specific. Although specific labor cannot move to work in sectors where such a specific factor is not in demand, at sector level the perfect substitution between unskilled native workers and immigrants remains. This means that immigrants are allocated only among a few sectors and compete only with natives in these sectors.

¿From the cost minimization problem we can obtain the zero profit equations

[7]The fixed coefficients assumption borne in Leontief functions is frequently used in applied general equilibrium models, (see Dixon *et al*., 1992- pp. 211-219). The rationale is that a wide range of empirical studies do not prove that at this level changes in relative prices of inputs imply changes in relative demands.

[8]See Biscourp and Gianella (2001) for an empirical test on this assumption.

and market clearing conditions. Nevertheless, available data forces us to convert effective production in distributed production with a fixed coefficients matrix, in the same way as Ballard et al. (1985) (pp. 76-77).

Domestic distributed production is then used to obtain the total supply of goods in this economy, which is composed of domestic production and imports, modelled through a CES Armington[9] aggregate. The meaning of this aggregate is that producers choose the optimal mix between domestic goods and imports.

There are two possible destinations for the total supply from a geographical criteria: the domestic and the foreign markets. Consequently, producers maximize their revenue subject to a constant elasticity of transformation function (CET)[10] nested in two levels. At a first level, the resolution on the destination of goods is between domestic and foreign markets. At a second level, producers resolve the problem of choosing among different uses of goods destined for the domestic market: gross capital formation, intermediate use and final consumption.

Finally, production goods are transformed into final consumption goods by means of a fixed coefficients matrix. This implies a change in the accounting classification of goods and services from production to consumption, in the same sense as Ballard et al. (1985) (pp. 76-77).

2.2 Consumption

Private consumers are distributed in twelve households, according to the main householder's socioeconomic characteristics. Each household is endowed with a fixed amount of capital, skilled and unskilled labor. The fixed amount of skilled and unskilled labor should be interpreted as the maximum supply of labor because we also consider the existence of leisure and unemployment.

Skilled and unskilled workers coexist in each household, and it is not possible to move from one level to the other. For the versions of the model in which there exists specific unskilled labor, each type of household is endowed with a certain amount of specific and non-specific unskilled labor.

Households maximize a three-nesting level utility function subject to a budget constraint from which we can derive demand functions. The first nesting level for each household is a Cobb-Douglas[11] welfare function depending on saving and aggregate consumption. The second nesting level shows the decision on aggregate consumption between leisure and consumption of goods and services. At the third nesting level, leisure is split between leisure for skilled and for unskilled labor, while consumption is separated into different goods and services.

[9] The Armington (1969) assumption takes goods with different geographical origin as close but not perfect substitutes.

[10] See Powell and Gruen (1968) for an analytic description of CET functions. CET functions involve a certain degree of substitution among goods assigned to different markets or uses.

[11] Given our static approach, we consider a unitary elasticity of substitution between consumption and saving (see Howe, 1975).

2.3 Public sector

The starting point for modelling the public sector is the musgravian notion of differential incidence, which deals with the effects of substitution among taxes, holding constant public revenue and expenditure. In a broader sense, we could say that this notion involves the maintenance of the public sector dimension when fiscal policy changes are applied.

The public sector equations in the model include public sector income, which comes from capital rents, transfers from households and from the rest of the world, and collection of taxes. Taxes include social security contributions paid by employers and employees, net indirect taxes, import tariffs and income taxes. All those taxes are modelled as effective rates ad valorem estimated from benchmark data.

Macro closure for the public sector imposes the restriction that public investment and deficit (or surplus) are exogenous and fixed, so public savings are also exogenous.

2.4 Investment and savings

Total investment is split into sectorial gross capital formation through a fixed coefficients Leontief matrix (see Dervis *et al.* , 1981). In our static framework, investment influences the economy as a component of final demand. There also exists a macro closure equation related to investment and savings. It states that the difference between total savings and total investment is the net lending/borrowing for the economy.

2.5 Foreign sector

The country faces exogenous world prices, so we use the small open economy assumption. This assumption implies that export demand and import supply functions are perfectly elastic.

The foreign sector closure for a small economy follows de Melo and Tarr (1992). This equation shows that the difference between receipts and payments with the rest of the world is again the net exogenous lending/borrowing of the economy. This equation avoids, for example, a high increase in exports with no changes in imports which would be unreliable as it would involve a continuous capital flow from abroad.

2.6 Factor markets

Capital endowments are fixed both for families and for the public sector. Capital is internationally immobile, but perfectly mobile across domestic sectors so its price adjusts to clear the market that is unique for the whole economy.

In addition, each household is endowed with a fixed amount of skilled and unskilled labor. Due to the existence of leisure, the supply function would be elastic. It is assumed that workers have some degree of market power and the way in which

wages react is affected by aggregate unemployment. Hence, we use an equation with a parameter β as a measure of wage flexibility. As β approaches infinity, real wages approach the benchmark value. The case where β approaches infinity is the rigid wages case because real wages do not change when the unemployment rate changes. If β approaches zero, unemployment approaches its benchmark value, so real wages are flexible. Other values of β show the greater or lesser sensibility of real wages to changes in the unemployment rate.

Skilled labor is intersectorially mobile but unskilled labor is intersectorially mobile only when it is homogeneous, and sector specific otherwise.

2.7 Immigrants

Immigrants are only endowed with unskilled labor. Furthermore, we assume that immigrants and domestic unskilled workers are perfect substitutes in production. In some versions of the model, immigrants are perfect substitutes for all unskilled domestic workers, and in other versions they are only perfect substitutes for sector specific unskilled domestic workers.

Illegal immigrants receive lower wages than native unskilled workers. The gap between both wages is a fixed wedge. For example, if wages for legal unskilled workers are W^{us} (or W^{uss} in the specific sectors), then wages for illegal immigrants are equal to $(1-\nu)W^{us}$ (or $(1-\nu)W^{uss}$in the specific sectors), where ν is the wedge. In addition, workers do not pay taxes because they are assumed to be working illegally.

Immigrants maximize a Cobb-Douglas welfare function defined over consumption of goods and services and savings. Furthermore, a new demand function is introduced in the model with immigrants, and market clearing equations change both for factors and goods and services.

2.8 General equilibrium conditions

The model consists of three kinds of equations which can been seen in Appendix 2 and are summarized here:

1. *Zero profit conditions* (equations 1, 2, 3, 10, 13 and 26).

2. *Market clearing in good markets* (equations 4, 5, 11, 12, 14 to 16 and 19 to 22) *and factor markets* (equations 6 to 8).

3. *Restrictions on disposable income* (equations 18 and 23), *unemployment* (equations 29 and 30), *transformation of goods* (equations 9 and 17), *and macro closure* (equations 24, 25, 27 and 28).

When immigrants are included in the model, equations 31, 31a, 31b, 32 and 33 replace equations 8, 8a, 8b, 22 and 19, respectively.

3 Calibration

The model outlined has been calibrated with reference to the social accounting matrix MCS-90 elaborated by Uriel *et al.* (1997). This data framework represents the benchmark equilibrium for the model.

To calibrate scale and share parameters we use Rutherford's (1999) method, applied with software GAMS/MPSGE. The method starts with the balanced equilibrium for the social accounting matrix as reference equilibrium, with a set of elasticities from empirical evidence.

Calibration is carried out in three steps with this data. In the first step, the matrix collects quantities that are used as a first reference point in the isoquant of the calibrated function. In the second step, relative prices fix the isoquant's slope at that point. Matrix data does not distinguish between prices and quantities, and only indicates values. Hence, we follow Harberger's assumption (see Harberger (1972)) and choose the quantity units so that prices are unitary. This means that value magnitudes from MCS-90 are equal to quantities.

The last step in calibration uses elasticities, which show isoquant curvatures. In conclusion, we have the slope and curvature for a point in each isoquant, and from them using Rutherford's method we calibrate all the unknown parameters.

Elasticities for CES and CET functions are displayed in table 1. As commonly used in computable general equilibrium models, elasticities of substitution between labor and capital σ_i^{LK} and Armington elasticities σ_i^A are from GTAP (see Hertel, 1997). Elasticities of transformation ϵ_i are from de Melo and Tarr (1992). The estimations for the elasticities of substitution between leisure and consumption σ_h^{LQ} have been obtained using the Ballard *et al.* (1985) procedure from the uncompensated elasticity of labor supply estimated in García and Molina (1998)[12]. A total of 40 hours worked per week, out of a potential 70 has been assumed. The results for σ_h^{LQ} are shown in table 2. Elasticities of substitution of the remaining equations are initially set to zero (for Leontief functions) and one (for Cobb-Douglas functions). Finally, the β parameter, which explains the labor market behavior, is fixed at $\beta = 1.5$.[13] The level of unemployment in the base year ($\overline{U_s}$ and $\overline{U_{us}}$) is 10% for skilled and 20% for unskilled workers.

4 Scenarios

We use the model sketched in the previous sections to raise two questions regarding the situation of immigrants working in Spain. The first one refers to the different effects of immigration depending on the degree of mobility across sectors. The second has to do with the role of wage discrimination. In the simulations that

[12]They estimated the own-wage labour supply elasticity for both men and women from different functional forms. There is no evidence against the null that those elasticities are zero, so we use this value as a starting point to calculate σ_h^{LQ}.

[13]This is the value employed in MOISEES which is the Ministry of Economy wide macoeconomic model for the Spanish economy.

Table 1: Elasticities by productive sector

Sector	σ_i^{LK}	σ_i^A	ϵ_i
Agriculture	0.56	4.4	3.9
Energy and water	1.26	5.2	2.9
Non-energy minerals, chemicals	1.26	3.8	2.9
Metal and machinery	1.26	10.4	2.9
Other manufacturing	1.26	5.6	2.9
Construction	1.40	3.8	0.7
Commerce and hotel trade	1.26	3.8	0.7
Transport and communications	1.68	3.8	0.7
Finance and insurance	1.26	3.8	0.7
House renting	1.26	3.8	0.7
Other services	1.26	3.8	0.7

Note: Elasticities elaborated from Hertel (1997) and de Melo and Tarr (1992).

Table 2: Elasticities by households

Household type number	Definition	σ_h^{LQ}
1	Rural, employed	0.428
2	Rural, self-employed, non-agricultural	0.057
3	Rural, self-employed, agricultural	0.037
4	Rural, other incomes, males	0.060
5	Rural, other incomes, females	0.038
6	Urban, employed, graduate	0.304
7	Urban, employed, non-graduate	0.402
8	Urban, self-employed	0.048
9	Urban, other incomes, males, under 65	0.087
10	Urban, other incomes, females, under 65	0.059
11	Urban, other incomes, males, over 65	0.062
12	Urban, other incomes, females, over 65	0.019

Note: Elasticities elaborated from Ballard *et al.* and García and Molina (1998).

follow, we focus on four scenarios depending on whether immigrant workers are confined to a small part of the economic activities in the host country or not, and on the existence of a wedge in the wages paid to immigrants with respect to native workers. These scenarios can be depicted in the following way:

(1) $SP-GAP$: immigrants are locked up in selective sectors and they earn a lower wage than their national counterparts ($\upsilon = 0.4$).

(2) SP: immigrants are locked up in selective sectors but they are paid the same wage as native workers with the same level of qualifications ($\upsilon = 0$).

(3) $NSP-GAP$: immigrants can work in any sector in the host economy but they are paid a lower wage than native workers ($\upsilon = 0.4$).

(4) NSP: immigrants can work in any sector in the host economy and they are paid the same wage as native workers ($\upsilon = 0$).

Obviously, the different scenarios imply different levels of integration of the foreign workers in the host economy. Thus, the first scenario illustrates the worst situation for immigrants, whereas if foreign workers can get a job in any activity and they are paid the same wage as native workers with the same qualifications (scenario 4), they cannot be considered clandestine workers from an economic point of view. We will call these extreme situations the short run and the long run scenarios, as it is likely that restrictions to mobility disappear as time goes by. Furthermore, from comparisons with transitory situations such as scenarios (2) and (3) we can guess the additional impact on the economy due to better wage conditions in the two regimes of mobility.

In order to decide which industries will concentrate foreign workers in scenarios (1) and (2), we rely on statistics provided by OECD (1999). Table 3 displays the distribution of legal immigrants by sectorial division.

Figures in table 3 mean that services have concentrated more than 57 per cent of the average work permits in the four years depicted. Services and agriculture together represent more than 78 per cent, and adding construction this figure reaches almost 90 per cent of all the permits granted. Services is, however, a very wide sector which includes many different activities. For the Spanish case, inside services, commerce and the hotel trade is the activity which attracts the highest number of unskilled workers. Therefore, we initially chose agriculture, construction and commerce/hotel trade as the final destination for those immigrants who will not move freely among all the sectors. However, our assumption is that once they are allocated to one of these three sector-specific labors they may move freely among them, but cannot jump to other sectors in the economy.

We consider that immigrants ($\overline{L_I^{us}}$) stand for an initial impact of 10 per cent of total domestic unskilled employment in the base year[14].

[14]A different rate only changes the level of the effects with no variation in the quality of the results.

Table 3: Total work permits granted by sector

	1994	1995	1996	1997
Agriculture	18.7	18.9	26.0	17.7
Industry	6.9	7.5	8.6	5.6
Construction	9.4	10.4	12.2	7.0
Services	50.6	57.2	72.7	51.9
Not specified	3.1	6.3	6.9	2.0

*In thousands of work permits.

Table 4: Effects of immigration on macroeconomic variables*

	Sector-specific factor		Non sector-specific factor	
	(1)	(2)	(3)	(4)
	$SP-GAP$	SP	$NSP-GAP$	NSP
GDP	2.168	1.434	2.059	1.244
CPI	1.002	1.000	1.011	1.004
EMPLOYMENT				
Skilled labor	2.745	1.586	2.556	1.185
Unskilled labor (non specific)	3.166	1.962	4.901	3.459
Unskilled labor (specific)	8.385	6.910	-	-
REAL RENTS				
Capital	4.281	1.806	4.261	1.588
Skilled labor	1.441	0.472	1.341	0.239
Unskilled labor (non specific)	1.339	0.377	-0.672	-1.782
Unskilled labor (specific)	-4.154	-5.230	-	-

*Percentage variation from bechmark equilibrium except for IPC which is an index 1 in the benchmark.

5 Results

The effects on macroeconomic variables of the different scenarios described above are displayed in table 4. Columns (1) and (2) reproduce the case in which immigrants are confined to work only in some sectors. The first column shows the effect of migration when immigrants are paid a wage ($(1-\upsilon)W^{uss}$) that is 40% lower than the wage of unskilled national workers, whereas in the second column both groups are paid the same wage. Columns (3) and (4) reproduce both cases but now immigrants are able to find a job in any sector. Therefore, columns (1) and (4) represent the two extreme situations that immigrants can face in the host country.

Clearly, the arrival of foreign workers has two effects. Firstly, a higher population increases the aggregate demand leading in time to a greater requirement for all types of labor. Secondly, more competition in the unskilled labor market leads to a reduction in the unskilled wage which in turn leads employers to substitute

capital and skilled labor for unskilled labor.

Results confirm that increases in GDP and total employment occur as the expected consequence of immigration, and the rise in employment is shared by skilled and unskilled workers but because of decreasing marginal productivity in the production function and the assumption of fixed capital, growth in GDP is smaller than growth in employment. However, in scenarios (1) and (2) as the substitution effect only applies to the sector-specific labor market the only workers that are worse off are the unskilled workers working in agriculture, construction and commerce/hotel trade. In terms of employment, the initial impact stands for about 26 per cent of unskilled native workers in the three sectors. As, by assumption, immigrants are not unemployed, a rise in total sector-specific unskilled employment of 8.385 per cent (scenario 1) qualifies for about a 17.6 per cent fall in native sector-specific employment. Nevertheless, native unskilled labor and real wages in the rest of the sectors increases as a consequence of the driven demand effect. The capital factor and skilled labor also gain in all the cases considered.

The most striking outcome in the simulations is the (moderate) fall in GDP, employment and rents as a result of wage equalization. This is due to the downward movement of the native sector-specific labor demand curve that follows the rise in the labor cost.

Immigration concentrated in only a few sectors benefits the economy as comparison of columns (1) and (3) (or (2) and (4)) reflects. The three sectors considered are the most unskilled labor intensive and so unskilled immigration directed towards these sectors is also the most efficient allocation.

The effect on the real rent of unskilled labor strongly depends on the immigrant labor force being concentrated in the three sectors considered or whether they are not concentrated in any sector in particular. When immigrants are specific factors, unskilled workers in agriculture, construction and commerce/hotel trade lose out, whereas the rest of unskilled workers gain. If immigrants are not a specific factor, all unskilled workers lose out. However in this case the immigrants spread out all over the activities, therefore lessening the impact on wages.

Let us now turn to a sectorial performance of the results. Table 5 and table 6 represent the short run and the long run scenarios. Table 5 corresponds to the case in which immigrants are specific factors for some sectors and they earn less than native workers with the same qualification. Output of all the sectors in the economy increases, regardless of the fact that immigrants only work in three of them. Similarly, there is a generalized rise in employment of all types of labor. But the most striking result that arises from table 5 is the very important contribution of immigration to the production of industries different to those which match the immigrants' destination. This is the case for energy and water; metal and machinery and other manufacturing and the reason is the positive change in the aggregate final demand and the diffusion effects via intermediate inputs. Another important fact is the moderate expansion of construction in spite of being a sector-specific immigrant labor. This is precisely the sector that due to the important reduction in sector-specific unskilled wages to a higher degree substitutes away

Table 5: Sectorial otcomes for the long run

	Output	Capital	Skilled Employment	Unskilled Employment
Agriculture	2.252	1.033	0.260	6.114
Commerce and hotel trade	3.127	0.231	4.896	11.021
Construction	0.947	-5.152	0.319	6.177
Energy and water	6.056	4.764	8.489	8.598
Non-energy minerals, chemicals	1.127	-1.063	2.456	2.559
Metal and machinery	3.049	0.086	3.645	3.745
Other manufacturing	2.707	0.450	4.027	4.132
Transport and communications	1.572	-0.930	3.813	3.918
Finance and insurance	1.969	0.007	3.554	6.659
Other Services	0.983	-1.906	1.578	1.680
House Renting	1.342	1.246	4.841	4.497

*Percentage variation from bechmark equilibrium.

from capital and skilled labor to unskilled employment.

Table 6 shows the long run sectorial outcomes when immigrants are not constrained to working in a few activities and are not discriminated against. As mentioned already, one straightforward consequence of labor mobility is that the reduction in labor costs in agriculture, construction and commerce/hotel trade is not different from the remaining sectors and, therefore, differences across sectors in the degree of factor substitution are reduced with respect to the short run. This is why, for example, construction expands more in the long run than in the short run even although the direct impact of the labor supply on it is now lower. Agriculture and commerce/hotel trade, however, experience an important reduction with respect to the short run, and consequently those sectors such as energy and water and metal and machinery that benefited indirectly from pull (direct and indirect) demand.

Changes in welfare in table 7 summarize who gains and who loses with immigration in terms of equivalent variations. Table 7 contains only the effect on welfare of the six types of households whose main householder participates in the productive process. The cases not displayed in the table correspond to main householders whose basic source of income are transfers (principally from the public sector) or rents.

All the households considered experience gains in the short run due to immigration, the bigger ones corresponding to the self-employed both in rural and urban areas and the skilled employed in urban areas. This is an expected result that holds whatever the wage regime for immigrants or the sector allocation. More ambiguous are the results for the unskilled employed. Unskilled households (rural and urban) are grouped according to the origin of the rents of the main householder and are yet quite an aggregate group with heterogenous rents and sectorial

Table 6: Sectorial otcomes for the long run

	Output	Capital	Skilled Employment	Unskilled Employment
Agriculture	0.952	0.463	0.380	2.445
Commerce and hotel trade	1.643	0.470	2.570	4.680
Construction	1.080	-1.444	1.048	3.126
Energy and water	2.069	0.958	2.988	5.107
Non-energy minerals, chemicals	1.469	-0.545	1.473	3.560
Metal and machinery	2.741	0.077	2.096	4.197
Other manufacturing	1.544	-0.713	1.377	3.463
Transport and communications	1.294	-0.892	2.140	4.241
Finance and insurance	1.324	0.003	1.846	3.942
Other Services	0.599	-1.674	0.223	2.285
House Renting	1.025	0.953	2.874	4.990

*Percentage variation from bechmark equilibrium.

Table 7: Immigration effects on households welfare

Type of households	sector-especific factor		non sector-specific factor	
	(1) $SP-GAP$	(2) SP	(3) $NSP-GAP$	(4) NSP
1. Rural, employed	0.844	-0.943	0.679	-1.300
2. Rural, self-employed, non agric.	3.507	1.535	3.485	1.362
3. Rural, self-employed, agricultural	3.000	1.374	2.991	1.249
6. Urban, employed, graduate	2.868	1.101	2.779	0.791
7. Urban, employed, non graduate	1.088	-0.752	0.924	-1.115
8. Urban, self-employed	4.013	1.752	4.031	1.572

*Percentage variation from bechmark equilibrium.

Table 8: Effects of immigration on macroeconomic variables (flexible wages)

	sector-specific factor		non sector-specific factor	
$\beta = 0.5$	(1)	(2)	(3)	(4)
	$SP-GAP$	SP	$NSP-GAP$	NSP
GDP	2.067	1.880	1.971	1.762
CPI	0.997	0.998	1.010	1.006
EMPLOYMENT				
Skilled labor	1.636	1.458	1.405	1.143
Unskilled labor (non specific)	2.221	2.032	5.423	5.149
Unskilled labor (specific)	11.327	11.011	-	
REAL RENTS				
Capital	3.835	2.485	4.021	2.554
Skilled labor	2.641	1.663	2.372	1.207
Unskilled labor (non specific)	2.533	1.570	-1.376	-2.478
Unskilled labor (specific)	-7.832	-8.832	-	-

*Percentage variation from bechmark equilibrium except for IPC which is an index 1 in the benchmark.

representation. This is why when immigrants are considered as a specific factor for some sectors, unskilled workers working in jobs that compete with immigrants suffer important losses in their real rents, but the improvement in employment and incomes both from the non sector-specific unskilled labor and from capital and skilled labor which also contribute to the household's economy totally compensate for this loss. Even so, in the long run, when immigrants compete with natives in all the sectors and at the same wage, households working in rural areas and those without qualification working in urban areas are damaged by immigration even at a high level of aggregation.

5.1 Sensitivity analysis

Here we measure the sensitivity of our results to changes in selective parameters and assumptions in the model. We focus on the parameter β, as a way of characterizing the labor market rigidities, and the number of sectors which hire specific unskilled labor in which immigrants are included.

We have assumed, up to this point, an intermediate strategy for trade unions that weighs both the unemployment rate and real wages in the union's objective function. Now, we repeat our experiments under the assumption that $\beta = 0.5$. This new value for the parameter implies a higher flexibility in real wages.

Table 8 shows the macroeconomic outcomes. More flexible wages causes the differences between the short and the long run to be narrower, due mainly to a larger impact on the economy when immigrant wages are on a level with native wages. In terms of welfare (table 9), all households do still prefer that immigrants are discriminated against. However, greater flexibility of wages enhances the wel-

Table 9: Effects on housheols welfare (flexible wages)

	sector-specific factor		non sector-specific factor	
$\beta = 0.5$	(1)	(2)	(3)	(4)
	$SP - GAP$	SP	$NSP - GAP$	NSP
1. Rural, employed	0.719	-0.196	0.546	-0.490
2. Rural, self-employed, non agric.	3.127	2.082	3.280	2.154
3. Rural, self-employed, agricultural	2.676	1.813	2.829	1.907
6. Urban, employed, graduate	2.564	1.674	2.513	1.473
7. Urban, employed, non graduate	0.953	0.011	0.786	-0.279
8. Urban, self-employed	3.561	2.365	3.796	2.483

*Percentage variation from bechmark equilibrium.

Table 10: Short run effects without construction sector

	$\beta = 1.5$		$\beta = 0.5$	
	(1)	(2)	(1)	(2)
	$SP - GAP$	SP	$NSP - GAP$	NSP
GDP	2.583	1.759	2.611	2.308
CPI	0.997	0.998	0.991	0.994
EMPLOYMENT				
Skilled labor	2.740	1.695	1.581	1.444
Unskilled labor (no specific)	3.005	1.993	2.012	1.881
Unskilled labor (specific)	13.328	11.325	19.001	18.410
REAL RENTS				
Capital	4.232	1.912	3.638	2.391
Skilled labor	1.462	0.572	2.632	1.760
Unskilled labor (non specific)	1.326	0.463	2.423	1.590
Unskilled labor (specific)	-7.386	-8.599	-10.316	-10.424

*Percentage variation from bechmark equilibrium except for IPC which is an index 1 in the benchmark.

fare results in the non discrimination scenarios reducing (or even eliminating) the losses of unskilled employed workers and increasing the gains for the other groups.

Finally, in table 10 we drop *Construction* from the set of sectors which concentrates immigrants as a specific factor. This sector contains a substantially smaller share of foreign workers that obtain a work permit than *Agriculture* and *Commerce/Hotel trade,* and its elimination allows us to check the effects of narrowing the scope of job possibilities for immigrants. As a way of comparison, only scenarios (1) and (2) now make sense. And comparing figures in table 10 with those in table 8 and table 4 a further growth in GDP and employment is detected.

6 Conclusions

The results of this paper have indicated the importance of the initial immigrants allocation in the labor market. Our findings were illustrated by simulations using a large multisectorial computable general equilibrium model. Two cases were considered related to the degree of mobility across sectors. After analyzing the effects of illegal immigrants locked up in a few sectors, we moved on to the study of legal immigrants that move freely in the economy. The comparison between both situations draws a first approximation to the short run and long run effects of immigration.

Results show that any type of immigration has an unequivocal helpful effect on GDP and total employment and that legalization is especially important for improving total unskilled employment. This fact means that domestic substitution by foreign workers is not perfect. Nevertheless, while skilled workers and capital owners gain from immigration and legalization, the effects on the wages of unskilled workers depends on the working sector when immigration can be considered as a sector-specific factor.

As most of the income origin for Spanish families is heterogeneous, we look likewise to the welfare effect on households. Interestingly, the bulk of the different types of households considered here profit from the influx of illegal immigrants and their legalization. Only those households headed by unskilled workers are damaged, the loss in this case being much less important than when unskilled workers are considered individually. Conversely, households whose main provider is either self-employed or a skilled worker all benefit from immigration.

All the productive sectors regard to expand their production and their demand for labor. In the short run output increases in all the sectors in the economy and this is independent of the fact that immigrants only work in some of them. In addition to the obvious direct impact on sectors for which foreign workers are a specific factor, immigration in the short run also has an important indirect effect on industries such as Energy and water, Metal and machinery and Other manufacturing. In the long run, sectorial effects are more evenly distributed on the economy.

Results rely on some key assumptions and therefore the sensitivity of the equilibrium to different parameters of the model has been checked. Especially important seems to be the way in which wages respond to a labor supply shock. The simulations in this case indicate that more flexible wages tighten the differences between the short and the long run, reducing the short run effect and enlarging the long run effect.

The sensitivity analysis on the size of the market for newcomers concludes that there indeed exists a chance to broaden immigration while minimizing social costs. It could entail an active redistributive policy but the final point that comes up from all the sets of results is that immigration, when targeted towards very specific sectors, multiplies the positive impact on aggregate production and employment, variables from which, in the end, is hinged aggregate welfare.

APPENDIX 1 - NOTATION

As a general rule, the notation in the model is as follows: endogenous variables are denoted by capital letters, exogenous variables by capital letters with a bar, and parameters by small Latin and Greek letters.

There are n $(i, j = 1, \ldots, n)$ production sectors. In versions of the model with specific factors, n_s are sectors with specific factors, and n_{ns} sectors do not have specific factors $(n_s + n_{ns} = n)$. The goods produced by these n sectors are transformed into m $(k = 1, \ldots, m)$ consumption goods, of which good m is public final consumption; whereas good $m - 1$ is residents' consumption abroad. There exists r $(h = 1, \ldots, r)$ private households.

Table 11: Endogenous variables

Symbol	**Definition**
A_i	Armington aggregate (sector i)
CF_i	Final domestic consumption in goods from sector i
$CPUB$	Public consumption
$DIST_i$	Distributed production (sector i)
EXP_i	Exports (sector i)
FC	Conversion factor
I_i	Investment or gross capital formation in goods from sector i
II_{ij}	Intermediate inputs produced by sector j and used by sector i
IMP_i	Imports (goods from sector i)
INC_h^s, INC_h^{us}, INC_h^{uss}	Revenue from income taxes on labour
IT_i	Revenues from tariffs (imports of goods from sector i)
K_i	Capital (sector i)
L_i	Labor (sector i)
NIT_i	Revenues from indirect taxes which burden sector i
O_i	Domestic offer from sector i
P_k	Consumption good k price
P_{sav}	Savings *price*
PA_i	Average cost for Armington aggregate (sector i)
$PDIST_i$	Average cost for distributed production (sector i)
PL_i	Average cost for labor used in sector i
PO_i	Average cost for goods sold into domestic market (sector) i
PVA_i	Average cost for primary factors (sector i)
PX_i	Average cost for efective production (sector i)
Q_k	Demand (consumption good k)
Q_l^h, Q_{ls}^h, Q_{lus}^I, Q_{luss}^I	Demand (leisure)
Q_{sav}^h, Q_{sav}^I	Demand (savings)
R	Rent of capital

Table 11: Endogenous variables (cont.)

Symbol	**Definition**
$SOCCE_i$	Revenues from social contributions pais by employers, which burden sector i
$SOCCW_i$	Revenues from social contributions pais by employees, which burden sector i
U_s, U_{us}, U_{uss}	Unemployment rates for skilled, unskilled and specific unskilled labour
VA_i	Primary inputs used by sector i
W^s, W^{us}, W^{uss}	Wages for skilled, unskilled and specific unskilled labour
X_i	Efective production (sector i)
Y^G	Public sector income
Y_h	Disposable income for household h
Y^I	Disposable income for immigrants
Π^I	Profits in investment
Π_i^A	Profits in Armington aggregate
Π_i^{CET}	Profits in CET function
Π_i^L	Profits for labor
Π_i^{LK}	Profits for value added
Π_i^X	Profits for production

Table 12: Exogenous variables and parameters

Symbol	**Definition**
a_i	Share parameter
b_i, b_i^{ns}, b_i^s	Share parameter
$\overline{BALPUB}$	Public sector balance
c_{0i}, c_{ji}	Share parameter
$\overline{CFNR_k}$	No residents final consumption (goods form sector k)
d_i	Share parameter
e_i	Share parameter
f_h	Share parameter
g_h, g_{hs}, g_{hus}	Share parameters
inc_h^s, inc_h^{us}, inc_h^{uss}	Income taxes
$\overline{INVPUB}$	Public investment
$\overline{INVTOTAL}$	Total investment
it_i	Tariff *ad valorem* rates which burden sector i
$\overline{K_h}, \overline{K^G}$	Capital endowment for household h and public sector
l_i	Share parameter
$\overline{L_h^s}, \overline{L_h^{us}}, \overline{L_h^{uss}}$	Endowment for household h of skilled, unskilled and specific unskilled labour
$\overline{L_I^{us}}, \overline{L_I^{uss}}$	Endowment for household h of skilled, unskilled and specific unskilled labour

Table 12: Exogenous variables and parameters (cont.)

Symbol	**Definition**
nit_i	Indirect taxes *ad valorem* rates which burden sector i
$\overline{NLB}$	Net lending/borrowing
$\overline{NTPS_h}$	Net transfers given by public sector and received by r household h
o_{ki}	Transformation coefficients (i production goods into k consumption goods)
$\overline{PFX}$	World prices
$\overline{Q_{sav}}$	Total savings
q_{ij}	Transformation coefficients (efective production into distributed production)
$\overline{SAVPUB}$	Public sector savings
$soccw_i$	Social contributions *ad valorem* rates paid by employees which burden sector i
$socce_i$	Social contributions *ad valorem* rates paid by employers which burden sector i
$\overline{TNROW_h}$	Net transfers given by the rest of the World and received by household h
$\overline{TNROW^G}$	Net transfers given by the rest of the World and received by public sector
$\overline{U_s}, \overline{U_{us}}, \overline{U_{uss}}$	Unemployment rates for skilled, unskilled and specific unskilled labour
α_i	Scale parameter
β	Wage sensibility parameter
ϵ_i	Elasticity of transformation (sector i)
ζ_i	Scale parameter
$\mu_i, \mu_i^s, \mu_i^{ns}$	Scale parameter
ν	Wages wedge
σ_i^A	Armington elasticity (sector i)
σ_i^{LK}	Elasticity of substitution between labor and capital (sector i)
$\tau_{sav}^h, \tau_{sav}^I, \tau_k^h, \tau_k^I$	Share parameter
χ_k	Share parameter
ψ_i	Share parameter
Θ_i	Share parameter

APPENDIX 2 - EQUATIONS

In this Appendix we present equations included in the model, according to sections where they have been explained: production, consumption, public sector, investment and savings, foreign sector, factor markets and immigrants.

Production

$$\Pi_i^X = PX_i - c_{0i} PVA_i - \sum_{j=1}^{n} c_{ji} PO_j = 0 \tag{1}$$

$$\Pi_i^{LK} = PVA_i - \frac{1}{\alpha_i} \left(a_i^{\sigma_i^{LK}} PL_i^{1-\sigma_i^{LK}} + (1-a_i)^{\sigma_i^{LK}} R^{1-\sigma_i^{LK}} \right)^{\frac{1}{1-\sigma_i^{LK}}} = 0 \tag{2}$$

With homogeneous unskilled labor we use equation 3, and with specific unskilled labor we substitute it by equations 3a ($i = 1, \ldots, n_{ns}$) and 3b ($i = 1, \ldots, n_s$):

$$\Pi_i^L = PL_i - \frac{1}{\mu_i} \left(\frac{W^s(1 + socce_i + soccw_i)}{b_i} \right)^{b_i} \left(\frac{W^{us}(1 + socce_i + soccw_i)}{1 - b_i} \right)^{1-b_i} = 0 \tag{3}$$

$$\Pi_i^L = PL_i - \frac{1}{\mu_i^{ns}} \left(\frac{W^s(1 + socce_i + soccw_i)}{b_i^{ns}} \right)^{b_i^{ns}} \left(\frac{W^{us}(1 + socce_i + soccw_i)}{1 - b_i^{ns}} \right)^{1-b_i^{ns}} = 0 \tag{3a}$$

$$\Pi_i^L = PL_i - \frac{1}{\mu_i^{s}} \left(\frac{W^s(1 + socce_i + soccw_i)}{b_i^{s}} \right)^{b_i^{s}} \left(\frac{W^{uss}(1 + socce_i + soccw_i)}{1 - b_i^{s}} \right)^{1-b_i^{s}} = 0 \tag{3b}$$

$$VA_i = -X_i \frac{\partial \Pi_i^X}{\partial PVA_i} \tag{4}$$

$$II_{ji} = -X_i \frac{\partial \Pi_i^X}{\partial PO_j} \tag{5}$$

$$\sum_{h=1}^{r} \overline{K_h} + \overline{K^G} = -\sum_{i=1}^{n} VA_i \frac{\partial \Pi_i^{LK}}{\partial R} \tag{6}$$

$$\sum_{h=1}^{r} (\overline{L_h^s} - Q_{ls}^h)(1 - U_s) = -\sum_{i=1}^{n} L_i \frac{\partial \Pi_i^L}{\partial W^s} \tag{7}$$

Equation 8 is used with homogeneous unskilled labor, and we replace it by equations 8a and 8b to include specific unskilled labor:

$$\sum_{h=1}^{r}(\overline{L_h^{us}} - Q_{lus}^h)(1-U_{us}) = -\sum_{i=1}^{n} L_i \frac{\partial \Pi_i^L}{\partial W^{us}} \tag{8}$$

$$\sum_{h=1}^{r}(\overline{L_h^{us}} - Q_{lus}^h)(1-U_{us}) = -\sum_{i=1}^{n_{ns}} L_i \frac{\partial \Pi_i^L}{\partial W^{us}} \tag{8a}$$

$$\sum_{h=1}^{r}(\overline{L_h^{uss}} - Q_{luss}^h)(1-U_{uss}) = -\sum_{i=1}^{n_s} L_i \frac{\partial \Pi_i^L}{\partial W^{uss}} \tag{8b}$$

$$\begin{pmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ q_{n1} & q_{n2} & \cdots & q_{nn} \end{pmatrix} \times \begin{pmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{pmatrix} = \begin{pmatrix} DIST_1 \\ DIST_2 \\ \vdots \\ DIST_n \end{pmatrix} \tag{9}$$

$$\Pi_i^A = PA_i - \left(e_i^{\sigma_i^A}\,(PDIST_i(1+nit_i))^{1-\sigma_i^A} + (1-e_i)^{\sigma_i^A}(\overline{PFX}\ FC(1+it_i))^{1-\sigma_i^A}\right)^{\frac{1}{1-\sigma_i^A}} = 0 \tag{10}$$

$$DIST_i = -A_i \frac{\partial \Pi_i^A}{\partial PDIST_i} \tag{11}$$

$$IMP_i = -A_i \frac{\partial \Pi_i^A}{\partial FC} \tag{12}$$

$$\Pi_i^{CET} = PA_i - \frac{1}{\zeta_i}\left(d_i^{-\epsilon_i} PO_i^{\epsilon_i+1} + (1-d_i)^{-\epsilon_i}(\overline{PFX}FC)^{\epsilon_i+1}\right)^{\frac{1}{\epsilon_i+1}} = 0 \tag{13}$$

$$O_i = -A_i \frac{\partial \Pi_i^{CET}}{\partial PO_i} \tag{14}$$

$$EXP_i = -A_i \frac{\partial \Pi_i^{CET}}{\partial FC} \tag{15}$$

$$O_i = I_i + \sum_{j=1}^{n} II_{ij} + CF_i \tag{16}$$

$$\begin{pmatrix} o_{11} & o_{12} & \dots & o_{1n} \\ o_{21} & o_{22} & \dots & o_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ o_{(m-2)1} & o_{(m-2)2} & \dots & o_{(m-2)n} \\ o_{m1} & o_{m2} & \dots & o_{mn} \end{pmatrix} \text{ x } \begin{pmatrix} CF_1 \\ CF_2 \\ \vdots \\ CF_n \end{pmatrix} = \begin{pmatrix} Q_1 + \overline{CFNR_1} \\ Q_2 + \overline{CFNR_2} \\ \vdots \\ Q_{(m-2)} + \overline{CFNR_{(m-2)}} \\ Q_m \end{pmatrix} \tag{17}$$

Consumption

$$\begin{aligned} Y_h &= W^s(\overline{L_h^s} - Q_{ls}^h)(1-U_s)(1-inc_h^s) + \\ &\quad + W^{us}(\overline{L_h^{us}} - Q_{lus}^h)(1-U_{us})(1-inc_h^{us}) + \\ &\quad + W^{uss}(\overline{L_h^{uss}} - Q_{luss}^h)(1-U_{uss})(1-inc_h^{uss}) + \\ &\quad + R\overline{K_h} + \overline{NTPS_h} + \overline{NTROW_h}FC \end{aligned} \tag{18}$$

$$\overline{Q_{sav}} = \sum_{h=1}^{r} Q_{sav}^h = \sum_{h=1}^{r} \frac{\tau_{sav}^h Y_h}{P_{sav}} \tag{19}$$

$$Q_{ls}^h = f_h Q_l^h \tag{20}$$

With homogeneous unskilled labor we use equation 21, and with specific unskilled labor we replace it by equations 21a and 21b:

$$Q_{lus}^h = g_h Q_l^h \tag{21}$$

$$Q_{lus}^h = g_{hns} Q_l^h \tag{21a}$$

$$Q_{luss}^h = g_{hs} Q_l^h \tag{21b}$$

$$Q_k = \sum_{h=1}^{r} \frac{\tau_k^h \left(Y_h(1-\tau_{sav}^h) - W^s Q_{ls}^h - W^{us} Q_{lus}^h - W^{uss} Q_{luss}^h \right)}{P_k} \tag{22}$$

Public sector

$$\begin{aligned} Y^G &= R\overline{K^G} + \sum_{i=1}^{n} (SOCCE_i + SOCCW_i) + \sum_{i=1}^{n} (NIT_i + IT_i) + \\ &+ \sum_{h=1}^{r} (INC_h^s + INC_h^{us} + INC_h^{uss}) - \sum_{h=1}^{r} \overline{NTPS_h} + \overline{TNROW^G} FC \end{aligned} \tag{23}$$

$$\overline{BALPUB} = \overline{SAVPUB} - \overline{INVPUB} \tag{24}$$

$$CPUB = P_m Q_m = Y^G - \overline{SAVPUB} \tag{25}$$

Investment and savings

$$\Pi^I = PINV - \sum_{i=1}^{n} l_i PO_i = 0 \tag{26}$$

$$P_{sav}\overline{Q_{sav}} + \overline{SAVPUB} - PINV\ \overline{INVTOTAL} = \overline{NBL}\ FC \tag{27}$$

Foreign sector

$$\begin{aligned} &\sum_{i=1}^{n} \overline{PFX} EXP_i + \sum_{h=1}^{s} \overline{NTROW_h} + \overline{NTROW^G} + \\ &+ \frac{\sum_{k=1}^{m-2} P_k \overline{CFNR_k}}{FC} - \sum_{i=1}^{n} \overline{PFX}\ IMP_i - \sum_{h=1}^{r} \overline{PFX} Q_{m-1}^h = \\ &= \overline{NBL} \end{aligned} \tag{28}$$

Factor markets

$$\frac{W^s}{\sum_{k=1}^{m}\Theta_i P_k} = \left(\frac{1-U_s}{1-\overline{U_s}}\right)^{\frac{1}{\beta}} \tag{29}$$

Equation 30 appears when unskilled lobar is included in the model, and is replaced by equation 30a and 30b when there is specific unskilled labor:

$$\frac{W^{us}}{\sum_{k=1}^{m}\Theta_i P_k} = \left(\frac{1-U_{us}}{1-\overline{U_{us}}}\right)^{\frac{1}{\beta}} \tag{30}$$

$$\frac{W^{us}}{\sum_{k=1}^{m}\Theta_i P_k} = \left(\frac{1-U_{us}}{1-\overline{U_{us}}}\right)^{\frac{1}{\beta}} \tag{30a}$$

$$\frac{W^{uss}}{\sum_{k=1}^{m}\Theta_i P_k} = \left(\frac{1-U_{uss}}{1-\overline{U_{uss}}}\right)^{\frac{1}{\beta}} \tag{30b}$$

Immigrants

Equation 31 is applied in the homogeneous unskilled labor version of the model, and equations 31a and 31b in the specific factor version:

$$\sum_{h=1}^{r}(\overline{L_h^{us}} - Q_{lus}^h)(1-U_{us}) + \overline{L_I^{us}} = -\sum_{i=1}^{n} L_i \frac{\partial \Pi_i^L}{\partial W^{us}} \tag{31}$$

$$\sum_{h=1}^{r}(\overline{L_h^{us}} - Q_{lus}^h)(1-U_{us}) + \overline{L_I^{us}} = -\sum_{i=1}^{n_{ns}} L_i \frac{\partial \Pi_i^L}{\partial W^{us}} \tag{31a}$$

$$\sum_{h=1}^{r}(\overline{L_h^{uss}} - Q_{luss}^h)(1-U_{uss}) + \overline{L_I^{uss}} = -\sum_{i=1}^{n_s} L_i \frac{\partial \Pi_i^L}{\partial W^{uss}} \tag{31b}$$

$$Q_k = \sum_{h=1}^{r} \frac{\tau_k^h \left(Y_h(1-\tau_{sav}^h) - W^s Q_{ls}^h - W^{us} Q_{lus}^h - W^{uss} Q_{luss}^h\right)}{P_k} + \frac{\tau_k^I Y^I}{P_k} \tag{32}$$

$$\overline{Q_{sav}} = \sum_{h=1}^{r} Q_{sav}^h + Q_{sav}^I = \sum_{h=1}^{r} \frac{\tau_{sav}^h Y_h}{P_{sav}} + \frac{\tau_{sav}^I Y^I}{P_{sav}} \tag{33}$$

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