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**TRADE, EMPLOYMENT AND WAGES IN TUNISIA: AN  
INTEGRATED AND DYNAMIC CGE MODEL**

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Directed By  
Mongi Boughzala, Université de Tunis El Manar, Tunisie**

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# **TRADE, EMPLOYMENT AND WAGES IN TUNISIA: AN INTEGRATED AND DYNAMIC CGE MODEL**

**Hedi BCHIR, Sami BIBI, Mongi BOUGHZALA,  
Rim CHATTI, and Taoufik RAJHI.**

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## Abstract

Although the literature on the links between trade liberalization, unemployment and poverty using CGE model is extensive, few studies have attempted to build a coherent macro framework integrating the labor market, the financial market, and the real sectors in the context of a developing country and under alternative government policies. It is well known that the poor in developing countries are generally concentrated in the rural agricultural sector and in the urban informal sector, while the unemployed are concentrated in the formal urban sector, and most of the poor and the unemployed have little assets and skills; thus, they may gain or lose from trade reforms depending more on the impact of these reforms on wages and on the prices of the basic consumer commodities, and less on their impact on the financial market. To explore the link between trade reforms, poverty and employment in Tunisia, we indeed construct a comprehensive *dynamic computable general equilibrium model* embedded in a macro framework integrating the fundamental fact that unemployment and poverty depend on the structure and the functioning of the labor market, on the links between the formal and the informal sectors, on government policy choices, and, to a less extent, on the financial market behavior. Our model draws extensively on the IMMPA model developed by Agénor et al. (2002) but has several specific features; for instance, it allows for exploring the external effects generated by trade liberalization in the form of technical progress.

This model is used to simulate the impact of trade liberalization and other concomitant reforms, mainly fiscal reforms, on growth, unemployment and poverty under different public policies, with and without technical progress and with and without integrating the financial market.

These simulations show that opening the economy is for a small country like Tunisia an important and necessary condition for the acceleration of growth and possibly for job creation, but it is not a sufficient condition. Domestic policies enabling the development of the country's own capacity to assimilate and develop new and appropriate technology are also needed. Technical progress should lead to higher growth but is not always job creator.

The importance of the financial system and of fiscal reforms is also confirmed, given their impact on the incentive system and on the government resources. By accounting for these goods and services as production factors we highlight the role of government in the growth process, employment and income generation. Potentially, the financial system is a development facilitator but in our case the financial system has a rather negative impact because it is inefficient.

It is also shown that some trade-offs between *pro-growth policies* and *pro-poor policies* may exist in the short run, but in the long run, policies aiming to enhance openness and human capital lead to higher growth and wages and to reduced unemployment and poverty. Tax reduction may also have a positive impact through its effect on investments.

## 1. Introduction

Do we need another CGE model to study once more the impact of trade liberalization and fiscal reforms on employment and poverty?

Indeed, a large number of studies and CGE models have already addressed the issues linked to the impact of trade liberalization and fiscal reforms on employment and poverty in various countries, including in Tunisia and other countries of the Middle East and MENA region. Some of the very first and most significant and pioneering CGE models were built to study fiscal and trade liberalization issues and the impact of the creation of free trade areas in the seventies and the eighties by Shoven and Whalley (1972), Fullerton, Shoven, and Whalley (1983), Harris (1984), Goulder and Summers (1989), and later in a dynamic setup by Kehoe (1995) and (1996). For the MENA region, a large number of CGE studies have been produced to examine the impact of the creation of a free trade area (FTA) in the Mediterranean zone and of its enlargement to agriculture.<sup>2</sup> More specifically for Tunisia, in connection with the formation of its free trade area (FTA) with the EU<sup>3</sup>, many CGE trade models were proposed, each of them usually emphasizing one main feature. For instance, Marouani (2004) focused on the structure of the labor market. Brown et al. (1997) and Chatti (2005) introduced increasing returns to scale, horizontal product differentiation and monopolistic competition. Alternatively Chatti (2003) and Kress (1994) assumed homogenous goods and oligopoly market structures in Tunisian industries.<sup>4</sup>

Our fundamental idea is that a more comprehensive CGE model embedded in a more coherent macro framework, integrating the labor market, the financial market, and the real sectors under alternative government policies is still worth constructing, and can provide deeper insights and more significant results as regards the links between trade, growth, employment, incomes and poverty in Tunisia. This model should capture the fundamental fact that unemployment and poverty depend on the structure and functioning of the labor and financial markets and on the links between the formal and the informal sectors, and also on policy choices.

In the developing countries however, the poor are generally concentrated in the agricultural and in the urban informal sectors, while the unemployed are concentrated in the formal urban sector, and most of the poor and the unemployed have little assets and skills. Therefore, we expect them to gain or lose from trade reforms depending more on the impact of these reforms on wages and prices of the basic commodities they consume, and less on their impact on the financial market. For this reason, we focus more on the labor market. The framework we are proposing also allows for exploring the indirect benefits of trade liberalization in the form of technical progress generated by enhancing skill formation, and by importing production commodities from technologically more advanced countries. Surprisingly enough, previous CGE models have neglected this crucial technological progress feature. Some other complex links between trade reforms, employment and poverty exist and will also be explored in our model.

In the first place, economic growth is a main indirect channel through which freer trade could contribute to unemployment and poverty alleviation. Although there is a substantial

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<sup>2</sup> See, among many others, DecaluwÈ and Souissi (1996), Chemingui and Dessus (1999), and Dessus and Suwa-Eisenmann (2000).

<sup>3</sup> The EU Tunisian FTA agreement is part of the association agreement signed in 1995, and is to be implemented gradually between 1996 and 2008.

<sup>4</sup> For a wide overview of models built for the countries of the MENA region, see, for instance: Galal and Hoekman (1997), Hoekman, Michalopoulos and Tarr (2000), and Dessus and Suwa-Eisenmann (2000).

empirical evidence supporting a positive association between more open trade regimes, growth and poverty alleviation, our finding is that trade openness does not guarantee more jobs and more income for the poor. Trade does not always lead to higher growth, unless there are strong enough incentives in favor of higher investment, innovation and flows of FDI, which facilitate larger technological spillovers. The extent to which growth impacts positively on poverty depends on how the additional income generated by growth is distributed across the population. The more the income of the bottom segment of the population rises, the more the growth pattern is pro-poor.<sup>5</sup>

Trade liberalization may therefore help the unemployed and the poor, but not always. Trade liberalization should be supplemented by a combination of other pro-poor growth policies, including policies targeting the more vulnerable. Government has with this respect an important role to play, including through encouraging absorption of new technologies, expanding access to education, providing basic social services to the poor and investing in infrastructure.

The idea of integrating the labor market, the financial market and policies in a multi-sector framework and according to a dualistic approach has already been developed in the framework called IMMPA described in Ag  nor, Izquierdo and Fofack (2002)<sup>6</sup>, and later in its simplified version called mini-IMMPA as in Ag  nor (2003). The IMMPA framework was already applied in the context of several countries, including Morocco [Ag  nor, Pierre-Richard and Karim El Aynaoui (2003)] and Turkey [Ag  nor, Henning, Verghis and Yeldan (2003)] but without the financial market component. Although, when constructing our own framework, we have drawn extensively on these models, we have introduced many changes according to the objective of the current study and in order to reflect some important features of the Tunisian economy. For instance, technical progress is integrated and, since international trade is more essential, the framework becomes multi sectoral, while in IMMPA, there is a single formal sector producing a single (aggregate) traded commodity.

In this paper, we use this new framework to simulate the impact of trade liberalization and other reforms, mainly fiscal, on growth, employment and poverty. However, the poverty dimension is only partially analyzed, mainly through income distribution and wage variations; and more attention is paid to growth, employment and incomes. This is so because poverty is the main topic of a separate paper concomitantly written by Bibi and Chatti (2005) using basically the same framework<sup>7</sup>.

Before the presentation of the framework, in section 3, and of the simulation results, in section 4, it is important to give an overview of the labor market and of poverty in the Tunisian context (section 2).

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<sup>5</sup> More details about what is pro-poor growth are in Bibi (2005).

<sup>6</sup> An electronic copy of the paper can also be downloaded (together with additional materials) from the website of WBI's Macroeconomics and International Finance Program, at [www.worldbank.org/immpa](http://www.worldbank.org/immpa).

<sup>7</sup> 'Is trade Liberalization Poverty Alleviating in Tunisia?' Sami BIBI and Rim CHATT May 2005, a paper produced as part of the same FEMISE project.

## ***2. Unemployment and poverty in Tunisia***

### **2.1. The labor market**

In Tunisia, unemployment has been persistently high at around 15%, and the unemployed are increasingly urban, young and educated. The country is also liberalizing its international trade, which is generating both hopes and fears: hopes to gain from the growing trade and from the technological spillover, and fears from foreign competition and its destructive effects, especially in terms of job losses and wage cuts. However, poverty is more important in the rural areas where agriculture is the main activity but not directly involved in the FTA. The dynamics of poverty is rather complex, and trade liberalization is not poverty neutral.

Tunisia major exports are constituted of labor intensive manufactured commodities (textile and clothing in the first place), and industries are located mostly within the formal urban sector. As to services, they are both in the informal sector and in the formal sector (modern private enterprises, public enterprises and government services). The formal sector relies mainly on wage earners, while in the informal sector, family aids and independent workers are an important share of the labor force.

As expected, people have been moving away from the rural sector and from agriculture (which includes forestry and fishing) to manufacturing and more and more to services located in urban areas. In Tunisia, agriculture employs about 20 percent of the labor force compared to more than 50 percent forty years ago, and the growth rate of the rural working population is much lower than that of the urban, partly because rural employment is more volatile, and remains very sensitive to climate variations. Agricultural employment may have recently increased instead of decreasing but this is a temporary change, and the trend for agricultural sector employment remains down sloping. Close to 20 percent of total employment is in manufacturing, half of which in textile and clothing, but manufacturing job creation has slowed down since the end of the nineties, while more jobs are created in services.

Men provide three fourths of the labor force but the share of women is growing. In terms of schooling, the rate of illiteracy is decreasing and is quite low among the youngest, but the share of those having a secondary or a university education is growing fast. Unemployment is highest among those with a completed primary education or an incomplete secondary education. The completely illiterate have less trouble finding employment because they tend to accept any available jobs.

**Table 1: Employed total population by age and education attainment in 2002**

	None	Primary	Secondary	higher	Total
15-17	4984	54552	12989	241	72766
18-19	5794	55410	27509	232	88945
20-24	17962	174994	130927	8935	332818
25-29	24799	193949	173287	54839	446874
30-34	39280	150892	167869	66691	424732
35-39	52800	158225	135992	49854	396871
40-44	44900	162726	102506	38351	348483
45-49	52867	104262	93383	33515	284027
50-54	54500	58793	55102	21127	189522
55-59	48920	30711	16406	7843	103880
60-64	42267	16637	3430	1389	63723
65-69	38161	10134	1680	460	50435
70 et +	38598	8722	1199	416	48935
<b>Total</b>	465832	1180007	922279	283893	2852011

**Table 2: Employment by gender and production sector**

	1997	1999	2000	2001	97-99	99-00	00-01
<b>Employment</b>	2503,5	2634,9	2704,93	2788,7	5%	3%	3%
Male	1906,4	1992,0	2039,46	2095,4	4%	2%	3%
Female	597,17	642,89	665,47	693,35	8%	4%	4%
Part-time	496,66	438,76	59,54	452,21	-12%	36%	-24%
Seasonal	334,36	405,06	547,11	342,65	18%	35%	-37%
<b>Sectors:</b>							
Agriculture	546,17	595,94	593,02	609,79	9%	0%	3%
Manufacturing excl.	247,29	239,30	249,58	291,76	-3%	4%	17%
Textiles (incl. clothing,	259,23	242,01	268,19	276,91	-7%	11%	3%
Non-manufacturing	32,87	32,70	33,20	33,45	0%	2%	1%
Construction	304,85	371,94	339,97	337,04	22%	-9%	-1%
Health, education, public	41,32	443,49	473,16	452,67	7%	7%	-4%
o/w public health,	406,87	na	461,06	442,10			-4%
o/w general public	193,87	na	230,60	213,94			-7%
Other Services (excl. civil	672,94	696,25	724,25	768,36	3%	4%	6%
Outside of Tunisia	2,17	0,00	1,66	0,21	-8%	-17%	27%

Source: Employment surveys 1997, 1999, 2000; 2001 INS

**Table 3: Labor force structure by education level and employment status**

	<b>Total Labor</b>	<b>Emnloved</b>	<b>Unemnloved</b>
<b>None</b>	17%	18%	10%
<b>Primary incomplete</b>	2%	2%	1%
<b>Primary complete</b>	41%	40%	47%
<b>Secondary</b>	32%	31%	36%
<b>Postsecondary</b>	9%	10%	6%
<b>Total</b>	100%	100%	100%

Source: INS, Labor survey 2002

Trade liberalization is evidently more challenging for the less skilled, but even for the more educated, unemployment is an increasingly serious concern. On the one hand, there is a great need to develop more human capital; on the other hand, the country has not been able to use the stock of human capital already available. This seemingly paradoxical situation reflects current weak demand by the private sector for educated workers and also weak links between the education system and the labor market. The return to education has not been altogether low, but the quality of the training is not adjusting rapidly enough to the current needs, and seems to be even deteriorating. Other indicators suggest that unemployment is caused mainly by the low level of aggregate labor demand, and less so by the mismatch between supply and demand. Lack of mobility is an aggravating factor for unemployment but it is less crucial than the weakness of the level of total labor demand; which is partly the outcome of the functioning of the labor market and its institutions. The size of the informal sector may be taken as a rough measure of the effectiveness of these institutions and of the government enforcement capacity. A larger informal sector means that the existing regulations impose too many constraints on doing business formally and/or it is hard to implement. The Tunisian labor market is quite segmented indeed, and the informal sector remains substantial as indicated by the following table on micro-enterprises, which are often used as a proxy for the informal enterprises.

**Table 4: Micro-enterprises Key Results from the 1997 Survey**

<b>Distribution (%) of:</b>	<b>Firm Size (Number of Employees)</b>				
	1-2	3-5	6-9	10+	Total
<b>Firms</b>	86	13	1	0,3	100
<b>Employment</b>	68	26	4	2	100
<b>Value added</b>	61	31	5	3	100
<b>Average Share of Wage Workers (percent)</b>	13	47	65	88	25
<b>Value Added/Worker: as percent of Sector Average</b>	90	117	119	179	100

Source: INS, Micro-enterprise Survey 1997.



Private enterprises in Tunisia are predominantly small. 99% of them are very small or micro enterprises, and around half of private employment is within these enterprises. Even though the distinction between the formal and informal sectors is not in principle based on the size of firm, the share of small and micro enterprises is a rough measure of the size of the informal sector, given the high correlation between informality and the size of the enterprise.

By definition, informal enterprises are enterprises which operate without abiding by the basic legal requirements, especially those in terms of taxation and labor laws, but they generally produce legal goods or services. According to this definition, an informal enterprise may be of any size, but in practice, small and micro enterprises are the most likely to belong to the informal sector.

In 1997, the Tunisian National Statistics Institute launched a series of wide surveys on micro firms (less than 6 employees), which show that approximately 18% of total non-agricultural employment is in the informal sector. However, if we add the agricultural informal employment and employment within the households and some other less visible parts of the informal sector, total informal employment would be near 40%. The World Bank gives 38 percent of GDP as an estimated measure of the informal sector in Tunisia. The INS 1997 survey shows that most of the informal employment is concentrated in the following sectors: manufacturing, mainly in food-activities, wood products, metal products, construction, commerce, automobile repair, and transportation, and that employment is highly correlated with production and value added<sup>8</sup>. This confirms that the informal sector produces mostly non-tradable goods and hence constitutes a burden in terms of foreign currency generation, essential for growth.

This survey brings also further evidence on the education and skill levels of the labor employed in the informal sector and on investment and access to the financial market. It shows that the proportion of those with high school and higher education is significantly lower in the informal market, although not at all negligible: 12% of the employed reached high school.

It is usually admitted that flexibility is much higher in the informal sector than in the formal sector and that the formal sector is more attractive for wage earners and offers them more job security, better social coverage (pension, health...), and higher wages. Wage variations in the formal and informal sectors are yet interrelated as a result of the mobility between these sectors. The degree of mobility between the formal and the informal sectors depends mainly on the wage gap between them and on the rate of unemployment. Skilled workers are very seldom attracted by the informal sector, except as employers; which explains that the informal sector does not have enough access to modern technologies and does not generally produce goods according to international standards, that is tradable goods. The informal sector does not have enough access to public goods and services, to formal financial sources and to new technologies. Consequently, its productivity is lower and it pays lower wages. Its outgrowth is thus a hindrance for growth and even for future employment.

In periods of slow growth, a decrease in formal sector employment is likely to be compensated by an increase in informal sector employment. In particular, less public sector recruitment or public sector layoffs, as a result of stabilization and structural adjustment programs, may lead to more informal activities; and, so do excessive wage increases in the formal sector. There are signs that the size of the informal sector increased in Tunisia during the past decade or two, in particular during the reform period and as a result of the growing restrictions on public sector growth and of the stagnating private investment rate (as a ratio to GDP).

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<sup>8</sup> Only the 1997 survey results are published.

Labor markets institutions are organized according to the French pattern, which has the reputation of being excessively rigid. Overall, the Tunisian labor market is indeed characterized by substantial regulation, outlined in the Labor Code and the system of collective wage determination. The strength of the country's institutions and of the government ability to enforce compliance with the rule of law is also fundamental in determining the size of the informal sector; both excessively restrictive laws and lax enforcement lead to a larger informal sector. In the mid-1990s, the labor market has undergone a limited transition toward greater flexibility.

Minimal wages are imposed, but are relatively moderate in absolute terms and have often been near equilibrium wages, since the observed wage has seldom been lower than minimal wages, even in the informal sector. Over the last decades, minimal wages have followed an increasing trend in real terms but they also fluctuated. They decreased in certain periods, for instance during the macro stabilization period in the late eighties. Hence, minimal wages do not seem to be a major source of rigidity.

For the more skilled workers in the formal private sector and in the public sector, salaries are negotiated, at the national level, within national and sectoral frameworks by employers, labor unions and Government representatives. These agreements define wage and work conditions, incentives and specific benefits, and the procedure for job assignment and promotions.

Collective bargaining may be constraining from the enterprise point of view, but compliance within the private sector is less strict and depends on many factors, mainly on the size of the enterprise and on the strength of labor unions.

Social security charges and health insurance are compulsory for all employees. Social coverage represents from 20 to 35% of take home earning and entitles employees to various insurance benefits, including against work-related injuries, illness, as well as old-age retirement, disabilities and death. However, there is no unemployment benefit scheme. The public sector employees, representing approximately 25% of the labor force, are indeed fully covered while private sector employees (75% of the total employed labor force) do not effectively have this guarantee, in spite of the legal requirement. The ongoing campaign launched by the Tunisian government since the mid nineties in order to strengthen the enforcement process, gradually led to a significant increase in the coverage rate within the private sector.

It is also commonly claimed that income taxes and social security are a disincentive for employment.

Hiring and firing are legally subjected to institutional requirements. This sort of legislation is meant to protect workers, and Labor Unions, which are historically important and relatively powerful in Tunisia, have acted for their preservation.

However, reform projects were introduced and some laws in favor of more flexibility were passed in 1994 and 1996,<sup>9</sup> allowing mainly for:

- ◆ More freedom as to the duration and the type of contracts, so that a substantial room is given to fixed term contracts,
- ◆ And for simplified procedures in case of layoffs, and
- ◆ For putting a limit on maximum severance payment in case of firing.

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<sup>9</sup> Two laws passed: No 1994-29 Feb 1994 and 1996 July 1996, Journal Officiel de la République Tunisienne 1994 and 1996.

**Table 5: social charges (in%)**

<b>Employer's contribution</b>	16.0
<b>Vocational Training Tax (TFP)<sup>1/</sup></b>	2.0
<b>FOPROLOS<sup>2/</sup></b>	1.0
<b>Work Injury insurance</b>	2.0
<b>Group insurance<sup>3/</sup></b>	2.0
<b>Health protection</b>	2.0
<b>Protective clothing</b>	2.0
<b>Employers contribution (LdF 1974)</b>	0.5
<b>Fiscal stamps &amp; others</b>	0.5
<b>Total Social Charges</b>	<b>28.0%</b>

<sup>1/</sup> i Taxe sur la formation professionnelle; the regular tax rate is 2 percent, except for manufacturing, it is one percent.

<sup>2/</sup> Fonds de Promotion du Logement pour les Salariés.

**Source** : Ministère du Développement et de Coopération Internationale.

Layoffs remain tightly regulated and involve rather complicated procedures. Only around 14 percent of dismissal announced by the employers end up being accepted by the labor tribunal, and yearly layoffs are less than 1 percent of the labor force. These rates are low compared for instance to rates observed in OCDE countries, meaning that layoff regulations are quite restrictive. The 1996 amendment introduced limited change: it put a reasonable limit on severance payments. It is arguably true that layoff costs, altogether, are a disincentive for employers. Previous calculations show that the ultimate impact on total employment is limited, but it contributes to pushing people to go to the informal sector.

In spite of this rather strong regulation, overall, wage determination may be described as not totally rigid, it is altogether partially flexible, since observed real wages have fluctuated and even decreased for significantly long time periods, as a result of inflation and the slow speed of nominal wage adjustment. Our analytical framework should reflect this limited flexibility.

## 2.2. Poverty

Since its independence from French domination, and consistently, Tunisia has made rapid progress in social development. From 1970 to 2001, real per capita incomes grew from \$700 to \$2,070, while the incidence of poverty has declined from 40 to less than five percent, and the average life expectancy reached 72 years in 2002 (slightly higher in 2005). Infant, child and maternal mortality rates are quite low now. Tunisia has also significantly closed the gender gap and assured legal rights for women. Important progress was achieved in education with almost all children today enrolled in primary schools.

However, poverty remains higher in rural areas, and the rate of vulnerable people is significantly high. Because the poverty line for the rural population calculated by the national statistic institute (INS) is much lower than for the urban population the official headcount measure for the rural areas comes out smaller than for the urban. This result was highly criticized given the little difference in food prices between rural and urban areas and that the poverty line used in Tunisia depends mainly on these prices. Alternative and more accurate poverty lines calculated by the World Bank (1995) and by Bibi (2003) show that poverty is indeed significantly higher in rural areas: 8.7 percent in 2000, while it is 2.3 percent in urban areas and 4.7 percent in average.

In education and health, there is also much need and room for improvement, mainly qualitatively. Especially in education, quality, much more than quantity, is now the real challenge. As to the health sector, even though it is providing free or highly subsidized care not only to the poor but to about half of the population, its organization and financial means are not viable. Reforms are being considered to make it more viable: the major reform is to develop a new health insurance policy.

In Tunisia, poverty is closely linked to unemployment and to the weak productivity of the unskilled workers. Reducing unemployment, at the current real wage, and enhancing the productivity of the unskilled are the most sustainable way to eradicate poverty and improve the quality of life in the country. To this end, a significant acceleration of growth and investments (both in physical and human capital) is required. Currently, the national investment rate is at about 25 percent of GDP, but close to half of it is still public investment. Private investment is not responding as fast as desired to the various incentives provided by the government.

Understanding employment and unemployment is not enough for understanding poverty. The links between trade and poverty are indeed more challenging to identify and to integrate in model building. Although the focus on the link between trade and poverty has spurred important research,<sup>10</sup> the available literature is mostly theoretical, and few empirical investigations have been undertaken. There is however a consensus that rapid economic growth is essential for sustained poverty alleviation. By providing incentives for an efficient allocation of resources, an open and transparent trade regime becomes an important precondition for broad base and sustained growth. However, although trade reform is expected to have an important role in fighting poverty through its effects on the rate and pattern of growth, in the short run it could have negative redistributive effects that can hurt the poor. Trade reforms may raise average incomes in the medium and long term, but in the short run some segments of society can suffer losses. Even in the long run, lump sum redistribution of the gains from trade may be required to avoid negative redistributive effects, but they are hardly practical let alone politically feasible. Because the poor or near poor have fewer assets to protect them during hard times, they are less able to absorb adjustments costs than the other segments of society.

This is not the first time trade is linked to income distribution and/or poverty in a CGE model. In the literature two main approaches are identified.

The first approach classifies the population into different household groups. A distribution function is constructed for each group, with the relevant statistical parameters obtained from the household survey. For each policy simulation, the model provides a corresponding mean income, and for a given poverty line, poverty indices can be computed for each group and for the whole population. However, as the within-group variances are assumed unchanged, it is impossible to compute the change in intra-group inequalities. As a result, poverty measures that are sensitive to the well-being distribution within the poor will be surely underestimated if the intra-group distribution is subject to important variations.

Research using the **first** approach includes Dervis et al. (1982), Chia et al. (1994), Khan, (1997), DecaluwÈ et al. (1999), L^ fgren (1999), Dorosh and Sahn (2000), L^ fgren et al. (1999), Evans (2001), Levin (2001), Bussolo and Round (2001), Harrison et al. (2003), Jensen and Tarr (2002) and AgÈnor, **Chen** and Grimm (2003).

The second approach is based on micro-simulations using individual data directly stored in the CGE model;<sup>11</sup> it consists in introducing as many agents as there are in the survey in order to save all the information about the heterogeneity with regards to endowments and consumption. The new income data produced by the simulations are integrated in the data

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<sup>10</sup> See, *inter alia*, Friedman (2000), Bannister and Thugge (2001), Winters (2000) Ö

<sup>11</sup> On this approach, see, among many others, Cogneau & Robillard (2000) and Cockburn (2001).

base, which allows for an endogenous determination of the intra-group distribution. Micro-simulation models produce better poverty and inequality analysis, but they are costlier in terms of calculations and data requirements, and may amplify the error risks.

Our choice is in favor of an intermediate approach which avoids some drawbacks of the previous ones. However, as indicated above, the effects of these income and price variations are examined in Bibi and Chatti (2005), and in this paper, we only examine the impact of trade liberalization on income distribution; assuming revenue neutral adjustments in indirect taxation.

### **3. The conceptual framework**

The conceptual framework used for this study is a dynamic financial CGE model incorporating the channels through which various policy changes, including trade liberalization, may affect the structure of output, employment and wages and poverty levels. It is based on the idea that poverty and unemployment cannot be addressed in a meaningful manner without a coherent macroeconomic framework accounting for the linkages between the labor market, the financial sector, the real sector and the government revenues and expenditures. It devotes a strong attention to the labor market.

This framework draws widely from the IMMPA and mini-IMMPA models, whose main features are relevant for Tunisia; in particular, the importance and the characteristics of the informal sector, the links between the financial system and the supply side, and the analysis of public expenditure. However, our framework is quite different, especially in the way it reflects some important characteristics of the Tunisian economy and addresses trade liberalization issues. The following are some features in our framework that make it different from IMMPA.

- Our framework accounts for the ongoing trade liberalization process and the country's commitment to form a free trade area with the European Union taken in 1995. It includes a large number of formal urban production sectors in order to determine the effect on the pattern of specialization.
- With this respect, alternative market structures, under both perfect and monopolistic competition, are also considered.
- Technical progress is introduced as a dynamic outcome of trade liberalization and as an important innovation.
- In IMMPA, a fixed exchange rate regime is assumed, whereas Tunisia has adopted a managed floating exchange regime, and has successfully protected its nominal and real exchange rates from instability due to external shocks. However, for the future, Tunisia is likely to become more open and more integrated in the global economy, and, hence, more exposed to international financial shocks.
- The effects of fiscal reforms on poverty and employment may also be simulated and assessed using a specific procedure.

Once the necessary changes are achieved and integrated in our framework, and taking advantage of its dynamic character, various policy scenarios are analyzed. For a given policy shock, the impact on poverty and on unemployment is explored, and it has been possible to generate unemployment rates for both skilled and unskilled labor over time for the chosen horizon, 15 years.

The main scenarios considered in this paper are linked to the abolition of trade barriers on manufactured goods as a result of the creation of the free trade areas and to the positive spillover effects leading to technical progress and productivity gains.

### **3.1. Treatment of the labor market**

The labor market and the level of employment and real activity are the key macroeconomic variables in this macroeconomic model; which intends to pay a stronger attention to the implications of labor market segmentation and to differences in wage formation and wage rigidity across various labor categories. The Tunisian labor market, like in all similar countries, is characterized by its segmentation and by the importance of the informal sector. The share of the informal sector in employment outside agriculture is currently about 30 percent in Tunisia. (It is even higher in some other countries: close to 50 percent in Morocco and in Egypt, for example).<sup>12</sup> The urban poor are also disproportionately employed in the informal sector.

Wage formation and the composition of the labor force tend to differ substantially between the formal and the informal segments of the labor market. Workers in the informal economy have relatively lower skill levels and face more flexible wages than in the formal sector. Wage differentials, unemployment, low productivity and low income are persistent in the informal sector.

Skilled workers are concentrated in the formal sector. As a result of both the relative scarcity of highly educated labor and its complementary with physical capital, wages for skilled workers tend to be high, relative to average wages in the economy. In addition, there is enough evidence suggesting that larger formal firms pay higher efficiency wages, especially to skilled workers. Efficiency wages are designed to motivate all the employees and maintain their loyalty and morale and to enhance the level of efforts and hence of productivity and to attract better workers. It is indeed observed in Tunisia that larger more modern firms pay higher average wages.

### **3.2. The treatment of the financial system**

There is a wide consensus that the financial sector is essential for growth and determines the speed and the structure of investments. Consequently, its performance explains, at least to a certain extent, the levels of employment and poverty.

As in IMMPA, some simplifying assumptions are adopted, mainly that savers have access only to a limited number of assets, money and bank deposits, and that commercial banks play a predominant role in the financial intermediation process, which abstracts from the more complex financial structure existing in Tunisia.

We also assume that Government runs a deficit and issues bonds. In contrast with IMMPA, we also recognize the fact that the informal sector, although it uses more labor intensive techniques, uses capital and invests in physical assets. It is indeed assumed that this sector has a limited access to financial services and is not totally excluded from the formal financial market.

Public finance also matters significantly. In spite of the consensus among economists that public investments (infrastructure, communications, education, basic health, security, and public institutions) are essential for production and employment, their effect has seldom been incorporated in macroeconomic models and development policy analysis. Ag nor (1996) and Loayza (1997) are among those who allowed for public goods and services in their studies of the informal sector. We assume that the stock of public capital affects directly not only the

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<sup>12</sup> See for instance Boughzala (2003) and Togan S & H Kheireddin (2003)

level of production in the urban formal sectors but also in the rural agriculture. Public infrastructure is crucial for all types of activities even though the informal sector cannot fully benefit from them, which partly explains its low productivity and wages, and makes employment in the informal sector less attractive. Not only the informal sector does not fully benefit from public goods and services, it does not contribute to their development since it hardly pays any taxes, needed to finance public goods and to deliver services.

Government policies matter in many other ways. In particular, Government subsidies and taxes, and hence tax reforms, always have significant effects on income distribution and on employment. Above all government policies may be more crucial in developing new industries and enhancing technical progress, which turns out to be essential in making trade liberalization and reforms potentially more beneficial.

### **3.3. Technical progress**

Usually, production is assumed to require intermediate goods, labor and capital, according to one of the standard production functions (CD, CES and fixed coefficients). IMMPA also assumes that there is a possibility of acquisition of new skills through training, and that public goods constitute an important production factor, but almost all other CGE models, including IMMPA do not even consider technical progress, in spite of the wide agreement that accumulation of physical and human capital does not fully explain growth and that technical progress is a major source of growth.

Allowing for technical progress and for the interaction between trade variables and technical progress is therefore a main improvement we are integrating into the analytical framework. The role of technological progress in growth models has been popularized with the development of the endogenous growth theory. Grossman and Helpman (1990a, 1990b), Romer (1990), Aghion and Howitt (1998), and Keller (2000), among many others, contributed theoretically and empirically to the clarification of the link between trade, technical progress and growth, especially trade of intermediate and capital goods. This is crucial because the most important benefit to be expected from trade liberalization is linked to technical progress and increasing returns to scale facilitated by the access to a much wider market and by the incentive generated by the need to compete internationally. However, some doubt has been cast on this claim, as it has been argued that trade does not always serve as a transmission mechanism of technical progress, and that the effectiveness of this mechanism depends on the domestic ability to innovate and imitate new technology and on the domestic accumulation of human capital and investment in R&D. In other words, if the local environment is not well prepared, or without a coherent technological policy, trade liberalization does not suffice to ignite and sustain significant technical progress and faster growth.

Indeed, we consider two scenarios: the first one is no technological progress is obtained, and under the second, Tunisia accumulates enough human capital and undertakes the necessary R&D to ensure that trade liberalization will be beneficial in terms of technical progress. The model is then used to reveal the impact of this technical progress on employment and poverty reduction and to verify in what sense allowing for technical progress can make a difference.

Given our concern with poverty and income distribution, the household sector is disaggregated into six household groups, identified by their source of income: two rural households and four urban households.

This is also a multi-sector model; which is a major development in this context.

The calculations are based on Tunisian data for 1998; the year for which all the required information for the construction of a complete social accounting matrix is available.

### 3.4. Production

**Fourteen productive sectors are defined** and denoted by indices  $i$  and  $j$ , with  $i$  and  $j = 1$  to 14. Except for the agricultural activity, which is assimilated to the rural sector (R) and identified by  $i = 1$ , the production of each of the remaining urban industries  $u = 2, 14$  could be simultaneously realized by three types of firms: Informal, private formal or state owned enterprise (SOE). The three types of firms are respectively identified by I, P and G; the set of urban firms is labeled  $f = I, P, G$ , and the set of all firms is denoted by  $k = R, I, P, G$ . From the national accounts data in 1998, it appears that the construction activity is fully informal and water and electricity are provided only by two state monopolies.

The economy is segmented in two ways: between formal and informal enterprises and between rural and urban enterprises.

In the rural area, enterprises produce one (aggregate) agricultural good, which is sold both domestically and abroad. The segmentation between the formal and informal components is becoming more essential. Informal firms produce non traded goods, whereas private formal firms produce tradable goods, a fraction of which is exported. The SOEs produce both non-tradable and tradable goods and services as they also participate in the export activities, namely in mining, petroleum, transport and telecommunications.

Gross output,  $X_k$ , of all categories of firms, rural, informal and formal, is produced by combining intermediates goods in fixed proportions and a composite of primary factors generating value added,  $V_k$ . Value added is given by a production function of the nested form, either Cobb-Douglas or CES of the various factors used in production (skilled and unskilled labor, land, specific physical capital ...).

For any  $k$ , we can write:

$$X_k = V_k + X_k \sum_i a_{ik}$$

Where  $a_{ik}$  are constant input- output coefficients.



**Table 6: Sectoral features of the Tunisian sectors in 1998 (in percentage)**

Sector	Status	VA/GDP	uld/tot_uld	sld/tot_sld	USAL/tot_USAL	SSAL/tot_SSAL
Agriculture	Rural	14.6	24.7	0.0	3.5	0.0
Food processing	Public	0.5	0.9	0.3	1.0	0.3
	Private	1.4	1.2	0.3	1.3	0.3
	Informal	1.7	1.6	0.0	0.9	0.0
Quarrying products	Public	0.7	0.7	0.3	0.8	0.3
	Private	0.8	0.6	0.3	0.7	0.3
	Informal	0.4	0.5	0.0	0.3	0.0
Mechanical	Public	0.5	0.8	0.4	0.9	0.4
	Private	1.9	1.9	0.8	2.1	0.8
	Informal	0.4	0.2	0.0	0.1	0.0
Chemicals	Public	1.4	0.7	0.4	0.8	0.4
	Private	1.0	0.7	0.3	0.8	0.3
	Informal	0.1	0.1	0.0	0.0	0.0
Textile, apparel and leather	Public	0.0	0.0	0.0	0.0	0.0
	Private	6.6	6.5	1.5	6.9	1.5
	Informal	1.0	1.8	0.0	1.1	0.0
Miscellaneous manufacture	Public	0.2	0.2	0.1	0.3	0.1
	Private	1.2	1.0	0.5	1.2	0.5
	Informal	1.3	0.7	0.0	0.4	0.0
Mining and petroleum	Public	2.5	1.2	1.2	1.7	1.2
	Private	1.3	0.1	0.1	0.1	0.1
	Informal	0.0	0.0	0.0	0.0	0.0
Electricity	Public	1.8	0.6	1.2	1.1	1.2
	Private	0.0	0.0	0.0	0.0	0.0
	Informal	0.0	0.0	0.0	0.0	0.0
Water	Public	0.5	0.5	0.4	0.7	0.4
	Private	0.0	0.0	0.0	0.0	0.0
	Informal	0.0	0.0	0.0	0.0	0.0
Construction	Public	0.0	0.0	0.0	0.0	0.0
	Private	0.0	0.0	0.0	0.0	0.0
	Informal	5.3	16.9	0.0	9.9	0.0
Transport and telecom.	Public	6.7	5.8	3.9	7.1	3.9
	Private	1.2	0.9	0.6	1.1	0.6
	Informal	1.0	1.7	0.0	1.0	0.0
Other services	Public	0.0	0.0	0.0	0.0	0.0
	Private	8.9	6.4	5.0	8.2	5.0
	Informal	18.9	13.4	0.0	7.9	0.0
Public services	Public	15.9	7.6	82.3	38.2	82.3
Total		100.0	100.0	100.0	100.0	100.0

**Notes:** VA/GDP represents the contribution of each type of firm in each sector to GDP; uld/tot\_uld is the share of each type of firm in each sector in total unskilled labor demand; sld/tot\_sld is the share of each type of firm in each sector in total skilled labor demand; usal/tot\_usal is the contribution of each type of firm in each sector to total unskilled labor wage bill; ssal/tot\_ssar is the contribution of each type of firm in each sector to total skilled labor wage bill.

Land is specific to the production of agriculture. Physical capital is firm specific, whereas unskilled labor is employed by all enterprises, the skilled are employed only by the formal urban enterprises and by government and SOEs.

In addition to private inputs, it is assumed along the lines of Rioja (1999) Loayza (1997) and Kato (2002) that private and public firms as well as farmers use the economy wide composite public stock of public goods (infrastructure, healthÖ ), which is provided by the government, as a given external input. Morrison and Schwartz (1996) and Kamps (2004), among others, have shown the positive effect of public goods on private investment and value-added. This assumption signifies that the benefits generated by these public goods are reaped mainly by the private sector.

All private firms maximize their profit. However, the model allows for alternative assumptions as to the structure of each market. For the formal sector, monopolistic competition is introduced as an alternative to perfect competition.

### **Rural Production**

Agricultural firms in rural areas produce the agricultural output (an aggregate product) using intermediate goods, land, unskilled labor, public capital and physical capital, implicitly assumed constant. Land is also in fixed amount; so the focus is on unskilled labor because it constitutes indeed the majority of the rural labor force. Their value-added is a Cobb-Douglas (CD) of land and of a constant- elasticity- of- substitution (CES) composite of unskilled labor  $U_A$  and the stock of public capital  $K_G$

$$V_A = A(K_G)CD(LAND_A, U_A)$$

### **Urban Informal Production**

Value-added in the informal urban sector is given by a simpler production function in order to reflect the simplicity of the techniques used by the firms of this sector. However, unlike IMMPA's assumption, it is quite evident in Tunisia that these firms use and invest in physical capital.

$$V_I = CD(U_I, K_I)$$

Hence, an extreme assumption is made: informal firms combine unskilled labor with capital, but do not use skilled labor and have no access to public capital. This is a strong assumption but it captures in a stylized way an important and real fact about the informal sector.

### **Urban Formal Private Production**

Urban formal production, both private and public, is essential for understanding the generation of unemployment, income distribution and growth. In this sector, both unskilled and skilled labors are important; and so are private physical capital and public capital. Moreover, because in this sector firms are larger than in the informal sector, the employer or the firm's manager cannot directly observe and control the employee's behavior and productivity. The size of the labor force is such that effort (*ef*) exerted by workers, which determines their productivity, is not directly observable and is worth isolating in the

production function. The latter is thus more complex; twice nested CES incorporated effort is assumed:

$$V_P = A(K_G)CES(CES(ef, S_P, K_P), ef.U_P)$$

where  $ef$ , denotes the level of on-the-job effort exerted by workers;  $S_P$  and  $U_P$  denote skilled and unskilled workers employed by the private formal firms. For this reason, formal firms pay efficiency wages.

### **State Owned Enterprises Production (SOE)**

Public firms' production function is given by:

$$V_G = A(K_G)CES(CES(S_G, K_P), U_P)$$

$U_G$  and  $S_G$  denote unskilled and skilled employment in SOEs. They are fixed by the government and are policy variables in the public administration. The wage rate that skilled workers receive in the public sector is the same as in the private activities; it is equal to the efficiency wage. How are these and other wages determined?

## **3.5. Wages, Employment, and Unemployment**

Both the government and private firms in the formal and informal urban sectors use unskilled labor in production. The wage rate paid to unskilled labor in the formal urban sector is assumed to be systematically greater than the wage rate paid in the informal sector as a result of the efficiency wage mechanism. Indeed, in Tunisia, wages paid by the formal sector are generally higher than those paid by the informal sector and generally higher than the legal minimum wage; in IMMPA, the minimum wage is the wage paid to the unskilled by all the formal private and public firms, and the informal sector always pays less than the minimum wage. While the average wage in the Tunisian informal sector is close to the minimum wage, there are actually important variations depending on the type of activity. Consequently, unskilled workers in the urban area will always seek employment in the private formal sector first. Likewise, urban wages are higher than the rural ones.

Mobility of the unskilled labor force between the rural and the urban areas, and between the formal and the informal sectors is assumed to be determined by expected income opportunities, according to the Harris-Todaro hypothesis based on expected (not observed) wage differentials. Given the lower probability to find employment in the formal sector and more generally in the urban area, part of the workers stay in the rural areas and others in the informal sector where it is easier to find employment but at a lower wage. It is assumed that the expected urban wage is equal to the observed average real wage weighted by the probability of being hired in the private sector and this probability can be approximated by the ratio of employed workers to those seeking employment. Hence, the total supply of unskilled workers in the formal sector (including public sector workers),  $U_F$ , is taken to change over time as a function of the expected wage differential across sectors. Wage and employment prospects are formed on the basis of prevailing conditions in the labor market.

As to public employment it is not included in the definition of the expected urban wage because there has recently been very little unskilled labor turnover and employment in the public sector; the lack of turnover is in part due to the fact that working for the government provides a non-pecuniary benefit, which takes the form of greater job security. As noted earlier, the employment levels of both skilled and unskilled workers in the public urban activities are taken as exogenous.

The specification used for determining wages in the private activities is based on the efficiency wage hypothesis as explained in Greenwald and Stiglitz (1995) and Maechler and Roland-Holst (1997). It is the wage that motivates workers so as to produce maximum profit to the firm. It must be higher than the equilibrium market wage because it is such that the opportunity cost of being fired is high for the worker; and, based on this fact he will exert more efforts. It is also admitted that the higher the unemployment rate, the higher the opportunity cost for the worker and the more effort he would be willing to make. A higher wage leads to more effort with a decreasing marginal benefit for the firm. Obviously, unskilled labor supply in the urban areas is the sum of supply in the formal sector and supply in the informal sector. Between the two, mobility is prompted by the wage differential and slowed by the unemployment rate in the formal sector. Indeed, it is assumed that the informal labor market is totally flexible and, consequently, unemployment happens only in the formal sector.

Skilled workers who are unable to find a formal sector job are assumed to all prefer unemployment to entering the informal economy, as a result of either a reservation wage that systematically exceeds the informal sector wage, or concerns about adverse signaling effects to potential future employers, as argued in a different setting by McCormick (1990) and Gottfries and McCormick (1995).

As to the unskilled wanting a formal job, some of them keep searching and waiting and, hence, stay unemployed; the rest will accept work in the informal sector. This is how unskilled unemployment is generated: through a combination of efficiency wage behavior on the firm side and of a job search process with a preference for formal jobs on the worker's side.

The evolution of the unskilled labor supply in the rural areas is such that, at any given time,  $U_R$  is equal to the previous period level multiplied by the demographic growth factor minus migration to the urban areas ( $MIG_U$ ).

$$U_R = U_{R,-1}(1 + g_R) - MIG_U$$

The evolution of the unskilled labor in the urban areas is determined by demographic growth plus migration minus those who are upgraded to the skilled labor through training.

$$U_U = U_{U,-1}(1 + g_U) + MIG_U - SKL$$

$$U_U = U_{UF} + U_{UI}$$

In the informal labor market, demand is equal to supply, which determines the informal equilibrium wage. In the formal market, excess supply prevails.

The evolution of the skilled labor force depends on the rate at which unskilled workers acquire skills:

$$S = S_{-1} + SKL$$

**The acquisition of skills** by unskilled workers is possible and would allow them to move to the skilled category. Acquisition of skills is assumed to depend on the difference between the expected consumption wages for skilled and unskilled urban workers (as a proxy for the future stream of earnings associated with higher levels of education), and on the government ability to invest in skills indicated by the stock of capital used for education.

The private demand functions for all production factors, in particular for skilled and unskilled labor are the result of profit maximization. Government and SOEs demand is exogenous.

It is clear that at equilibrium, there is unemployment of the skilled and the unskilled as long as there is wage differential between the formal and the informal sectors. At equilibrium,

by definition, the expected unskilled wage is equalized in both sectors, but not the observed wages.

### 3.6. Market structures

#### 3.6.1. Demand

Producers demand composite goods, imported and local, for intermediate use, according to a Leontief input-output technology; that is, the coefficients of intermediate goods in production are fixed. The model furthermore explicitly features the expenditures flows arising from government behavior and the activities of private investors.

It is assumed that both government expenditures, saving and transfers to households are in fixed proportion of their revenue. Government expenditures consist of current expenditures as well as productive public investment. It is also made a distinction between the investments in infrastructure, education and health.

More generally, as in IMMPA, we assume that all the components of aggregate demand (intermediate and final consumptions government and investment demand), for each sector are determined by fixed coefficients. Households allocate their income to consumption and saving; then, by aggregating over households, total final consumption is obtained, and final consumption for each commodity is derived by applying predetermined consumption coefficients.

$$C_i = \sum_h cc_{ih} CON_h$$

$cc_{ih}$  is the final consumption coefficient for product  $i$  by household  $h$ . Six (categories of) households are defined depending on their source of income: two rural (workers and land owners), and four urban categories: unskilled workers in the informal sector, unskilled workers in the formal sector (private and public) skilled workers in the formal sector (private and public), and employers in the formal and informal sectors.

$C_{ih}$  is consumption of product  $i$  by household  $h$ ;  $CON_h$  is total consumption of household  $h$  and  $C_i$  is total final demand for product  $i$ .

The same reasoning applies to investments.

**Table 7: Characteristics of household groups**

Household type	Population Share (%)	Poverty Index <sup>a</sup> (%)	Per capita income (TND)
H1: Landholders	13.7	10.6	<b>670</b>
H2: Agriculture laborer	9.9	19.7	<b>498</b>
H3: Unskilled households in the informal sector	29.3	4.1	<b>747</b>
H4: Unskilled households in the formal (private and public) sector	33.8	4.8	<b>764</b>
H5: Skilled households in the formal (private and public) sector	9.9	0	<b>1937</b>
<b>H6: Capitalists in the private and informal sectors</b>	<b>3.4</b>	<b>0</b>	<b>2957</b>

<sup>a</sup> Percentage of households in the group below the lower poverty line estimated by the World Bank (1999) based on 1995 household survey.

### **3.6.2. External trade**

Informal firms do not produce traded goods. The SOEs export mining and petroleum products and transport and telecommunication services. Basically we use the same assumption as in IMMPA; which gives that export of product  $i$  ( $E_i$ ) is determined by the ratio of world price to the domestic price of this product with a constant elasticity of **transformation** between foreign and domestic products. Obviously, alternative and less restrictive specifications are available.

### **3.6.3. Profits and Income**

Firms reinvest part of their profit, and also pay interest on loans they contracted. Household income is constituted of labor salaries, distributed profits, transfers, and net interest receipts on holdings produced by their financial assets, mainly in the form of bank deposits. Of course, income varies according to the type of household. These types are defined according to their source of income.

Allocation of income to final consumption and saving is simply determined by constant rates.

### **3.6.4. Supply**

Rural and informal firms are assumed to operate in perfectly competitive markets whereas formal firms producing tradable goods operate under monopolistic competition.

### **3.6.5. Government**

Government expenditures  $G$  consist of final consumption  $GC$  and public investment.  $GC$  has only demand-side effects, while public investments have both demand and supply side effects. Total public investment consists of investment in infrastructure, education and health; which are all considered exogenous policy variables.

## **3.7. The Financial Sector**

For the modeling of the financial sector we focus mainly on the structure of household portfolios, the demand for credit by firms, and the behavior of commercial banks and of the central bank. Overall, simple specifications are tentatively adopted (they may be reconsidered in future studies).

### **○ Households**

We assume that households allocate their wealth to either money in the form of cash or to bank deposits producing interests according to their relative rates of return. They demand cash because it is more liquid. Hence their real money demand depends positively on real income and negatively on inflation and the rates of interest.

- **Firms**

As to investment, our focus is on the urban private firms only. Firms' decision to invest depends on several factors: the after-tax rate of return to capital relative to the cost of funds, the availability of public capital and an accelerator effect indicated by changes in real GDP.

- **Commercial Banks**

Banks are at the heart of the financial system in the economy. We assume, as in IMMPPA, that banks do not accumulate assets and therefore entirely allocate the funds they receive (domestic deposits and foreign loans) to reserve requirements and loans to the private sector and to the government. The actual stock of loans is demand determined, and if there is excess demand, banks borrow the required funds from abroad.

- **Central Bank**

The central bank acts as a regulator through the interest rate but not as a last resort lender. The asset side of the central bank balance sheet consists of domestic credit to the government and the private sector, and the stock of foreign reserves. For simplicity, the focus is on loans to the government, while commercial banks are assumed to serve the private sectors. Liabilities consist only of the monetary base. The central bank net worth is taken to be constant and normalized to zero.

Whereas domestic credit to the government is treated as an exogenous policy variable, the accumulation of foreign reserves depends on the balance of payments, as any current account surplus (or deficit) must be compensated by a net flow of foreign capital. Note that if the exchange rate was really flexible, the foreign reserve FF would be constant. In fact, Tunisia has an administered flexible exchange regime which does not ensure full stabilization of the balance of payment. Hence, the need for foreign capital has been persistent.

In the simulations reported below, the public foreign borrowing is assumed exogenous while the private foreign borrowing adjusts to equilibrate the balance of payments.

The basic equations of the model in the case of absence of technical progress and technological spillover through trade are presented in two main blocks: the physical (non financial) block, which is the main one, and the financial block. The simulations are undertaken with and without the financial block.



### 3.8. The Model

**Table 8: The real block**

	<b>Factor demand</b>	
Unskilled labor demand in agriculture	$ULD_{AR} = \frac{X_{AR}}{AT_{AR}} \left( \frac{\alpha_{X_{AR}} PL}{(1 - \alpha_{X_{AR}}) WR} \right)^{1 - \alpha_{X_{AR}}}$	1
Land demand in agriculture	$LAND_{AR} = \frac{X_{AR}}{AT_{AR}} \left( \frac{(1 - \alpha_{X_{AR}}) WR}{\alpha_{X_{AR}} PL} \right)^{\alpha_{X_{AR}}}$	2
Primary factors cost in agriculture	$PFC_{AR} = WR ULD_{AR} + PL LAND_{AR}$	3
Land market equilibrium condition	$\overline{LAND}^S = \sum_A \sum_R LAND_{AR}$	4
Rural labor market equilibrium condition	$RUR\_ULS = \sum_A \sum_R ULD_{AR}$	5
Unskilled labor demand by informal urban firms	$ULD_{il} = \frac{X_{il}}{AT_{il}} \left( \frac{\alpha_{X_{il}} R_{il}}{(1 - \alpha_{X_{il}}) WI} \right)^{1 - \alpha_{X_{il}}}$	6
Specific capital demand by informal urban firms	$\overline{KD}_{il} = \frac{X_{il}}{AT_{il}} \left( \frac{(1 - \alpha_{X_{il}}) WI}{\alpha_{X_{il}} R_{il}} \right)^{\alpha_{X_{il}}}$	7
Primary factors cost of informal urban firms	$PFC_{il} = WI ULD_{il} + R_{il} \overline{KD}_{il}$	8
Unskilled labor demand by SOEs	$ULD_{iG} = \frac{X_{iG}}{AT_{iG}} \frac{\left( \frac{\alpha_{X_{iG}} R_{iG}}{(1 - \alpha_{X_{iG}} - \beta_{X_{iG}}) WM} \right)^{1 - \alpha_{X_{iG}}}}{\left( \frac{\beta_{X_{iG}} R_{iG}}{(1 - \alpha_{X_{iG}} - \beta_{X_{iG}}) WS} \right)^{\beta_{X_{iG}}}}$	9
Skilled labor demand by SOEs	$SLD_{iG} = \frac{X_{iG}}{AT_{iG}} \frac{\left( \frac{\beta_{X_{iG}} R_{iG}}{(1 - \alpha_{X_{iG}} - \beta_{X_{iG}}) WS} \right)^{1 - \beta_{X_{iG}}}}{\left( \frac{\alpha_{X_{iG}} R_{iG}}{(1 - \alpha_{X_{iG}} - \beta_{X_{iG}}) WM} \right)^{\alpha_{X_{iG}}}}$	10
Specific capital demand by SOEs	$\overline{KD}_{iG} = \frac{X_{iG}}{AT_{iG}} \frac{\left( \frac{\alpha_{X_{iG}} R_{iG}}{(1 - \alpha_{X_{iG}} - \beta_{X_{iG}}) WM} \right)^{-\alpha_{X_{iG}}}}{\left( \frac{\beta_{X_{iG}} R_{iG}}{(1 - \alpha_{X_{iG}} - \beta_{X_{iG}}) WS} \right)^{\beta_{X_{iG}}}}$	11
Primary factors cost of SOEs	$PFC_{iG} = WM ULD_{iG} + WS SLD_{iG} + R_{iG} \overline{KD}_{iG}$	12
Primary factors cost of Central Government	$PFC_{GOV} = WM \overline{ULD}_{GOV} + WS \overline{SLD}_{GOV}$	13
Unskilled labor demand by formal private firms	$ULD_{iP} = \left( \frac{X_{iP}}{AT_{iP}} \right)^{1 - \Omega_{X_{iP}}} \left( \frac{\alpha_{iP} PFC_{iP}}{WM} \right)^{\Omega_{X_{iP}}}$	14
Capital and skilled labor composite demand by formal private firms	$SK_{iP} = \left( \frac{X_{iP}}{AT_{iP}} \right)^{1 - \Omega_{X_{iP}}} \left( \frac{(1 - \alpha_{iP}) PFC_{iP}}{PSK_{iP}} \right)^{\Omega_{X_{iP}}}$	15
Primary factors cost of formal private firms	$PFC_{iP} = WM ULD_{iP} + PSK_{iP} SK_{iP}$	16

**Skilled labor demand by formal private firms**

$$SLD_{iP} = SK_{iP} \left( \frac{AK_{iP}(1-\gamma_{iP})PSK_{iP}}{WS} \right)^{\Psi_{X_{iP}}} \quad 17$$

**Specific capital demand by formal private firms**

$$KD_{iP} = SK_{iP} \left( \frac{AK_{iP}\gamma_{iP}PSK_{iP}}{R_{iP}} \right)^{\Psi_{X_{iP}}} \quad 18$$

**Capital and skilled labor composite price**

$$PSK_{iP}SK_{iP} = WS SLD_{iP} + R_{iP} KD_{iP} \quad 19$$

**Labor market**

**Informal labor market equilibrium condition**

$$ILS = \sum_i ULD_{iI} \quad 20$$

**Urban unskilled labor unemployment**

$$U\_Unemp = \frac{FSUF - \sum_i (ULD_{iP} + ULD_{iG})}{FSUF} \quad 21$$

**Evolution of formal unskilled labor supply**

$$FSUF_t = FSUF_{t-1} \left( \frac{WM_{t-1}(1-u\_unemp_{t-1})}{WI_{t-1}} \right)^{\sigma_{FSUF}} \quad 22$$

**Urban total labor population**

$$URB\_ULS = ILS + FSUF \quad 23$$

**Skilled labor unemployment**

$$S\_Unemp = \frac{URB\_SLS - \sum_i (SLD_{iG} + SLD_{iP})}{URB\_SLS} \quad 24$$

**Rural population growth**

$$RUR\_ULS_T = (1 + \bar{g}_{RUR})RUR\_ULS_{(T-1)} - MIG_T \quad 25$$

**Migration**

$$MIG_T = A_{MIG}RUR\_ULS_{(T-1)} \left( \frac{WUE}{WRE} \right)^{\sigma_{MIG}} \quad 26$$

**Expected urban wage**

$$WUE = \frac{\theta WM_{(T-1)} + (1-\theta)WI_{(T-1)}}{CPI_{H4(T-1)}} \quad 27$$

**Expected rural wage**

$$WRE = \frac{WR_{(T-1)}}{CPI_{H2(T-1)}} \quad 28$$

**Weight in the expected urban wage**

$$\theta = \frac{\sum_i ULD_{iP(T-1)}}{URB\_ULS_{(T-1)} - \sum_i ULD_{iG(T-1)}} \quad 29$$

**Consumer price index**

$$CPI_H = \sum_i a_{con_{iH}} PQ_i \quad 30$$

**Urban unskilled labor growth**

$$URB\_ULS_T = (1 + \bar{g}_U)URB\_ULS_{(T-1)} + MIG_T - SKL_T \quad 31$$

**Formal labor population growth**

$$\frac{FSUF_T}{FSUF_{(T-1)}} = B_{FSUF} \frac{\sum_i ULD_{iP(T-1)}}{FSUF_{(T-1)} - \sum_i ULD_{iG(T-1)}} \left( \frac{WM_{(T-1)}}{WI_{(T-1)}} \right)^{\sigma_{FSUF}} \quad 32$$

**Skilled labor population growth**

$$URB\_SLS_T = URB\_SLS_{(T-1)} + SKL_T \quad 33$$

**Skill Formation**

$$SKL_T = \lambda_{SKL}URB\_SLS_{(T-1)} \left( \frac{WSE}{WUE} \right)^{\sigma_W} \left( \frac{KPub_{EDU(T-1)}}{URB\_SLS_{(T-1)}} \right)^{\sigma_{KE}} + (1 - \lambda_{SKL})SKL_{(T-1)} \quad 34$$

**Expected skilled labor wage**

$$WSE = \frac{WS_{(T-1)}}{CPI_{H5(T-1)}} \quad 35$$

**Prices**

**Import price**

$$PM_i = ER(1 + tm_i)(1 + tc_i - sc_i)\overline{WPM}_i \quad 36$$

**Export price**

$$PE_{ik} = \overline{WPE}_{ik}ER \quad 37$$

$$PDFD_{ik} = (1 + tc_i - sc_i)PDF_{ik} \quad 38$$

	<b>Trade equations in the competitive sectors</b>	39
<b>Imports demand</b>	$XM_i = Q_i \left( \frac{AM_i \alpha_{M_i} PQ_i}{PM_i} \right)^{\Phi_{M_i}}$	40
<b>Composite local good demand</b>	$XD_i = Q_i \left( \frac{AM_i (1 - \alpha_{M_i}) PQ_i}{PD_i} \right)^{\Phi_{M_i}}$	41
<b>Armington composite good price</b>	$PQ_i Q_i = PD_i XD_i + PM_i XM_i$	42 43
<b>Local demand of informal, private and SOEs goods</b>	$XDF_{if} = \frac{XD_i}{AD_i} \left( \frac{\alpha_{D_{if}} AD_i PD_i}{PDFD_{if}} \right)^{\Phi_{D_i}}$	44
<b>Local composite good unit price</b>	$PD_i XD_i = \sum_f XDF_{if} PDFD_{if}$	45
<b>Export supply</b>	$XE_{ik} = \frac{X_{ik}}{AE_{ik}} \left( \frac{PE_{ik}}{AE_{ik} \alpha_{E_{ik}} PX_{ik}} \right)^{\Phi_{E_{ik}}}$	46
<b>Local supply by local firm type</b>	$XDF_{ik} = \frac{X_{ik}}{AE_{ik}} \left( \frac{PDF_{ik}}{AE_{ik} (1 - \alpha_{E_{ik}}) PX_{ik}} \right)^{\Phi_{E_{ik}}}$	47
<b>Gross production unit price</b>	$PX_{ik} X_{ik} = PDF_{ik} XDF_{ik} + PE_{ik} XE_{ik}$	48
	<b>Trade equations in sectors with monopolistic competition</b>	49
<b>Composite price of local and imported varieties</b>	$PDS_n = \left( N_n^* PM_n^{1-\sigma_n} + N_{nP} PDFD_{nP}^{1-\sigma_n} \right)^{\frac{1}{1-\sigma_n}}$	50
	<b>Demand</b>	
<b>First-order condition of utility maximization</b>	$\frac{XDF_{nP}}{XM_n} = \frac{N_{nP}}{N_n^*} \left( \frac{PM_n}{PDFD_{nP}} \right)^{\sigma_n}$	51
<b>Operating surplus in rural activities</b>	$PROF_R = \sum_A PL LAND_{AR}$	52
<b>Composite price of informal and public firms goods</b>	$PCIG_n CIG_n = PDFD_{nI} XDF_{nI} + PDFD_{nG} XDF_{nG}$	53
<b>Local demand of good produced by informal firms in sector n</b>	$XDF_{nI} = \frac{CIG_n}{AT\_IG_n} \left( \frac{\alpha\_IG_{nI} AT\_IG_n PCIG_n}{PDFD_{nI}} \right)^{\sigma\_CIG_n}$	54
<b>Local demand of good produced by public firms in sector n</b>	$XDF_{nG} = \frac{CIG_n}{AT\_IG_n} \left( \frac{\alpha\_IG_{nG} AT\_IG_n PCIG_n}{PDFD_{nG}} \right)^{\sigma\_CIG_n}$	55
<b>Composite good of private and imported varieties</b>	$DS_n = \frac{Q_n}{AM_n} \left( \frac{AM_n \alpha\_DS_n PQ_n}{PDS_n} \right)^{\sigma\_M_n}$	56
<b>Composite of public and informal goods in each sector n</b>	$CIG_n = \frac{Q_n}{AM_n} \left( \frac{AM_n (1 - \alpha\_DS_n) PQ_n}{PCIG_n} \right)^{\sigma\_M_n}$	57
<b>Composite consumption price</b>	$PQ_n Q_n = PCIG_n CIG_n + PDS_n DS_n$	58
<b>Foreign decreasing export demand</b>	$XE_{nP} = AEW_{nP} WPE_{nP}^{-eIa_n^e}$	59
<b>Fixed proportion of imported and local varieties</b>	$\overline{NN}_n = \frac{N_{nP}}{N_n^*}$	60

<b>Imported variety level</b>	$XMF_n = \frac{XM_n}{N_n^*}$	61
<b>Level of domestic variety</b>	$XDF_{nP} = \frac{XDF_{nP}}{N_n}$	62
<b>Operating surplus of urban firms</b>	$PROF_f = \sum_i R_{iF} (KD_{if} + N_{if} KFF_{if})$	63
<b>Net profit</b>	$NPROF_k = PROF_k (1 - ctx_k) - IL_{T-1} DL_{k(T-1)} - ER \text{ IFF } FL_{k(T-1)}$	64
<b>Price level</b>	$plev = \frac{\sum_H \sum_i PQ_i XAC_{0iH}}{\sum_H \sum_i PQ_{0i} XAC_{0iH}}$	65
<b>Income saving and investments</b>		
<b>Firms saving</b>	$SAVF_k = sf_k NPROF_K$	66
<b>Households' non labor revenue</b>	$NLYH_h = \sum_k \rho_{hk} (1 - sf_k) NPROF_k + \varepsilon_h GTH + \chi_h ER \overline{ROWTH}$	67
<b>Landholders group revenue</b>	$YH_{h1} = NLYH_{h1}$	68
<b>Agricultural workers group revenue</b>	$YH_{h2} = NLYH_{h2} + WR ULD_{AR}$	69
<b>Urban informal household group revenue</b>	$YH_{h3} = NLYH_{h3} + WI \sum_i ULD_{iI}$	70
<b>Formal unskilled workers group revenue</b>	$YH_{h4} = NLYH_{h4} + WM \sum_i (ULD_{iP} + N_{iP} ULFF_{iP} + ULD_{iG})$	71
<b>Formal skilled workers group revenue</b>	$YH_{h5} = NLYH_{h5} + WS \sum_i (SLD_{iP} + N_{iP} SLFF_{iP} + SLD_{iG})$	72
<b>Urban capitalists group</b>	$YH_{h6} = NLYH_{h6}$	73
<b>Household group disposable revenue</b>	$YD_h = (1 - rtx_h) YH_h$	74
<b>Household group saving</b>	$SAVH_h = sh_h YD_h$	75
<b>Total consumption expenditures</b>	$HTC_h = (1 - sh_h) YD_h$	76
<b>Final consumption demand</b>	$XAC_{ih} = con_{ih} \frac{HTC_h}{PQ_i}$	77
<b>Investment demand by sector of origin</b>	$XAI_i = ainv_i \frac{PK}{PQ_i}$	78
<b>Domestic absorption</b>	$Q_i = \sum_h XAC_{ih} + \sum_k \sum_j CI_{ijk} + XAG_i + XAI_i$	79
<b>Investment profitability</b>	$RK_{iP} = \frac{R_{iP}}{PK}$	80
<b>Investment demand</b>	$\frac{IND_{iPT}}{KD_{iP(T-1)}} = AI_{UPT} \frac{\left[ \frac{KPub_{INFT}}{KPub_{INF(T-1)}} \right]^{\sigma_{KI}} \left[ \frac{GDP_T}{GDP_{(T-1)}} \right]^{\sigma_{GDP}}}{\left[ (1 + RK_{iPT}) (1 - rtx_{H6}) \right]^{\sigma_{RK}}}$	81
<b>Total investment</b>	$ZI = \sum_i IND_{iP}$	82
<b>Capital accumulation</b>	$KD_{iPT} = (1 - \delta_{iP}) KD_{iP(T-1)} + IND_{iP(T-1)}$	83
<b>Government</b>		
<b>Fiscal revenue</b>	$TXREV = \sum_i tm_i ER \overline{WPM}_i XM_i + \sum_i \sum_k tx_{ik} (PDF_{ik} XDF_{ik} + PE_{ik} XE_{ik}) + \sum_h rtx_h YH_h + \sum_k ctx_k PROF_k - \sum_i (sc_i + sc_i tm_i) \overline{WPM}_i XM_i - \sum_i \sum_{sr} sc_i PDF_{i,sr} XDF_{i,sr}$	84
<b>Government revenue</b>	$YG = TXREV + \sum_i R_{iG} \overline{KD}_{iG}$	85
<b>Government transfers to</b>		86

<b>households</b>	$GTH = \varphi YG$	
<b>Government total expenditures</b>	$CTG = \eta YG$	87
<b>Public investment</b>	$IPub_{gk} = IPubshr_{gk} CTG$	88
<b>Government current expenditures</b>	$GC = \left(1 - \sum_{gk} IPubshr_{gk}\right) CTG$	89
<b>Government saving</b>	$SAVG = (1 - \varphi - \eta)YG - \nu ER BOP$	90
<b>Government consumption</b>	$XAG_i = agov_i \frac{CTG}{PQ_i}$	91
<b>Public capital accumulation</b>	$KPub_{GKT} = (1 - \delta_{GK})KPub_{GK(T-1)} + IPub_{GK(T-1)}$	92
<b>Composite of Public capital stocks</b>	$KGT = \left[\varpi KPub_{INF}^\rho + (1 - \varpi)KPub_{HEL}^\rho\right]^{\frac{1}{\rho}}$	93
<b>Public capital stock externality</b>	$ATT_{ik} = ATT_{ik} KGT^\zeta$	94
<b>Growth</b>		
<b>Value-added</b>	$VA_{i,k} = ax_{i,k} X_{i,k}$	95
<b>Value-added price</b>	$PVA_{i,k} VA_{i,k} = PX_{i,k} X_{i,k} - \sum_j PQ_j CI_{j,i,k}$	96
<b>Real GDP</b>	$GDP = \sum_i \sum_k PVA_{i,k} VA_{i,k}$	97
<b>Real GDP growth</b>	$GDP_T = (1 + g_{GDP})GDP_{(T-1)}$	98
<b>Total factor productivity growth</b>	$ATT_{ik} = ATT_{ik} \left(\frac{SKL}{SKL_{T-1}}\right)^{0.6} \left(\frac{\sum_i XM_i}{\sum_i XM_{i(T-1)}}\right)^{0.3}$	99

**Table 9: The financial block (nearly the same as in IMMPA):**

<b>Non-distributed profit of banks</b>	$NPROF_{Bank} = IL_{T-1} \left( \sum_k DL_{k(T-1)} + DLG_{T-1} \right) - ID \sum_H DD_{H(T-1)} - IFF \ ER \ FL_{Bank_{T-1}}$	100
<b>Foreign borrowing</b>	$ER \ \Delta FL_{Bank} = \sum_k \Delta DL_k + \Delta DLG - (1 - rreq) \sum_H \Delta DD_H$	101
<b>Interest rate on domestic loans</b>	$IL \ (1 - rreq) = pr \ ID^{\alpha_b} \left( (1 + IFF) (1 + EDEV) - 1 \right)^{1 - \alpha_b}$	102
<b>Premium</b>	$pr = \lambda_{-pr} \left( \delta_{-c} \left( PK \sum_i KD_{ip} - ER \ FL_p \right) \right)^{-\gamma - pr} DL_p^{-pr} + (1 - \lambda_{-pr}) pr_{T-1}$	103
<b>Inflation</b>	$plev_T = (1 + PInf) plev_{T-1}$	104
<b>Devaluation</b>	$dev \ ER_{T-1} = ER - ER_{T-1}$	105
<b>Expected devaluation</b>	$Edev = \lambda_{-dev} \ dev_{T-1} + (1 - \lambda_{-dev}) dev$	106
<b>Household's wealth</b>	$WT_h = H_h + DD_h$	107
<b>Household's demand for money</b>	$H_h = \gamma_h P \left( \frac{Y_h}{P} \right)^{\sigma_h} (1 + IL)^{-\beta_h} (1 + \pi) (1 + Edev)^{-\beta_h}$	108
<b>Money supply</b>	$H^S = \sum_h H_h$	109
<b>Private investment</b>	$PK.Z_P = \Delta DL_P + ER \Delta FL_P + re.YF_P$	110
<b>Banks reserve requirements:</b>	$RR = rreq \sum_h DD_h$	111
<b>Commercial banks balance sheet</b>	$NW_{PB} = DL_P + DL_G + RR - \sum_h DD_h - ER.FL_B$	112
<b>Central bank's net worth</b>	$NW_{CB} = DCG + ER.FF - MB$	113
<b>Monetary base changes</b>	$MB = MB_{-1} + \Delta DC_G + ER.\Delta FF$	114
<b>Central bank's profit</b>	$PROF_{CB} = IL.DC_{G,-1} + IL_F.FF_{-1}$	115
<b>Government saving</b>	$DEF = \sum_G (PV_G X_G - WM.U_G + WS.S_G) + PROF_{CB} + TXREV - G - IF.ER.FL_{G,-1} + IL.(DC_{G,-1} + DL_{G,-1})$	116
<b>Total tax revenue</b>	$DEF = ER.\Delta FL_G + \Delta DL_G + \Delta DC_G$	117

**List of endogenous variables**

$CI_{ijk}$	Intermediate consumption of good $i$ by firm $k$ in sector $j$
$X_{ik}, PX_{ik}$	Quantity and price of composite output
$TIC_{ik}, PFC_{ik}, TC_{ik}$	Total intermediate goods, primary factors and total costs
$ULD_{ik}, SLD_{ik}$	Unskilled and skilled labor demands
$VA_{ik}, PVA_{ik}$	Value added quantity and price
$WR, WI, WM, WS$	Rural, informal, formal unskilled and skilled wages
$WRE, WUE, WSE$	Expected rural, urban unskilled and skilled wages
$RUR\_ULS, URB\_ULS, URB\_SLS$	Rural, urban unskilled and urban skilled labor supply
$FSUF, ILS$	Formal and informal unskilled labor supply
$U\_Unemp, S\_Unemp$	Unskilled and skilled labor unemployment
$MIG, SKL$	Migration and skill formation
$\Theta$	Weight in the migration function
$KPub_{gk}, IPub_{gk}$	Public capital stock and investment in infrastructure, education or health
$SK_{iP}, PSK_{iP}$	Composite of skilled and capital level and price
$KD_{ik}, R_{ik}$	Capital demand and price; demand is fixed for informal and public firms
$Land_{AR}, PL$	Land demand and price
$XM_i, PM_i$	Import level and price
$XD_i, PD_i$	Composite local good demand and price
$XDF_{ik}, PDF_{ik}, PDFD_{ik}$	Local supply by firm type and supply and demand price of firm's local good
$XE_{ik}, PE_{ik}$	Export level and price by sector and firm
$Q_i, PQ_i$	Armington composite good level and price
$GDP, gGDP$	Real GDP level and growth
$K_G$	Composite public capital stock
$ATT_{ik}$	Total factor productivity growth
$PROF_k, NPROF_k$	Firm's operating surplus and non-distributed operating surplus
$YH_H, YD_H$	Household group's revenue and disposable revenue
$SAVF_b, SAVH_H, SAVG$	Firm's, household's and government saving
$XAI_b, XAC_{iH}, XAG_i$	Composite demand of good $I$ for investment and households and government consumption
$RK_{iP}, IND_{iP}$	Investment profitability and investment demand
$ZI, PK$	Total investment and total investment deflator
$YG, TXREV$	Government revenue and fiscal receipts net of subsidies
$CTG, GC, GTH$	Government total and current expenditures and transfers to household groups
$NLYH_H, HTC_H$	household group's non labor revenue and total consumption expenditures
$CPI_H$	Household group's consumption price index
$ER$	Exchange rate
$IL, IL_f$	Domestic Interest rate, foreign interest rate

**List of exogenous variables**

$LAND^s$	Land supply
$WPM_b, WPE_i$	World price of import and export
$tm_b, tc_b, sc_i$	Tariff rates and consumption taxes and subsidies
$PINDEX$	Price index chosen as numéraire
$a_{ij}$	Input-output coefficient
$ULFF, SLFF, KFF$	Fixed unskilled and skilled labor and fixed capital

Technical progress is built in the model by assuming that global factor productivity grows as a result of the concomitant action of three factors: imports growth of technically advanced production goods, the formation of additional skills and the investment in R&D prompted by government investment. We implicitly assume that a proportion of total imports is in the form of technically advanced production goods; which incorporate R&D and technical progress achieved in the partner countries (the EU). As to domestic R&D, it is also assumed that part of government capital formation is allocated to R&D enabling activities. Thus growth of public capital is used as a raw indicator of domestic R&D.

That is, in the formal sector, technical progress is enhanced by skill, imports and public capital growth.

$$at\_x(i, sr, t) = at\_x(i, sr, t - 1) \left[ \left( \frac{Skill(t)}{Skill(t-1)} \right)^2 \left( \frac{M(t)}{M(t-1)} \right) \right]^{0.4} \left[ \frac{kg(i, sr, t)}{kdt(t)} \frac{kg(i, sr, t-1)}{kdt(t-1)} \right]^{0.25} \quad (118)$$

#### 4. Simulations and results

**Six scenarios** over the period 1999 to 2015 are studied and will be presented here. 1999 is chosen as the initial year because the model is calibrated with 1998 data. Moreover, in order to isolate the effect of the financial system on the functioning of the economy some calculations are performed using the same model but without its financial block. The difference between the performances of the economy with and without the financial sector indicates the impact of the financial sector on the economy.

**Sim 1:** the first one is the base line scenario where no reforms take place. The economy evolves mainly as a result of natural demographic growth as projected by the national statistic institute (INS) and of regular extrapolation of the other variables. The effects of the changes envisaged in all the other scenarios are measured by comparing with this first scenario.

**Sim 2:** the second scenario is the basic liberalization one; it consists in undertaking a general tariff reduction on all non agricultural goods at ten percent per year until complete tariff elimination in 2008. This scheme is meant to reflect the formation of the free trade area with the EU, which is designed according to the same pattern. In order to make this tariff reduction fiscally neutral, in terms of government income, a 6.8% compensating increase in consumption or value added taxes over the 17 years is assumed.

**Sim 3:** the third scenario **allows for technical progress**, as described by equation 118, in connection to trade liberalization.

**Sim 4:** in the fourth scenario, the same features of scenario 3 are maintained and, in addition, a gradual reduction in income taxes over the 17 years is assumed, the purpose being to encourage employment.

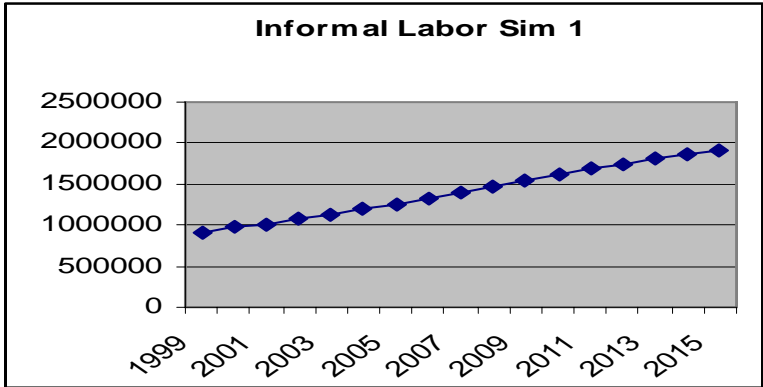
**Sim 5:** this scenario is like in Sim 4, except that a gradual decrease in corporate taxes is considered instead of decreasing income taxes.

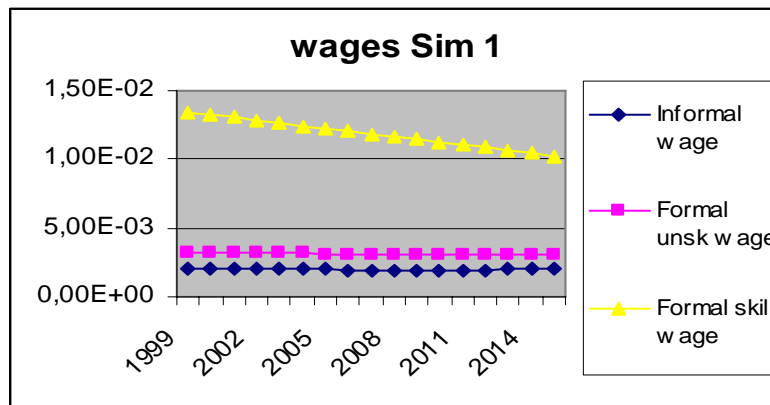


**Sim 6:** in the last scenario, a different fiscal reform is explored; it assumes a reduction in food subsidies. For the rest, it is like Sim 3. Food subsidies remain a relatively important burden on government budget and their reduction or elimination has been in the government agenda for a long time, but it has been maintained because it significantly contributes to poverty reduction.

**4.1. The statue-quo scenario (Sim1)**

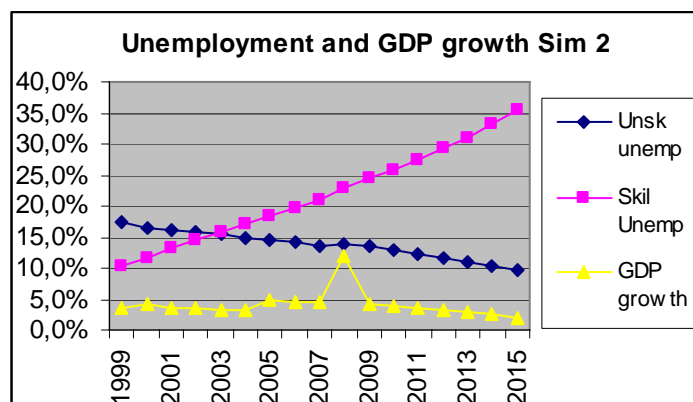
What would happen if no reforms were undertaken? This is of course not only the reference situation to which the alternative scenarios are compared but also a possibility not to be ignored. In fact if trade liberalization is well in the process in Tunisia and other trade reforms are contemplated or being prepared because the country is facing serious challenges and consequently, has to take actions. Given its high unemployment rate and the discrepancy between skill formation and demand for skilled (or educated) labor, there are fears that the rate of unemployment, especially of the educated, will reach extremely high levels and the overall situation becomes explosive. Projections by the World Bank (2003) based on INS data of the new job seekers by education level show that around 2015 more than half of the labor force will have a higher education, and the rate of unemployment of this highly educated category will more than triple, that is it will be above 30%. The same projections show that the overall unemployment rate will decrease in the long run. Our calculations confirm this hypothesis as regards the highly educated unemployment rate. It also shows that GDP growth rate will remain first in the current four percent- range and then decrease towards two percent. Meanwhile, all wages, more so for the skilled, will diminish, and the size of the informal sector will double. Unskilled wages will decrease; although slightly this is still a very low performance as people normally expect some substantial improvement in a seventeen year horizon. The skilled would loose about one third of their current purchasing power, which is obviously catastrophic. These indicators mean that poverty will go up, and that the overall social situation will not be sustainable.

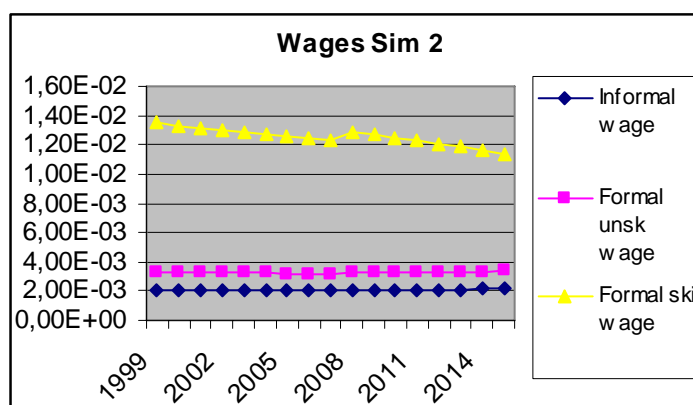
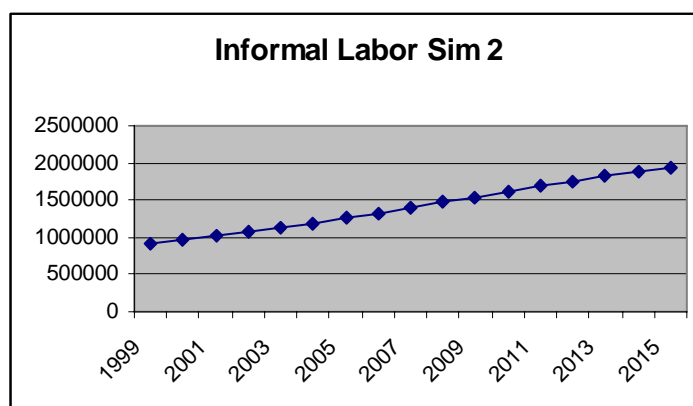




#### 4.2. Trade liberalization (Sim2)

One of our main findings is that trade liberalization accompanied by merely a compensating increase in consumption taxes would not provide enough relief, and basically the same hardships will persist as in sim1. The impact is positive but very small. Growth and wages would be slightly higher but unemployment would be a little worse, and the same trend is observed with respect to the size of the informal sector. Of course, trade would be accelerated but without generating the targeted welfare improvements. One may say that we are getting what we built in the model and is the outcome of our assumptions. This is true; nevertheless the result is significant. We obtain that as long as the structure of the economy remains basically the same and no fundamental transformations are allowed in the production techniques, the economy would not operate very differently. It is revealed that the allocative gains generated by the opportunity to export a larger share of the produced tradable goods are small compared to the progress needed to face the growth and employment challenges. In other words, these poor performances are the consequence of the lack of dynamic gains, which are integrated in the model in the third simulation.



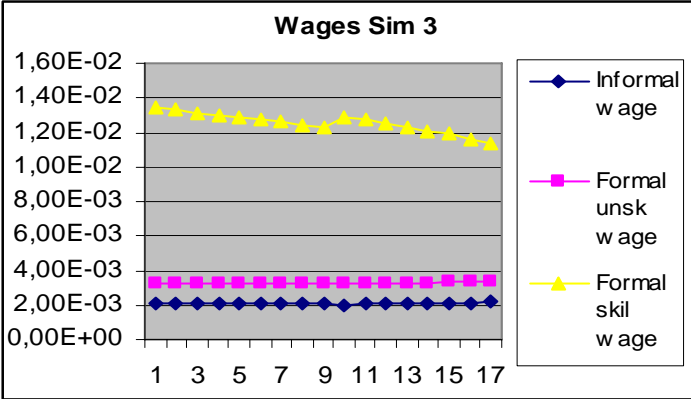
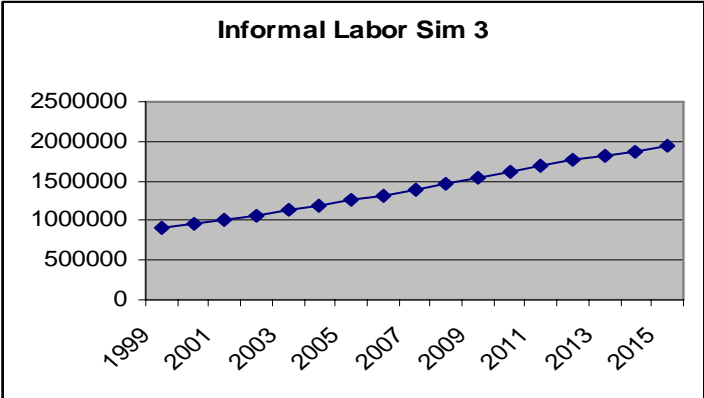
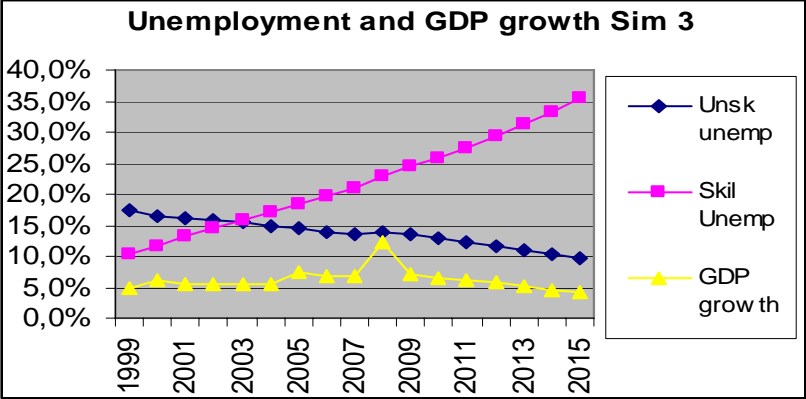


### 4.3. Introducing technical progress

There are many channels linking trade to technical progress as mentioned above. In our framework we tried to capture the widely accepted idea that technical progress is obtained when two types of conditions are jointly fulfilled: first, to have access to new and more performing equipments and production commodities through trade and, second, to invest at home enough in human capital and R&D in order to be able to absorb and assimilate and adapt the new technologies to the domestic production needs.

However, the gain from technical progress is not always shared by all. In particular, technical progress when labor saving may cause reductions in labor demand if there is not enough compensating factors. Indeed, our simulations reveal that technical progress as we specified it would certainly engender a large jump in terms of GDP growth, to the 7% neighborhood, but, in terms of employment and wages the gains are very small although there are no losses. In addition, skilled unemployment remains as high. This is surprisingly close to the current evolution with the Tunisian labor market, where GDP growth is moderately high but generating very little employment because of the technological transition which is easily observable. Skilled unemployment has been the outcome of the low demand of skilled labor by the private sector; more than 80% of skilled labor is concentrated in the public sector

where recruitment has been subjected to severe restrictions. Technical progress is expected to enhance the private demand for skilled labor but the simulation result indicates that this effect does not absorb all the supply. Obviously an upsurge in public employment would be the easiest way to reduce skilled employment. Sim4 and Sim5 allow for a moderate adjustment of public skilled employment.



**4.4. Fiscal reforms (Sim4, Sim5 and Sim6)**

In the fourth scenario, which consists in reducing income taxes, an important modification in the relative factor price is introduced and one may expect that the behavior of the workers and the firms would be readjusted and eventually more employment would be generated. In this and the following case, technical progress is maintained. The outcome is that two important changes happened; there are other changes but hardly perceivable. The first change is that, during the first six year period, the rate of GDP growth is dropped back to the three to four percent interval and gets back to the higher growth afterwards. Obviously, households' disposable incomes, and thus consumption and saving, increase. This initial loss in terms of growth is logically the result of the reduction in government investment in public goods and services because of the lost government incomes. The second change is that skilled employment goes up, and ends up with about twenty percentage-points gain.

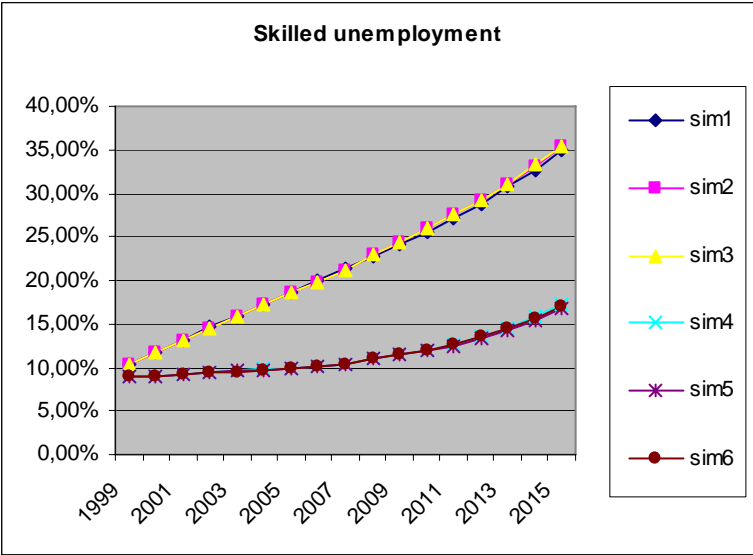
The fifth scenario, where corporate tax is reduced instead of income tax, leads to similar outcomes, including for the pattern of growth and skilled employment, significantly more than the exogenous increase in public employment assumed in this simulation.

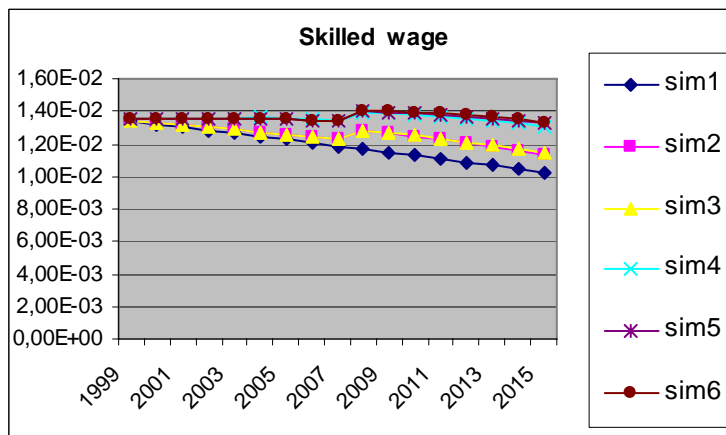
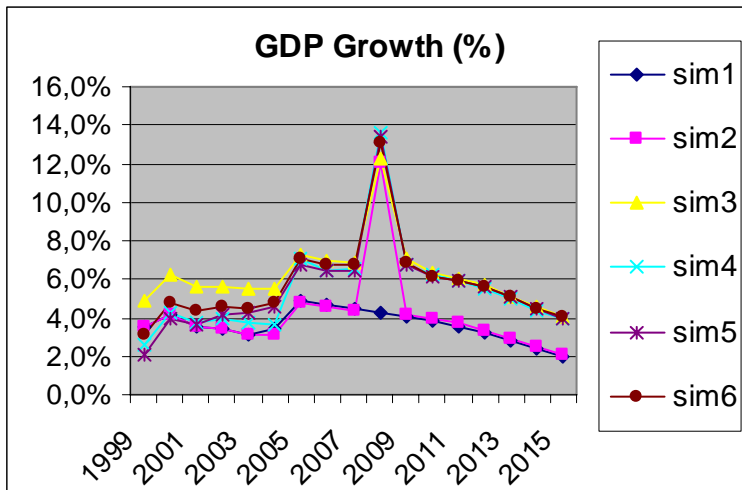
The food subsidy reduction scenario, surprisingly, did not generate the opposite effects, compared to tax reduction. Similar results are obtained with the same order of magnitude.

The following set of graphs show the impact of the fiscal reforms and give an overview of the six scenarios.

In summary, these graphs say that:

- o Skilled unemployment is lower under fiscal reforms,
- o Technical progress increases growth,
- o And wages will remain sticky in all scenarios even after 17 years, with slight differences over scenarios.





#### 4.5. The role of the financial sector

One of our major innovations in this study is the integration of the financial sector. The main question raised is does the financial sector really matter and what difference does it make? Would it be neutral at least in the long run as some macro theories tend to assert?

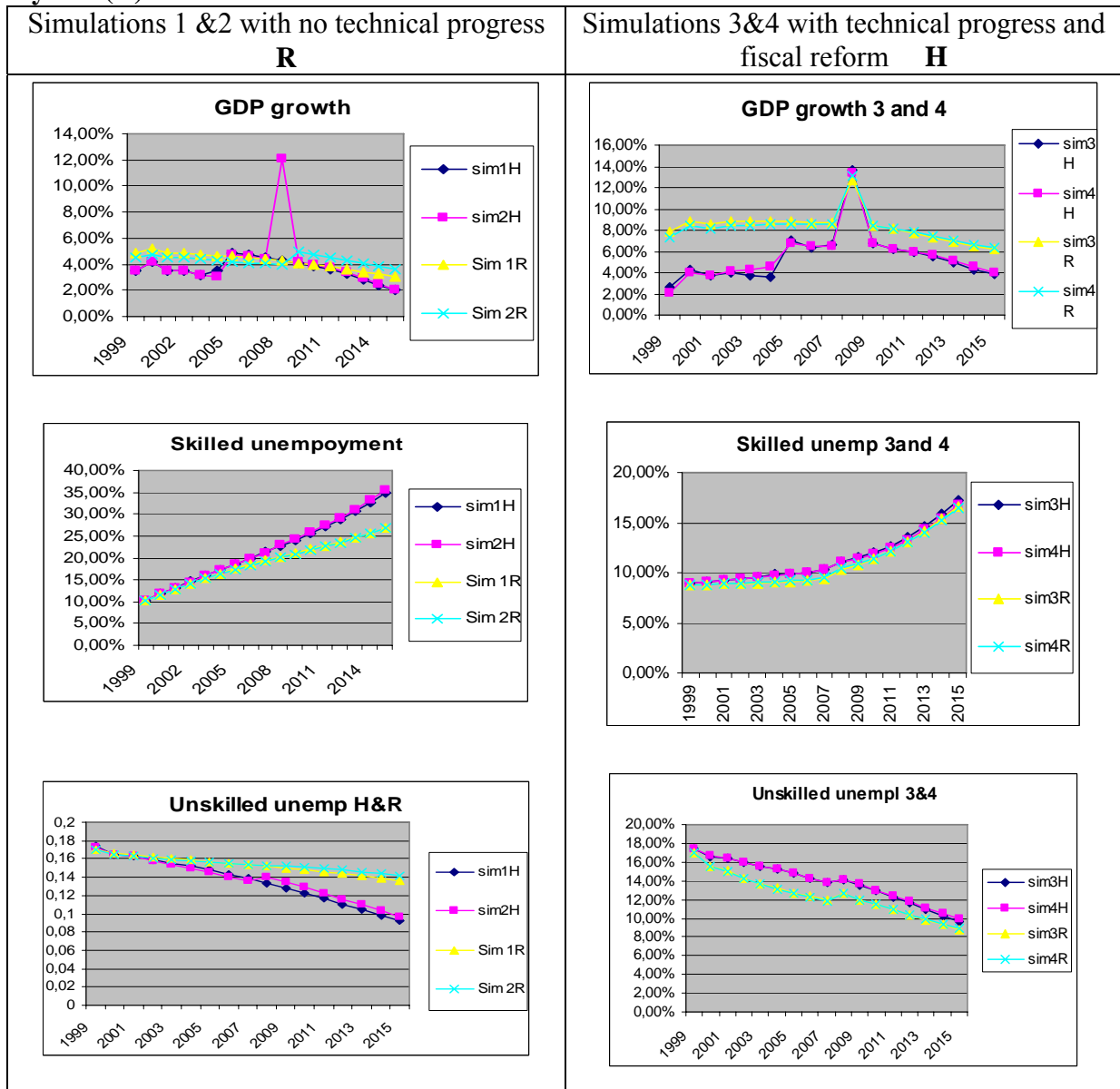
In order to identify the difference we performed a set of calculations under the same scenarios but without the financial sector. The model with no financial assets abstracts from financial institutions (no banks and no open possibility for them to obtain financial resources from abroad) and puts aside all concerns with money demand and supply and portfolio composition, but the constraint about the current account of the balance of payment is maintained: a limit on the current balance is kept to close the system.

Large and unexpected differences emerged from the comparison of the new results with those produced by the complete model with the financial sector. Allowing for financial transactions and for filling the investment gap by foreign capital inflows was expected to provide additional investment capacities and to stimulate growth. That is, a financially open system was expected to yield higher performances. The opposite proved to be true by the simulations. Without financial sector, growth and wages are higher and unemployment lower, and the size of the informal sector is smaller; all of these factors mean certainly less poverty. A closer examination of the rules and mechanisms governing the financial sector leads to the following explanation of these negative differences. The financial sector, in our case, leads to imperfect intermediation between savers and investors. First, with the financial sector money is introduced and households split their wealth between holding money and deposits. Hence, a first part of the saving is in a way withdrawn from the investment circuit. The second saving leakage is caused by the required reserves that banks have to keep at the central bank. These are also resources kept away from investors. Finally, the open possibility for the banking system to borrow abroad offers opportunities but is not costless. It may over burden the investors (primarily the urban formal firms), and consequently impede investments and growth.

This is clearly not a general result; under a different setting fundamentally different patterns could be obtained. Perhaps, our specification does not represent accurately enough the Tunisian case, given the strong restrictions imposed on short and long term capital flows by the Tunisian government. Nevertheless, this result is very meaningful as it shows that the financial sector does matter and very significantly.

The following set of graphs depicts the main results and differences when we abstract from the financial system. Simulations indicated by H are obtained when the full model integrating the financial system is used and simulations indicated by R are obtained using a model without the financial system. Except for the case of unskilled unemployment with no technical progress allowed for, the performances are superior without the financial sector.

## Comparing simulations with the financial system (H) and without the financial system(R)





## **5. Conclusion**

Opening the economy is for a small country like Tunisia an important and necessary condition for the acceleration of growth and possibly for job creation, but it is not a sufficient condition. Our simulations offer a clear counter-example. More is needed: essentially domestic policies enabling the development of the country's own capacity to assimilate and develop new and appropriate technology. Technical progress should lead to higher growth but is not always job creator.

Our study also confirms the importance of the financial system and of fiscal reforms, given their impact on the incentive system and on the government resources, which are needed for the provision of the necessary public goods and services. By accounting for these goods and services as production factors we highlight the role of government in the process of growth, employment and income generation. Potentially, the financial system is to serve as a development facilitator but it may turn out to be inefficient and to misguide the use of resources. In our case the financial system has a rather negative impact.

Finally, in spite of the complexity of the framework we have constructed, in many ways it remains incomplete, and only provides a gross approximation of the real world. Additional work is therefore needed to improve some of its essential features and consequently the results obtained.

### Annex 1: Sim1: the no reform scenario

	Unsk unemp	Skil Unemp	GDP growth	Informal Labor	Informal wage	Formal unsk wage	Formal skil wage
1999	17,4%	10,3%	3,5%	904094	2,09E-03	3,25E-03	1,34E-02
2000	16,5%	11,7%	4,1%	968775	2,03E-03	3,25E-03	1,32E-02
2001	16,4%	13,2%	3,5%	1012355	2,05E-03	3,23E-03	1,30E-02
2002	15,9%	14,6%	3,5%	1071691	2,02E-03	3,21E-03	1,28E-02
2003	15,6%	16,0%	3,2%	1129245	2,01E-03	3,18E-03	1,26E-02
2004	15,2%	17,3%	3,4%	1190275	2,00E-03	3,15E-03	1,24E-02
2005	14,8%	18,7%	4,8%	1255760	1,98E-03	3,12E-03	1,22E-02
2006	14,3%	20,0%	4,7%	1326603	1,96E-03	3,09E-03	1,21E-02
2007	13,8%	21,3%	4,5%	1398012	1,95E-03	3,07E-03	1,19E-02
2008	13,3%	22,7%	4,3%	1469615	1,94E-03	3,05E-03	1,17E-02
2009	12,8%	24,1%	4,1%	1541459	1,93E-03	3,03E-03	1,15E-02
2010	12,2%	25,5%	3,8%	1612368	1,93E-03	3,03E-03	1,13E-02
2011	11,6%	27,1%	3,6%	1681535	1,94E-03	3,02E-03	1,11E-02
2012	11,0%	28,8%	3,2%	1747527	1,95E-03	3,03E-03	1,09E-02
2013	10,4%	30,7%	2,8%	1808954	1,97E-03	3,04E-03	1,07E-02
2014	9,9%	32,8%	2,4%	1865088	2,00E-03	3,06E-03	1,04E-02
2015	9,3%	34,9%	2,0%	1916915	2,05E-03	3,08E-03	1,02E-02

### Annex2: Sim 2 Trade liberalization

	Unsk unemp	Skil Unemp	GDP growth	Informal Labor	Informal wage	Formal unsk wage	Formal skil wage
1999	17,3%	10,26%	3,5%	904094	2,10E-03	3,27E-03	1,35E-02
2000	16,4%	11,71%	4,2%	968283	2,05E-03	3,28E-03	1,33E-02
2001	16,3%	13,16%	3,5%	1011545	2,08E-03	3,26E-03	1,32E-02
2002	15,7%	14,54%	3,5%	1070521	2,06E-03	3,26E-03	1,30E-02
2003	15,4%	15,89%	3,2%	1127665	2,06E-03	3,24E-03	1,29E-02
2004	14,9%	17,20%	3,1%	1188351	2,06E-03	3,23E-03	1,27E-02
2005	14,6%	18,51%	4,7%	1252655	2,07E-03	3,21E-03	1,26E-02
2006	14,0%	19,79%	4,6%	1323496	2,06E-03	3,20E-03	1,24E-02
2007	13,5%	21,08%	4,4%	1394658	2,05E-03	3,19E-03	1,23E-02
2008	14,0%	23,03%	12,1%	1466319	2,04E-03	3,30E-03	1,29E-02
2009	13,5%	24,44%	4,2%	1536161	2,04E-03	3,28E-03	1,27E-02
2010	12,9%	25,93%	4,0%	1610060	2,04E-03	3,27E-03	1,25E-02
2011	12,2%	27,49%	3,7%	1682933	2,05E-03	3,28E-03	1,23E-02
2012	11,6%	29,22%	3,4%	1751915	2,07E-03	3,29E-03	1,21E-02
2013	11,0%	31,12%	3,0%	1816680	2,09E-03	3,30E-03	1,18E-02
2014	10,3%	33,20%	2,5%	1875699	2,13E-03	3,33E-03	1,16E-02
2015	9,7%	35,36%	2,1%	1929750	2,18E-03	3,36E-03	1,14E-02

**Annex3: Sim3 : Technical progress**

	Unsk unemp	Skil Unemp	GDP growth	Informal Labor	Informal wage	Formal unsk wage	Formal skil wage
1999	17,4%	10,27%	4,8%	904094	2,09E-03	3,26E-03	1,34E-02
2000	16,5%	11,72%	6,2%	966139	2,05E-03	3,27E-03	1,33E-02
2001	16,3%	13,16%	5,6%	1011955	2,07E-03	3,26E-03	1,32E-02
2002	15,8%	14,54%	5,6%	1069861	2,06E-03	3,25E-03	1,30E-02
2003	15,4%	15,89%	5,5%	1127998	2,06E-03	3,24E-03	1,29E-02
2004	14,9%	17,20%	5,5%	1188703	2,07E-03	3,23E-03	1,27E-02
2005	14,5%	18,51%	7,3%	1253568	2,07E-03	3,22E-03	1,26E-02
2006	14,0%	19,79%	6,9%	1325591	2,06E-03	3,21E-03	1,24E-02
2007	13,5%	21,08%	6,8%	1396410	2,06E-03	3,20E-03	1,23E-02
2008	13,9%	23,02%	12,2%	1468750	2,03E-03	3,30E-03	1,28E-02
2009	13,6%	24,46%	7,1%	1535511	2,06E-03	3,29E-03	1,27E-02
2010	12,8%	25,92%	6,3%	1614462	2,05E-03	3,29E-03	1,25E-02
2011	12,2%	27,50%	6,0%	1686307	2,06E-03	3,29E-03	1,23E-02
2012	11,5%	29,23%	5,7%	1755613	2,08E-03	3,30E-03	1,21E-02
2013	10,9%	31,14%	5,1%	1820670	2,10E-03	3,32E-03	1,19E-02
2014	10,3%	33,22%	4,5%	1879648	2,14E-03	3,34E-03	1,16E-02
2015	9,7%	35,39%	4,1%	1933693	2,19E-03	3,38E-03	1,14E-02

**Annex4: Sim4: Income tax reduction**

	Unsk unemp	Skil Unemp	GDP growth	Informal Labor	Informal wage	Formal unsk wage	Formal skil wage
1999	17,3%	8,91%	2,0%	904094	2,07E-03	3,25E-03	1,36E-02
2000	16,6%	9,06%	4,0%	961108	2,04E-03	3,26E-03	1,36E-02
2001	16,3%	9,23%	3,7%	1007832	2,05E-03	3,25E-03	1,35E-02
2002	16,0%	9,38%	4,1%	1062125	2,05E-03	3,24E-03	1,35E-02
2003	15,6%	9,55%	4,2%	1119674	2,04E-03	3,24E-03	1,36E-02
2004	15,3%	9,73%	4,5%	1178130	2,04E-03	3,23E-03	1,36E-02
2005	14,8%	9,88%	6,8%	1241361	2,05E-03	3,21E-03	1,35E-02
2006	14,3%	10,04%	6,4%	1311875	2,04E-03	3,20E-03	1,35E-02
2007	13,8%	10,25%	6,5%	1380435	2,04E-03	3,18E-03	1,34E-02
2008	14,1%	11,03%	13,4%	1451072	2,00E-03	3,26E-03	1,40E-02
2009	13,7%	11,43%	6,8%	1518337	2,03E-03	3,25E-03	1,39E-02
2010	13,0%	11,91%	6,2%	1593890	2,02E-03	3,25E-03	1,38E-02
2011	12,4%	12,51%	5,9%	1664623	2,03E-03	3,25E-03	1,38E-02
2012	11,8%	13,29%	5,6%	1732457	2,05E-03	3,25E-03	1,37E-02
2013	11,1%	14,26%	5,1%	1796692	2,07E-03	3,27E-03	1,35E-02
2014	10,5%	15,43%	4,5%	1855284	2,10E-03	3,29E-03	1,34E-02
2015	9,9%	16,75%	4,0%	1909213	2,15E-03	3,32E-03	1,33E-02

**Annex5: Sim5: corporate tax reduction**

	Unsk unemp	Skil Unemp	GDP growth	Informal Labor	Informal wage	Formal unsk wage	Formal skil wage
1999	17,3%	8,91%	2,0%	904094	2,07E-03	3,25E-03	1,36E-02
2000	16,6%	9,06%	4,0%	961108	2,04E-03	3,26E-03	1,36E-02
2001	16,3%	9,23%	3,7%	1007832	2,05E-03	3,25E-03	1,35E-02
2002	16,0%	9,38%	4,1%	1062125	2,05E-03	3,24E-03	1,35E-02
2003	15,6%	9,55%	4,2%	1119674	2,04E-03	3,24E-03	1,36E-02
2004	15,3%	9,73%	4,5%	1178130	2,04E-03	3,23E-03	1,36E-02
2005	14,8%	9,88%	6,8%	1241361	2,05E-03	3,21E-03	1,35E-02
2006	14,3%	10,04%	6,4%	1311875	2,04E-03	3,20E-03	1,35E-02
2007	13,8%	10,25%	6,5%	1380435	2,04E-03	3,18E-03	1,34E-02
2008	14,1%	11,03%	13,4%	1451072	2,00E-03	3,26E-03	1,40E-02
2009	13,7%	11,43%	6,8%	1518337	2,03E-03	3,25E-03	1,39E-02
2010	13,0%	11,91%	6,2%	1593890	2,02E-03	3,25E-03	1,38E-02
2011	12,4%	12,51%	5,9%	1664623	2,03E-03	3,25E-03	1,38E-02
2012	11,8%	13,29%	5,6%	1732457	2,05E-03	3,25E-03	1,37E-02
2013	11,1%	14,26%	5,1%	1796692	2,07E-03	3,27E-03	1,35E-02
2014	10,5%	15,43%	4,5%	1855284	2,10E-03	3,29E-03	1,34E-02
2015	9,9%	16,75%	4,0%	1909213	2,15E-03	3,32E-03	1,33E-02

**Annex6: Sim 6: food subsidy reduction**

	Unsk unemp	Skil Unemp	GDP growth	Informal Labor	Informal wage	Formal unsk wage	Formal skil wage
1999	17,4%	8,91%	3,1%	904094	2,07E-03	3,25E-03	1,36E-02
2000	16,6%	9,05%	4,8%	962936	2,04E-03	3,27E-03	1,36E-02
2001	16,4%	9,21%	4,3%	1009319	2,05E-03	3,25E-03	1,36E-02
2002	15,9%	9,36%	4,6%	1064777	2,05E-03	3,25E-03	1,35E-02
2003	15,5%	9,51%	4,5%	1122339	2,04E-03	3,24E-03	1,35E-02
2004	15,2%	9,67%	4,8%	1181307	2,05E-03	3,23E-03	1,35E-02
2005	14,8%	9,83%	7,0%	1245108	2,05E-03	3,21E-03	1,35E-02
2006	14,2%	10,01%	6,7%	1316511	2,04E-03	3,20E-03	1,34E-02
2007	13,8%	10,23%	6,8%	1386261	2,04E-03	3,19E-03	1,34E-02
2008	14,1%	11,08%	13,1%	1458008	2,00E-03	3,28E-03	1,41E-02
2009	13,7%	11,51%	6,8%	1525309	2,03E-03	3,26E-03	1,40E-02
2010	13,0%	12,01%	6,2%	1602721	2,02E-03	3,26E-03	1,39E-02
2011	12,4%	12,66%	5,9%	1674154	2,03E-03	3,26E-03	1,38E-02
2012	11,8%	13,48%	5,6%	1742907	2,05E-03	3,27E-03	1,37E-02
2013	11,1%	14,51%	5,1%	1807683	2,07E-03	3,29E-03	1,36E-02
2014	10,5%	15,73%	4,5%	1866578	2,11E-03	3,31E-03	1,35E-02
2015	9,9%	17,08%	4,0%	1920715	2,16E-03	3,34E-03	1,33E-02

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