



**HAL**  
open science

# Migration Impact on Moroccan Unemployment : a Static Computable General Equilibrium Analysis

Bernard Decaluwé, Fida Karam

► **To cite this version:**

Bernard Decaluwé, Fida Karam. Migration Impact on Moroccan Unemployment : a Static Computable General Equilibrium Analysis. 2008. halshs-00331322

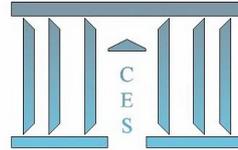
**HAL Id: halshs-00331322**

**<https://shs.hal.science/halshs-00331322>**

Submitted on 16 Oct 2008

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**Migration Impact on Moroccan Unemployment : a Static  
Computable General Equilibrium Analysis**

Fida KARAM, Bernard DECALUWE

**2008.52**

*Version révisée*

# Migration Impact on Moroccan Unemployment: a Static Computable General Equilibrium Analysis\*

Fida Karam<sup>†</sup>      Bernard Decaluwé<sup>‡</sup>

April 2008

First version: March 2007

## Abstract

Recently, much research interest is directed towards the impact of migration on the sending country. However, we think that this literature does not successfully analyse the effects of migration on unemployment and wage rates especially in urban areas. It studies the effect of one kind of migration flow, mainly international migration, on labour market in the country of origin and shows that international migration is able to reduce the unemployment rate and/or raise the wage rate. However, it is common to find labour markets affected simultaneously by inflows and outflows of workers. Using a detailed CGE model applied to the Moroccan economy, we show that if we take simultaneously into account Moroccan emigration to the European Union, immigration from Sub-Saharan Africa into Moroccan urban areas and rural-urban migration, the impact on Moroccan urban labour market disaggregated by professional categories is ambiguous.

**Keywords:** Imperfect labour market, Migration, Computable general equilibrium model.

**JEL Classification:** C68, F22, J44, J61, J64

## 1 Introduction

Analysing the impact of migration on Moroccan unemployment is an interesting question. Unemployment, which represented less than 17% of the economic causes of emigration before 1960, far behind the search for a more lucrative work (50%) or the improvement of the living standards (25%), became the principal economic

---

\*We thank Lionel Fontagné for excellent suggestions and fruitful discussions.

<sup>†</sup>Paris School of Economics, University of Paris 1 & CNRS, Sorbonne Economic Center (TEAM), 106-112 boulevard de l'Hôpital, 75647 Paris Cedex 13, France; karam@univ-paris1.fr

<sup>‡</sup>Laval University, Economic Department, Pavillon J.-A.-DeSève, Quebec, Canada G1K 7P4; bernard.decaluwe@ecn.ulaval.ca

cause of emigration in the 90s. According to the data collected by Hamdouch (2000), 41% of answers indicate unemployment as the first cause of emigration, whereas the search for a more lucrative work and the improvement of the standard of living represent 38% and 14% respectively of the reasons for emigration. The relation between migration and economic development of the country of origin has not been correctly addressed for a long time primarily because of the scarcity of reliable data on migratory flows and migrants characteristics at the macro and micro levels<sup>1</sup>. In the majority of the cases, studies have mainly analysed the impact of migration on the country of destination<sup>2</sup>, and in very rare occasions on the country of origin. Only a limited number of studies address the impact of migration (directly or indirectly through remittances) on inequality and wages, growth and welfare, its social effects (children health, education, women's role...), or the impact of returned migrants who acquired experience in the host country and the relation between migration and trade<sup>3</sup>. The "brain drain" and "brain gain" were also the issue addressed by several works.

The very few works that try to encircle in a systematic way the impact of migration on labour market are limited to the effect of international migration on unemployment in developing countries. However, it is common to find that labour mobility is observed in several directions. For example, a transitory South-South migration, from a developing country towards another before migrating to a developed country, can coexist with internal migration from rural to urban areas, or emigration to more developed countries. The combination of these forces is able to exert unexpected effects on the labour market, and in order to understand them and study their consequences, we choose the Moroccan case. Indeed, Morocco seems the typical example of a developing country undergoing the combination of different migratory flows: rural and urban emigration towards the European Union, internal migration from rural to urban areas, and finally Sub-Saharan immigration to Morocco for transit towards Europe or in order to stay there definitely.

A sketchy analysis of the impact of these migratory flows on unemployment and labour remuneration would lead us to conclude that on one hand, urban emigration reduces urban unemployment rates and raises wages, whereas internal migration and Sub-Saharan immigration to the cities increase the pressure on urban labour market. However, the simultaneous impact of these different forces on labour market conditions cannot be predicted without ambiguity since it will depend on the magnitude of each migratory flow and the initial conditions of the labour market. If internal migration to urban areas and Sub-Saharan immigration to Morocco dominate urban emigration, urban unemployment rate

---

<sup>1</sup>Fortunately, databases become increasingly available, like the one of Docquier and Marfouk (2004) on brain drain.

<sup>2</sup>For a review of the literature on the effects of migration on the destination country, see Drinkwater et al. (2003).

<sup>3</sup>For a review of the literature on the effects of migration on the sending country, see Katseli et al. (2006).

must increase. Conversely, if urban emigration overrides internal migration and Sub-Saharan immigration, unemployment rate will probably decrease.

In order to take the existing forces simultaneously into account, we build a computable general equilibrium model. This method allows to endogenize the principal determinants of migratory flows and to capture their simultaneous direct effects on urban labour market, particularly on unemployment, and their direct and indirect effects on the remainder of the economy. Contrary to other studies on this question<sup>4</sup>, we do not think that an aggregate approach is sufficient to seize the complexity of the existing mechanisms, and this is why we have privileged a fine disaggregation by professional categories. This fine description of the labour market which will take into account unemployment rates by professional categories is justified by the fact that emigration and immigration do not affect all categories in the same way. It will enable us to seize the impact of migration on each segment of labour market.

The paper is structured in five sections. Section 1 is an introductory section. Section 2 describes Moroccan labour market. Section 3 presents, in addition to the general structure of the CGE model we have built, the principal characteristics of the migratory block. Section 4 shows the results of a 10% fall in migration costs, a 10% rise of the Sub-Saharan immigrant stock, and finally, the simultaneous effects of the two previous shocks. Section 5 concludes and discusses the economic policy implications of this study.

## 2 Short description of the Moroccan labour market

Data from OECD (OECD 2006) indicate that the traditional destinations of Moroccan international migrants such as Belgium, France, Spain, Italy, and the Netherlands continue to receive important migratory flows. Thus, in 2004, 8,000 Moroccans entered to Belgium, 21,700 to France, 24,600 to Italy, 3,300 to the Netherlands and 58,800 to Spain, with 21.5% of the foreign population living in Spain in 2002. Moroccan Spanish represented the largest foreign community in this country. Moreover and according to an opinion of the International Organization of Migration, Moroccan migration towards the European Union is mostly originated from rural areas (Van der Erf and Heering (2002)).

Concerning internal migration, climatic risks associated to agricultural production induce farmers migration towards the cities. These rural workers search for a stable employment in order to mitigate the fall or the great fluctuations of their agricultural income. The available estimations indicate that each year, approximately 200,000 migrants move into urban areas, which is equivalent to 40% of the total increase in urban population (Agénor and El Aynaoui (2003)).

The extremely fast expansion of clandestine migration from Sub-Saharan

---

<sup>4</sup>See for example Agénor and El Aynaoui (2003).

Africa since the beginning of the 90s is due to the fragility of this continent. The exacerbation of poverty, the shortage of natural resources (water in particular) and conflicts and wars of any nature encourage African immigrants to transit by Morocco in direction of Spain and Europe<sup>5</sup> or to settle definitely in Morocco in order to profit from its stability and prosperity. One of the more important consequences of illegal immigration into Morocco is the fact that an increasingly significant number of Sub-Saharan immigrants, scalded by the difficulties they meet on the migratory way leading them to Europe, choose finally to stay in different Moroccan localities (rather urban). Data on Sub-Saharan immigration to Morocco are fragmentary and their collection is made difficult because the majority of African immigrants are illegal. Lahlou (2003) pointed out that there would be between 6,000 and 15,000 irregular migrants. We will retain the upper bound.

Let us examine Moroccan labour market characteristics<sup>6</sup>. National employment is roughly equally distributed between rural and urban areas. In 2005, urban employment constituted 50.5% of national employment. This percentage varies slightly with respect to the previous years.

**Table 1-** *Employment (%) by aggregate sectors of activity in 2005*

<b>Sectors</b>	<b>National</b>	<b>Rural</b>	<b>Urban</b>
Agriculture	45.5	80.2	5.2
Industry	12.4	3.9	22.3
Services	26	8.8	45.9
Construction	7.1	5.2	9.3
Public sector	9	1.9	17.3

*Source: Department of Statistics, Rabat*

The structure of employment by sectors of activity shows the relatively important weight of agriculture. In 2005, this sector, absorbing 45.5% of national employment, predominates in rural areas, with 80.2% of total rural employment, and is particularly based on family work. The services sector is ranked second with 26% of national employment. However, it is the principal provider of urban employment (45.9%). The industrial sector occupies only 12.4% of total employment (3.9% in rural areas against 22.3% in urban areas). The construction sector employs 7.1% of total labour (9.3% in the cities and 5.2% in the campaigns).

<sup>5</sup>The transit by Morocco is explained by geographical reasons (Morocco being at 14 km of the Spanish coast), by historical, sometimes cultural and religious reasons, and by socio-economic reasons like the possibility to work on spot during the long waiting periods or all along the migratory way.

<sup>6</sup>The illustrative figures come from the survey of the Department of Statistics on activity, employment and unemployment in 2005. The ventilation of employment between different professional categories is taken from the Analytical Nomenclature of Professions established by the Department of Statistics (2001).

Employment opportunities come principally from the private sector. The latter offers 91% of total employment at the national level (98% in rural areas and 83% in urban areas). On the other hand, the public sector employs primarily townsmen (17.3% of total employment in the cities against only 1.9% in the campaigns).

**Table 2-** *Employment (%) by professional categories in 2005<sup>7</sup>*

<b>Professions</b>	<b>National</b>	<b>Rural</b>	<b>Urban</b>
Directors...	0.8	0.1	1.6
Senior executive...	1.1	0	2.4
Junior staff	3.6	0.4	7.2
Employees	7.9	1.6	15.2
Commercants...	7.5	3.3	12.4
Farmers...	12.4	21.6	1.7
Craftsmen...	16.3	6.6	27.5
Workmen and farm labourers...	32.6	58.1	3.2
Drivers...	3	1.3	5
Warehousemen...	14.8	7	23.8

*Source: Department of Statistics, Rabat*

The distribution of Moroccan working population by professional categories shows that at the national level, the most exerted profession is “workmen and farm labourers”. The category “craftsmen and artisanal trades qualified workers” comes in the second place followed by the category “warehousemen and workers of small trades”. In rural areas, the category “workmen and farm labourers” occupies the first place followed by the category “farmers, fishermen, foresters, hunters and workers assimilate”, “warehousemen and workers of small trades” and “craftsmen and artisanal trades qualified workers”. The examination of urban working population indicates that the share of the category “workmen and farm labourers” is not more than 3.2%, and the category “craftsmen and artisanal trades qualified workers” is henceforth ranked first followed by “warehousemen and workers of small trades”, “employees” and “commercants, commercial and financial intermediaries”.

In total, we display two segments of labour market: urban and rural, each one composed of 10 under segments of professional categories.

**Table 3-** *National unemployment rate (%) by professional categories in 2005*

---

<sup>7</sup>The exact headings of professions can be examined in Appendix 2.

<b>Professions</b>	<b>Unemployment rates</b>
Directors...	2.2
Senior executive...	1.7
Junior staff	6.1
Employees	11.2
Commercants...	3.2
Farmers...	0.3
Craftsmen...	10.1
Workmen and farm labourers...	2
Drivers...	8.5
Warehousemen...	12

*Source: Department of Statistics, Rabat*

As in many developing countries, unemployment in Morocco is primarily an urban phenomenon. Unemployment rate rose in 1999 to 22% and diminished to 18.3% in 2005. In contrast, rural unemployment rate is not more than 3.6% in 2005. At the national level, unemployment rate reached 13.9% in 1999 but fall to 11% in 2005. In addition, unpublished data provided by the Department of Statistics show that the professions “warehousemen...”, “employees” and “craftsmen and artisanal trades qualified workers” have the higher unemployment rates (12%, 11.2% and 10.1% respectively). On the other hand, “farmers...” and “senior executive...” exhibit the lowest rates (0.3% and 1.7% respectively).

### **3 Theoretical framework**

If we wish to analyse correctly the impact of migration on the different segments of labour market, it will be important to identify the origin of migratory flows. Thus and if one can think that Moroccan emigration from rural or urban areas will relax the pressure on the corresponding domestic labour markets, the drop in labour supply in the countryside or the city will induce a rise in rural or urban wages. Given that unemployment is an important characteristic of urban labour market, emigration of urban workers, when it touches mainly some professional categories, will obviously reduce unemployment rates for these categories and not for the others, if there is some degree of specificity of the qualifications. On the contrary, migration of rural workers towards cities and the entry of African immigrants into urban areas increase labour supply and unemployment rates of the different professions. Since emigration and immigration do not touch the same categories, their impact will be different from a market to another. It is also clear that the eventual labour surplus on some segments of labour market will reduce wages (freely fixed by the market or negotiated by the means of a wage convention). When these migratory flows coexist, the ultimate effect on urban unemployment rates by professional categories is ambiguous. In order to understand these effects, a fine modelisation of labour market, illustrative of all these migratory movements, is necessary. The remainder of this section describes the behavioural assumptions we retain.

Our benchmark computable general equilibrium model is a standard one inspired from the model of Decaluwé et al. (2001) developed by Cockburn et al. (2006). This basic structure will however be deeply modified in order to describe adequately the behaviour of labour market and the internal and external determinants of migratory flows. Very briefly, our version of this model contains 34 monoproduktive sectors distributed between two aggregate sectors: a rural sector (agriculture and fishing) and an urban sector (industry, tradable services and non tradable services); two factors of production (a labour factor bundle of the different professional rural/urban categories mobile between rural/urban sectors and a capital factor specific for each sector); five agents (rural and urban households, firms, government, and the Rest of the World). Then, we modify the specification of the rural sector in order to distinguish, within this sector, between subsistence agriculture and industrial agriculture. Given the relative complementarity of capital and labour in the public value added, the latter is modeled using a Leontief function, contrarily to private value added represented by a CES<sup>8</sup>. We endogenize labour supply on each segment of labour market and we take into account unemployment rates by professional categories. We further assume that unemployed persons can not change their profession. In other words, the cross elasticity of labour supply should be null. Finally, we introduce a new block of equations relative to rural and urban emigration, internal migration from rural to urban areas and Sub-Saharan immigration, and we suppose the existence of migration costs. Our model is calibrated on the SAM of the year 1998.

We describe here the new equations. All the equations can be examined in Appendix 3.

### 3.1 Migratory flows

#### 3.1.1 Migration costs

When an individual or a household migrates from a region to another or when he decides to leave his country, this can not be done without costs. Any migratory movement induces financial costs (travel cost, search for an apartment, search for a job...) and psychological costs (change of the way of life, adaptation to a new culture and a new community...) for the migrant. In order to express migration costs, we adopt the approach proposed by Chan et al. (2005): when workers migrate from a region to another due to wage differentials, their net wage in the region of destination is lower than the effective wage in this region, where the difference represents migration costs. To seize this phenomenon, the authors consider that this gap is equivalent to a reduction in household's available time to work and results in a reduction of his labour endowment. In other words, migration costs are a fraction of the migratory flow. For lack of precise information on the width of this cost, we follow Chan et al. (2005) who postulate

---

<sup>8</sup>Constant Elasticity of Substitution.

that migration costs are equal to 10% of the international migratory flow. Given that migrant labour supply in the region of destination is reduced of 10%, total labour remuneration of their work decreases too. For internal migration, the cost of labour mobility is obviously lower than international mobility and we suppose that internal migration costs are equal to 5% of the migratory flow<sup>9</sup>. In the dynamic version of the model, these costs are brought to decrease gradually during the first periods and vanish thereafter.

We neglect adjustment costs associated with Sub-Saharan immigration because we suppose that the latter is exogenous and not motivated by economic factors. Indeed, according to Lahlou (2003), political and security factors (disorders and conflicts between and inside several African countries) play a crucial role in stimulating illegal African immigration to Morocco. Thus, migration towards Morocco takes place whatever migration costs fall down or not.

### 3.1.2 Internal and international migration from rural areas

Two types of migratory flows take place from rural areas: internal migration towards the cities and international migration. In 1960, more than 70% of Moroccans lived in rural zones. Four decades later, they are not more than 46% due to internal migration from rural areas to cities and to foreign countries. Migration phenomenon seems originated mainly from rural areas. The gap between annual growth rates of rural and urban populations, which was around 2.5% in 1960 (4.2% in urban areas against 1.7% in rural areas), rose to more than the 3% in the 90s. Moreover, in 1997, the growth rate of rural population was negative (Van der Erf and Heering (2002)).

In order to characterise this migratory movement, we postulate that the rural worker of professional category  $c$  carries out a choice in two stages: initially, he maximizes his expected income  $REVR_c$  considering the choice of staying in Morocco (staying in rural zones or migrating to the cities) or leaving the country<sup>10</sup>:

$$\text{Max } REVR_c = wn_c NAT_c + wi_c e(1 - mc)EMR_c$$

s.t.

$$LSR_c = Br_c [\varpi_c NAT_c^{(\varepsilon_c - 1)/\varepsilon_c} + (1 - \varpi_c) EMR_c^{(\varepsilon_c - 1)/\varepsilon_c}]^{\varepsilon_c / (\varepsilon_c - 1)} \quad (1)$$

where

$wn_c$  is the national wage rate of professional category  $c$ ,  
 $NAT_c$  Moroccan rural workers of category  $c$  who decide to stay in Morocco,  
 $wi_c$  the international wage rate of category  $c$  in foreign currency,

<sup>9</sup>The sensitivity analysis over the value of international and internal migration costs parameters has revealed that the main results are not affected by the value of these parameters.

<sup>10</sup>Given that in CGE models we analyse the behaviour of a representative agent,  $NAT_c$  and  $EMR_c$  correspond to the number of hours that the representative worker of category  $c$  chooses to offer respectively in Morocco and abroad.

$e$	the nominal exchange rate,
$mc$	international migration costs expressed as a percentage of the migratory flow,
$EMR_c$	the flow of Moroccan rural emigrants of category $c$ ,
$LSR_c$	the rural population of category $c$ ,
$\varepsilon_c$	the elasticity of transformation (negative).

The percentage of rural emigrants is deduced from the optimisation problem:

$$\frac{EMR_c}{NAT_c} = \left[ \frac{\varpi_c}{1 - \varpi_c} \frac{wi_c e(1 - mc)}{wn_c} \right]^{-\varepsilon_c} \quad (2)$$

In the second stage, the rural worker of category  $c$  who has decided to stay in Morocco carries out the choice of staying in rural areas or migrating to the cities. The potential internal migrant compares a rural job to an urban one belonging to the same professional category. Thus, labour supply of each professional category does not depend on the wage of the other categories. However, when he takes the decision to migrate to urban areas, he is aware of the possibility not to find a job there. Therefore, the expected urban wage of category  $c$  is equal to the urban wage of this category times the probability to find a job in town. This probability is itself equal to the ratio of total urban labour demand and total labour supply of category  $c$ :

$$wa_c = wug_c \frac{\sum_{up} LU_{c,up} + \sum_{pub} LG_{c,pub}}{NATU_c + (1 - imc)MIG_c + IMMIG_c} \quad (3)$$

where

$wug_c$	is the average urban wage rate of professional category $c$ ,
$LU_{c,up}$	the labour demand of urban category $c$ by urban private sector $up$ ,
$LG_{c,pub}$	the labour demand of urban category $c$ by urban public sector $pub$ ,
$NATU_c$	Moroccan urban workers of category $c$ who decide to stay in urban areas
$imc$	internal migration costs expressed as a percentage of the migratory flow,
$MIG_c$	migrants of category $c$ from rural to urban areas,
$IMMIG_c$	the stock of African immigrants of category $c$ .

The maximization problem of this potential internal migrant is written as follows:

$$Max REVI_c = wa_c(1 - imc)MIG_c + wr_c NATR_c$$

s.t.

$$NAT_c = Bu_c [\vartheta_c NATR_c^{(\varrho_c - 1)/\varrho_c} + (1 - \vartheta_c) MIG_c^{(\varrho_c - 1)/\varrho_c}]^{\varrho_c / (\varrho_c - 1)} \quad (4)$$

where

- $REVI_c$  is his expected income when he divides his working hours between urban and rural areas,  
 $wr_c$  the rural wage rate of professional category  $c$ ,  
 $NATR_c$  Moroccan rural workers of category  $c$  who decide to stay in rural areas,  
 $\varrho_c$  the elasticity of transformation (negative).

The percentage of rural migrants to urban areas is then written:

$$\frac{MIG_c}{NATR_c} = \left[ \frac{\vartheta_c}{1 - \vartheta_c} \frac{wa_c(1 - imc)}{wr_c} \right]^{-\varrho_c} \quad (5)$$

The elasticity of transformation is, in absolute value, lower in equation (2) than in equation (5), reflecting a much stronger preference of workers for their country of origin. This is due to higher costs associated to migration abroad.

### 3.1.3 Migration from urban areas

At his turn, the urban worker maximizes his expected income  $REVI_c$  by choosing to stay in Morocco or to migrate abroad. Given that urban markets are imperfect, the urban worker is unable to offer all his disposable working hours. He is considered unemployed for the hours he can not offer. Therefore, to make his choice, he compares the international wage to the urban expected wage and solves the following maximization problem:

$$Max REVI_c = wa_c NATU_c + wi_c e(1 - mc) EMU_c$$

s.t.

$$LSU_c = Bi_c [\xi_c NATU_c^{(o_c-1)/o_c} + (1 - \xi_c) EMU_c^{(o_c-1)/o_c}]^{o_c/(o_c-1)} \quad (6)$$

where

- $EMU_c$  represents Moroccan urban workers of category  $c$  who decide to emigrate,  
 $LSU_c$  the urban population of category  $c$   
 $o_c$  the elasticity of transformation (negative).

The percentage of Moroccan urban workers of category  $c$  choosing to leave their country is given by:

$$\frac{EMU_c}{NATU_c} = \left[ \frac{\xi_c}{1 - \xi_c} \frac{wi_c e(1 - mc)}{wa_c} \right]^{-o_c} \quad (7)$$

Note that the elasticity of transformation  $o_c$  is greater, in absolute value, than the one of equation (2), reflecting less financial constraint for urban workers to migrate abroad, compared to rural workers. It is however lower than the one of equation (5) because the costs associated to internal migration are lower than those associated to international migration.

### 3.1.4 African immigration

To take into account the characteristics of the African immigrant, we suppose that, when he comes to stay in Moroccan cities, he does not have the same behaviour of the Moroccan urban worker. He does not maximize his income by choosing to offer his work in Morocco or abroad. He comes to work in Morocco, fleeing war or poverty, in order to stay there definitely or to survive before migrating to Spain. The decision to migrate towards Europe is taken before the arrival to Morocco, and thus does not depend on the living conditions and on the wage differential between Morocco and the Rest of the World. Moreover, given that African immigration does not only occur for economic or financial reasons, but also for personal and security reasons, living conditions in Morocco and in particular urban wage variation will not affect Sub-Saharan immigration towards Morocco. For this reason, we choose to exogenize the stock of African immigrants in Morocco. This variable will be subject to a shock later on, a 10% rise of the Sub-Saharan immigrant stock, in order to study how exogenous reasons such as the exacerbation of poverty or conflicts in Sub-Saharan Africa can exert a strong pressure on the Moroccan economy.

In addition, the majority of these immigrants are not qualified, and if they are, they do not occupy qualified jobs in Morocco (shoe-makers, mason assistant, guards of private residences...). Therefore, we also assume that these African immigrants will occupy jobs of weak qualification. They will belong to the urban category “warehousemen and workers of small trades”. Moreover, these immigrants are not perfectly substitutable to local labour. The majority of them being clandestine, they can only work in the informal sector. Thus, a company that employs workers belonging to the above category does not pay social security contributions on the wages assigned to African immigrants, contrary to nationals belonging to the same category. Urban labour demand of category “10” (“warehousemen and workers of small trades”) by urban private sector  $up$  is a CES function of national and foreign workers. Relative demand of foreign workers is deduced from the wage cost minimization problem of sector  $up$ :

$$\text{Min } wup_{up}LU^{“10”,up} = (1 + cs)wu^{“10”}NATI_{up} + wu^{“10”}ETR_{up}$$

s.t.

$$LU^{“10”,up} = Ai_{up}[\Omega_{up}NATI_{up}^{(\varsigma_{up}-1)/\varsigma_{up}} + (1 - \Omega_{up})ETR_{up}^{(\varsigma_{up}-1)/\varsigma_{up}}]^{\varsigma_{up}/(\varsigma_{up}-1)} \quad (8)$$

where

$wup_{up}$  is the average wage of category “10” in sector  $up$ , given by the following equation:

$$wup_{up} = \frac{(1 + cs)wu^{“10”}NATI_{up} + wu^{“10”}ETR_{up}}{LU^{“10”,up}}$$

$LU^{“10”,up}$	the urban labour demand of category “10” by private urban sector $up$ ,
$cs$	social security contributions,
$wu_c$	the private urban wage of category $c$ ,
$NATI_{up}$	the demand of domestic workers belonging to category “10” by sector $up$ ,
$ETR_{up}$	the demand of foreign workers belonging to category “10” by sector $up$ ,
$\varsigma_{up}$	the elasticity of substitution between nationals and immigrants in sector $up$ (positive).

This elasticity can be interpreted as a parameter of “repression” reflecting the fear of the firm from being punished for having engaged informal Sub-Saharan workers. The weaker the elasticity is, the more the repression is strong and less the firm will change the proportion of domestic and foreign workers after the variation of their relative wage. Conversely, more the elasticity is strong, more the repression is laxist and more the firm will be incited to engage Africans when their relative wage decreases. The parameters of distribution  $\Omega_{up}$  and  $(1 - \Omega_{up})$  are then interpreted as parameters of “tolerance”, i.e. the proportions of nationals and Sub-Saharan immigrants socially accepted for a given level of the parameter of “repression”.

Relative demand for Sub-Saharan labour is therefore written:

$$\frac{ETR_{up}}{NATI_{up}} = \left[ \left( \frac{1 - \Omega_{up}}{\Omega_{up}} \right) \left( \frac{wu_{10} (1 + cs)}{wu_{10}} \right) \right]^{\varsigma_{up}} \quad (9)$$

Social security contributions  $cs$  are fixed to 20% of the private urban wage of each professional category. The employer pays 18,6% of the gross salary to the Social Security for contributions to retirement and other social security covers, and an obligatory tax of 1.6% imposed on the wage bill as a contribution to the financing of the public system of vocational training.

Therefore, social security contributions create a gap between the wage paid by firms and labour remuneration received by households and the Rest of the World. They are modeled explicitly in the urban private sector and in industrial agriculture. On the other hand, we assume that they are null in subsistence agriculture where a significant part of labour comes from family work. In addition, they are neglected in the public sector because if they are paid by public firms, they are received by the agent “government” which is constituted of the Central Government and public firms.

### 3.2 A particular treatment of the rural sector

We distinguish, within the rural sector, two types of agriculture: subsistence agriculture and industrial agriculture. This modeling agrees perfectly with the reality of Moroccan agriculture of which a considerable share is for subsistence<sup>11</sup>. With agricultural production directed towards the domestic market, the subsistence sector satisfies consumers final demand and its production is not used as an intermediary input in other industries. By opposition, industrial agriculture delivers intermediary inputs to industrial and food processing industries. It is intended to domestic and international markets and resorts to production techniques different from subsistence agriculture (transport, storage, conditioning, quality control...). The fishing sector is associated to industrial agriculture because Moroccan fishing is primarily industrial: domestic consumption remains very weak and is only around 6 kg/person. The canning facility corresponds to one third of pelagic catches, the remainder being intended to flour and fish oil production. We will also assume that subsistence agriculture uses only labour for production, whereas industrial agriculture uses labour and capital.

As it is known, the history of Moroccan agriculture is marked by frequent periods of dryness and extreme pluviometric fluctuations. The successive drynesses in 1981, 1983 and 1984 induced a negative growth rate of agricultural production (-1,9% on average). Such periods are heavy on the peasants who live from land and do not have other incomes<sup>12</sup>. Often, they will be obliged to move in order to seek a job allowing them to mitigate the fall of their agricultural income.

What will be the impact of these variations of rural working population on agricultural production? In principle, production should be done in the zone of decreasing marginal productivity of the mobile factor (to the right of the inflection point in figure 1). However one can think that it is not necessarily the case. Indeed, given that the departure of peasants into urban areas increases agricultural properties (for example after the sale of lands by leaving peasants) or leads to the abandonment of less productive pieces, the variations of rural working population can drive us to the left of our inflection point, which is a zone where marginal labour productivity is increasing. In the same way, the opposite movement of eventual comeback of urban workers to rural areas could lead to a fall in agricultural marginal productivity because of land bursting or the exploitation of more arid and less productive zones.

---

<sup>11</sup>By definition, subsistence agriculture (also known as self sufficiency) is a method of farming in which farmers plan to grow only enough food to feed the family farming, pay taxes, and perhaps provide a small marketable surplus. This definition is problematic because when the production is intended to feed the family, it will not be offered on the domestic market and therefore will not enter national statistics. Here, we mean by subsistence agriculture the production of foodstuffs that uses traditional production techniques and is offered on the domestic market in order to satisfy the representative consumer demand and not only peasants' consumption.

<sup>12</sup>Certainly, transfers from internal and international migrants to their family in rural areas can compensate for the loss of their agricultural income. However, given that transfers are not only allocated to consumption but also to investment, this requires a dynamic CGE model and not a static one, as it is the case of our model.

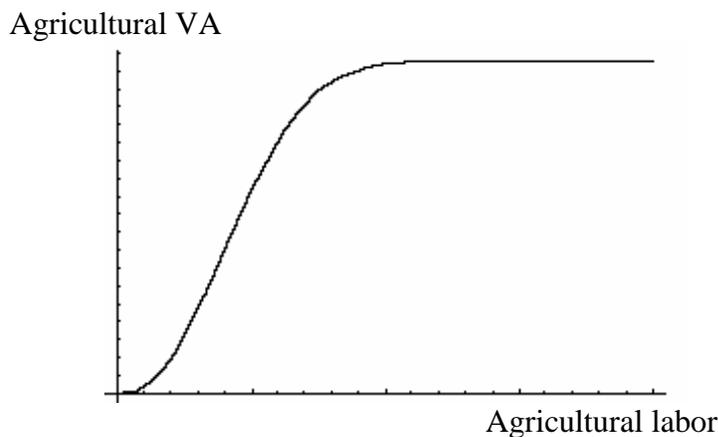


Figure 1:

In order to model this phenomenon and to allow a change of regime (to pass from a situation of increasing productivity to a situation of decreasing productivity) after the migratory movements between rural and urban areas, we adopt for subsistence agriculture a value added function of the Weibull type<sup>13</sup> represented by figure 1:

$$VA^{sa} = a(1 - e^{-(LDR^{sa}/b)^f}) \quad (10)$$

where

$LDR^{sa}$  is the labour demand by the subsistence agriculture sector,  
 $a, b, f$  parameters in the Weibull function.

Subsistence agriculture value added being created only by labour, we can write labour demand by this sector in the following form:

$$LDR^{sa} = \frac{PV^{sa} VA^{sa}}{w^{sa}} \quad (11)$$

where

$PV^{sa}$  is the value added price of subsistence agriculture,  
 $w^{sa}$  the wage in the subsistence agriculture sector.

In other words, and contrary to industrial agriculture, all the profits of this sector are incorporated in labour remuneration.

The parameter  $f$  is fixed to 2.2814, which corresponds to a symmetric function. In order to calibrate the parameters  $a$  and  $b$ , we must make an assumption about the volume of labour corresponding to the inflection point. For that, let us

<sup>13</sup>This is not possible with a CES function which models a productivity either increasing, or decreasing, but not both at the same time.

postulate that, before any migratory movement from rural areas, labour marginal productivity is decreasing. Once rural workers leave the countryside towards urban areas or abroad, we suppose that labour demand by subsistence agriculture corresponds to the inflection point of figure 1.

### 3.3 The public sector

Contrary to production functions characterising private firms behaviour that choose the volume of labour and capital in order to maximize their profits, we postulate that the value added of non tradable public services is a “Leontief” combination of the two factors of production. Indeed, the government as a producer of services does not have an optimisation behaviour. Thus, for each job created in the public sector, the government must mobilize some quantity of capital (public buildings, etc...) and add this cost to the remuneration of civil servants. The value added in the public sector is then written:

$$VA_{pub} = KD_{pub}/k_{pub} \quad (12)$$

and labour demand by this sector:

$$LDG_{pub} = l_{pub}VA_{pub} \quad (13)$$

where

$VA_{pub}$  is the value added of public sector  $pub$ ,  
 $KD_{pub}$  the capital demand by public sector  $pub$ ,  
 $k_{pub}$  a technical coefficient in the Leontief value added function,  
 $LDG_{pub}$  the labour demand by public sector  $pub$ ,  
 $l_{pub}$  a technical coefficient in the Leontief value added function.

Moreover, we will assume that the government needs a constant proportion of each professional category. Therefore, if the wage of engineers increases, it cannot replace them by office workers. By postulating that labour demand of category  $c$  by the public sector is insensitive to the variation of relative wages, we can express total labour demand by non tradable public services as a Leontief function of labour demand by professional categories, that is to say:

$$LG_{c,pub} = LDG_{pub}lc_{c,pub} \quad (14)$$

where

$LG_{c,pub}$  is the labour demand of category  $c$  by public sector  $pub$ ,  
 $lc_{c,pub}$  the technical coefficient of the Leontief public labour demand function.

In tradable sectors, firms maximize their profits. Then, if the capital available is sectoral specific, the profit or capital remuneration is residual and varies from a sector to another. This approach is obviously irrelevant for the public sector since the government, as a supplier of non tradable services, does not have an

optimisation behaviour. The cost and thus the price of public services is then the result of the combination of wage and capital costs. Consequently, we normalize the rental rate of capital in the public sector and we calculate capital demand in the following way:

$$KD_{pub} = \frac{PV_{pub}VA_{pub} - w_{pub}LDG_{pub}}{r_{pub}} \quad (15)$$

where

$PV_{pub}$  is the value added price of public sector  $pub$ ,  
 $w_{pub}$  the wage of public sector  $pub$  given by the following equation:

$$w_{pub} = \sum_c \frac{LG_{c,pub}wg_c}{LDG_{pub}} \quad (16)$$

$wg_c$  the public wage rate of professional category  $c$ ,  
 $r_{pub}$  the rental rate of capital in public sector  $pub$ .

According to the World Bank (2002), monetary compensations in the public sector are, in Morocco, 8% higher than in the private sector. If we add to that nonpecuniary compensations, like job security and the existence of generous pension funds, the divergence between the public and private sectors becomes larger. According to the National Survey on Household Living Standards in 1998-1999, this corresponds to a public wage of 1.5 to 2 times higher than private sector wage. The existence of an important wage differential between the public and private sectors leads to an excessive labour supply in the public sector and, in particular for young and qualified people, waiting unemployment and a high reservation wage. We take into account this wage differential in the calibration procedure by postulating that:

$$wg_c \succ wu_c \quad (17)$$

The public wage by professional category  $wg_c$  is also considered exogenous. This wage rigidity allows internal migration flows in spite of urban unemployment rates.

### 3.4 Endogenization of labour supply by professional categories

The assumption of a representative agent usually used in the literature on CGE models is not without posing conceptual difficulties when it is applied to the household agent. Indeed, incomes and in particular labour incomes of this “household” come from the participation of a multitude of individuals to different labour markets. In our model, wage rates are different between categories and the increase in the wage rate of a professional category does not induce necessarily a fall in labour supply of another category. In other words, the concepts of cross elasticities lose their significance when the representative agent is composed of

individuals having different qualifications.

In order to solve this problem, Decaluwé, Lemelin, Bahan and Annabi (2005) proposed to describe each representative household as a group of individuals, each one belonging to a professional category and exerting only one profession. Each individual of this group maximizes its utility independently from the others, taking into account its own preference for leisure. Thus, labour supply of each member (or each professional category) is independent from the wage rate of the other members (or categories) and thus the opportunity cost of leisure differs between members. This approach is similar to a particular case of the collective household model (Chiappori 1992) where the decision process is carried out in two stages: initially, income - here non-labour income - is divided between household members. Then, each member maximizes his utility independently from the others.

We follow this approach and postulate that the individual carries out an arbitration between the time allocated to work and the time allocated to leisure. Given that leisure is considered as a normal good, its opportunity cost is equal, in presence of unemployment, to the expected wage rate of the corresponding professional category, which is the product of the wage rate by the probability of being employed. In other words, we suppose that unemployment on urban labour market  $c$  affects proportionally all individuals who offer this type of work. When the expected wage increases, an income effect and a substitution effect come into play. On one hand, the rise in wage rate increases the leisure opportunity cost, and therefore the individual raises his labour supply. This is the substitution effect. On the other hand, the rise in wage rate induces an increase in the consumption of all goods, including leisure (a normal good), and consequently a fall in labour supply. This is the income effect. The final effect on labour supply depends on the extent of the two effects: if the substitution effect dominates, the labour supply curve is increasing. If the income effect is greater than the substitution effect, the labour supply curve is decreasing. It is called “Backward-bending” (Hanoch 1965). It will have the form of figure 2. For our simulations, we will assume that the substitution effect dominates and that the labour supply curve has a positive slope review!!!!.

The consumer carries out initially the choice between the consumption of goods and the consumption of leisure, using an ELES function<sup>14</sup>. In order to define the optimisation problem of household’s member  $c$  using a Stone-Geary utility function, it is necessary to separate between household members the minimum level of consumption of each good and service  $i$  as well as the non-labour

---

<sup>14</sup>Extended Linear Expenditure System (Lluch 1973). The ELES demand function is obtained from a static maximization problem of the Stone-Geary function, considering savings as a good with a null minimum consumption. In our problem of labour supply endogenization, we replace savings by leisure and we consider that the household must also consume a minimum level of leisure (De Melo and Tarr 1992, Deaton and Muellbauer 1980).

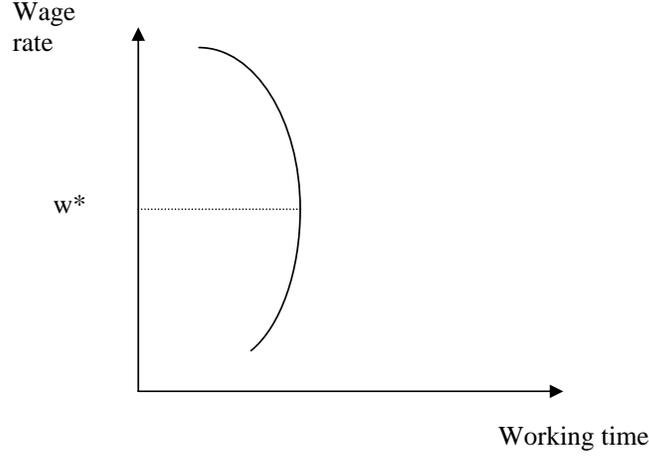


Figure 2:

income. Let  $\lambda_c$  be the share of household's member  $c$ , with

$$\lambda_c = \frac{w_c \sum_j LD_{c,j}}{\sum_c (w_c \sum_j LD_{c,j})} \text{ and } \sum_c \lambda_c = 1.$$

The optimisation problem of household's member  $c$  is written:

$$Max U_c = \sum_i m_{i,c} \ln(C_{i,c} - \lambda_c Cmin_i) + \beta_c \ln(TNL_c - TNLmin_c)$$

s.t.

$$\begin{aligned} \sum_i PC_i C_{i,c} &= (1 - \psi)(1 - ty \times adj) w_c \sum_j LD_{c,j} + \\ &\lambda_c (1 - \psi)(1 - ty \times adj) [Y - \sum_c (w_c \sum_j LD_{c,j})] \\ &= prl_c (T_c - TNL_c) + \lambda_c (1 - \psi)(1 - ty \times adj) [Y - \sum_c (w_c \sum_j LD_{c,j})] \end{aligned}$$

where

- $U_c$  is the utility of household's member  $c$ ,
- $m_{i,c}$  the budgetary share of good  $i$  in the supernumerary income of member  $c$ ,
- $C_{i,c}$  member  $c$ 's consumption of good  $i$ ,
- $Cmin_i$  household's minimum consumption of good  $i$ ,
- $\beta_c$  the leisure share in member  $c$ 's income,
- $TNL_c$  the leisure time of member  $c$ ,
- $TNLmin_c$  the minimum leisure time of member  $c$ ,

$PC_i$	the composite price of good $i$ ,
$\psi$	the marginal (and average) propensity to save applied uniformly to all household members,
$ty$	the direct tax rate on household income applied uniformly to all household members,
$adj$	a compensatory tax,
$w_c$	the wage of professional category $c$ ,
$LD_{c,j}$	the labour demand of professional category $c$ by sector $j$ ,
$Y$	the total income of the representative household,
$prl_c$	the leisure opportunity cost of member $c$ given by:

$$prl_c = (1 - \psi)(1 - ty \times adj)(1 - u_c)w_c$$

$u_c$	the unemployment rate of professional category $c$ ,
$T_c$	the total available time for member $c$ ,

The equations of goods and services demand and leisure demand become:

$$C_{i,c} = \lambda_c Cmin_i + \frac{m_{i,c}}{(1 - \beta_c)PC_i} \left( \sum_i PC_i C_{i,c} - \sum_i PC_i \lambda_c Cmin_i \right) \quad (18)$$

and

$$TNL_c = TNLmin_c + \frac{\beta_c}{(1 - \beta_c)prl_c} \left( \sum_i PC_i C_{i,c} - \sum_i PC_i \lambda_c Cmin_i \right) \quad (19)$$

From the equality  $TNL_c - TNLmin_c = lsmax_c - LS$ , where  $lsmax_c$  is household's member  $c$  maximum time available to work, and from equation (19), we deduce the labour supply function of professional category  $c$ :

$$LS_c = lsmax_c - \frac{\beta_c}{(1 - \beta_c)prl_c} \left( \sum_i PC_i C_{i,c} - \sum_i PC_i \lambda_c Cmin_i \right) \quad (20)$$

In the three previous equations, we replace  $\sum_i PC_i C_{i,c}$  by its value given in the optimisation problem.

Because we are taking into account two segments of the labour market, rural and urban, each one divided in ten under categories according to the different professional categories, we distinguish two equations of labour supply, one for the rural market applied to all rural professions and one for the urban market applied to all urban professions:

$$NATR_c = lsmax_c - \frac{\beta_c}{(1 - \beta_c)prl_c} \left( \sum_i PC_i C_{i,c} - \lambda_c \sum_i PC_i Cmin_{i, "hr"} \right) \quad (21)$$

where

$$\begin{aligned} \sum_i PC_i C_{i,c} &= (1 - \psi^{"hr"}) (1 - ty^{"hr"} adj) wr_c \sum_{ru} LR_{c,ru} + \\ &\lambda_c (1 - \psi^{"hr"}) (1 - ty^{"hr"} adj) [Y^{"hr"} - \sum_c (wr_c \sum_{ru} LR_{c,ru})] \end{aligned} \quad (22)$$

in rural areas. For the urban areas, this equation is more complex because the representative urban household is composed of Moroccans having decided to stay in urban areas, but also of rural migrants towards the cities and Sub-Saharan immigrants. The labour income of these migrants is added to the integral income of the representative household and is used for consumption and saving ends. For lack of information on the consumption behaviour of these migrants and on the proportion that is employed, we must make an assumption about the fraction of the consumption budget and labour income that come from the participation of these individuals to the urban household. For that, we postulate that this fraction is equal to the proportion of internal migrants and African immigrants in the labour supply of each category.

$$NATU_c = lsmax'_c - \frac{\beta'_c}{(1 - \beta'_c)plu_c} (1 - \zeta_{1c} - \zeta_{2c}) \left( \sum_i PC_i C'_{i,c} - \lambda'_c \sum_i PC_i Cmin_{i, "hu"} \right) \quad (23)$$

where

$$\zeta_{1c} = \frac{(1 - imc)MIG_c}{NATU_c + (1 - imc)MIG_c + IMMIG_c}$$

$$\zeta_{2c} = \frac{IMMIG_c}{NATU_c + (1 - imc)MIG_c + IMMIG_c}$$

$$\begin{aligned} \sum_i PC_i C'_{i,c} &= (1 - \psi_{"hu"}) (1 - ty_{"hu"} adj) (wu_c \sum_{up} LU_{c,up} + wg_c \sum_{pub} LG_{c,pub}) + \\ &\lambda'_c (1 - \psi_{"hu"}) (1 - ty_{"hu"} adj) [Y_{"hu"} - \sum_c (wu_c \sum_{up} LU_{c,up} + wg_c \sum_{pub} LG_{c,pub})] \quad (24) \end{aligned}$$

Now, rural household demand of good  $i$  is written:

$$CT_{i, "hr"} = \sum_c \lambda_c Cmin_{i, "hr"} + \sum_c \frac{m_{i,c}}{(1 - \beta_c)PC_i} \left( \sum_i PC_i C_{i,c} - \lambda_c \sum_i PC_i Cmin_{i, "hr"} \right) \quad (25)$$

and urban household demand (excluding the consumption of internal and African immigrants):

$$CT_{i, "hu"} = \sum_c (1 - \zeta_{1c} - \zeta_{2c}) \left[ \lambda'_c Cmin_{i, "hu"} + \frac{m'_{i,c}}{(1 - \beta'_c)PC_i} \left( \sum_i PC_i C'_{i,c} - \lambda'_c \sum_i PC_i Cmin_{i, "hu"} \right) \right] \quad (26)$$

For lack of data on consumption and income elasticity of household members that are necessary to calibrate the budgetary share of each one of them, we suppose, as in Decaluwé et al. (2005), that all household members distribute their supernumerary consumption budget in the same proportions, whatever their leisure budgetary share is. In other words, the fractions

$$\frac{m_{i,c}}{(1 - \beta_c)} \quad \text{and} \quad \frac{m'_{i,c}}{(1 - \beta'_c)}$$

are the same between all members of rural and urban households, they are independent of the professional category to which the individual belongs. Thus, rural household demand of good  $i$  is written:

$$CT_{i, "hr"} = Cmin_{i, "hr"} + \frac{\gamma_{i, "hr"}}{PC_i} (BC_{"hr"} - \sum_i PC_i Cmin_{i, "hr"}) \quad (27)$$

and urban household demand (excluding the consumption of internal and African immigrants):

$$CT_{i, "hu"} = \sum_c (1 - \zeta_{1c} - \zeta_{2c}) [\lambda'_c Cmin_{i, "hu"} + \frac{\gamma_{i, "hu"}}{PC_i} (\sum_i PC_i C'_{i,c} - \lambda'_c \sum_i PC_i Cmin_{i, "hu"})]$$

where  $BC_{"hr"}$  et  $BC_{"hu"}$  are respectively the consumption budgets of rural and urban households.

After the internal migrants and African immigrants enter the urban household, they will participate to the maximisation problem of this household. Urban household consumption (including that of internal and African immigrants) will be written:

$$CT_{i, "hu"} = Cmin_{i, "hu"} + \frac{\gamma_{i, "hu"}}{PC_i} (BC_{"hu"} - \sum_i PC_i Cmin_{i, "hu"})$$

### 3.5 Labour market equilibrium

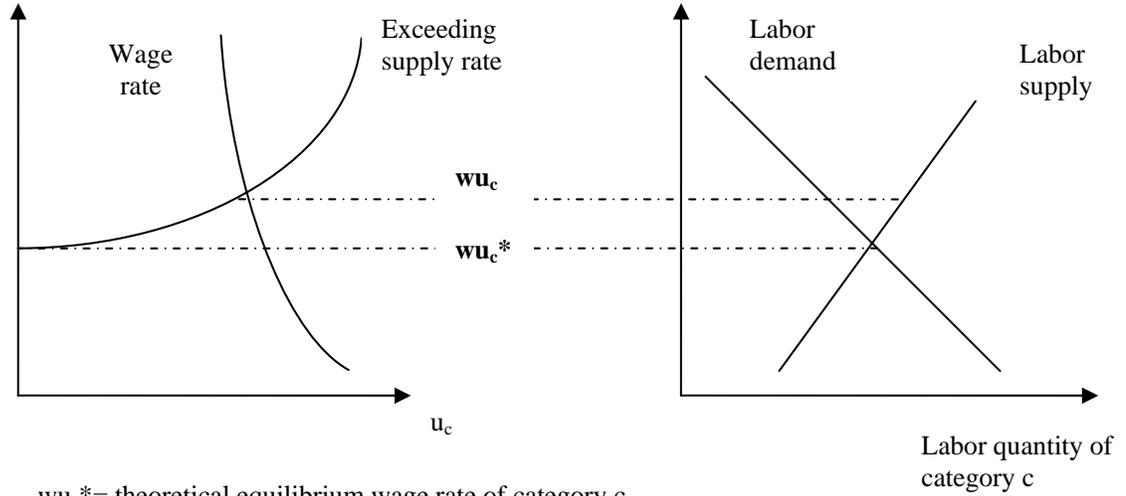
In Morocco, like in the majority of developing countries, unemployment is a characteristic phenomenon of urban labour market. Therefore, a realistic representation of this market must take unemployment into account in equilibrium, in contrast with the bulk of the CGE literature.

We rely here on a Blanchflower and Oswald (1995) type approach. Using international microeconomic data on more than twelve developed nations, Blanchflower and Oswald identified a negative relation between the wage rate and the unemployment rate implying that, other things equal, if the unemployment rate of a particular region increases during a year, the corresponding workers will see their wage rate decreasing. Blanchflower and Oswald (1995) showed that the relation between wage and unemployment rates is stable among countries and through time with an elasticity around -0.1. We follow this approach (figure 3) in order to model urban unemployment by professional categories and make the assumption that this elasticity does not depend on the level of development of the country<sup>15</sup>:

$$\ln \frac{wu_c}{Pindex} = D_c - 0.1 \ln u_c \quad (28)$$

<sup>15</sup>We perform a sensitivity analysis on alternative values of the wage elasticity. No substantial changes are detected. For wage and unemployment rates, the variables of our interest, the sign of their variation is the same as before.

Wage rate of category  $c$



$w_{u_c}^*$  = theoretical equilibrium wage rate of category  $c$   
 $w_{u_c}$  = the wage of category  $c$  compatible with the unemployment rate of this category according to the wage curve

Figure 3:

where

- $u_c$  is the unemployment rate of category  $c$  compatible with the corresponding wage rate  $w_{u_c}$ ,
- $P_{index}$  the GDP deflator, numéraire,
- $D_c$  fixed effects related to the regions and to the industries in question, as well as the whole characteristics of workers (age, sex, education...).

On the other hand, rural labour markets are competitive. Equilibrium occurs when:

$$NATR_c = \sum_{ru} LR_{c,ru} \quad (29)$$

with  $NATR_c$  being the rural labour supply by professional category  $c$  and  $LR_{c,ru}$  the labour demand of category  $c$  by rural sector  $ru$ .

## 4 Simulation experiments

### 4.0.1 A 10% drop in migration costs

We first ask how an increase in migration will impact the various segments of the Moroccan labour market. To address this issue, we simulate the impact of a 10% fall in migration costs  $mc$  and  $imc$ . Such a shock can be interpreted as a translation of a larger facility for the migrant to become operational, for example because of a fall in migration costs, or a larger simplification and transparency of

administrative procedures, or the existence of migrants networks that facilitate integration in the host country.

The reduction in migration costs affects simultaneously rural and urban migration, and internal migration. We are obviously interested in the level of labour remuneration and in the evolution of unemployment rates by professional categories.

First of all, we expect that the fall in migration costs accelerates emigration, reduces labour supply of the corresponding urban workers and their unemployment rate, given that other things are equal. On the other hand, internal migration towards cities, also facilitated by the drop in migration costs, should increase labour supply and, *ceteris paribus*, the corresponding unemployment rates. If these two migratory flows coexist, the final effect on unemployment rates by professional categories and consequently on urban wages is ambiguous.

The results of Table 4 indicate that in the Moroccan case, the fall in labour supply due to urban emigration is more than compensated by the increase in internal migratory flows. Thus, unemployment rates of all categories, except for “senior executive...” and “commercants...”, increase and their wage decreases. Unemployment rates of “farmers...” and “workmen and farm labourers...” increase more (9.64% and 9.56% respectively), inducing the strongest fall in their wages. Those of “senior executive...” and “commercants...” diminish by 0.05% and 0.2% respectively, despite the rise of labour supply, leading to a higher wage. Indeed, labour supply  $LS_c$  of these two categories increases, despite the absence of internal migration pressure on their markets, because urban emigration induces a rise of their wages. Consequently, their leisure opportunity cost goes up and the corresponding workers increase their labour supply  $NATU_c$ . In spite of the rise in labour supply, their unemployment rates decrease because the sectors using them intensively (such as mining industry, chemical industry, rubber industry, electricity and water, construction, trade and repair, financial and non financial services) expand and thus increase their labour demand. Finally, only “senior executive...” and “commercants...” staying in urban areas seem to profit from the emigration of their counterparts, which agrees with the literature (Lucas, 1987; Lucas, 2005)<sup>16</sup>. Migrants, whatever they were employed or not before their departure, yield their place to workers initially not employed, inducing a fall of unemployment and an increase in wages. On the other hand, and contrary to what is predicted in the literature, the other urban labour categories are losing<sup>17</sup>.

---

<sup>16</sup>Lucas (2005) showed that, in Bangladesh, India, Indonesia and Sri Lanka, workers migration has not induced a loss of production or a rise of wages. He gave different explanations to this stylised fact such as the possibility that those who have migrated did not have a job before leaving. Therefore, their departure generated a fall of unemployment rate. On the other hand, in Pakistan, workers emigration towards the Gulf countries has exerted an upper pressure on wages. A rise of wages has also been noticed in Philippines. Lucas (1987) arrived to the same conclusion in Mozambique and Malawi after workers emigration towards South African mines.

<sup>17</sup>Since “workmen and farm labourers...” constitute a negligible share of urban employment,

In rural areas, we observe an increase in wages because rural emigration and migration towards the cities (facilitated by the fall in migration costs) reduce labour supply on each rural market. Only internal migration of “workmen and farm labourers...” decreases. This is by the drop in the expected urban wage (net of migration costs) of this category relatively to its rural wage. But international emigration of these workers is enough to reduce their labour supply on the corresponding rural market. When labour supply diminishes, the wage rate increases *ceteris paribus*, in order to reequilibrate the corresponding market. International migratory movements and internal movements towards Moroccan cities create a scarcity of labour on rural markets and push upward labour remunerations. On the contrary, two forces of opposed directions are expressed on urban markets: departure of workers towards foreign countries and internal migration from rural to urban areas. By consequence, wage evolution is ambiguous.

Rural household welfare, measured by the equivalent variation, increases by 30 million dirhams, that is to say 0.033% of his initial income, because workers staying in rural areas profit from the wage increase after the migration of their counterparts. On the other hand, urban household welfare decreases by 21 million dirhams, or 0.010% of his initial income, because urban wages of the majority of workers fall after the different types of migratory movements affecting urban labour markets.

**Table 4-** *Shock 1: Percentage change in unemployment and wage rates, migratory flows and urban labour supply by professional categories*

Categories	$u_c$	$wu_c$	$EMU_c$	$MIG_c$	$LS_c$	$wr_c$	$EMR_c$
Directors	0.2175	-0.0217	2.2707	2.5993	0.0047	0.0682	1.7847
Senior executive	-0.0518	0.0052	2.25	0	0.0009	0	0
Junior staff	0.1195	-0.0119	2.2773	2.5914	0.0044	0.0682	1.7832
Employees	0.0594	-0.0059	2.2717	2.5993	0.0082	0.0682	1.782
Commercants	-0.1971	0.0197	2.1991	0	0.0014	0	0
Farmers, fishermen	9.6414	-0.9162	4.2041	0.2198	0.0939	0.0664	1.6896
Craftsmen	0.1836	-0.0183	2.322	2.5373	0.0129	0.0682	1.768
Farm labourers	9.559	-0.9088	4.5358	-0.1778	-0.1466	0.0667	1.6178
Drivers	0.1746	-0.0174	2.3065	2.5552	0.0148	0.0679	1.7696
Warehousemen	0.3735	-0.0373	2.4011	2.4423	0.0446	0.067	1.9328

**Table 4bis-** *Shock 1: Absolute change in wage rates (in Moroccan*

it is perfectly true to think that these workers, who migrate massively to the cities, will change their professional category and will belong for example to the category “warehousemen and workers of small trades”. However, given that the pressure on the market of “warehousemen and workers of small trades” increases with the fall of migration costs, the reception of workers belonging to the category “workmen and farm labourers...” will do nothing but exacerbate the pressure on this market. Thus, our contradictory results with the literature on the impact of migration on unemployment are still verified.

*Dirhams), unemployment rates, urban labour supply and migration flows (in millions of working hours)*

<b>Categories</b>	<b>u<sub>c</sub></b>	<b>wu<sub>c</sub></b>	<b>EMU<sub>c</sub></b>	<b>MIG<sub>c</sub></b>	<b>LS<sub>c</sub></b>	<b>wr<sub>c</sub></b>	<b>EMR<sub>c</sub></b>
Directors	0.04786	-0.00022	0.15895	0.05199	0.10000	0.00068	0.01785
Senior executive	-0.00881	0.00005	0.24750	0	0.00000	0	0
Junior staff	0.07289	-0.00012	0.72873	0.23323	0.30000	0.00068	0.05350
Employees	0.06651	-0.00006	1.61293	0.90975	1.10000	0.00068	0.19602
Commercants	-0.06308	0.00020	0.81368	0	0.10000	0	0
Farmers, fishermen	0.28924	-0.00916	0.16817	1.12773	1.00000	0.00066	2.61886
Craftsmen	0.18548	-0.00018	3.25084	3.70445	4.20000	0.00068	0.77794
Farm labourers	1.91179	-0.00909	0.22679	-1.77751	-1.60000	0.00067	6.45484
Drivers	0.14844	-0.00017	0.50743	0.74102	0.70000	0.00068	0.14157
Warehousemen	0.44815	-0.00037	2.76130	11.62516	11.40000	0.00067	0.88910

#### **4.0.2 A 10% rise in Sub-Saharan immigrant stock**

We now ask what is the impact of the South-South migration on the Moroccan labour market. The difficulty for African countries to ameliorate the welfare of their populations and the multiplication of conflicts let think that migratory flows originated from Sub-Saharan Africa will not be over soon. For that, we simulate the impact of a 10% rise in the stock of Sub-Saharan clandestine immigrants. This surge of clandestine migrants deteriorates the situation of Moroccan urban labour market, and can exert a pressure on the other migratory movements, those from rural areas to the cities or to foreign countries, or urban emigration. One can thus expect an increase in urban emigration due to the rise of unemployment and the decrease of urban wage. Simultaneously this exit of urban workers reduces, at its turn, the pressure exerted by immigration on urban labour market, and increases wages.

As one can note in Table 5, the increase in Sub-Saharan immigration creates a pressure on the urban labour market of “warehousemen and workers of small trades”. This category absorbs all the entries of Sub-Saharan immigrants, qualified or not. Given that other things are equal, the unemployment rate of these workers increases and induces *ceteris paribus* a fall in their urban wage. Moroccan urban workers belonging to the same category are thus incited to leave the country whereas rural workers are incited to stay in rural areas. Let us notice however that in the Moroccan case, the fall of internal migration and the rise of urban emigration do not compensate the entry of African immigrants. Indeed, the unemployment rate of these workers increases by 0.72% and their wage decreases.

This wage variation induces indirect effects on the other urban markets. Indeed, urban sectors increase their demand of “warehousemen and workers of small trades” (nationals and foreign in the same proportion) because their wage falls and the production of the sectors intensive in this category of workers expands

(especially mining, textile, clothing and chemical industries, construction services, hotels and restaurants, transport and telecommunication that are the most intensive in this type of labour). Given that capital is sector-specific, the increase in production should induce, on its turn, a rise in labour demand of the other categories, reduce their unemployment rate and increase their urban wage. This is the case of all categories except “farmers...”, “workmen and farm labourers...” and “drivers and assembly workers...”. Let us examine now the evolution of rural wages that affects the decision to migrate towards the cities and consequently the urban labour supply of the other categories.

Given that other things are equal, the nominal exchange rate depreciation (which increases the value of the foreign wage in local currency) should motivate rural workers of all categories to migrate. At constant rural population, this should induce a fall in Moroccan population wishing to stay in its country and consequently a reduction in labour supply on the different rural markets. Since these markets are competitive, rural wages will rise. This discourages rural workers of all categories to migrate to urban areas. In addition, rural workers belonging to the categories “farmers...” and “workmen and farm labourers...” revise downward their decision to emigrate because the wage increase compensates the stimulating effect of the exchange rate depreciation. Urban emigration, also motivated by the nominal exchange rate depreciation, and the decrease of internal migration towards the cities reduce labour supply of all professional categories. Consequently, unemployment rates of all categories except “drivers and assembly workers” decrease and the corresponding wages increase. The unemployment rate of “drivers and assembly workers” increases because labour demand of these workers decreases more than their labour supply. The reason why labour demand of “drivers and assembly workers” falls is that the production of the sectors “machines and equipment manufacturing”, “radio and TV equipment” and “car industry” is negatively affected by the drop of total internal demand addressed to them. Finally, let us note that urban emigration of “senior executive”, “commerçants...”, “farmers...” and “workmen and farm labourers...” decreases because the nominal exchange rate depreciation does not compensate the rise of the average urban wage of these categories.

We have just seen how the entry of workers on a specific urban labour market stimulates the emigration of the corresponding workers. However, emigration does not succeed to reduce the pressure on this market. Moreover, this entry of workers induces indirectly a variation in migratory flows on the other markets through wage variation.

The positive evolution of urban wages of the majority of categories induces a rise in labour remuneration of the urban household, and *ceteris paribus*, a rise in his total income. Therefore, their welfare measured by the equivalent variation, increases by 6 million dirhams, or 0.003% of their initial income. In the same way, the rise of rural wages of all professional categories gives place to an increase in rural household income and to an improvement of his welfare. His equivalent

variation is of 3 million dirhams, or 0.004% of his initial income.

The growth impact, measured by the variation of real GNP, is positive (a rise of 0.002%) and it is mainly due to the expansion of sectoral production. Indeed, despite the positive evolution of wages, the firms in all sectors (except “machines and equipment manufacturing”, “radio and TV equipment” and “car industry”) benefit from the increase in consumers demand in order to rise their production. Moreover, since any increase in interior demand is satisfied by domestic and imported, total import volume increases. Exports must also increase in order to maintain current surplus fixed. The depreciation of the real exchange rate is therefore necessary.

**Table 5-** *Shock 2: Percentage change in unemployment and wage rates, migratory flows and urban labour supply by professional categories*

Categories	$u_c$	$wu_c$	$EMU_c$	$MIG_c$	$LS_c$	$wr_c$	$EMR_c$
Directors	-0.0192	0.0019	0.004	-0.0219	-0.0003	0.0095	0.0023
Senior executive	-0.1009	0.0101	-0.0007	0	-0.0002	0	0
Junior staff	-0.0052	0.0005	0.0044	-0.0225	-0.0003	0.0095	0.0026
Employees	-0.0177	0.0018	0.0009	-0.0189	-0.0009	0.0095	0.0029
Commercants	-0.0922	0.0092	-0.0187	0	0.0000	0	0
Farmers, fishermen	-0.0427	0.0043	-0.0033	-0.0181	-0.0082	0.0115	-0.013
Craftsmen	-0.0027	0.0003	0.0043	-0.0223	-0.0003	0.0095	0.0014
Farm labourers	-0.0533	0.0053	-0.0074	-0.0123	-0.0101	0.0112	-0.0128
Drivers	0.003	-0.0003	0.0063	-0.0256	-0.0004	0.0098	0.0015
Warehousemen	0.7189	-0.0716	0.2872	-0.3783	0.1402	0.0108	0.0193

**Table 5bis-** *Shock 2: Absolute change in wage rates (in Moroccan Dirhams), unemployment rates, urban labour supply and migration flows (in millions of working hours)*

Categories	$u_c$	$wu_c$	$EMU_c$	$MIG_c$	$LS_c$	$wr_c$	$EMR_c$
Directors	-0.00423	0.00002	0.00028	-0.00044	0.00000	0.00009	0.00002
Senior executive	-0.01715	0.00010	-0.00008	0	0.00000	0	0
Junior staff	-0.00316	0.00001	0.00141	-0.00203	0.00000	0.00009	0.00008
Employees	-0.01980	0.00002	0.00065	-0.00661	-0.10000	0.00009	0.00032
Commercants	-0.02950	0.00009	-0.00692	0	0.00000	0	0
Farmers, fishermen	-0.00128	0.00004	-0.00013	-0.09273	-0.10000	0.00012	-0.02022
Craftsmen	-0.00269	0.00000	0.00598	-0.03254	-0.10000	0.00009	0.00063
Farm labourers	-0.01065	0.00005	-0.00037	-0.12271	-0.10000	0.00011	-0.05103
Drivers	0.00259	0.00000	0.00138	-0.00743	0.00000	0.00010	0.00012
Warehousemen	0.86270	-0.00072	0.33028	-1.80093	35.80000	0.00011	0.00889

### 4.0.3 The simultaneous impact of a 10% drop in migration costs and a 10% rise in Sub-Saharan immigrant stock

We must now consider an experiment reflecting the actual shocks to the Moroccan labour market, containing the two previous elements. Since the two previous shocks induce a greater pressure on the labour market of “warehousemen and workers of small trades”, their simultaneous effect consists, as expected, in a stronger rise of unemployment (of 1.09% against 0.37% and 0.72% respectively during the first and second shocks<sup>18</sup>). Since the unemployment rate of this category rises more, the corresponding urban wage falls more and urban sectors express a stronger labour demand of this category. Given that other things are equal, sectors intensive in this type of labour expand more (especially mining, textile, clothing, and chemical industries, construction services, hotels and restaurants, transports and telecommunication). These sectors will also require additional workers belonging to the other categories, and this could reduce the pressure exerted by internal migration on some labour markets. We notice that the rise of labour demand and urban emigration flows of “directors...”, “junior staff”, “employees” “farmers...” and “craftsmen...” reduce the pressure exerted by internal migration but do not succeed to reduce unemployment rates of the previous categories. They evolve positively but their variation is less than the one resulting from the first shock (i.e. the reduction in migration costs). On the other hand, the unemployment rate of “drivers...” increases under the simultaneous impact of internal migration and the indirect effect of African immigration that induces a rise of their unemployment. Finally, the increase of labour demand and urban emigration of “senior executive...” and “commercants...” cause a stronger fall of their unemployment rates. All urban wage rates vary in the opposite sign of unemployment rates.

Rural wages increase more under the simultaneous effect of the drop in migration costs and the increase in Sub-Saharan immigration: indeed, the fall in migration costs stimulates rural emigration (direct effect) and Sub-Saharan immigration induces indirectly an exchange rate depreciation favourable to rural emigration (indirect effect).

The positive evolution of rural household equivalent variation is accentuated with respect to the previous shocks due to the higher rise of rural wages acting on rural household income. Welfare is improved by 33 million dirhams (against 30 millions and 3 millions before), that is to say 0.037% of his initial income. For urban household, the deterioration of welfare at the first shock is reduced because his welfare improves during the second shock. It ends up decreasing by 15 million dirhams (instead of 21 millions during first shock), or 0.007% of his initial income.

---

<sup>18</sup>Since the evolution of most variables in the last simulation is generally the sum of the variations of the same variable in the two previous shocks, one may think of a shock linearity. However, we can show that this is mainly due to the weak intensity of the selected shocks: a stronger fall of migration costs is sufficient to eliminate the apparent linearity.

**Table 6-** *Shock 3: Percentage change in unemployment and wage rates, migratory flows and urban labour supply by professional categories*

Categories	$u_c$	$wu_c$	$EMU_c$	$MIG_c$	$LS_c$	$wr_c$	$EMR_c$
Directors	0.1984	-0.0198	2.2748	2.5770	0.0044	0.0776	1.7870
Senior executive	-0.1521	0.0152	2.2493	0	0.0007	0	0
Junior staff	0.1143	-0.0114	2.2818	2.5684	0.0041	0.0776	1.7858
Employees	0.0418	-0.0042	2.2727	2.5801	0.0073	0.0776	1.7849
Commercants	-0.2887	0.0289	2.1801	0	0.0015	0	0
Farmers, fishermen	9.5948	-0.9120	4.2007	0.2019	0.0858	0.0779	1.6764
Craftsmen	0.1810	-0.0181	2.3264	2.5146	0.0126	0.0776	1.7695
Farm labourers	9.5019	-0.9036	4.5281	-0.1899	-0.1566	0.0779	1.6048
Drivers	0.1777	-0.0177	2.3129	2.5291	0.0144	0.0777	1.7711
Warehousemen	1.0914	-0.1085	2.6946	2.0556	0.1845	0.0778	1.9512

**Table 6bis-** *Shock 3: Absolute change in wage rates (in Moroccan Dirhams), unemployment rates, urban labour supply and migration flows (in millions of working hours)*

Categories	$u_c$	$wu_c$	$EMU_c$	$MIG_c$	$LS_c$	$wr_c$	$EMR_c$
Directors	0.04364	-0.00020	0.15923	0.05154	0.10000	0.00078	0.01787
Senior executive	-0.02586	0.00015	0.24742	0	0.00000	0	0
Junior staff	0.06975	-0.00011	0.73016	0.23116	0.30000	0.00078	0.05357
Employees	0.04680	-0.00004	1.61359	0.90302	0.90000	0.00078	0.19634
Commercants	-0.09238	0.00029	0.80664	0	0.10000	0	0
Farmers, fishermen	0.28785	-0.00912	0.16803	1.03554	0.90000	0.00078	2.59840
Craftsmen	0.18280	-0.00018	3.25692	3.67128	4.10000	0.00078	0.77857
Farm labourers	1.90038	-0.00904	0.22641	-1.89935	-1.70000	0.00078	6.40330
Drivers	0.15100	-0.00018	0.50883	0.73345	0.70000	0.00078	0.14169
Warehousemen	1.30966	-0.00108	3.09877	9.78466	47.10000	0.00078	0.89755

## 5 Conclusion

In this paper, we are interested in a particular shutter of the relation between migration and economic development of the sending country. We paid attention to the relation between migration and unemployment by professional categories, which is little exploited in the literature. Moreover, all the proposed analysis do not treat, to our knowledge, more than one type of migratory flow (particularly emigration from the country of origin). The originality of our work is to take simultaneously into account three types of migratory flows characterising a country having a long history with migration: Morocco. The following flows are considered: rural and urban emigration, internal migration towards the cities and Sub-Saharan immigration (towards Moroccan cities). Each one of these migratory flows has different effects on urban labour market and does not affect

equally all the professional categories. Urban emigration reduces unemployment rates and increases wages. On the other hand, Sub-Saharan immigration and internal migration increase unemployment rates and reduce wages. If these flows coexist, the final effect on unemployment and wage rates is ambiguous: this is the interest of our analysis.

Our results obtained from a CGE model of the Moroccan economy, calibrated on the SAM of the year 1998, attests to the expected ambiguity of the impact of these three migratory flows on wage and unemployment rates. In the first simulation where migration costs decrease, the increase in internal migration upsets the expected effects associated to urban emigration, such as the fall in unemployment and the rise in wage rate. In the second simulation, Sub-Saharan immigration affects indirectly the urban labour market of the other categories, by modifying their unemployment rates, wages and emigration flows. But the variation of emigration induced by the exchange rate depreciation does not lead to the expected effects on unemployment rates of all the professions because it is thwarted by the evolution of the other variables in the model. In the third simulation, we run simultaneously the two previous shocks since they will coexist in the future and will lead to different results. The effects on unemployment and wage rates of urban emigration do not correspond, once again, to what is awaited, because of the existence of other migratory flows affecting the urban labour market.

Currently, the debates on migration evoke that a good management of migratory policies can generate important profits to the sending and receiving countries. The results of migration impact on Morocco show that it is dangerous to set up migratory policies without having a global vision of all migratory flows existing and the way in which they affect labour market and the remainder of the economy. In particular, we saw that the expected effect of urban emigration can be upset by the impact of another flow entering urban labour market. By comparing the three previous scenarios, we find that a rise of Sub-Saharan immigration is not such harmful to welfare. Urban household welfare is largely improved. It becomes positive. On the other hand, the amelioration of rural household welfare is reduced. In addition, the last scenario is the best in terms of welfare for rural household.

## References

- [1] T. Abdelkhalek and N. Zaoujal, Une matrice de comptabilité sociale de l'économie marocaine base 1998 : cadre comptable d'un MCEG micro simulé, *Cahier de recherche de l'équipe MIMAP-Maroc*, (2004), INSEA, Rabat.
- [2] T. Abdelkhalek , Construction d'une matrice de comptabilité sociale de l'économie marocaine : base comptable du modèle IMMPA, *mimeo*.
- [3] P.R. Agénor and K. El Aynaoui, Labour Market Policies and Unemployment in Morocco: A Quantitative Analysis, *Policy Research Working Paper Series 3091*, (2003), The World Bank, Washington, D.C.
- [4] N. Annabi, Labour Markets Modeling in CGE Models: Endogenous Labour Supply, Unions and Efficiency Wages, (2003), *mimeo*.
- [5] L. Barros, M. Lahlou, C. Escoffier, P. Pumares and P. Ruspini, L'immigration irrégulière subsaharienne à travers et vers le Maroc, *Cahiers de Migrations Internationales*, Bureau International du Travail, Genève.
- [6] D. Blanchflower and A. Oswald, An introduction to the wage curve, *The Journal of Economic Perspectives*, **9(3)**, (1995), 153-167.
- [7] M. Beine, F. Docquier and H. Rapoport, Brain Drain and Economic Growth: Theory and Evidence, *Journal of Development Economics*, **64(1)**, (2001), 275-89.
- [8] P. Cahuc and A. Zylberberg, Economie du travail : la formation des salaires et les déterminants du chômage, Collection Balises, De Boeck, Paris-Bruxelles, (1996).
- [9] N. Chan, T.K. Dung, M. Ghosh and J. Whalley, Adjustment Costs in Labour Markets and the Distributional Effects of Trade Liberalization: Analytics and Calculation for Vietnam, *Journal of Policy Modeling*, **27**, (2005), 1009-1024.
- [10] P-A. Chiappori, Collective Labour Supply and Welfare, *Journal of Political Economy*, **100**, (1992), 437-67.
- [11] J. Cockburn, B. Decaluwé, I. Fofana and V. Robichaud, Un Modèle Standard d'Equilibre Général Calculable pour l'Analyse de l'Impact des Politiques Economiques, (2006), *mimeo*.
- [12] S. Commander, M. Kangasniemi and A. Winters, The Brain Drain: Curse or Boon, *IZA Discussion Paper Series No.809*, (2003).
- [13] B. Decaluwé, A. Martens and L. Savard, La politique économique du développement et les modèles d'équilibre général calculable, Les Presses de l'Université de Montréal, (2001), Montréal.

- [14] B. Decaluwé, A. Lemelin, D. Bahan and N. Annabi, Offre de Travail Endogène et Mobilité du Capital dans un Modèle d'Equilibre Général Calculable Birégional, *Travaux de recherche 2005-001*, (2005), Ministère des Finances du Québec.
- [15] A. Deaton and J. Muellbauer, *Economics and Consumer Behavior*, Cambridge University Press, (1980).
- [16] J. De Melo and D. Tarr, *A General Equilibrium Analysis of US Foreign Trade Policy*, The MIT Press, (1992).
- [17] Direction de la Statistique, *Activité, Emploi et Chômage en 1999*, Rapport de synthèse, Rabat.
- [18] Direction de la Statistique, *Activité, Emploi et Chômage en 2001*, Rapport de synthèse, Rabat.
- [19] Direction de la Statistique, *Activité, Emploi et Chômage en 2002*, Rapport de synthèse, Rabat.
- [20] Direction de la Statistique, *Activité, Emploi et Chômage, Premiers Résultats*, (2003), Rabat.
- [21] Direction de la Statistique, *Activité, Emploi et Chômage, Premiers Résultats*, (2004), Rabat.
- [22] Direction de la Statistique, *Activité, Emploi et Chômage, Premiers Résultats*, (2005), Rabat.
- [23] Direction de la Statistique, *Enquête Nationale sur la Consommation et les Dépenses des Ménages 2000/2001* Rapport de synthèse, Rabat.
- [24] Direction de la Statistique, *Nomenclature Analytique des Professions*, (2001), Rabat.
- [25] F. Docquier and A. Marfouk, *Measuring the International Mobility of Skilled Workers (1990-2000) - Release 1.0*, *Policy Research Working Paper Series 3381*, (2004), The World Bank, Washington D.C.
- [26] S. Drinkwater, P. Levine, E. Lotti and J. Pearlman, *The Economic Impact of Migration: A Survey*, *Department of Economics Discussion Papers 103*, (2003), Department of Economics, University of Surrey.
- [27] B. Hamdouch, *Les Marocains résidant à l'étranger, une enquête socioéconomique*, (2000), INSEA, Rabat.
- [28] G. Hanoch, *The "Backward-Bending" Supply of Labour*, *The Journal of Political Economy*, **73**, (1965), 635-642.
- [29] G.W. Harrison, T.F. Rutherford, D.G. Tarr and A. Gurgel, *Trade policy and poverty reduction in Brazil*, (2003), *mimeo*.

- [30] L.T. Katseli, R.E.B. Lucas and T. Xenogiani, Effects of Migration on Sending Countries: What Do We Know?, *OECD Development Center Working Paper No.250*, (2006), OECD.
- [31] M. Lahlou, Le Maghreb et les migrations des Africains du Sud du Sahara, présenté lors du colloque “Entre mondialisation et protection des droits - Dynamiques migratoires marocaines : histoire, économie, politique et culture”, Casablanca, 13, 14 et 15 Juin 2003.
- [32] C. Lluch, The Extended Linear Expenditure System, *European Economic Review*, **4**, (1973), 21-32.
- [33] R.E.B. Lucas, Emigration to South Africa’s Mines, *American Economic Review*, **77**, (1987), 313-330.
- [34] R.E.B. Lucas, International Migration and Economic Development: Lessons from Low-Income Countries, (2005), Edward Elgar in association with the Expert Group on Development Issues, Swedish Ministry for Foreign Affairs, Cheltenham, UK and Northampton, MA, USA.
- [35] OECD, International Migration Outlook, Annual Report, 2006 Edition.
- [36] M. Schiff, Brain Gain: Claims about its Size and Impact on Welfare and Growth are Greatly Exaggerated, *in M. Schiff and C. Ozden (eds.), International Migration, Remittances, and the Brain Drain*, (2005), The World Bank, Washington, D.C.
- [37] O. Stark, C. Helmenstein and A. Prskawetz, A Brain Drain with a Brain Gain, *Economics Letters*, **55(2)**, (1997), 227-34.
- [38] R. Van der Erf and L. Heering, Migration Dynamics: Prospects for the Future, *IOM Migration Research Series No.10*, (2002), IOM International Organization for Migration, Geneva.

## APPENDIX 1

### DATA

The social accounting matrix (SAM) constitutes the empirical database required to satisfy the accounting coherence of a CGE model. We use the Moroccan SAM built by Touhami Abdelkhalek and Nouzha Zaoujal (2004) for the year 1998 from several Moroccan data sources: the Input-Output table of the Moroccan economy for 1998, built by the Direction of Statistics and published, in a preliminary version, in 2002, the National Survey on Household Living Standards in 1998-1999 (NSHLS) carried out by the Direction of Statistics, documents from the Ministry of Economy and Finance, from External Trade department, from the Ministry of Agriculture, from Foreign Exchange department, and from Bank Al-Maghrib. The SAM gathers two factors of production (labour and capital), four types of agents (Households, Firms, Government, the Rest of the World), 34 sectors of activity that correspond exactly to those of the Input-Output table of the Moroccan economy in 1998.

In order to distinguish between rural and urban areas, we need to take into consideration two types of households and two types of production factors, rural labour offered by rural household and urban labour offered by urban household. All household accounts must be adjusted in order to distinguish, from now on, between two representative households:

- 1- The submatrix of transfers is distributed between the two households according to weights calculated essentially from the Moroccan SAM built for the IMMPA<sup>19</sup> project of the World Bank.
- 2- Labour remuneration going to rural household comes only from rural labour and the one going to urban household comes only from urban labour.
- 3- The NSHLS of 2001 provides percentages on the distribution of total consumption between rural and urban households. These percentages are respectively around 0.3% and 0.7% of total consumption. In addition, the NSHLS publishes percentages on the distribution of rural and urban households' consumption between the different aggregated sectors of activity. From these percentages, different calculations are made in order to quantify the distribution of rural and urban households' consumption according to the 34 sectors of the Input-Output table.
- 4- According to the NSHLS of 2001, the distribution of consumption expenditures would be a good approximation of the distribution of total income between rural and urban households. Thus, we suppose that rural household income constitutes 0.3% of households total income and urban household income constitutes 0.7% of households total income.

---

<sup>19</sup>Integrated Macroeconomic Model for Poverty Analysis.

The distinction between rural and urban areas should also be done in terms of production. The agricultural and fishing sectors are supposed to constitute the rural sector, and all the remaining sectors, including the public ones, are supposed to form the urban sector. Indeed, as we have just seen in section 2, agriculture absorbs 80.2% of rural employment while industry and services absorb 77.5% of urban employment. The public sector employs mainly townsmen, that is 17.3% of total employment in the cities against only 1.9% in the countryside.

Rural employment, given in terms of our matrix by the sum of labour demand by the agricultural and fishing sectors is around 3,166 workers. On the other hand, urban sectors employ 103,996 workers. This implies that rural employment is not more than 3% of total employment whereas in reality, it corresponds to the half of national employment. According to Harrison et al. (2003), capital remuneration is overestimated in the agricultural sector because it is calculated residually from the production value after deducing labour remuneration and the cost of intermediary consumption. However, the agricultural sector uses generally family work and informal labour that are not computed in input-output tables. Therefore, given that agricultural work is underestimated, capital remuneration is overestimated. This is why agricultural and fishing sectors seem to be capital intensive whereas they should be labour intensive. The basic SAM should be adjusted in order to make rural sectors labour intensive while having a positive (although weak) capital demand.

We further disaggregate our SAM in order to take into account the different professional categories. There are ten categories listed in Morocco. These categories exist in urban and rural areas. We then find ourselves with 20 labour markets. We use the national survey of the Direction of Statistics on activity, employment and unemployment in 1999 in order to distribute rural and urban employment between professional categories. The only difference is that we assume that there is no “commerçants...” in rural areas because they work primarily in trade services that belong to the urban sector and are consumed as intermediary inputs by the rural sector.

Finally, since we analyse the impact of migration on labour market, we need data on Moroccan emigration towards foreign countries, on rural-urban migration and on Sub-Saharan immigration:

1- For lack of data on Moroccan emigration, we resort to the data published by the OECD in 2006 on immigrant inflows by nationality in some OECD countries. More specifically, we approximate Moroccan emigration by the flows of Moroccan migrants to their traditional destinations in 1999, such as Belgium, France, Italy, the Netherlands and Spain. The sum of these flows is reported to the Moroccan working population of 1999 in order to calculate the annual percentage of emigrants.

2- According to a report of the International Organization of Migration, Moroccan emigration towards European countries is more originated from rural areas. We suppose that 60% of the national emigration flow take place from rural areas

and 40% from urban areas.

3- Agénor and El Aynaoui (2003) point out that each year, around 200,000 workers migrate from rural to urban areas. This corresponds approximately to 3.7% of the rural working population of 1999.

4- Data collection on African immigrants to Morocco is the most difficult task because the majority of these immigrants are clandestine. According to Lahlou (2003), there would be between 6,000 and 15,000 clandestine immigrants, but these estimates are uncertain. We retain the upper bound. This number is reported to the urban working population of 1999 in order to calculate the stock of immigrants corresponding to our matrix.

5- Finally, for lack of data on migration by professional categories, we suppose that the number of rural/urban migrants belonging to a professional category is proportional to the share of this category in rural/urban total employment. We have also simulated the previous shocks with an equal distribution of migrant flows between professional categories but we have not detected substantial changes in the main results.

## APPENDIX 2

### ABBREVIATION OF SECTORS AND PROFESSIONAL CATEGORIES

#### Sectors

SA	subsistence agriculture
IA	industrial agriculture
MII	mining industry
FOO	food industry
TOB	tobacco industry
TEX	textile industry
CLO	clothing industry
LEA	leather and shoes industry
WOO	fabrication of wood and wood-based products
PAP	paper industry
EDI	edition, printing and reproduction
OIL	oil refining
CHE	chemical industry
RUB	rubber and plastic industry
MIN	manufacture of other non-metallic mineral products
MET	metallurgy
MEP	metal processing
MAC	machines and equipment manufacturing
OFF	office machinery
RAD	radio and TV equipment
MED	medical instruments manufacturing
CAR	car industry
TRM	manufacture of other transport means
FUR	furniture manufacturing, other industries
ELE	electricity and water - production and distribution
CON	construction
TRR	trade and repair
HOT	hotels and restaurants
TRA	transports and telecommunication
FIN	financial activities and insurance
REN	rental services
ADM	public administration and social security
EDU	education and health
SER	other non financial services

## Professional categories

- 1 directors
- 2 senior executive and members of liberal professions
- 3 junior staff
- 4 employees
- 5 commercants, commercial and financial intermediaries
- 6 farmers, fishermen, foresters, hunters and workers assimilate
- 7 craftsmen and artisanal trades qualified workers (farm labourers excluded)
- 8 workmen and farm labourers (including skilled workers)
- 9 drivers and assembly workers
- 10 warehousemen and workers of small trades

## APPENDIX 3

### EQUATIONS OF THE MODEL

#### Notations

$i$  and  $j$  refers to sectors,  $ps$  and  $pub$  to private and public sectors respectively,  $up$  and  $ru$  to urban and rural private sectors,  $tr$  and  $ntr$  to tradable and non tradable sectors,  $ag$  to agents,  $da$  to domestic agents,  $h$  to households and  $c$  to professional categories.  $cm1$  is the set of professional categories  $c$  excluding category  $n^\circ 10$ .

#### Parameter definition

$A_{ps}$	Scale parameter of the value added CES function
$\alpha_{ps}$	Share parameter of this function
$\sigma_{ps}$	Elasticity of substitution between labour and capital
$a$	Parameter in the value added function of subsistence agriculture
$b$	Parameter in the value added function of subsistence agriculture
$f$	Parameter in the value added function of subsistence agriculture
$B_{ps}$	Scale parameter of the Cobb-Douglas function of labour in sector $ps$
$\omega_{c,ps}$	Share of category $c$ in total labour demand by sector $ps$
$Ai_{up}$	Scale parameter of the CES function of imperfect substitutability between domestic workers and immigrants
$\Omega_{up}$	Share parameter of this function
$\zeta_{up}$	Elasticity of substitution between domestic workers and immigrants
$l_{pub}$	Labour share in public value added (Leontief)
$k_{pub}$	Capital share in public value added (Leontief)
$lc_{c,pub}$	Share of category $c$ in total labour demand (Leontief) by the public sector
$io_j$	Share of intermediary consumption in the production (Leontief) of sector $j$
$v_j$	Share of value added in the production (Leontief) of sector $j$
$ai_{j,i}$	Intermediary consumption of good $i$ by unit of production of sector $j$
$tx_j$	Indirect taxes on product $j$
$tm_{tr}$	Import tariff rate on product $tr$
$te_{tr}$	Export tariff rate on product $tr$
$ty_h$	Direct tax rate on household $h$ 's income
$ty_e$	Direct tax rate on firms' income
$Br_c$	Scale parameter of the CET function of the rural population
$\varpi_c$	Share parameter of this function

$\varepsilon_c$	Elasticity of transformation between international rural migrants and national workers
$Bu_c$	Scale parameter of the CET function of the rural population that decides to stay in Morocco
$\vartheta_c$	Share parameter of this function
$\varrho_c$	Elasticity of transformation between internal migrants and rural workers
$Bi_c$	Scale parameter of the CET function of the urban population
$\xi_c$	Share parameter of this function
$\omega_c$	Elasticity of transformation between international urban migrants and urban workers
$Be_{tr}$	Scale parameter of the CET production function
$\delta_{tr}$	Share parameter of this function
$\kappa_{tr}$	Transformation elasticity (CET production function)
$\varphi_{tr}$	Price elasticity of export demand
$Am_{tr}$	Scale parameter of the Armington CES function
$\theta_{tr}$	Share parameter of this function
$\chi_{tr}$	Substitution elasticity (Armington function)
$\gamma_{i,h}$	Budgetary share of good $i$ in the supernumerary income of household $h$
$\beta_c$	Leisure share in the income of rural household's member $c$
$\beta'_c$	Leisure share in the income of urban household's member $c$
$lsmax_c$	Maximal number of working hours offered by rural worker $c$
$lsmax'_c$	Maximal number of working hours offered by urban worker $c$
$\lambda_c$	Share of member $c$ in rural household's non-labour income
$\zeta_{1c}$	Share of internal migrants in the labour supply of category $c$
$\zeta_{2c}$	Share of African immigrants in the labour supply of category $c$
$\lambda'_c$	Share of member $c$ in urban household's non-labour income
$\mu_i$	Share of product $i$ in total investment
$\theta_j$	Share of the value added of sector $j$ in GDP at factor cost
$\psi_h$	Household $h$ 's propensity to save
$\eta_{ag}$	Share of capital remuneration received by agent $ag$
$\phi_{ag}$	Share of labour remuneration received by agent $ag$
$D_c$	Scale parameter of the wage curve
$mc$	International migration costs
$imc$	Internal migration costs
$cs$	Social security contributions

## Variable definition

### Endogenous variables

#### a) Prices

$w_j$	Average wage rate of sector $j$
$wr_c$	Rural wage rate of professional category $c$
$wu_c$	Wage rate of category $c$ in the urban private sector
$wg_c$	Wage rate of category $c$ in the urban public sector
$wi_c$	International wage rate of category $c$ , in foreign currency
$wn_c$	National wage rate of category $c$
$wug_c$	Average urban wage rate of category $c$
$wup_{up}$	Average wage of category “10” in private urban sector $up$
$wa_c$	Expected urban wage of category $c$
$r_j$	Capital return in sector $j$
$PV_j$	Value added price of sector $j$
$PL_j$	Producer price of local product $j$
$PD_j$	Market price of local product $j$ sold on the domestic market
$P_j$	Production price of sector $j$
$PC_j$	Market price of the composite good belonging to sector $j$
$Pwm_{tr}$	International import price of product $tr$ , in foreign currency
$Pwe_{tr}$	International export price of product $tr$ , in foreign currency
$PM_{tr}$	Domestic price of the imported good $tr$
$PE_{tr}$	Producer price of the exported good $tr$
$Pfob_{tr}$	Fob price of the exported good $tr$
$PINV$	Aggregate price of investment
$Plr_c$	Leisure price of rural household’s member $c$
$Plu_c$	Leisure price of urban household’s member $c$
$e$	Nominal exchange rate (the price of a unit of foreign currency in domestic currency)
$Pindex$	GDP deflator, numéraire

## b) Production

$XS_j$	Production of sector $j$
$VA_j$	Value added of sector $j$
$DI_{i,j}$	Intermediary demand of product $i$ by sector $j$
$CI_j$	Total intermediary consumption of sector $j$

## c) Factors of production

$KD_j$	Capital demand by sector $j$
$LDR_{ru}$	Labour demand by rural sector $ru$
$LR_{c,ru}$	Labour demand of category $c$ by rural sector $ru$
$LDU_{up}$	Labour demand by urban private sector $up$
$LU_{c,up}$	Labour demand of category $c$ by urban private sector $up$
$LDG_{pub}$	Labour demand by public sector $pub$
$LG_{c,pub}$	Labour demand of category $c$ by urban public sector $pub$

$LSR_c$	Rural population belonging to category $c$
$LSU_c$	Urban population belonging to category $c$
$u_c$	Urban unemployment rate of category $c$

d) **Migration**

$NAT_c$	Moroccan rural workers of category $c$ who decide to stay in Morocco
$EMR_c$	The flow of Moroccan rural emigrants belonging to category $c$
$NATR_c$	Moroccan rural workers of category $c$ who decide to stay in rural areas
$MIG_c$	Moroccan rural migrants flow of category $c$ towards urban areas
$NATU_c$	Moroccan urban workers of category $c$ who decide to stay in urban areas
$EMU_c$	The flow of Moroccan urban emigrants belonging to category $c$
$IMMIG_c$	The stock of Sub-Saharan immigrants belonging to category $c$
$NATI_{up}$	The demand of national workers of category “10” by urban private sector $up$
$ETR_{up}$	The demand of Sub-Saharan immigrants of category “10” by urban private sector $up$

e) **Income/Savings**

$Y_{ag}$	Agent $ag$ 's income
$YD_h$	Disposable income of household $h$
$S_{ag}$	Agent $ag$ 's savings
$T_{ag,ag}$	Transfers between agents

f) **Tax revenues**

$TI_j$	Indirect taxes on product $j$
$TIM_{tr}$	Import tariffs on product $tr$
$TIE_{tr}$	Export tariffs on product $tr$
$adj$	Compensatory tax

g) **External trade**

$EXS_{tr}$	Export supply of product $tr$
$DOM_j$	Domestic production of sector $j$ sold on the domestic market
$Q_j$	Supply of the composite product belonging to sector $j$
$EXD_{tr}$	Export supply of product $tr$
$M_{tr}$	Import demand of product $tr$

h) **Final demand**

$CT_{i,h}$	Consumption of good $i$ by household $h$
$Cmin_{i,h}$	Minimum consumption of good $i$ by household $h$
$BC_h$	Consumption budget of household $h$
$IBC_{c,h}$	Consumption budget of the member $c$ belonging to household $h$
$G_i$	Public consumption of product $i$
$DIT_i$	Total intermediary consumption of product $i$
$INV_i$	Investment demand of product $i$
$STK_i$	Stock variation of product $i$
$ITVOL$	Gross fixed capital formation (volume)
$IT$	Gross fixed capital formation (value)

## Exogenous variables

$wg_c$	Wage rate of category $c$ in the urban public sector
$wi_c$	International wage rate of category $c$ , in foreign currency
$r_{pub}$	Capital return of public sector $pub$
$KD_{ps}$	Capital demand by sector $ps$
$Pwm_{tr}$	International import price of product $tr$ , in foreign currency
$Pwe_{tr}$	International export price of product $tr$ , in foreign currency
$IMMIG_c$	The stock of Sub-Saharan immigrants belonging to category $c$
$Cmin_{i,h}$	Minimum consumption of product $i$ by household $h$
$G_i$	Public consumption of product $i$
$STK_i$	Stock variation of product $i$
$ITVOL$	Gross fixed capital formation (volume)
$S^{“row”}$	External savings
$T_{h,ag}$	Transfers by agent $ag$ to household $h$
$T^{“fm”,ag}$	Transfers by agent $ag$ to firms
$T^{“row”,ag}$	Transfers by agent $ag$ to the Rest of the World
$T^{“gv”,“gv”}$	Transfers made by the government to itself
$T^{“gv”,“row”}$	Transfers by the Rest of the World to the government
$Pindex$	GDP deflator, numéraire

## Equations

### Rural sector

$$XS_{ru} = VA_{ru}/v_{ru} \quad (A1)$$

$$CI_{ru} = io_{ru}XS_{ru} \quad (A2)$$

$$DI_{i,ru} = aij_{i,ru}CI_{ru} \quad (A3)$$

$$VA^{“sa”} = a(1 - e^{-(LDR^{“sa”}/b)^f}) \quad (A4)$$

$$VA^{ia} = A^{ia} [\alpha^{ia} LDR_{ia}^{(\sigma^{ia}-1)/\sigma^{ia}} + (1 - \alpha^{ia}) KD_{ia}^{(\sigma^{ia}-1)/\sigma^{ia}}] \sigma^{ia} / (\sigma^{ia}-1) \quad (A5)$$

$$LDR^{sa} = \frac{PV^{sa} VA^{sa}}{w^{sa}} \quad (A6)$$

$$LDR^{ia} / KD^{ia} = \left( \frac{\alpha^{ia}}{1 - \alpha^{ia}} \frac{r^{ia}}{w^{ia}} \right) \sigma^{ia} \quad (A7)$$

$$LDR_{ru} = B_{ru} \prod_c LR_{c,ru}^{\omega_{c,ru}} \quad (A8)$$

$$LR_{c,sa} = \frac{\omega_{c,sa} LDR^{sa} w^{sa}}{wr_c} \quad (A9)$$

$$LR_{c,ia} = \frac{\omega_{c,ia} LDR^{ia} w^{ia}}{wr_c (1 + cs)} \quad (A10)$$

$$NATR_c = lsmax_c - \frac{\beta_c}{(1 - \beta_c) prl_c} (IBC_{c,hr} - \lambda_c \sum_i PC_i Cmin_{i,hr}) \quad (A11)$$

## Urban private sector

$$XS_{up} = VA_{up} / v_{up} \quad (A12)$$

$$CI_{up} = i_{o_{up}} XS_{up} \quad (A13)$$

$$DI_{i,up} = a_{ij_{i,up}} CI_{up} \quad (A14)$$

$$VA_{up} = A_{up} [\alpha_{up} LDU_{up}^{(\sigma_{up}-1)/\sigma_{up}} + (1 - \alpha_{up}) KD_{up}^{(\sigma_{up}-1)/\sigma_{up}}] \sigma_{up} / (\sigma_{up}-1) \quad (A15)$$

$$LDU_{up} / KD_{up} = \left( \frac{\alpha_{up}}{1 - \alpha_{up}} \frac{r_{up}}{w_{up}} \right) \sigma_{up} \quad (A16)$$

$$LDU_{up} = B_{up} \prod_c LU_{c,up}^{\omega_{c,up}} \quad (A17)$$

$$LU_{cm1,up} = \frac{\omega_{cm1,up} LDU_{up} w_{up}}{(1 + cs) w_{uc}} \quad (A18)$$

$$LU_{\text{"10"},up} = \frac{\omega_{\text{"10"},up} LDU_{up} w_{up}}{w u p_{up}} \quad (\text{A19})$$

$$LU_{\text{"10"},up} = Ai_{up} [\Omega_{up} NATI_{up}^{(\varsigma_{up}-1)/\varsigma_{up}} + (1 - \Omega_{up}) ETR_{up}^{(\varsigma_{up}-1)/\varsigma_{up}}] \varsigma_{up}/(\varsigma_{up}-1) \quad (\text{A20})$$

$$\frac{ETR_{up}}{NATI_{up}} = \left( \frac{1 - \Omega_{up}}{\Omega_{up}} \frac{w u_{\text{"10"}} (1 + cs)}{w u_{\text{"10"}}} \right)^{\varsigma_{up}} \quad (\text{A21})$$

$$NATU_c = lsmax'_c - \frac{\beta'_c}{(1 - \beta'_c) plu_c} (1 - \zeta_{1c} - \zeta_{2c}) (IBC_{c,\text{"hu"}} - \lambda'_c \sum_i PC_i Cmin_{i,\text{"hu}}) \quad (\text{A22})$$

## Public sector

$$XS_{pub} = VA_{pub}/v_{pub} \quad (\text{A23})$$

$$CI_{pub} = i_{opub} XS_{pub} \quad (\text{A24})$$

$$DI_{i,pub} = ai_{j_i,pub} CI_{pub} \quad (\text{A25})$$

$$VA_{pub} = KD_{pub}/k_{pub} \quad (\text{A26})$$

$$LDG_{pub} = l_{pub} VA_{pub} \quad (\text{A27})$$

$$LG_{c,pub} = LDG_{pub} l_{c,pub} \quad (\text{A28})$$

$$KD_{pub} = \frac{PV_{pub} VA_{pub} - w_{pub} LDG_{pub}}{r_{pub}} \quad (\text{A29})$$

## Migratory flows

$$LSR_c = Br_c [\varpi_c NAT_c^{(\varepsilon_c-1)/\varepsilon_c} + (1 - \varpi_c) EMR_c^{(\varepsilon_c-1)/\varepsilon_c}]^{\varepsilon_c/(\varepsilon_c-1)} \quad (\text{A30})$$

$$\frac{EMR_c}{NAT_c} = \left( \frac{\varpi_c}{1 - \varpi_c} \frac{wi_c e(1 - mc)}{wn_c} \right)^{-\varepsilon_c} \quad (\text{A31})$$

$$NAT_c = Bu_c [\vartheta_c NATR_c^{(\varrho_c-1)/\varrho_c} + (1 - \vartheta_c) MIG_c^{(\varrho_c-1)/\varrho_c}]^{\varrho_c/(\varrho_c-1)} \quad (\text{A32})$$

$$\frac{MIG_c}{NATR_c} = \left( \frac{\vartheta_c}{1 - \vartheta_c} \frac{wa_c(1 - imc)}{wr_c} \right)^{-\varrho_c} \quad (\text{A33})$$

$$LSU_c = Bi_c [\xi_c NATU_c^{(o_c-1)/o_c} + (1 - \xi_c) EMU_c^{(o_c-1)/o_c}]^{o_c/(o_c-1)}$$

$$\frac{EMU_c}{NATU_c} = \left( \frac{\xi_c}{1 - \xi_c} \frac{wi_c e(1 - mc)}{wa_c} \right)^{-o_c} \quad (\text{A34})$$

### Income/Savings of households and firms

$$Y^{“hr”} = \sum_{ru} (\sum_c wr_c LR_{c,ru}) + \eta^{“hr”} \sum_j r_j KD_j + \sum_{ag} T^{“hr”,ag} \quad (A35)$$

$$Y^{“hu”} = (1 - \phi_{row}) [\sum_{up} (\sum_c wu_c LU_{c,up}) + \sum_{pub} (\sum_c wg_c LG_{c,pub})] + \eta^{“hu”} \sum_j r_j KD_j + \sum_{ag} T^{“hu”,ag} \quad (A36)$$

$$Y^{“fm”} = (1 - \eta^{“hr”} - \eta^{“hu”} - \eta^{“gv”} - \eta^{“row”}) \sum_j r_j KD_j + \sum_{ag} T^{“fm”,ag} \quad (A37)$$

$$YD^{“hr”} = Y^{“hr”} (1 - ty^{“hr”} \times adj) - (T^{“hr”,“hr”} + T^{“hu”,“hr”} + T^{“fm”,“hr”} + T^{“row”,“hr”}) \quad (A38)$$

$$YD^{“hu”} = Y^{“hu”} (1 - ty^{“hu”} \times adj) - (T^{“hr”,“hu”} + T^{“hu”,“hu”} + T^{“fm”,“hu”} + T^{“row”,“hu”}) \quad (A39)$$

$$S_h = \psi_h YD_h \quad (A40)$$

$$BC_h = YD_h - S_h \quad (A41)$$

$$S^{“fm”} = Y^{“fm”} - \sum_{ag} T_{ag,“fm”} \quad (A42)$$

### Government receipts and expenditures

$$TI_{tr} = tx_{tr} (P_{tr} X S_{tr} - PE_{tr} EX S_{tr}) + tx_{tr} (1 + tm_{tr}) ePm w_{tr} M_{tr} \quad (A43)$$

$$TI_{ntr} = tx_{ntr} PL_{ntr} X S_{ntr} \quad (A44)$$

$$TIM_{tr} = tm_{tr} ePm w_{tr} M_{tr} \quad (A45)$$

$$TIE_{tr} = te_{tr} PE_{tr} EX S_{tr} \quad (A46)$$

$$T^{“gv”,h} = (ty_h \times adj) Y_h \quad (A47)$$

$$T^{“gv”, “fm”} = tyeY^{“fm”} \quad (A48)$$

$$Y^{“gv”} = \eta^{“gv”} \sum_j r_j K D_j + \sum_{tr} TIM_{tr} + \sum_{tr} TIE_{tr} + \sum_j TI_j + \sum_{ag} T^{“gv”, ag} +$$

$$\left( \sum_{up} w_{up} LDU_{up} - \sum_{up} \left( \sum_c w_{uc} LU_{c,up} \right) \right) + \left( w^{“ar”} LDR^{“ar”} - \sum_c wr_c LR_{c, “ar”} \right) \quad (A49)$$

$$S^{“gv”} = Y^{“gv”} - \sum_i PC_i G_i - \sum_{ag} T_{ag, “gv”} \quad (A50)$$

## External Trade

$$XS_{tr} = Be_{tr} [\delta_{tr} EX S_{tr}^{(\kappa_{tr}-1)/\kappa_{tr}} + (1 - \delta_{tr}) DOM_{tr}^{(\kappa_{tr}-1)/\kappa_{tr}}]^{\kappa_{tr}/(\kappa_{tr}-1)} \quad (A51)$$

$$XS_{ntr} = DOM_{ntr} \quad (A52)$$

$$\frac{EX S_{tr}}{DOM_{tr}} = \left( \frac{\delta_{tr}}{1 - \delta_{tr}} \frac{PL_{tr}}{PE_{tr}} \right)^{\kappa_{tr}} \quad (A53)$$

$$EXD_{tr} = EXDO_{tr} \left( \frac{Pwe_{tr}}{Pfo_{tr}} \right)^{\varphi_{tr}} \quad (A54)$$

$$Q_{tr} = Am_{tr} [\theta_{tr} M_{tr}^{(\chi_{tr}-1)/\chi_{tr}} + (1 - \theta_{tr}) DOM_{tr}^{(\chi_{tr}-1)/\chi_{tr}}]^{\chi_{tr}/(\chi_{tr}-1)} \quad (A55)$$

$$Q_{ntr} = DOM_{ntr} \quad (A56)$$

$$\frac{M_{tr}}{DOM_{tr}} = \left( \frac{\theta_{tr}}{1 - \theta_{tr}} \frac{PD_{tr}}{PM_{tr}} \right)^{\chi_{tr}} \quad (A57)$$

$$S^{“row”} = \sum_{tr} Pwm_{tr} M_{tr} + \phi_{row} \frac{\sum_{up} (\sum_c w_{uc} LU_{c,up}) + \sum_{pub} (\sum_c wg_c LG_{c,pub})}{e}$$

$$+ \eta^{“row”} \frac{\sum_j r_j K D_j}{e} + \frac{\sum_{ag} T^{“row”, ag}}{e} \quad (A58)$$

$$- \sum_{tr} Pfo_{tr} EX S_{tr} - \frac{\sum_{ag} T_{ag, row}}{e}$$

## Final demand

$$CT_{i, "hr"} = Cmin_{i, "hr"} + \frac{\gamma_{i, "hr"}}{PC_i} (BC_{"hr"} - \sum_i PC_i Cmin_{i, "hr"}) \quad (A59)$$

$$CT_{i, "hu"} = Cmin_{i, "hu"} + \frac{\gamma_{i, "hu"}}{PC_i} (BC_{"hu"} - \sum_i PC_i Cmin_{i, "hu"}) \quad (A60)$$

$$\begin{aligned} IBC_{c, "hr"} &= (1 - \psi_{"hr"}) (1 - ty_{"hr"} \times adj) wr_c \sum_{ru} LR_{c, ru} + \quad (A61) \\ &\lambda_c (1 - \psi_{"hr"}) (1 - ty_{"hr"} \times adj) [Y_{"hr"} - \sum_c (wr_c \sum_{ru} LR_{c, ru})] \end{aligned}$$

$$\begin{aligned} IBC_{c, "hu"} &= (1 - \psi_{"hu"}) (1 - ty_{"hu"} \times adj) (wu_c \sum_{up} LU_{c, up} + wg_c \sum_{pub} LG_{c, pub}) \quad (A62) \\ &+ \lambda'_c (1 - \psi_{"hu"}) (1 - ty_{"hu"} \times adj) [Y_{"hu"} - \sum_c (wu_c \sum_{up} LU_{c, up} + wg_c \sum_{pub} LG_{c, pub})] \end{aligned}$$

$$INV_i = \mu_i IT / PC_i \quad (A63)$$

$$DIT_i = \sum_i aij_{i,j} CI_j \quad (A64)$$

## Prices

$$\ln \frac{wu_c}{Pindex} = D_c - 0.1 \ln u_c \quad (A65)$$

$$wg_c \succ wu_c \quad (A66)$$

$$wn_c = \frac{wr_c \sum_{ru} LR_{c, ru} + wu_c \sum_{up} LU_{c, up} + wg_c \sum_{pub} LG_{c, pub}}{\sum_{ru} LR_{c, ru} + \sum_{up} LU_{c, up} + \sum_{pub} LG_{c, pub}} \quad (A67)$$

$$wug_c = \frac{wu_c \sum_{up} LU_{c, up} + wg_c \sum_{pub} LG_{c, pub}}{\sum_{up} LU_{c, up} + \sum_{pub} LG_{c, pub}} \quad (A68)$$

$$w_{pub} = \sum_c \frac{wg_c LG_{c, pub}}{LDG_{pub}} \quad (A69)$$

$$wa_c = wug_c \frac{\sum_{up} LU_{c,up} + \sum_{pub} LG_{c,pub}}{NATU_c + (1 - imc)MIG_c + IMMIG_c} \quad (A70)$$

$$wup_{up} = \frac{(1 + cs)wu^{10} NATI_{up} + wu^{10} ETR_{up}}{LU^{10},up} \quad (A71)$$

$$r^{ia} = \frac{PV^{ia} VA^{ia} - w^{ia} LDR^{ia}}{KD^{ia}} \quad (A72)$$

$$r_{up} = \frac{PV_{up} VA_{up} - w_{up} LDU_{up}}{KD_{up}} \quad (A73)$$

$$PV_j = \frac{P_j X S_j - \sum_i PC_i DI_{i,j}}{VA_j} \quad (A74)$$

$$PM_{tr} = ePwm_{tr}(1 + tm_{tr})(1 + tx_{tr}) \quad (A75)$$

$$PE_{tr} = \frac{ePfb_{tr}}{(1 + te_{tr})} \quad (A76)$$

$$PC_{tr} = \frac{DOM_{tr} PD_{tr} + M_{tr} PM_{tr}}{Q_{tr}} \quad (A77)$$

$$PC_{ntr} = PD_{ntr} \quad (A78)$$

$$PD_j = PL_j(1 + tx_j) \quad (A79)$$

$$P_{tr} = \frac{PL_{tr} DOM_{tr} + PE_{tr} EXS_{tr}}{XS_{tr}} \quad (A80)$$

$$P_{ntr} = PL_{ntr} \quad (A81)$$

$$PINV = \prod_i \left( \frac{PC_i}{\mu_i} \right)^{\mu_i} \quad (A82)$$

$$Plr_c = (1 - \psi^{hr})(1 - ty^{hr} \times adj)wr_c \quad (A83)$$

$$Plu_c = (1 - \psi^{hu})(1 - ty^{hu} \times adj)(1 - u_c)wug_c \quad (A84)$$

$$Pindex = \sum_j \theta_j PV_j \quad (A85)$$

## Equilibrium conditions

$$NATR_c = \sum_{ru} LR_{c,ru} \quad (A86)$$

$$(NATU_c + (1 - imc)MIG_c + IMMIG_c)(1 - u_c) = \sum_{up} LU_{c,up} + \sum_{pub} LG_{c,pub} \quad (A87)$$

$$Q_i = G_i + DIT_i + \sum_h CT_{i,h} + INV_i + STK_i \quad (A88)$$

$$EXS_{tr} = EXD_{tr} \quad (A89)$$

$$ITVOL = IT/PINV \quad (A90)$$

$$IT + \sum_i STK_i PC_i = \sum_{da} S_{da} + eS_{row} \quad (A91)$$