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A Model with Heterogeneous Agents to Study Pension Reforms

A Theoretical Presentation and Application Using Tunisian Data

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Introduction

Most countries in the world have implemented some form of compulsory contributive pension system to cover their population against the risks associated with aging. Originally created to prevent poverty among the aged population, these pension plans have become some of the largest financial institutions in many economies and now pay benefits that are above poverty lines. Their design and their financial situation affect all economic actors and influence parts of economic growth and labour market conditions. Meanwhile, the increase in life expectancy worldwide combined with the decrease in fertility rates are affecting the financial sustainability these systems. The number of contributors is declining while the number of pensioners is increasing. This phenomenon started affecting most of the developed countries in the 1990s and has made efforts to reform their systems challenging.

Recently many developing countries, including some Arab countries, have started similar demographic transitions. The population of older persons, meaning those aged 60 years and above, has almost tripled over the past three and a half decades in the Arab region, increasing from around 9.3 million in 1980 to around 26.5 million in 2015, and these rates could accelerate in the future (ESCWA 2017).[1] The dependency ratio – meaning the age-specific ratio of population in the labour force compared to those not in the labour force, usually people under the age of 14 years and over the age of 65 years – is expected to reach 12.6 per cent in 2040, 14.4 per cent in 2045 and then 16.6 per cent in 2050. This phenomenon will impact the viability of pension systems and pressure many countries to address pensions sustainability in their reform agendas, a trend already beginning to be seen in the Arab region. In 2018, Morocco started a pension reform programme. Tunisia has also started to register a considerable deficit in its pension system and is currently studying various options of reforms, and is the case study for this paper.

In the study of the viability of pension systems and proposed ways of reforms, economic literature offers several approaches. The first and natural one is to use an actuarial partial equilibrium model. With this type of approach, demographic and economic variables are assumed to be exogenous. The model forecasts future revenues and expenditures of the system and estimates its financial viability and the monetary implications of possible reforms. While the International Labour Organization (ILO) Pension model[2] and the World Bank's Pension Reform Options Simulation Toolkit (PROST) model[3] are based on the actuarial partial equilibrium approach and have made it popular, it suffers from a myopia regarding the interlinkages between pension systems and the rest of the economy, limiting the analysis that it can provide. To compensate for this limitation, Auerbach and Kotlikoff (1987)[4] introduced the Overlapping Generations model (OLG) as a microfounded tool[5] for the analyses of the interactions between demography, pension systems and macroeconomic long-term prospects. The OLG models have been widely used to study the effects of retirement system reforms during demographic transitional periods and in a steady state economy. Fueled by exogenous demographic projections, such as the size each demographic group, the dynamics of the economy are fully explained by the reactions of rational agents and optimizers. However, the theoretical complexity of such models prevents them from considering the non-linearity of pension formulas (some pensions are tiered and have different levels of pay out at five years, 10 years, etc.) and the introduction of agents' heterogeneity within cohorts (male/female, type of employment, etc.). This makes their analysis longer term from a theoretical prospective. To address

[1] ESCWA, "Regional Meeting on the Third Review of the Madrid International Plan of Action on Ageing in Arab Countries – Achievements and Future Prospects", Beirut, 3 August 2017. Available at https://www.unescwa.org/sites/www.unescwa.org/files/events/files/third-review-ageing-arab-countries-background-paper-en.pdf.

[2] The ILO pension model - a Technical Guide, 2018. Available at http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---soc_sec/documents/instructionalmaterial/wcms_secsoc_7966.pdf.

[3] Tatyana Bogomolova, PROST – Pension Reform Options Simulation Toolkit, World Bank. Available at http://www.worldbank.org/content/dam/Worldbank/Event/pensions/1.%20Bogomolova%20_Core%20Course-prost-March2014.pdf.

[4] Allan J. Auerbach and Laurence J. Kotlikoff, *Dynamic Fiscal Policy* (London, Cambridge University Press, 1987).

[5] Models with microfoundations, meaning models in which behaviour is derived from basic assumptions about consumers' preferences, production technologies, information and so on.

these limitations, and make OLG models more practical, a new generation of hybrid models has been developed. Built in general equilibrium framework, they take into consideration the heterogeneity of the agents and the non-linearity of pension formulas. To reduce the complexity created by the forward-looking dynamics, these models suppose a total myopia of agents and run under recursive dynamics. They start with the partial equilibrium approach and include all demographic and parametric details (contribution rate, replacement rate, etc.) of the pension system and complete it with general equilibrium aspects, including production, trade, balance of payments and government account blocks.

This paper adopted this new approach and developed a model based on a framework developed by Bchir (2004)[6] and Bac and Chateau (2004).[7] It uses the Tunisian data to assess the viability of the pension system and to simulate a number of prototypical reforms. Following this introduction, the demographic and legislative context of the Tunisian pension system will be presented in section 2. Section 3 will present the theoretical structure of the model. Section 4 will present the model results and provide an assessment of some standard reforms. The fifth section will present the user manual of the interface developed for this model and the sixth section will conclude the paper.

I. THE TUNISIAN CONTEXT

The Tunisian pension system is a Pay as You Go (PAYG) system, based on the concept of solidarity within and across generations. It is a compulsory, defined benefit public system that covers aging risks with a distinction between workers in the public and private sectors. It is administered by two funds: The National Fund for Social Security (Caisse Nationale de Sécurité Sociale) (CNSS), and the National Fund for Retirement and Social Welfare (Caisse Nationale de Retraite et de Prévoyance Sociale) (CNRPS). Together, these two funds manage eleven financial schemes.

A. THE NATIONAL FUND FOR SOCIAL SECURITY

The National Fund for Social Security (CNSS by its acronym in French) is a public body with civil character and financial autonomy under the supervision of the Ministry of Social Affairs and administered by a board of directors, in which the State, employers' organizations and labour unions are represented. The pension branch is the largest account managed by the fund.[8] The pension accounts are financed by the contributions of employees and employers, the rate of which varies according to the sector of activity and its size, as follows:

- *Non-agricultural sectors*: Contributions are 25.75 per cent of salary for social security contributions, with 16.57 per cent payable by the employer and 9.18 per cent by the employee;
- *Agricultural sector*: If the employee works for at least 45 days during a quarter the amount of social security contributions is 12.29 per cent of salary of which 7.72 per cent is borne by the employer and 4.57 per cent by the employee. For permanent workers, the rate is 19.47 per cent with 12.48 per cent at the expense of the employer and 6.99 per cent at the expense of the employee;
- *Fishing sector*: The amount of the contributions depends on the shipment capacity of the boat. Contributions to the social security vary from 7.5 per cent for boats with a gauge capacity a capacity of less than five barrels to 25.75 per cent for boats with a gauge capacity of more than 30 barrels. Nearly two thirds of the contribution is at the expense of the employer and the rest at the expense of the employee;

[6] Mohamed Hedi Bchir, "Genèse et avenir des systèmes de retraite: enjeux théoriques et application au cas français", PhD dissertation, Université Sorbonne, Paris I, 2004. Summary available at http://www.theses.fr/2004PA010055.

[7] Catherine Bac and Jean Chateau, "Vieillissement démographique, épargne et retraite: une analyse à l'aide d'un modèle d'équilibre général à agents hétérogènes", CEPPI Working Paper, No. 2004 – 14 (Paris, CEPPI, October 2004).

[8] The Fund also manages other branches such as Family Benefits, Social Insurance, Death Benefits, Disability, Old-Age and Survivors.

- *Domestic workers, State and local collectivities*: Contributions to social security are up to 7.5 per cent, 5 per cent of which borne by the employer and the rest by the insured.

Retirement starts at age 60, although a pension may be paid earlier in certain situations, and not just for an old-age. This is the case, for example, for insured persons with at least 10 years of contributions and in proven hardship professions. Similar conditions govern early retirement, which can be granted from the age of 50, in the event of economic dismissal with at least five years of contributions and for women with at least three children and 15 years of contributions. In addition, the insured can claim early retirement at the age of 55 if at least 30 years of contributions have been made.

Pensions amount to 40 per cent of the average wage for the last 10 years of contributions and are increased by 0.5 per cent for each quarter beyond this period. In all cases the minimum pension cannot be less than two thirds of the guaranteed minimum wage (SMIG, by its acronym in French) and the maximum pension no more than six times the SMIG and/or 80 per cent of the salary. If the insured has contributed less than 10 years, the pension would be proportional to the pension that would have been received if he or she had contributed for 10 years, and then pro-rated to his or her period of service.

B. National Fund for Retirement and Social Welfare

The National Fund for Retirement and Social Welfare (CNRPS, by its acronym in French) manages the pensions of public sector employees in ministries and public institutions, local collectivities and public companies, which are approved by decree. In addition, there are some special schemes subsidized by the State (without contributions from employees) supporting former members of the Tunisian movement for independence, preachers, injured military veterans and members of the former constitutional council. The CNRPS reports to the Ministry of Social Affairs and has legal entity and financial autonomy and is administered by a Board of Directors composed of a Chief Executive Officer and twelve directors.

The salary contributions are divided between the affiliates and the State as follows:

- The special schemes governing the retirement of members of the government, the parliament and governors and for which the contribution of the affiliates amounts to 13.2 per cent and of the State to 20.5 per cent;
- The general scheme for all other employees for which the contribution of affiliates amounts to 8.2 per cent and of the State to 12.5 per cent.

These contributions entitle the employee to a pension amounting to 2 per cent for each year of the first 10 years of activity, 3 per cent for each of the following 10 years and 2 per cent per year thereafter. The minimum served is two thirds of the SMIG and the maximum is 90 per cent of the salary on which the last payment was calculated.

To benefit from the pensions mentioned, a minimum of 10 years of activity is required for casual workers and 15 years for other categories. For shorter periods of activity, a person can claim a refund of his contributions if he or she has less than five years of activity. If a person has worked more than five years, there is the possibility of receiving an old-age pension equivalent to 50 per cent of SMIG at the age of 60.

If there are periods of paid but unreported activity, the fund allows the recovery of those periods within a maximum of two years after this period according to rates positively correlated with the age of the affiliate.

The legal retirement age is 60 years and 55 years for challenging or unhealthy occupations. It can also be extended to five additional years of service by decree. This departure can also be granted earlier:

- By decision of the employer for economic reasons of disability or revocation (dismissal) of the worker;

- After 37 years of service for employees aged 57 and above, subject to the approval of the Prime Minister;
- And automatically after 15 years of military service.

The fund also serves a death benefit to the beneficiaries of affiliates who, at the time of their death, were in active employment or in any professional relationship with the administration, including if they were suspended as a disciplinary measure.

II. THE THEORETICAL STRUCTURE OF THE MODEL

Various prospective quantitative tools have been used to assess the viability of the Tunisian pension system and to propose reforms in Tunisia. When applied to the Tunisian context, the ILO and the PROST model have shown that deficit could reach 3 per cent of gross domestic product (GDP) by 2025. The Auerbach and Kotlikoff model has been used to assess the overall macroeconomic implications of aging in Tunisia. Abdesselem and Chekki Cherni (2017)[9] predicted the system would be unsustainable in the absence of reform measures. Their paper proposed structural reforms that diversify financing sources and extend contributions beyond labour income. Proposing the same approach, Ben Othman and Marouani (2016)[10] demonstrated that increasing contribution rates would be the worst solution in terms of welfare and unemployment, whereas postponing the retirement age would be less costly option both in terms of unemployment and aggregated welfare.

In this paper, we opted for the hybrid approach, taking the best elements of the OLG and partial equilibrium model, and developed a specific model for Tunisia.

A. THE DEMOGRAPHIC STRUCTURE

In this model, the demographic structure and projections replicates the structure of the ILO Pension Model (ILO-PENS), an actuarial model developed by ILO (Cichon and Hirose 2002). Accordingly, an individual born in generation g, enters to the labour market at g+D1. Each generation is indexed by its birth year $g \in \{1884, \ldots, 2049\}$; its s sex $\in \{H\ Male\ ,\ F\ Female\}$ and its socio-professional category c $\in$ {NonFonc, : working in private sector, Fonc: civil servant} . We define Pop(t,g,s) as the size of the population of generation g of sex s at time t and Mu(t,g,s) as the activity rate of the population of the category (g s c) at time t. A part of the active population is recruited by the Government, their number is given by NAc(t, g, s, FONC). The number of active persons that are looking for a job in the private sector is defined as:

$$NAc(t,g,s,NonFONC) = Pop(t,g,s)\,Mu(t,g,s) - NAc(t,g,s,FONC) - NPen\_new(t,g,s,NonFonc,CNSS)$$

B. PRODUCTION FUNCTION AND EFFICIENCY WAGE

The production in the private sector Y(t) is defined as a Cobb-Douglas production function of productive capital K(t) and private sector labour L(t):

$$Y(t) = TFP(t)K(t)^{\alpha(t)}L(t)^{(1-\alpha(t))}$$

[9] Tahar Abdessalem and Houyenm Chekki Cherni, "Tunisian pension system sustainability: towards a multidimensional reform", in *Région et Développement*, No. 44-2016 (Paris, L'Harmattan, 2017).

[10] Mouna Ben Othman and Mohamed Ali Marouani, "Labor market effects of pension reform: an overlapping generations general equilibrium model applied to Tunisia", ERF Working Paper, No. 1019 (Giza, Economic Research Forum, June 2016).

TFP(t) is the Total Factor Productivity and α(t) is the capital share in the Cobb-Douglas production function. The private sector labour L(t) is defined as the difference between total active population Nact(t) and total number of civil servants $NFonc(t)$:

$$L(t) = Nact(t) - NFonc(t)$$

Where the total number of civil servants is the total number of active population in the public sector $Nac(t, g, s, Fonc)$ by age and sex:

$$NFonc(t) = \sum_{(g,s)} Nac(t, g, s, Fonc)$$

The first order condition implies that capital rate of return req(t) and wages at equilibrium weq(t) are given by:

$$req(t) = \alpha(t) \frac{Y(t)}{K(t)}$$
$$weq(t) = \big(1 - \alpha(t)\big) \frac{Y(t)}{L(t)}$$

We introduce labour market rigidity and suppose that salaries at private sectors $wmoy(t)$ are different from their equilibrium level. We suppose that the two variables are linked by:

$$(1 - taxdir(t) - Tc(t, CNSS))wmoy(t) = \big(1 - taxdir(t-1) - Tc(t-1, CNSS)\big)\ (1 - 0.1)\ \text{weq(t)}\ 0.1\ \lambda(t)$$

Where tax_dir(t) is the direct tax, $Tc(t, CNSS)$ is the contribution rate at the CNSS and λ (t), the elasticity of $wmoy(t)$ with respect to weq(t). The effective labour force $Leff(t)$ is given by:

$$Leff(t) = \frac{\big(1 - \alpha(t)\big)\, Y(t)}{wmoy(t)}$$

Unemployment rate chomoy(t) is defined as:

$$chomoy(t) = 1 - \frac{\big(Leff(t) + NFonc(t)\big)}{Nact(t)}$$

C. PROFILE OF UNEMPLOYMENT AND WAGES BY CATEGORY

In the public sector, the representative wages profile wFonc(t,g,s,c) of the category (g,s,c) in the period t age g and gender s is given by:

$$wFonc(t, g, s, c) = ajwpub(t) profilw(t, g, s, c)$$

Profilw(t, g, s, c) is the wage profile of category (g,s,c) and ajwpub(t) is the adjustment variable for the public average wage. The average wage for civil servants Wpub(t) is defined as:

$$wpub(t) = \frac{\sum_{(g,s,c)\$fonction(c)} wFonc(t, g, s, c) NAc(t, g, s, c)}{\sum_{(g,s,c)\$fonction(c)} NAc(t, g, s, c)}$$

Similarly, in the private sector, the representative wages profile $\mathrm{wrep(t,g,s,c)}$ of the category (g,s,c) in the period t age and gender is given by:

$$wrep(t,g,s,c) = ajw(t)\ \ wmoy(t)\ \ profilw(t,g,s,c)$$

where ajw(t) is the adjustment variable of private sector wages defined in the equation:

$$wmoy(t) = \frac{\sum_{(g,s,c)\$nonfonction(c)} wrep(t,g,s,c)\big(1-cho(t,g,s,c)\big)NAc(t,g,s,c)}{\sum_{(g,s,c)\$nonfonction(c)}\big(1-cho(t,g,s,c)\big)\,NAc(t,g,s,c)}$$

Finally, the unemployment rate for each category (g,s,c) is then given by:

$$cho(t,g,s,c) = ajcho(t)chomoy(t)\ \ profilcho(t,g,s,c)$$

where profilcho(t,g,s,c) is the unemployment profile for each category (g,s,c) and ajcho(t) is an adjustment variable defined in the equation:

$$chomoy(t) = \frac{\sum_{(g,s,c)} cho(t,g,s,c)NAc(t,g,s,c)}{Nact(t)}$$

D. PENSION FUNDS

1. *Revenues*

The number of contributors Ncot(t,g,s,c,caisse) of category (g,s,c) at time (t) per fund (caisse) is given by:

For the CNRPS: $Ncot(t,g,s,Fonc,CNRPS) = Ncot(t-1,g,s,Fonc,CNRPS)\big(1-Shret(t,g,s,CNRPS)\big)\frac{Pop(t,g,s)}{Pop(t-1,g,s)+} + Ncot\_new(t,g,s,Fonc,CNRPS)$

Where $Shret(t,g,s,CNRPS)$ is the share of population (g,s,c) that decides to retire at t and $Ncot\_new$ is the number of new contributors supposed to be equal to the number of civil servant required:

$$Ncot\_new(t,g,s,Fonc,CNRPS)\ = NFONC\_new(t)Prof\_FONC\_new(t,g,s)$$

Where $NFONC\_new(t)$ is the total number of new recruitments at the public administration and $Prof\_FONC\_new(t,g,s)$ is the share of the category (t,g,s) in the total new recruited civil servants.

For the CNSS, the number of contributors is equal to the number of covered employed population:

$$Ncot(t,g,s,NonFonc,CNSS) = Nac(t,g,s,NonFonc)\big(1-cho(t,g,s,NonFonc)\big)TOCOV(t,g,s)$$

Where $TOCOV(t,g,s)$ is the coverage rate of population (g,s) working at the private sector.

The total revenue Rec(t,caisse) for each fund (caisse) at time (t) and it is defined as the sum of the contributions of all contributors:

For the CNRPS:

$$Rec(t,CNRPS) = \sum_{c\in Fonction(c)}\sum_{(g,s)} Tc(t,CNRPS)Ncot(t,g,s,c,CNRPS)\ wFonc(t,g,s,c)$$

For the CNSS:

$$Rec(t, CNSS) = \sum_{(g,s,c)c \in NonFonction(c)} Tc(t, CNSS)\ Ncot(t, g, s, c, CNSS)\ wrep(t, g, s, c)$$

Where Tc(t,caisse) is the contribution rate at time (t) in the fund (caisse).

2. *Expenditure*

The total expenditures Dep(t,caisse) of a fund (caisse) at time (t), define as the sum of all pensions $MP(t, g, s, c, caisse)$ payed for all pensionaries $NPen(t, g, s, c, caisse)$:

$$Dep(t, caisse) = \sum_{(g,s,c)} MP(t, g, s, c, caisse)\ NPen(t, g, s, c, caisse)$$

The number of pensionaries per fund (caisse) is defined as the survivor pensionaries from previous period and the new pensionaries from each category (g,s,c):

$$NPen(t, g, s, c, c, caisse) = NPen(t-1, g, s, c, caisse)\ \frac{Pop(t, g, s)}{Pop(t-1, g, s)} + NPen\_new(t, g, s, c, caisse)$$

The new pensionaries for each category are defined as of the share of living contributors that decide to retire:

$$NPen\_new(t, g, s, c, caisse) = Ncot(t-1, g, s, c, caisse)\ \frac{Pop(t, g, s)}{Pop(t-1, g, s)} ShRet(t, g, c, caisse)$$

The reference wages SR(t,g,s,c,caisse) of category (g,s,c) at time t in the fund (caisse) are defined as:

For the CNSS:

$$SR(t, g, s, c, CNSS) = Wrep(t-1, g, s, c) + \frac{\sum_{t'=t-dcaisse(T,CNSS)}^{t'=t-1} Wrep(t'-1, g, s, c) \prod_{t''=t'}^{t''=t-1}\left(1 + pi(t'')\right)}{dcaisse(t, CNSS)}$$

For CNRPS:

$$SR(t, g, s, c, CNRPS) = Wfonc(t-1, g, s, c) + \frac{\sum_{t'=t-dcaisse(t,CNRPS)}^{t'=t-1} Wfonc(t'-1, g, s, c) \prod_{t''=t'}^{t''=t-1}\left(1 + pi(t'')\right)}{dcaisse(t, CNRPS)}$$

For CNSS, the Liquidation pension MPL(t,g,s,c,caisse) for a category (g s c) is given by:

$$MPL(t, g, s, NONFONC, CNSS) = Max\left(min\left(to(t, g, s, CNSS)\ SR(t, g, s, NONFONC, CNSS), plafond(t, CNSS)\right), Minimumviellesse(t)\right)$$

Where to(t,g,s,caisse) is the replacement rate on liquidation at (t) of (g,s) for the fund (caisse). It is defined as:

For the CNRPS:

If career duration Ancg(t,g,s, CNRPS) is less than 10 years then:

$$\text{to}(\text{t}, \text{g}, \text{s}, \text{CNRPS}) = 0.02\text{Ancg}(\text{t}, \text{g}, \text{s}, \text{CNRPS})$$

If career duration Ancg(t,g,s, CNRPS) is between 10 and 20 years then:

$$\text{to}(\text{t}, \text{g}, \text{s}, \text{CNRPS}) = 0.03(\text{Ancg}(\text{t}, \text{g}, \text{s}, \text{CNRPS}) - 10) + 0.2$$

If career duration Ancg(t,g,s, CNRPS) more than 20 years then:

$$\text{to}(\text{t}, \text{g}, \text{s}, \text{CNRPS}) = \text{Min}(0.02(\text{Ancg}(\text{t}, \text{g}, \text{s}, \text{CNRPS}) - 20) + 0.5, 0.9)$$

For the CNSS:

If career duration Ancg(t,g,s, CNSS) is less than 10 years then:

$$\text{to(t,g,s,CNRPS)}=0$$

If career duration Ancg(t,g,s, CNSS) is between 10 and 20 years then:

$$\text{to(t,g,s,CNSS)}= 0.04\ (\text{Ancg(t,g,s, CNSS)-10})$$

If career duration Ancg(t,g,s, CNSS) more than 20 years then:

$$\text{to(t,g,s,CNSS)}= \text{Min}(0.02(\text{Ancg(t,g,s, CNSS)-10})+0.4, 0.8)$$

Plafond(t,caisse) is the maximum pension paid at (t) by a fund (caisse) and Minimumviellesse (t) is the minimum pension paid at (t).

For CNRPS, the amount of liquidation pension of (g,s,FONC) in the fund (CNRPS) is equal to the product of the rate to(t,g,s,CNRPS) by the Reference Wage SR(t,g,s,FONC,CNRPS) defined as follows:

$$MPL(t, g, s, FONC, CNRPS) = to(t, g, s, CNRPS)\ \ SR(t, g, s, FONC, CNRPS)$$

The average pension received by a category (g,s,c) from a fund (caisse) at time (t) MP(t,g,s,c,caisse) is defined by:

For CNRPS:

$$\begin{aligned} MP(t, g, s, FONC, CNRPS)&NPEN(t, g, s, FONC, CNRPS) \\ &= MP(t-1, g, s, FONC, CNRPS)\big(1 + IRP(t, CNRPS)\big)\ \ NPEN(t \\ &- 1, g, s, FONC, CNRPS)\frac{Pop(t, g, s)}{Pop(t-1, g, s)} \\ &+ NPENnew(t, g, s, FONC, CNRPS)MPL(t-1, g, s, FONC, CNRPS) \end{aligned}$$

For CNSS:

$$MP(t,g,s,NonFONC,CNSS)NPEN(t,g,s,NonFONC,CNSS) = MP(t-1)(t,g,s,NonFONC,CNSS)\big(1+IRP(t,CNSS)\big)NPEN(t-1)(t,g,s,NonFONC,CNSS)\frac{Pop(t,g,s)}{Pop(t-1,g,s)} + NPENnew(NonFONC,CNSS)MPL(t-1)(t,g,s,NonFONC,CNSS)$$

$$MP(t,g,s,FONC,CNRPS) = MP(t-1)(t,g,s,FONC,CNRPS)\ \big(1+IRP(t,CNRPS)\big)$$

$$MP(t,g,s,NonFONC,CNSS) = MP(t-1)(t,g,s,NonFONC,CNSS)\ \big(1+IRP(t,CNSS)\big)$$

For each category (g,s,c) the covered population $POP\_COUV(t,g,s,c)$ is defined as the population contributing to one of the two pension systems or the pensionaries from one of the two institutions.

$$POP\_COUV(t,g,s,c) = \big(Nac(t,g,s,c,CNRPS)+NPEN(t,g,s,c,caisse)\big) + (Nac(t,g,s,NonFONC)(1-cho(t,g,s,c))NAc(t,g,s,c)TOCOV(t,g,s)+NPEN(t,g,s,c,CNSS)$$

3. *Pension funds balance*

The balance of the fund Solde(t,caisse) is the difference between the revenues and expenditures:

$$Solde(t,caisse) = \big(Rec(t,caisse)-Dep(t,caisse)\big)$$

E. HOUSEHOLDS' CONSUMPTION BEHAVIOR

The households' revenues, $RevH(t,g,s,c)$ of a category $(g,s,c)$is defined as the weighted average of all the types of revenue that the individuals in the cohort (g,s,c) receive at t:

$$RevH(t,g,s,c)\ POP\_REV(t,g,s,c) = \big(1-Tc(t,CNSS)\big)\,wrep(t,g,s,c)\,\big(1-cho(t,g,s,c)\big)\,NAc(t,g,s,c)TOCOV(t,g,s) + wrep(t,g,s,c)\,\big(1-cho(t,g,s,c)\big)\,NAc(t,g,s,c)\,\big(1-TOCOV(t,g,s)\big) + MP(t,g,s,c,CNSS)\,NPEN(t,g,s,c,CNSS) + \big(\big(1-Tc(t,CNRPS)\big)\ wfonc(t,g,s,Fonc)\,NAc(t,g,s,Fonc) + MP(t,g,s,c,CNRPS)\,NPEN(t,g,s,c,CNRPS)\big)$$

Where $POP\_REV(t,g,s,c)$ is the population that has a revenue. It is defined as the sum of the active population plus the pensionaries from both funds:

$$POP\_REV(t,g,s,c) = Nac(t,g,s,FONC)+NPEN(t,g,s,c,CNRPS)+Nac(t,g,s,NonFONC)+NPEN(t,g,s,c,CNSS)$$

The households are supposed to consume a share $\mathrm{savH(t,g,s,c)}$ of their revenue $RevH(t,g,s,c)$ and the revenue of their past assets $\mathrm{Asset(t-1,g,s,c)}$. Their consumption $\mathrm{ConsH(t,g,s,c)}$ is defined as:

$$PDTOT(t)\ ConsH(t,g,s,c) = \big(1-savH(t,g,s,c)\big)\big(1-\ tax\_dir(t)\big)\big(req(t)\ Asset(t-1,g,s,c) + RevH(t,g,s,c)\big)$$

Where PDTOT(t) is the market price level. Before the age D1(g,s,c), individuals are supposed to have no assets. From D1 the dynamic of their assets evolution is defined by:

$$\begin{aligned}\text{open economy and the exchange rate EXR(t)} \quad & \text{Asset(t, g, s, c)} + \text{PDTOT(t)ConsH(t, g, s, c)}\left(1 + \text{cout(t, g, s, c)}\right) \\ &= \left(1 + \left(1 - taxdir(t)\right) req(t)\right) Asset(t-1, g, s, c) + \left(1 - taxdir(t)\right) RevH(t, g, s, c) \\ &+ Her(t, g, s, c) + \frac{EXR(t)\, TRANS(t)}{\sum_{(gp,sp,cp)}\left(POP_{REV(t,gp,sp,cp)}\right)}\end{aligned}$$

Where cout(t,g,s,c) number of dependents, Her(t,g,s,c) is the inheritance of category (g,s,c) at time t and TRANS(t) is the amount of foreign transfers received from abroad. In this model, we suppose that all the assets left by deceased population is fairly distributed among the population:

$$\begin{aligned}&Her(t, g, s, c) \\ &= Asset(t \\ &- 1, gp, sp, cp) \frac{\sum_{(gp,sp,cp)\$(age(t,gp)\geq D1(gp,sp,cp))}\left(POP\_REV(t-1, gp, sp, cp) - POP\_REV(t, gp, sp, cp)\right)}{\sum_{(gp,sp,cp)\$(age(t,gp)\geq D1(gp,sp,cp))}\left(POP\_REV(t, gp, sp, cp)\right)}\end{aligned}$$

The total households' consumption is then the sum of consumption of the population that has a revenue. It is defined as:

$$constot(t) = \sum_{g,s,c} POP\_REV(t, g, s, c) ConsH(t, g, s, c)(1 + cout(t, g, s, c))$$

F. THE TRADE BLOCKS

1. *Exports*

For domestic producers, the allocation between exports EXP(t) and domestic selling DLOC(t) results from the optimization of a CET function:

$$\text{Y(t)} = \text{Arg Max}\left(\left(\text{A(t)}\left(\text{b}_t\, \text{EXP(t)}^{\sigma_t} + \left(1 - \text{b}_t\right) \text{DLOC(t)}^{\sigma_t}\right)^{\frac{1}{\sigma_t}}\right)\right)$$

Under the constraint of the zero-profit rule:

$$PY(t)\, Y(t) = PDLOC(t)\, DLOC(t) + PEXP(t)\; EXP(t)$$

Where PEXP(t) is the local price of exported products defined as product of the world prices pwe(t), supposed to be given as we adopt the hypothesis of a small economy:

$$PEXP(t) = pwe(t)\, EXR(t)$$

The level of exports is then given by:

$$\frac{EXP(t)}{DLOC(t)} = \left(\frac{PEXP(t)}{PDLOC(t)}\right)\left(\frac{1 - b_t}{b_t}\right)^{\frac{1}{\sigma_t - 1}}$$

2. *Imports*

We adopt a classic Armington approach to define the arbitrage between the consumption of local $DLOC(t)$ product and imported products $IMP(t)$:

$$\mathrm{DTOT(t)} = \mathrm{A_{DEM}}\left(\mathrm{b_{DEM}IMP(t)^{(-\sigma_{DEM})}} + (1-\mathrm{b_{DEM}})\ \mathrm{DLOC(t)^{(-\sigma_{DEM})}}\right)^{\left(\frac{-1}{\sigma_{DEM}}\right)}$$

Under the contraint:

$$PDTOT(t)\left(1 - TaxInd(t)\right) DTOT(t) = PDLOC(t)\ DLOC(t) + PIMP(t)\ IMP(t)$$

Where $DTOT(t)$ is the total domestic demand. $TaxInd(t)$ is the indirect taxation rate and $PIMP(t)$ the price of imported product at the market products defined as the product of the world prices pwe(t) the exchange rate EXR(t) and the tariffs $tm(t)$:

$$PIMP(t) = pwm(t)\left(1 + tm(t)\right) EXR(t)$$

The resolution of the Armington programme allows the definition of a relationship between local and imported demand:

$$\frac{IMP(t)}{DLOC(t)} = \left(\frac{PDLOC(t)}{PIMP(t)}\frac{b_{DEM}}{(1-b_{DEM})}\right)^{\frac{1}{(\sigma_{DEM})}}$$

G. GOVERNMENT CONSOLIDATED ACCOUNT

The total Government revenue REVG(t) is the sum of direct tax applied on all households' revenue (labour and capital) and the indirect taxation on domestic sailings and tariffs applied on imported products:

$$\begin{aligned} REVG(t) = Taxdir(t)\sum_{(g,s,c)}\big(req(t)\ \ POP\_REV(t,g,s,c)Asset(t-1,g,s,c) \\ + POP\_REV(t,g,s,c)\ RevH(t,g,s,c)\big)\ \ + TaxInd(t)PDTOT(t)\ DTOT(t) \\ +\ pwm(t)tm(t)EXR(t)IMP(t) \end{aligned}$$

Government expenditure $DEPG(t)$ is the sum of the government wage bill MSAL(t), government current expenditure CG(t), public investment $INVPUB(t)$ the coverage of the pension funds deficit and the reimbursement of the amortization and the interest of domestic $DebtD$ and foreign debt $DebtF$:

$$\begin{aligned} DEPG(t) = MSAL(t) + PDTOT(t)\big(INVPUB(t) + CG(t)\big) + \big(amD(t) + req(t)\big)DebtD(t-1) \\ + \big(amF(t) + rF(t)\big)\ DebtF(t-1)Exr(t) + \sum_{caisse} Solde(t, caisse) \end{aligned}$$

Where $amD(t)$ is the amortization rate for domestic debt, *amf* the amortization rate for foreign debt, *rF* is the international interest rate applied on foreign debt. The government wage bill is the sum of the wages of all civil servants:

$$MSAL(t) = \sum_{(g,s)}\big(wFonc(t,g,s,c,fonc)Nac(t,g,s,c,Fonc)\big)$$

The government deficit $SoldG(t)$ is then defined as the difference between government expenditure and government revenue:

$$SoldG(t) = DEPG(t) - REVG(t)$$

This deficit is funded by domestic borrowing SoldGD(t) and foreign borrowing SoldGF(t) Exr(t):

$$SoldG(t) = SoldGD(t) + SoldGF(t)\, Exr(t)$$

The debt dynamic is then defined by:

$$Debt(t) = \big(1 - amD(t)\big)DebtD(t-1) + SoldGD(t)$$
$$DebtF(t) = \big(1 - amF(t)\big)\, DebtF(t-1) + SoldGF(t)$$

H. MARKET EQUILIBRIUM

The resources employment equilibrium condition for good and services is given by:

$$GDP(t) = Y(t) + MSAL(t) + Rec\_TaxInd(t) + Rec\_DD\ (t)$$

Where Rec_TaxInd is the indirect taxes revenues and Rec_DD is the tariffs revenue. The zero-profit rule for the private sector is defined by:

$$PY(t)\, Y(t) = Req(t)\, K(t) + wmoy(t)\, Leff(t)$$

The Capital accumulation rule is given by:

$$INV(t) + INVPUB(t) = K(t) - (1 - \delta)\, K(t-1)$$

Where INV(t) is the level of investment the private sector, INVPUB(t) the level of public investment and δ is the amortization rate.

The macroeconomic resources-employment equilibrium for the tradable goods is then given by:

$$Y(t) + IMP(t) = INV(t) + Constot(t) + CG(t) + INVPUB(t) + EXP(t)$$

The saving-investment market clearance is given by:

$$\sum_{(g,s,c)} POP\_REV(t,g,s,c)Asset(t-1,g,s,c) = K(t) + DebtD(t)$$

The balance of payment equilibrium:

$$pwm(t)\, IMP(t) + \big(amF(t) + rF(t)\big)\, DebtF(t-1) = EXP(t) + SoldGF(t) + trans(t)$$

III. ILLUSTRATION OF MODEL SIMULATION

The financial viability of the Tunisian pension system has been questionable since the 1990s (Vittas, 1993).[11] The aging phenomena occurring in Tunisia, coupled with high population replacement rates and the low linkages between contributions and pension benefits, has put the financial situation under intense pressure: the pension system has registered a deficit since 2015 which is projected to increase over time if the current legislation is not changed.

A. TUNISIAN DEMOGRAPHIC SITUATION AND PROSPECTS

From 2014 until 2025, the total Tunisian population is projected to grow at 1.12 per cent on average (figure 1). It will increase from 11 million in 2014 to 12.4 million in 2025. This demographic evolution coincides with a significant aging trend that will increase the share of the population that is over 60 years old from 11.7 per cent to 15.7 per cent of total population (figure 2).

Figure 1. The projected evolution of the Tunisian population

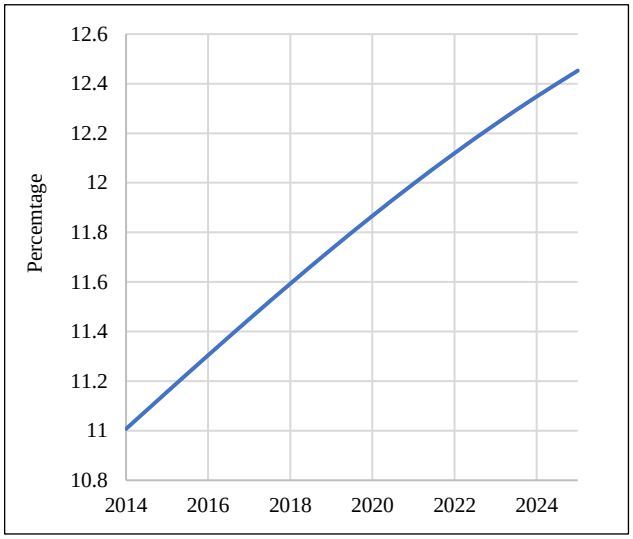
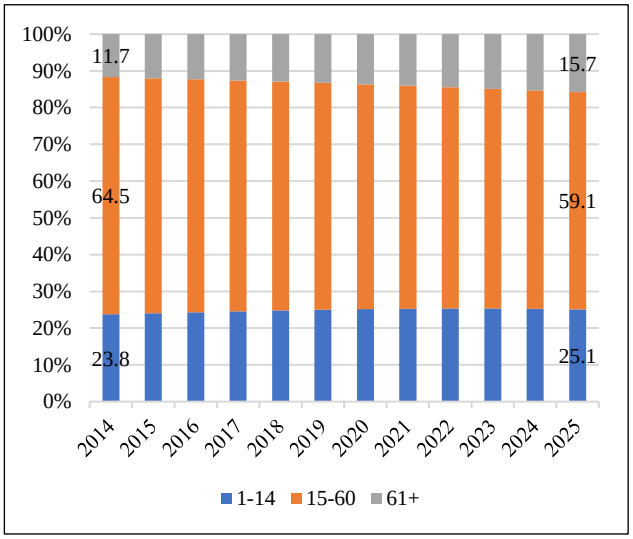


Figure 2. Evolution of aging structure of the Tunisian population



Source: Centre de Recherches et d'Etudes Sociales.

The shift in Tunisia's demographics began in the 1990s. Between 1970 and 2000 the number of births decreased significantly while at the same time, older cohorts enlarged thanks to increased life expectancy (ESCWA, 2018).[12] This phenomenon accelerated in 2014, the older cohorts' share in the population increased even in spite a slight rebound in birth rates (figure 4).

[11] Dimitri Vittas, "Options for pension reform in Tunisia", Policy Research Working papers, No. WPS 1154, (Washington, D.C., World Bank, July 1993). Available at http://documents.worldbank.org/curated/en/297941468781762735/pdf/multi-page.pdf.

[12] ESCWA, "Tunisia Labour market country profile", Working paper, forthcoming.

Figure 3. Age pyramid in 2014

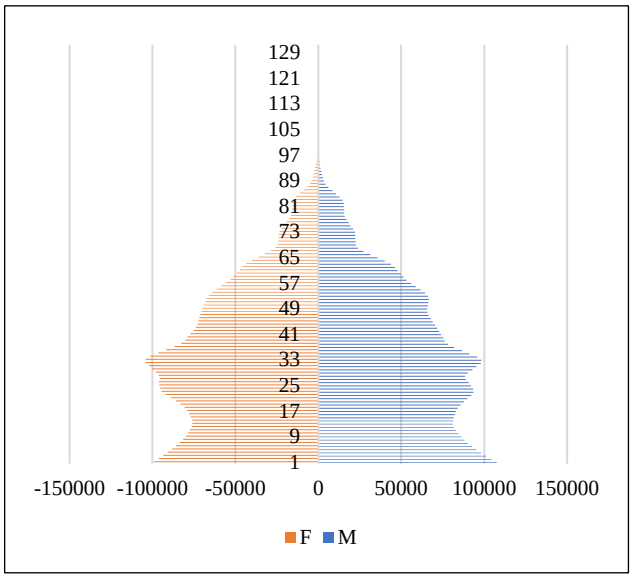
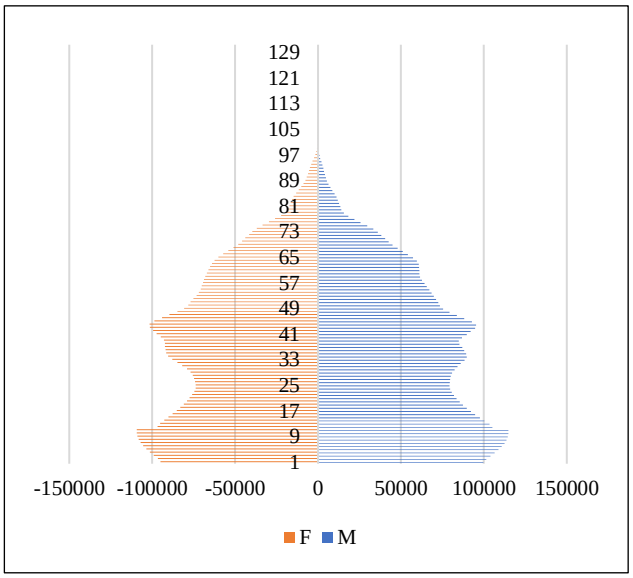


Figure 4. Age pyramid in 2025



Source: Tunisia Labour Market Country profile, ESCWA.

B. POPULATION CHARACTERISTICS BY AGE AND GENDER

Data shows that activity and unemployment rates vary significantly by age and gender. On average, a Tunisian male's activity rate is twice as high as a female's (figure 5). In addition, an active Tunisian female faces a much higher unemployment rate than a male (figure 6).

Figure 5. Activity rate by age and gender

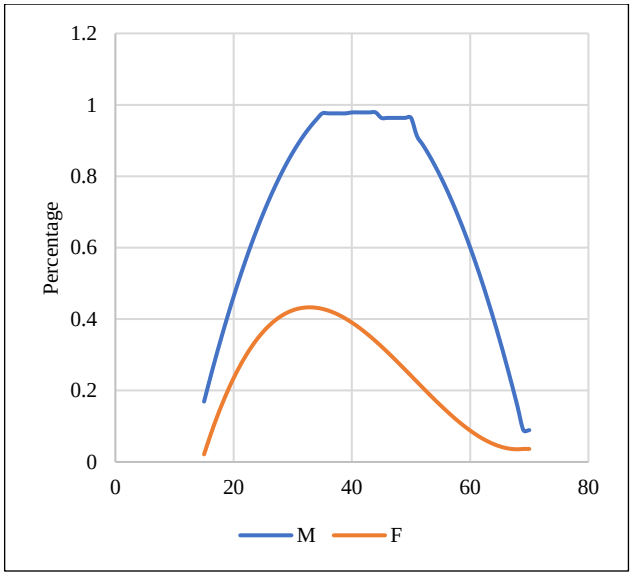
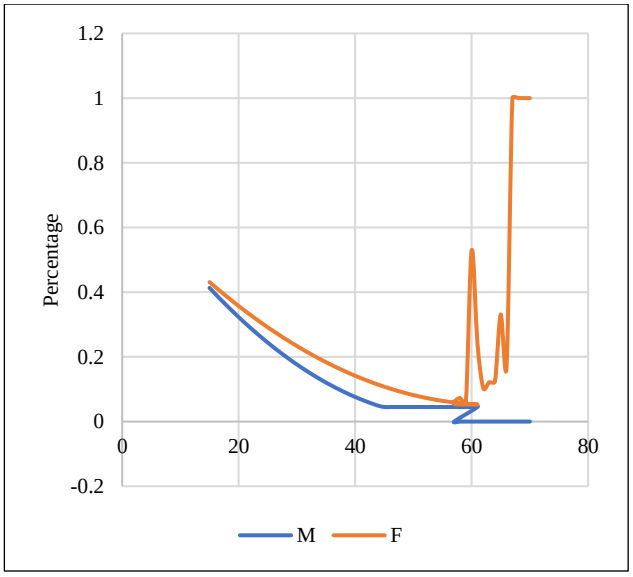


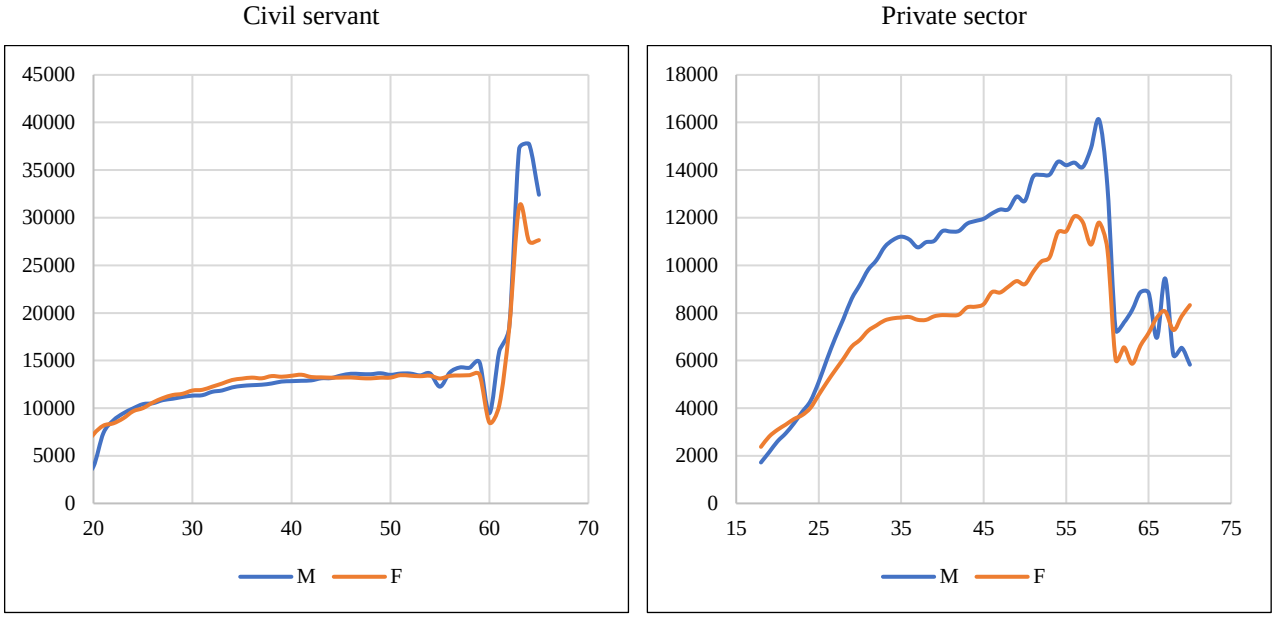
Figure 6. Unemployment rate by age and gender



Source: Centre de Recherches et d'Etudes Sociales.

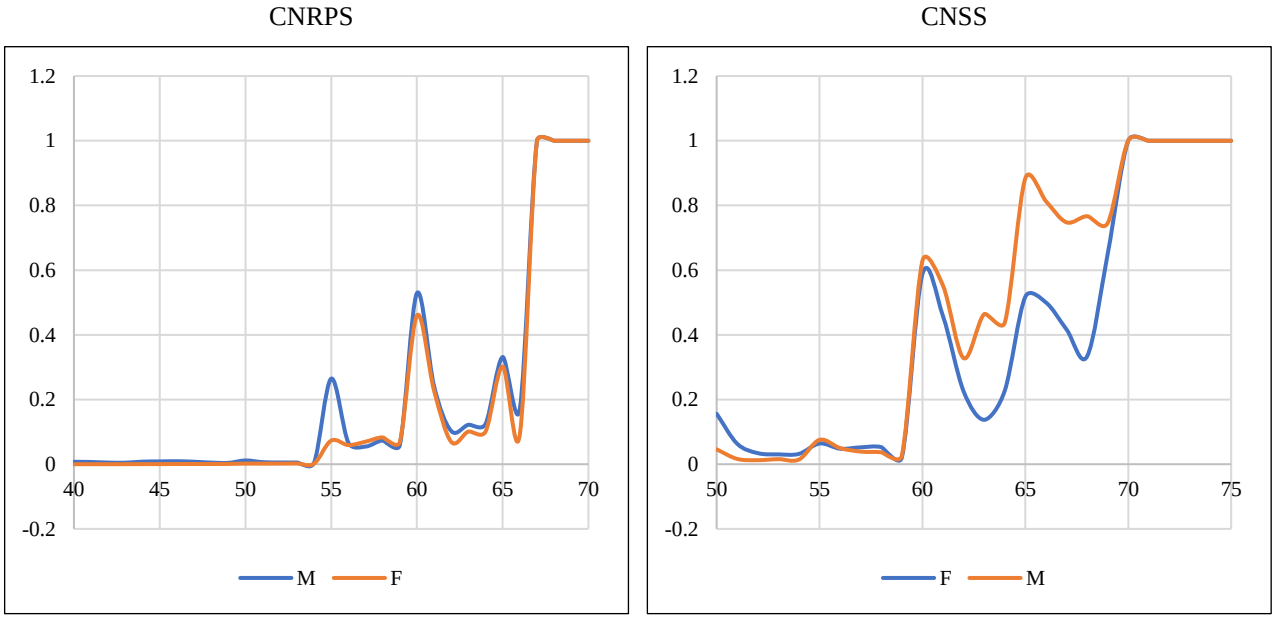
The wage profile and the share of population that decides to retire by professional category, age and gender is supposed to be fixed overtime. Their 2014 levels are illustrated in figure 7 and figure 8, respectively.

Figure 7. Salary profile by age and gender



Source: Centre de Recherches et d'Etudes Sociales.

Figure 8. Share of population that decides to retire by age and gender in 2014



Source: Centre de Recherches et d'Etudes Sociales.

C. MODEL SIMULATIONS

The model is calibrated using 2014 macroeconomic data and dynamically calibrated to reproduce the IMF's projected macroeconomic framework between 2014 and 2025 (table 1). This framework is considered the "Business as Usual" (BaU) scenario. Simulations results will be presented as relative variation vis-à-vis the BaU.

TABLE 1. PROJECTED MACROECONOMIC FRAMEWORK BETWEEN 2019 AND 2025

	2019	2020	2021	2022	2023	2024	2025
Real GDP	7.4	7.8	7.7	7.7	7.7	7.7	7.7
Capital	604.3	568.1	536.6	508.1	484.3	464.6	448.8
External transfers	10.4	11.0	12.1	11.8	11.9	12.1	12.2
Capital rate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Labour in private sector	2.5	2.3	2.2	2.0	1.9	1.8	1.6
Civil servant	0.7	0.6	0.6	0.5	0.5	0.4	0.4
Price index	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Consumption	53.7	54.4	55.0	55.4	54.1	52.8	51.3
Total Investment	24.9	25.5	25.6	25.0	26.8	28.5	30.5
Unemployment rate (in per cent)	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Exchange rate: dinar/US$ (average)	0.7	1.4	1.3	1.3	7.1	6.7	6.8

Source: Author's calculation using model simulation.

1. *"Business as usual": the no reform scenario*

If no reform is undertaken, the number of CNRPS contributors will decrease by 1.4 per cent annually while the number of pensioners will increase by 5.5 per cent annually. The dependency rate, defined as pensioners to contributors' ratio, could increase from 33.9 per cent in 2019 to around 48.2 per cent in 2025. The financial situation of both funds will be then deeply affected. The CNRPS revenue will decrease from 3.12 per cent of GDP to 2.79 per cent of GDP while its expenditure will increase from 3.87 per cent of GDP in 2019 to 4.47 per cent of GDP in 2025. (table 2).

TABLE 2. EVOLUTION OF THE FINANCIAL SITUATION OF THE CNRPS

	2019	2020	2021	2022	2023	2024	2025	Cumulative
Total contributors	-1.0	-0.9	-1.3	-1.2	-1.3	-1.4	-1.4	-1.4
Total pensioners	5.3	4.6	5.2	4.6	4.6	4.5	4.1	5.5
Dependency rate	33.9	36.1	38.1	40.5	42.9	45.5	48.2	
Total revenue	3.12	2.88	2.79	2.79	2.79	2.79	2.79	4.8
Total expenditure	3.87	3.75	3.81	3.96	4.13	4.30	4.47	10.3
CNRPS Balance	-0.74	-0.87	-1.02	-1.18	-1.34	-1.52	-1.68	

Source: Author's calculation using model simulation.

The number of contributors at the CNSS will continue to increase (0.4 per cent annually) but at a much slower pace than the number of contributors (4.4 per cent annually). Under these conditions, the dependency rate could increase from 27.6 per cent in 2018 to 33.9 per cent in 2025. The revenue of the CNSS will be relatively stable at around 2.0 per cent of GDP while expenditure will increase for 3.4 of GDP in 2019 to 3.6 per cent of GDP in 2025 (table 3).

TABLE 3. EVOLUTION OF THE FINANCIAL SITUATION OF THE CNSS

	2019	2020	2021	2022	2023	2024	2025	Cumulative
Total contributors	1.08	1.01	0.94	0.88	0.81	0.76	0.71	0.4
Total pensioners	0.31	0.30	0.29	0.28	0.27	0.26	0.25	4.4
Dependency rate	27.6	28.6	29.6	30.8	31.9	32.9	33.9	
Total revenue	2.07	2.09	2.08	2.07	2.06	2.06	2.05	9.3
Total expenditure	3.40	3.50	3.58	3.63	3.64	3.63	3.61	10.9
CNSS Balance	-1.33	-1.41	-1.50	-1.56	-1.58	-1.57	-1.55	

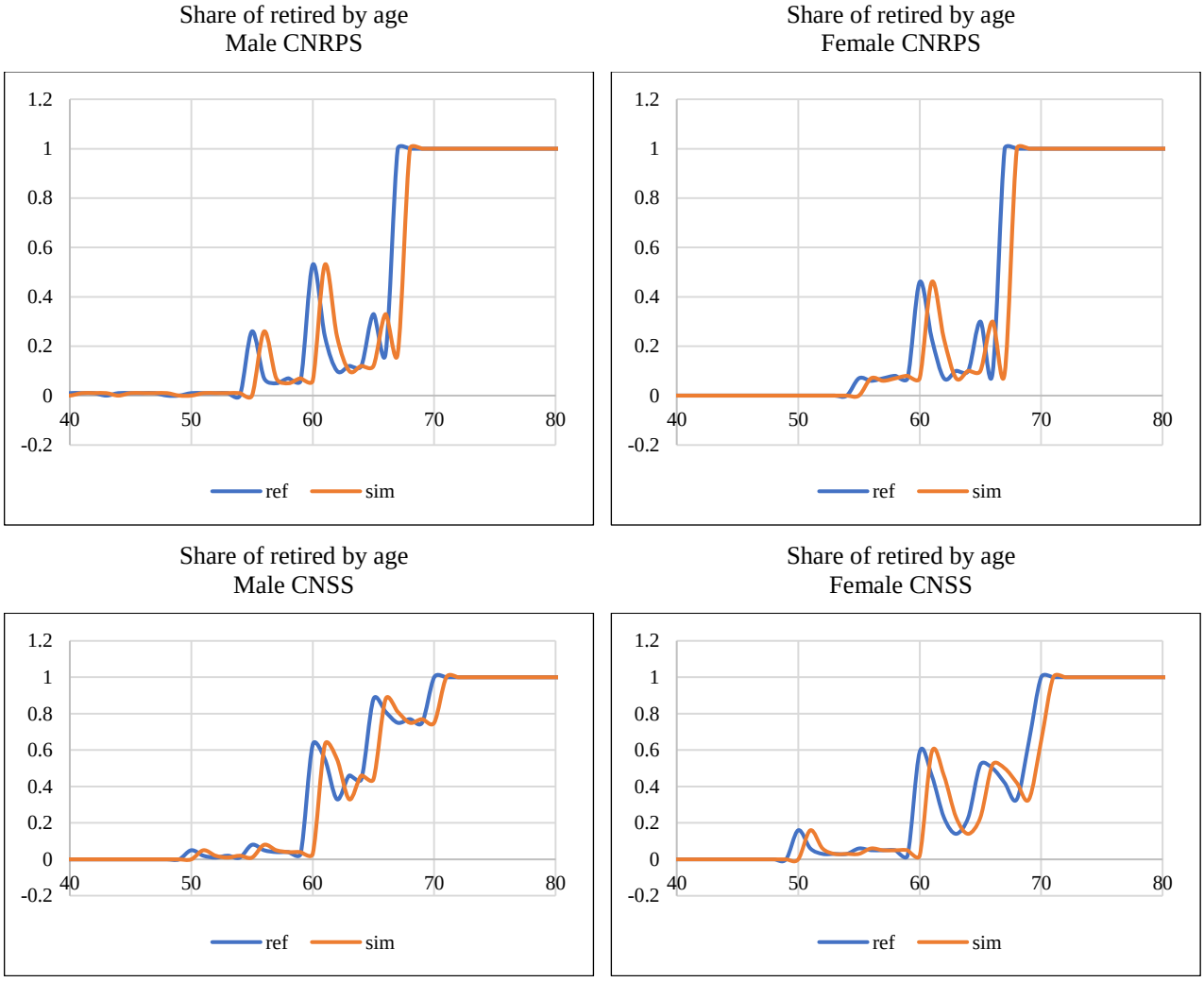
Source: Author's calculation using model simulation.

Both funds are forecast to register significant deficits of 1.68 per cent of GDP for CNRPS and 1.55 per cent for CNSS. The overall deficit of both funds could reach the alarming level of 3.24 per cent of GDP by 2025. To cover this deficit, this paper proposes the assessment of three parametric reforms that aim to maintain the basic structure of the existing system while attempting, through changes in the significant parameters of the system, namely: the retirement age, the replacement rate and the contribution rate.

2. *Increase in official retirement age*

An increase in the official retirement age is modeled as a shift in the retirement distribution function (figure 9). The government is supposed to adjust its recruitment program to maintain the number of civil servants as constant.

Figure 9. demographic implications of the increase of the official retirement age



Source: Centre de Recherches et d'Etudes Sociales.

Within this hypothesis, a one-year increase of the legal retirement age decreases the number of the CNRPS's pensioners by 5.4 per cent by 2025 compared to the BaU scenario and by 11.4 per cent for the CNSS (table 4). The number of contributors at the CNRPS remains unchanged as the government is supposed to maintain the number of civil servants constant. The number of contributors at the CNSS increases slightly as a result of the reduction of number of unemployed persons. The dependency rate of the CNRPS decreases by 2.4 basis points and by 3.6 basis points for the CNSS in 2025.

TABLE 4. IMPACTS OF A ONE-YEAR INCREASE OF THE LEGAL RETIREMENT AGE ON THE PENSION FUNDS
(*Relative variation vis-à-vis BaU*)

	2019	2020	2021	2022	2023	2024	2025	Cumulative
CNRPS								
Total contributors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total pensioners	-2.7	-2.9	-4.1	-4.3	-4.8	-5.4	-5.4	-3.9
Dependency rate	0.0	-1.0	-1.1	-1.7	-1.8	-2.2	-2.6	-1.5
Total revenue	0.2	0.2	0.4	0.3	0.4	0.5	0.5	0.3
Total expenditure	-2.2	-2.3	-3.2	-3.3	-3.8	-4.3	-4.3	-3.2
CNRPS balance	-12.1	-10.5	-12.9	-11.9	-12.5	-13.1	-12.2	-11.7
CNSS								
Total contributors	0.3	0.4	0.5	0.4	0.4	0.4	0.5	0.3
Total pensioners	-2.0	-4.0	-5.7	-7.2	-8.7	-10.0	-11.4	-6.4
dependency rate	0.0	-0.7	-1.3	-1.9	-2.4	-3.0	-3.5	-1.8
Total revenue	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.4
Total expenditure	-3.3	-6.2	-8.5	-10.3	-11.9	-13.2	-14.8	-9.4
CNSS balance	-8.9	-15.8	-20.9	-24.5	-28.0	-31.0	-35.0	-23.1

Source: Author's calculation using model simulation.

These evolutions improve the financial situation of both funds. Between 2019 and 2025, the CNRPS' cumulative revenue increases by 0.3 per cent while total cumulative expenditure decreases by 3.2 per cent. The cumulative deficit decreases by 11.7 per cent but this gain represents only 0.2 per cent of GDP. The improvement of the CNSS financial situation is more significant. Between 2019 and 2025, cumulative revenues increase by 0.5 per cent and cumulative expenditure decreases by 9.4 per cent compared to the BaU scenario. The deficit could be reduced by 23.1 per cent cumulatively representing the equivalent of 0.35 per cent of GDP. This difference in magnitude between the funds results from the determination of an employee's first pension. For CNRPS, the first pension depends only on the last salary. An additional year of work increases the last salary and is completely reflected in the first pension. For CNSS, the pension is proportional to the average of the last ten years of an employee's contribution. The additional year of contribution has less impact on the pension.

TABLE 5. FISCAL IMPLICATIONS OF A ONE-YEAR INCREASE OF THE LEGAL RETIREMENT AGE
(*Relative variation vis-à-vis BAU*)

Expenditure	2019	2020	2021	2022	2023	2024	2025	Cumulative
Total expenditure	-0.6	-1.0	-1.5	-2.0	-2.4	-2.8	-3.2	-1.9
Wage bill	0.2	0.2	0.4	0.3	0.4	0.5	0.5	0.3
Current expenditure	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.3
Public investment	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.4
Domestic amortization	0.0	-0.6	-1.4	-2.2	-3.2	-4.2	-5.1	-2.3
Domestic interest	0.0	-0.6	-1.4	-2.3	-3.3	-4.3	-5.2	-3.0
Foreign amortization	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-0.1
Foreign interest	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-0.1
Total revenue	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.4
Total deficit	-1.4	-2.6	-3.9	-5.1	-6.1	-6.8	-7.6	-4.7
Domestic financing	-2.3	-4.4	-5.3	-7.1	-8.2	-9.0	-9.8	-6.8
Foreign financing	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-0.1
Debt	-0.2	-0.5	-0.9	-1.4	-2.0	-2.5	-3.5	-1.7
Domestic debt	-0.6	-1.4	-2.2	-3.2	-4.2	-5.1	-6.0	-3.6
Foreign debt	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-0.1

Source: Author's calculation using model simulation.

As the Government is supposed to be the payer of the last resort for both funds, the improvement of their financial situations of pension funds improves the overall fiscal situation. Total expenditure could be reduced by 1.9 per cent while the wage bill could increase by 0.3 per cent as a result of maintaining more experienced (higher paid) workers in public administration. The overall deficit is consequently reduced by 4.7 per cent. The reduction of public deficit reduces the domestic indebtedness by 3.6 per cent and the overall deficit by 1.7 per cent which would appease debt servicing. Interest payment could be decreased by 3 per cent while amortization payments could be reduced by 0.1 per cent. (table 5).

The closure rule adopted in this simulation supposes that the deficit is financed by adjusting the level of domestic borrowing. The reduction of public deficit implies a 7.9 per cent decrease in domestic borrowing and a decrease the crowding out effect that increases total investment by 1.5 per cent, GDP by 0.2 per cent and decreases unemployment rate by 0.2 basis points (table 6).

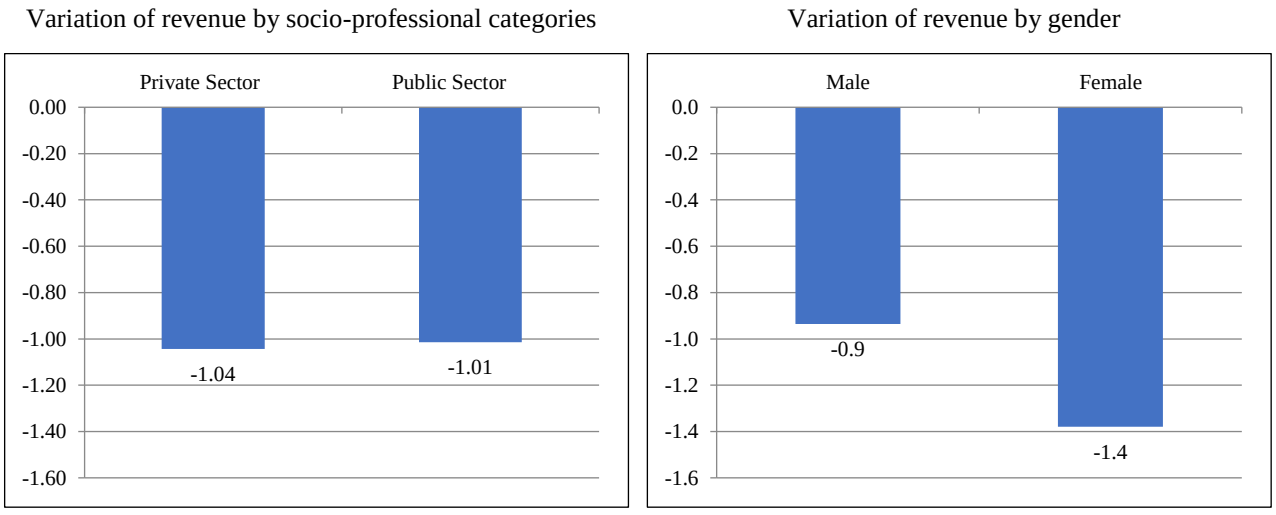
TABLE 6. THE MACROECONOMIC IMPLICATIONS OF A ONE-YEAR INCREASE OF THE LEGAL RETIREMENT AGE ON THE PENSION FUNDS
(*Relative variation vis-à-vis BAU*)

	2019	2020	2021	2022	2023	2024	2025	Cumulative
Real GDP	0.1	0.0	0.0	0.1	0.2	0.3	0.4	0.2
Labour in private sector	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Labour in public sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total investment	0.5	0.9	1.5	1.7	1.9	2.1	2.2	1.5
Unemployment rate (in per cent)	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2
Imports volume	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.2
Exports volume	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.2

Source: Author's calculation using model simulation.

The intragenerational redistributive impact of this reform is quite neutral in term of socio-professional categories (figure 10). Private and public sectors workers will undergo a comparable decrease in their revenue of around 1 per cent. Meanwhile, the gender impact is more pronounced. Females will be more affected as they will lose 1.4 per cent of their revenue between 2019 and 2025 while male will lose 0.9 per cent of their revenues.

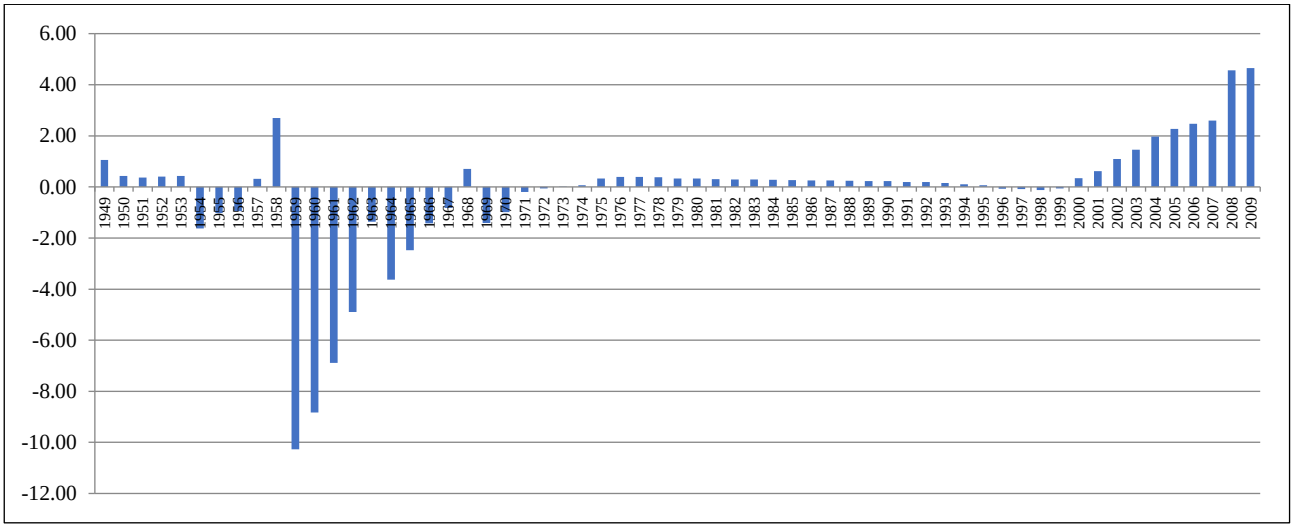
Figure 10. The intragenerational redistributive impacts of a one-year increase of the legal retirement age on the pension funds



Source: Author's calculation using model simulation.

The intergenerational redistributive effect is more pronounced. The generations that will be at the age of official retirement (between 47-60 years old) will be more affected than those already retired or at the working age (figure 11). New generations will profit from the long-term effects of the fiscal consolidation and see an increase in their revenues.

Figure 11. The intergenerational redistributive impacts of a one-year increase of the legal retirement age on the pension funds
(*Relative variation vis-à-vis BaU*)



Source: Author's calculation using model simulation.

3. *Contribution rate increase*

The second reform consists of an increase of the contribution rate by one basis point supported in totality by employers. Both funds will see their revenues increasing. Between 2019 and 2025 CNRPS's revenues increase by 4.9 per cent and CNSS revenues increase by 4.6 per cent. At the same time, CNRPS's expenditure decrease by 0.1 per cent because of the increase of reference salaries that are linked to gross salaries. Cumulatively, between 2019 and 2025, the CNRPS deficit could be reduced by 11.6 per cent when compared to its BaU level whereas the CNSS deficit could be reduced by 6.5 per cent.

TABLE 7. IMPACTS OF INCREASING THE CONTRIBUTION RATE BY ONE BASIS POINT ON PENSION FUNDS
(*Relative variation vis-à-vis BaU*)

	2019	2020	2021	2022	2023	2024	2025	Cumulative
CNRPS								
Total revenue	5.6	5.6	5.6	5.6	5.6	5.6	5.6	4.9
Total expenditure	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.1
CNRPS deficit	-23.4	-18.6	-15.0	-12.8	-11.0	-9.5	-8.4	-11.6
CNSS								
Total contributors	-1.61	-0.42	-0.42	-0.41	-0.41	-0.40	-0.40	-0.51
Total pensioners	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0
Dependency rate	0.0	0.5	0.1	0.1	0.1	0.1	0.1	0.2
Total revenue	4.9	5.1	5.1	5.1	5.1	5.1	5.1	4.6
Total expenditure	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
CNSS balance	-7.5	-7.6	-7.2	-6.9	-6.8	-6.9	-6.9	-6.5

Source: Author's calculation using model simulation.

The improvement of the pension funds' financial situation enhances the Government's overall fiscal position. Total expenditure could be reduced by 0.4 per cent but with a 1.2 per cent increase of public wage bill (table 8). Total government deficit is reduced by 1.1 per cent which reduces domestic borrowing by 1.6 per cent domestic debt by 1 per cent.

TABLE 8. FISCAL IMPLICATIONS OF INCREASING THE CONTRIBUTION RATE BY ONE BASIS POINT
(*Relative variation vis-à-vis BaU*)

	2019	2020	2021	2022	2023	2024	2025	Cumulative
Total expenditure	-0.3	-0.4	-0.4	-0.4	-0.5	-0.5	-0.5	-0.4
Wage bill	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2
Current expenditure	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public investment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Domestic amortization	0.0	-0.3	-0.6	-0.8	-1.0	-1.2	-1.3	-0.7
Domestic interest	0.0	-0.3	-0.6	-0.9	-1.1	-1.2	-1.4	-0.9
Foreign amortization	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foreign interest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total revenue								
Total deficit	-0.8	-1.0	-1.2	-1.3	-1.3	-1.4	-1.4	-1.1
Domestic financing	-1.3	-1.7	-1.6	-1.8	-1.8	-1.8	-1.8	-1.6
Foreign financing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Debt								
Domestic debt	-0.3	-0.6	-0.8	-1.0	-1.2	-1.3	-1.4	-1.0
Foreign debt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Author's calculation using model simulation.

The increases in the cost of labour affects recruitment in the private sector, which decreases by 0.4 per cent (table 9). This decrease jeopardizes the effects of the 0.2 per cent increase in production resulting from the reduction of the crowding out effect and the 0.3 per cent increase in total investment.

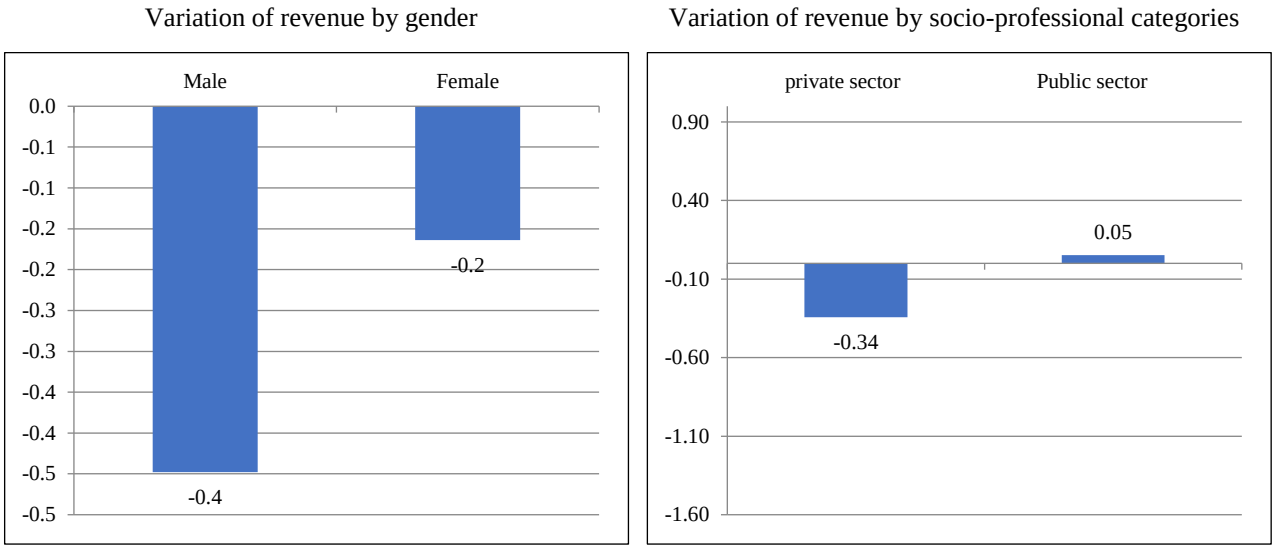
TABLE 9. THE MACROECONOMIC IMPLICATIONS OF INCREASING THE CONTRIBUTION RATE BY ONE BASIS POINT
(*Relative variation vis-à-vis BaU*)

	2019	2020	2021	2022	2023	2024	2025	Cumulative
Real GDP	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Labour in private sector	-1.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Labour in public sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total investment	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Unemployment rate (in percentage)	1.0	0.3	0.3	0.3	0.3	0.3	0.2	2.0
Imports volume	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Exports volume	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0

Source: Author's calculation using model simulation.

The intragenerational redistributive impact of this reform favours of females. Males could lose 0.4 per cent of their revenues where female may lose only 0.2 per cent. In terms of socio-professional redistribution, public sector workers could benefit from a 0.5 per cent increase of their revenues whereas workers in the private sectors could lose 0.34 per cent of their revenues.

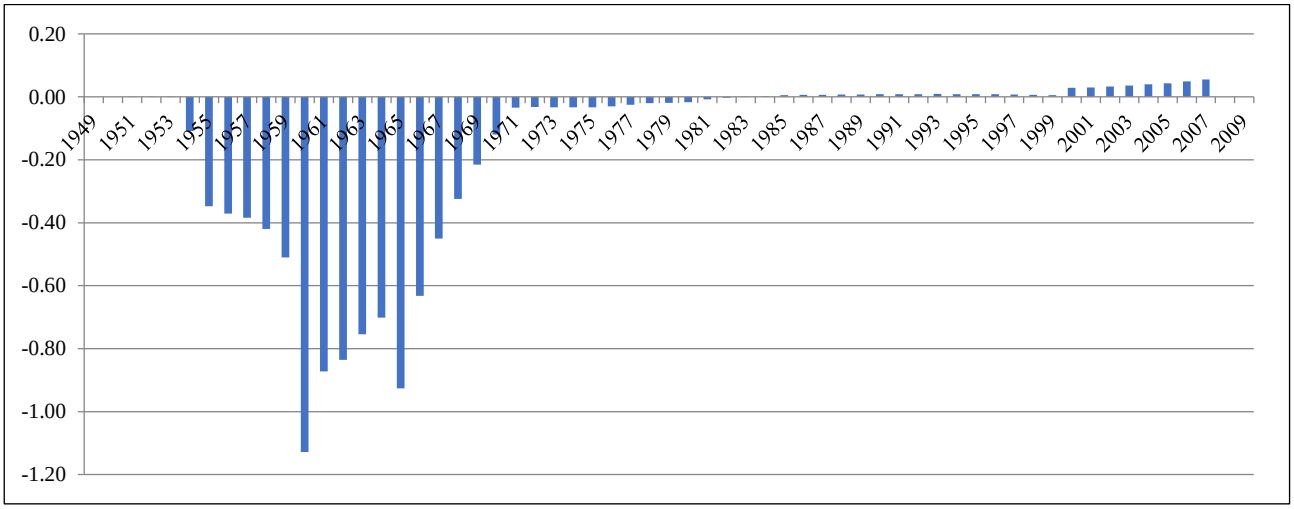
Figure 12. The intragenerational redistributive impacts of increasing the contribution rate by one basis point
(*Relative variation vis-à-vis BAU*)



Source: Author's calculation using model simulation.

In terms of intergenerational redistribution, this reform is mainly a net transfer from younger to older generations. The cost of the reform is supported for the most part by active generations. Most of the population born after 1967 will see a decrease in revenue between 0 and 0,7 per cent while the retired generations see their revenues marginally increasing.

Figure 13. The intergenerational redistributive impacts of increasing the contribution rate by one basis point
(*Relative variation vis-à-vis BaU*)



Source: Author's calculation using model simulation.

4. *Replacement rate reduction*

The third reform consists of reducing the replacement rate by one basis point for all pensioners. This reform does not affect the dependency rate of the CNRPS and its revenue but reduces its expenditure by 2.4 per cent. The deficit could be then reduced by 8.1 per cent (table 10). CNSS total expenditure could be reduced by 0.3 per cent which allows its deficit to be reduced by 0.8 per cent.

TABLE 10. IMPACTS OF A REDUCTION OF THE REPLACEMENT RATE BY ONE BASIS POINT ON PENSION FUNDS
(*Relative variation vis-à-vis BaU*)

	2019	2020	2021	2022	2023	2024	2025	Cumulative
CNRPS								
Total revenue	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total expenditure	0.0	-0.9	-1.7	-2.4	-3.1	-3.7	-4.3	-2.4
CNRPS balance	0.0	-4.1	-6.4	-8.1	-9.5	-10.6	-11.5	-8.1
CNSS								
Total contributors	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01
Total pensioners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
dependency rate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total revenue	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Total expenditure	0.0	-0.1	-0.2	-0.4	-0.5	-0.5	-0.6	-0.3
CNSS balance	0.0	-0.3	-0.6	-0.9	-1.1	-1.3	-1.5	-0.8

Source: Author's calculation using model simulation.

The macroeconomic impact is mainly driven from the reduction of the crowding out effect that results from the 1.1 per cent decrease of public deficit. Total investment could increase by 0.6 per cent and GDP by 0.02 per cent (table 11).

TABLE 11. THE MACROECONOMIC IMPLICATIONS OF A REDUCTION OF THE REPLACEMENT RATE BY ONE BASIS POINT ON PENSION FUNDS
(*Relative variation vis-à-vis BaU*)

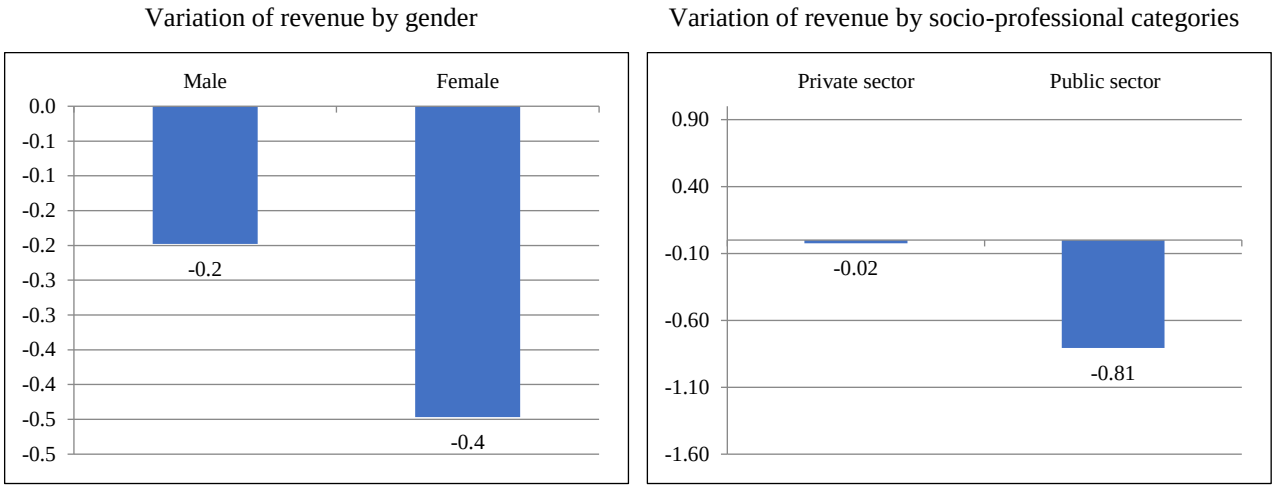
	2019	2020	2021	2022	2023	2024	2025	Cumulative
Real GDP	0.00	0.00	0.01	0.02	0.03	0.04	0.06	0.02
Total investment	0.0	0.1	0.2	0.3	0.3	0.4	0.5	0.3
Unemployment rate (in per cent)	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.03
Total expenditure	0.0	-0.1	-0.2	-0.4	-0.5	-0.7	-0.8	-0.4
Total revenue	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
Total deficit	0.0	-0.3	-0.7	-1.1	-1.4	-1.8	-2.2	-1.1

Source: Author's calculation using model simulation.

The distributive impact of this reform is the opposite to the previous option. Females could lose 0.4 per cent of their revenues where males may lose only 0.2 per cent. In terms of socio-professional redistribution, the workers at the public sector could lose 0.8 per cent of their revenues whereas the loss of revenues for workers at the private sectors would be limited to 0.02 per cent (figure 14).

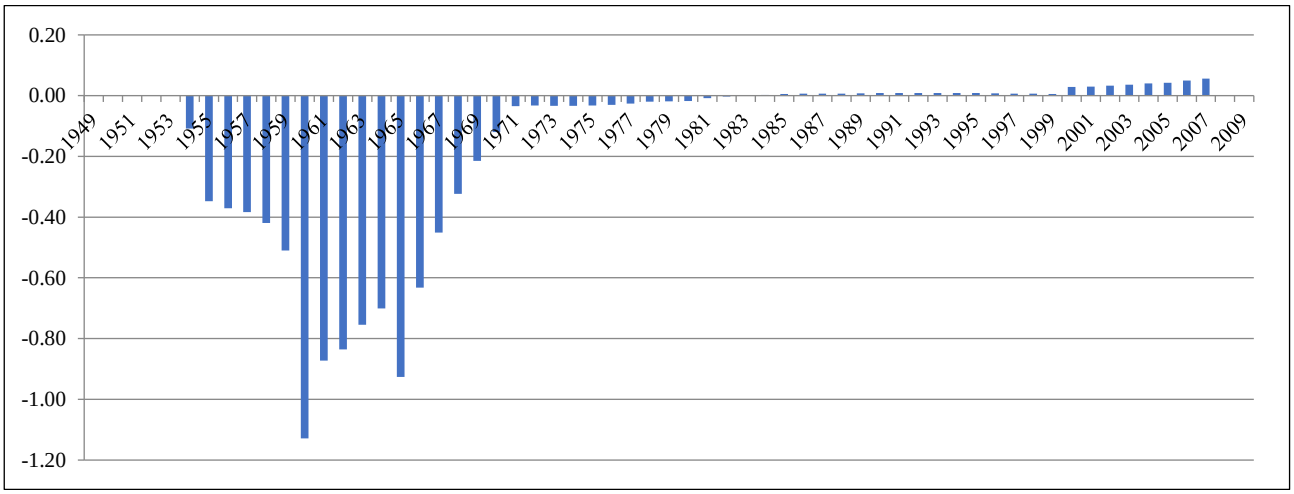
In terms of intergenerational redistribution, this reform is mainly a net transfer from the older generation to the younger. In this case, the cost of the reform is supported mainly by retired generations. Most of the population born before 1980 would see its revenue decreasing between 0 and 1.2 per cent and the active generations would see their revenues marginally increasing.

Figure 14. The intragenerational redistributive impacts of a reduction of the replacement rate by one basis point
(*Relative variation vis-à-vis BaU*)



Source: Author's calculation using model simulation.

Figure 15. The intergenerational redistributive impacts of increasing the contribution rate by one basis point
(*Relative variation vis-à-vis BaU*)



Source: Author's calculation using model simulation.

IV. USER MANUAL FOR THE MODEL INTERFACE

To facilitate the use of the model, ESCWA developed a user-friendly interface with optimized functions that assists policymakers in simulating pension policy reforms.

The interface includes functionalities and specifications for performing manipulations and simulations for the Tunisian pension plan. It can be used by technical and non-technical users.

Figure 16 depicts the main screen of the interface which is divided into two main parts representing the input and output. On the left-hand side, the user can input options and perform the needed simulation. It is divided into the following five sections: top menu, shock grid buttons, parameters, grid/list of shocks and running simulations. Results and outputs can be generated and displayed on the right-hand side. Results buttons, indicators and graphical representation of the results are included in the output part.

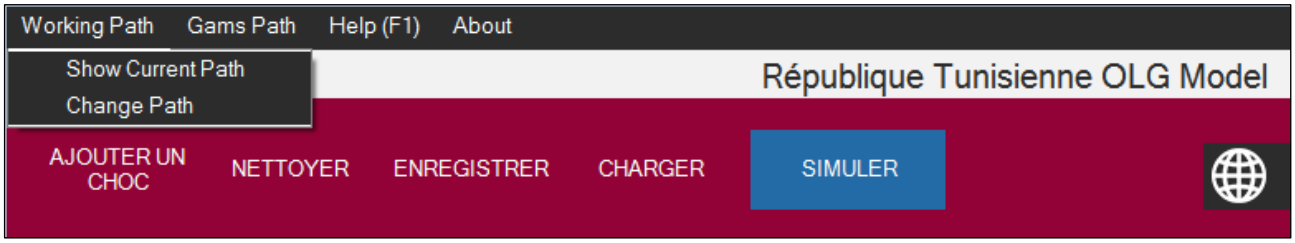
Figure 16. Final OLG simulator design

A. TOP MENU SECTION

In this section, there is the menu of OLG simulator which contains the following four function items as shown in figure 17:

- *Working Path*: a menu that has two sub-menu items (*Show Current Path* and *Change Path*). The first is used to show the current working path and the second is used to set the working path by selecting the corresponding folder;
- *Gams Path*: a menu item with two sub-menu items (Show Current Path and Change Path). The first is used to show the current gams application (gams.exe) path where the GAMS software is installed and where its executable file resides, and the second is used to set the gams path by selecting the corresponding gams.exe executable file which will be used to run the simulations;
- *Help (F1)*: This item would open the help and support information guidelines;
- *About*: this menu drop-down is used to show a small description about the OLG Simulator application.

Figure 17. OLG Simulator menu



B. SHOCK GRID BUTTONS SECTION

Figure 18. Grid action buttons

In this section, the OLG simulator has five function buttons. Each on is an action item used in editing the shock grid:

- *AJOUTER UN CHOC (Add Shock):* this button is used to add a new shock to the grid based on the selected parameters;
- *NETTOYER (Clear)*: this button is used to clear all the shocks added to the grid in one shot;
- *ENREGISTRER (Save)*: this button is used to save the added shocks to a text file (.txt) after specifying the name of the file;
- *CHARGER (Load)*: this button is used to load shocks from a saved .txt file, which is the output of the *ENREGISTRER (Save)* button, into the grid;
- *SIMULER (Run)*: this button is used to run the simulation with all the added shocks and parameters.

C. TYPE OF REFORM AND PARAMETERS TO SHOCK SECTION

The user can select one of the buttons (Fiscal/CNSS/CNRPS) on the top as shown in figure 19. Each button has its own scrolling menus of possible scenarios.

"Fiscal" represents the Tunisian fiscal plan that could be presented by Tunisian government or central bank. It is with a drop-down list with the following six possible options as shown in figure 19.

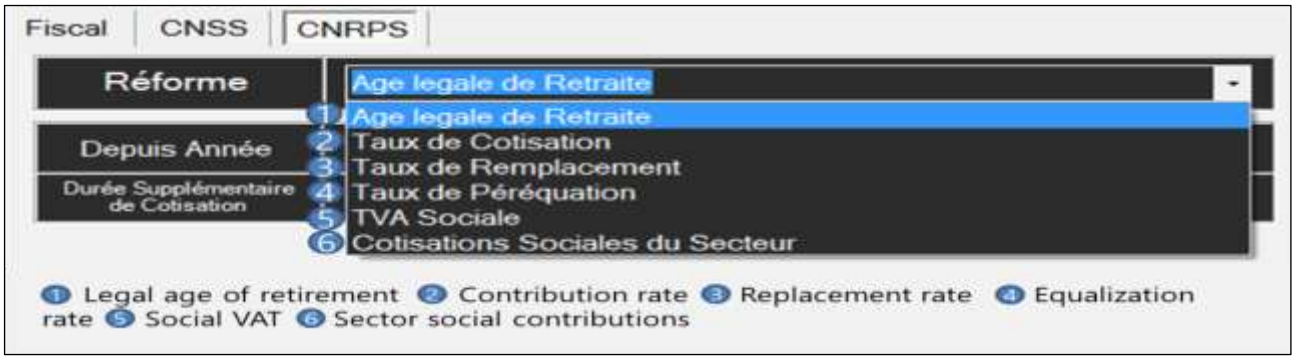
Figure 19. Possible scenarios for fiscal reforms

"CNSS" stands for *Caisse nationale de sécurité sociale (National Social Security Fund)*, which covers the private sector occupational groups. It has a drop-down list with the following seven possible options as shown in figure 20.

Figure 20. Possible scenarios for a reform of the CNSS

"CNRPS" stands for *Caisse nationale de retraite et de prévoyance sociale (National Pension and Social Insurance Fund)*. It is a drop-down list with the following six possible options as shown in figure 21.

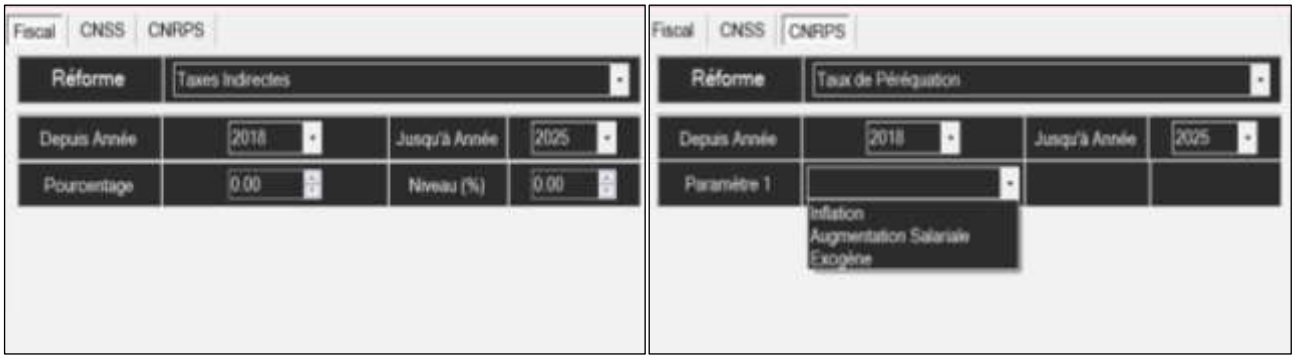
Figure 21. Possible scenarios for a reform of the CNRPS



Parameters to shock: In addition to selecting the type of reform, the user can specify the parameters that she/he wants to add to the simulation before running it. Each *shock* has different parameters that the user can select to run his/her simulation as shown in figure 22.

- *Réforme (Policy)*: this is the main parameter. It has a drop-down list of possible options, as pictured in figure 21;
- *Depuis/Jusqu'à Année (From/To Year)*: this is the second parameter where the user can specify the From Year and To Year values;
- *Pourcentage (Percentage)*: this is the percentage that will be added to the shock formula in the selected policy. Note that the percentage can go both up and down;
- *Paramètre (%) (Parameter)*: in certain reform options, the user can choose parameters such as Inflation, Augmentation Salariale (Salary increase) and Exogène (Exogenous) depending on the policy needs, as shown in figure 23;
- *Niveau (%) (level)*: this is the level that will be added to the shock formula, elaborated with the percentage parameter. "Niveau%" should be in the 0.0x figure;
- *Durée Supplémentaire de Cotisation (Additional duration of contribution)*: this is the duration of extra contribution that will be added to the shock formula in selected policy, seen in figure 21.

Figure 22. Parameters to shock



D. SHOCK GRID SECTION

Figure 23. Shock grid

Del	Réforme	Depuis Année	Jusqu'à Année	Paramètre 1	Pourcent.	Niveau
	Taxes Directes	2018	2025		3	0.02
	Taux d'actualisation	2018	2025	Inflation	0	0.00

This is main section of the OLG simulator. The user can click *AJOUTER UN CHOC (Add Shock)* button (as shown in figure 18) to add a new shock to the grid based on the selected parameters. The grid shows the added shocks along with their parameters. This grid has eight columns as shown in figure 23. The user can delete any row in the grid by clicking on the *delete* bin image in the corresponding *Del* column or by just selecting the row and pressing the *Delete* button on the keyboard. The user can also right click on the row and select *Delete Row*.

The user can increase the width of the columns with the mouse by holding the right corner of the column and moving the mouse right-left to increase/decrease the width. The user can also edit the *Depuis/Jusqu'à Année (From/To Year)*, *Pourcentage (Percentage)*, and *Niveau (level)* values from within the grid directly by double clicking on the cell to enter in *Edit* mode then pressing *Enter* when done editing.

E. RUNNING SIMULATION SECTION

When the *SIMULER (Run)* button is clicked to run the application, a dialogue box opens showing an animated image to tell the user that the simulation is running in the background as shown in figure 24.

When the simulation is completed, the dialogue box alerts the user that the simulation was successfully completed and the user can access the ".lst"file, the log file generated by gams in case he/she wants to go into the details of the simulation step-by-step, as shown in figure 25. When the user clicks "OK" in the dialogue box to check the results of the simulation, he/she will see by default the subindicator chart of *Agrégats Macroéconomiques (Macroeconomic impact)* and graphical results of *PIB réel (real GDP)* under the chart.

Figure 24. Running simulation

Figure 25. Successfully completed simulation

F. RESULT BUTTONS SECTION

Results buttons: buttons in figure 26 are used to show the simulation's results:

- *Résultats Agrégés (Aggregate Results)*: this button is used to show the aggregate results of the simulation. When clicking on this button, an excel file will open showing all the needed results as shown in figure 27;

- *Résultats Détaillés (Detailed results)*: this button is used to show the detailed results of the simulation. When clicking on this button, an excel file will open showing all results in more detail as shown in figure 28.

Figure 26. Results action buttons

Figure 27. Aggregate results

Impacts Macreconomique																
	Reference								Simulation							
	2018	2019	2020	2021	2022	2023	2024	2025	2018	2019	2020	2021	2022	2023	2024	2025
PIB	104603	112378	121197	130580	140689	151582	163317	175961	104617	112410	121251	130660	140801	151729	163505	176193
Travailleurs dans le prive	2798.97	2826.31	2845.75	2863.79	2881.14	2898.19	2915.56	2931.6	2790.06	2824.73	2844.06	2862.37	2879.93	2897.14	2914.73	2930.97
Fonctionnaires	729.56	718.97	714.21	709.21	703.64	697.53	690.62	684.86	729.56	718.97	714.21	709.21	703.64	697.53	690.62	684.86
Indice des prix	1.12	1.12	1.13	1.14	1.15	1.18	1.23	1.27	1.12	1.12	1.13	1.14	1.15	1.18	1.23	1.27
Consommation Totale	63250.2	70713.2	78405.3	86944.1	96176.5	103141	110511	118267	63090.4	70543.6	78218.4	86741.8	95957.7	102911	110272	118021
Investissement Total	66065.5	70519.6	78685.3	85411.1	91645.3	110055	130228	152342	66043.9	70522.7	78720	85483.1	91762.7	110235	130482	152679
Taux de Chomage	15	15	15	15	15	15	15	15	15.21	15.04	15.04	15.03	15.03	15.02	15.02	15.01
Taux de change dinar/US$ (average)	1.47	1.48	1.5	1.52	1.54	1.65	1.76	1.88	1.47	1.48	1.5	1.52	1.54	1.65	1.76	1.88
Salaire moyen dans la fonction publique	21.28	20.48	20.53	21.54	23.39	25.43	27.67	30.06	21.28	20.48	20.53	21.54	23.39	25.43	27.67	30.06
Salaire moyen dans le secteur prive	9.18	9.96	10.81	11.61	12.4	13.28	14.22	15.24	9.21	9.97	10.83	11.62	12.42	13.3	14.25	15.27
Importation Volume	83566.5	92024.7	102029	111473	121265	137762	155858	175676	83579.7	92054.5	102080	111551	121374	137914	156060	175938
Exportation volume	25629.7	27849.2	29719.8	31493.7	33137.7	32461.9	31832.7	31245	25633.8	27858.2	29734.8	31515.5	33167.4	32497.7	31874.2	31291.6
Impacts Fiscaux																
	Reference								Simulation							
	2018	2019	2020	2021	2022	2023	2024	2025	2018	2019	2020	2021	2022	2023	2024	2025
Depense																
Depense Totale	32571	34204.6	35304	36966.4	39443.8	42373.7	45606.7	49090.1	32798.6	34444.2	35567.3	37253.3	39756.7	42714.7	45978.7	49496
Masse Salariale	15525	14721.5	14664.9	15277.9	16460.7	17735	19108.1	20587.4	15525	14721.5	14664.9	15277.9	16460.7	17735	19108.1	20587.4
Depense Courante	3108.86	5380.69	5300	4941	4817.39	5178.06	5693.24	6162.39	3108.86	5380.69	5300	4941	4817.39	5178.06	5693.24	6162.39
Investissement Public	3438.25	3105.89	3385.67	3607.79	3952.91	4011.45	3993.04	4131.38	3665.2	3346.86	3650.97	3897.65	4269.87	4357.82	4371.65	4545.21
Amortissement damortique	2536	2267.92	2252.65	2454.57	2577.07	2797.04	2923.44	3059.63	2536	2267.92	2252.65	2454.57	2577.07	2797.04	2923.44	3059.63
Interetr Damortiquer	1360.88	1402.73	1574.02	1678.75	1839.54	1923.43	1993.8	2052.21	1360.77	1402.51	1573.62	1678.17	1838.72	1922.38	1992.5	2050.68
Amortiration Etrangere	3017	2943.14	3115.71	3303.2	3382.64	3500.21	3813.86	4151.8	3017	2943.14	3115.71	3303.2	3382.64	3500.21	3813.86	4151.8
Taux Interet Etranger	1162.11	1272.74	1361.96	1439.36	1475.89	1608.49	1751.37	1905.3	1162.11	1272.74	1361.96	1439.36	1475.89	1608.49	1751.37	1905.3
Revenue																
total revenur	22638	24273.7	26299.8	28597	31092.4	33499.5	36093	38887.3	22865.6	24513.3	26563	28883.9	31405.2	33840.6	36465.1	39293.2
Recettes taxes directes	10790	11237.8	12240.9	13188.6	14209.6	15309.7	16495	17772	11015.8	11473.2	12497.1	13464.7	14507.4	15630.8	16841.5	18146.4
Recettes taxes indirectes	11048	12136.8	13210.5	14494.4	15897.9	17128.7	18454.8	19883.6	11049.8	12140.8	13217.1	14504.4	15912.2	17147.6	18478.8	19913.3
Recette droits douaniers	800	899.03	848.38	914.06	984.83	1061.07	1143.22	1231.72	800.13	899.32	848.81	914.69	985.71	1062.24	1144.71	1233.56
Solde																
Deficit total	9933	9930.94	9004.27	8369.38	8351.44	8874.14	9513.69	10202.8	9933	9930.94	9004.27	8369.38	8351.44	8874.14	9513.69	10202.8
Financement Damortique	2400	4065.97	3343.42	4413.28	3702.59	4009.7	4229.98	4467.32	2400	4065.97	3343.42	4413.28	3702.59	4009.7	4229.98	4467.32
Financement Etranger	7533	5864.97	5660.84	3956.11	4648.85	4864.44	5283.71	5735.45	7533	5864.97	5660.84	3956.11	4648.85	4864.44	5283.71	5735.45
Dette totale																
Dette Damortique	20058.4	21856.5	22947.2	24905.9	26031.4	27244.1	28550.6	29958.3	20058.4	21856.5	22947.2	24905.9	26031.4	27244.1	28550.6	29958.3
Dette Etrangere	55360.4	58606.3	62133.2	63627.4	65838.8	71738.6	78095.2	84944	55360.4	58606.3	62133.2	63627.4	65838.8	71738.6	78095.2	84944
CNRPS																
	Reference								Simulation							
	2018	2019	2020	2021	2022	2023	2024	2025	2018	2019	2020	2021	2022	2023	2024	2025
Total Cotisant	729.56	718.97	714.21	709.21	703.64	697.53	690.62	684.86	7.3E+08	7.2E+08	7.1E+08	7.1E+08	7E+08	7E+08	6.9E+08	6.8E+08
Total Pensionnaires	269.38	290.43	305.4	320.36	335.63	351.17	367.22	381.84	2.7E+08	2.9E+08	3.1E+08	3.2E+08	3.4E+08	3.5E+08	3.7E+08	3.8E+08
Nouveau Pensionnaire	21.83	27.79	22.1	22.39	23.02	23.6	24.46	23.36	21.83	27.79	22.1	22.39	23.02	23.6	24.46	23.36
Nouveau Cotisants	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Total Recette	3698.72	3507.3	3493.8	3639.84	3921.64	4225.24	4552.36	4904.8	3698.72	3507.3	3493.8	3639.84	3921.64	4225.24	4552.36	4904.8
Total Depenser	4548.74	4725.59	4913.76	5303	5882.94	6507.07	7193.67	7896.6	4548.74	4725.59	4913.76	5303	5882.94	6507.07	7193.67	7896.6
Solde	850.03	1218.28	1419.97	1663.16	1961.31	2281.83	2641.31	2991.81	850.03	1218.28	1419.97	1663.16	1961.31	2281.83	2641.31	2991.81
CNSS																
	Reference								Simulation							
	2018	2019	2020	2021	2022	2023	2024	2025	2018	2019	2020	2021	2022	2023	2024	2025
Total Cotisant	1209.62	1216.33	1219.97	1221.84	1223.86	1225.74	1227.95	1229.34	1205.25	1215.57	1219.15	1221.16	1223.27	1225.24	1227.55	1229.05

Figure 28. Detailed results

	A	B	C	D	E	F	G	H	I	J	K
1	MP	2018	134	H	NonFonc	CNSS	0				
2	NPen	2018	134	H	NonFonc	CNSS	0				
3	Ncot	2018	134	H	NonFonc	CNSS	0				
4	MP	2018	134	H	NonFonc	CNRPS	0				
5	NPen	2018	134	H	NonFonc	CNRPS	0				
6	Ncot	2018	134	H	NonFonc	CNRPS	0				
7	MP	2018	134	H	Fonc	CNSS	0				
8	NPen	2018	134	H	Fonc	CNSS	0				
9	Ncot	2018	134	H	Fonc	CNSS	0				
10	MP	2018	134	H	Fonc	CNRPS	0				
11	NPen	2018	134	H	Fonc	CNRPS	0				
12	Ncot	2018	134	H	Fonc	CNRPS	0				
13	MP	2018	134	F	NonFonc	CNSS	0				
14	NPen	2018	134	F	NonFonc	CNSS	0				
15	Ncot	2018	134	F	NonFonc	CNSS	0				
16	MP	2018	134	F	NonFonc	CNRPS	0				
17	NPen	2018	134	F	NonFonc	CNRPS	0				
18	Ncot	2018	134	F	NonFonc	CNRPS	0				
19	MP	2018	134	F	Fonc	CNSS	0				
20	NPen	2018	134	F	Fonc	CNSS	0				
21	Ncot	2018	134	F	Fonc	CNSS	0				
22	MP	2018	134	F	Fonc	CNRPS	0				

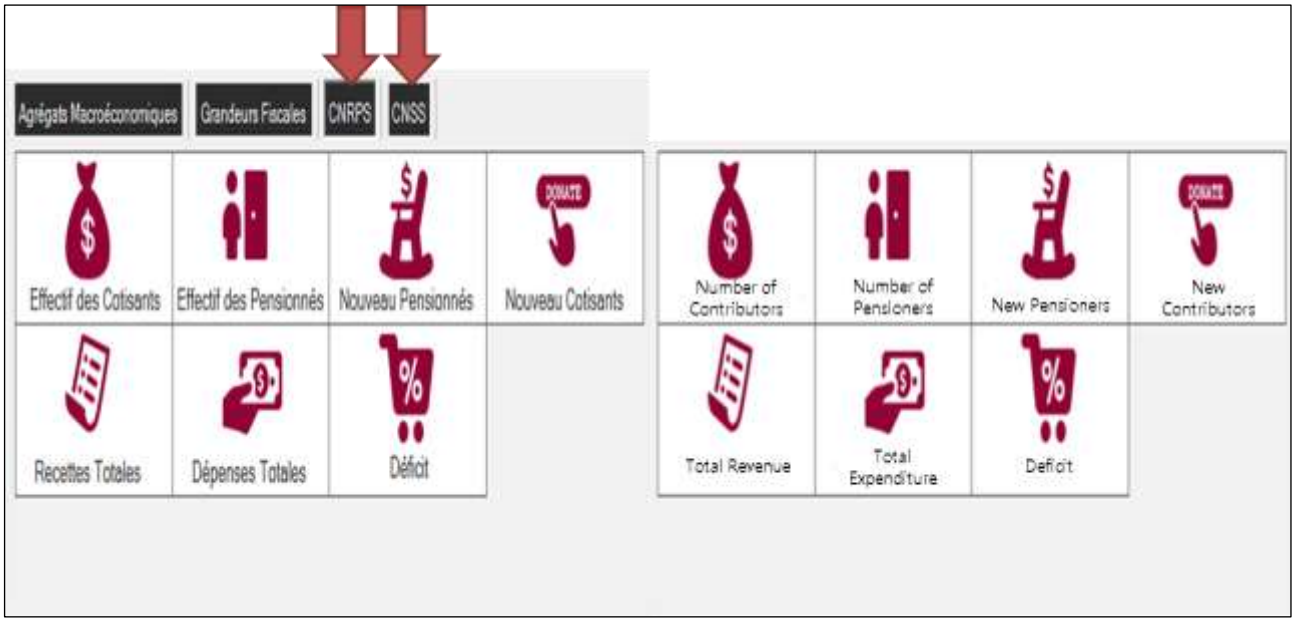
G. OUTCOME INDICATORS SECTION

In this section, the OLG Simulator categorizes outcome indicators into four groups: *Agrégats Macroéconomiques (Macroeconomic impact), Grandeurs Fiscales (Fiscal impact), and impact on CNRPS or CNSS*. Each group has their respective subindicators. Respective subindicators with translated version are shown in figure 29, figure 30 and figure 31.

Figure 29. Subindicators for macro impact

Figure 30. Subindicators for fiscal impact

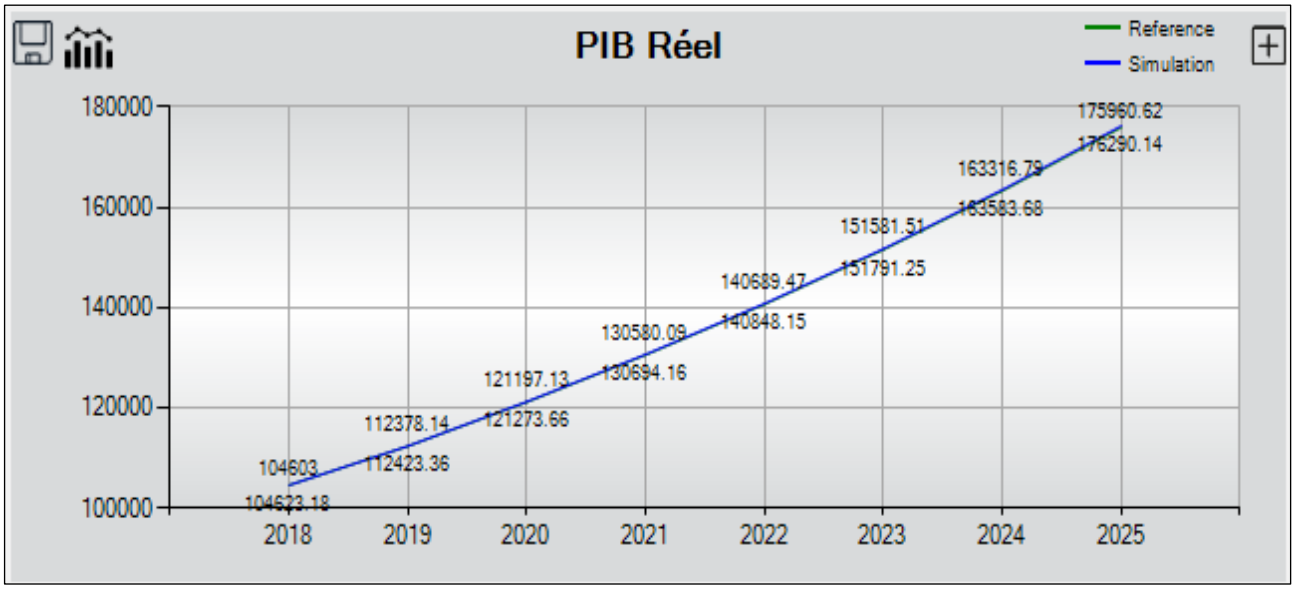
Figure 31. Subindicators for impact on CNSS or CNRPS



H. GRAPHICAL REPRESENTATION SECTION

In this section, the OLG Simulator displays the results in a graph under the economic indicators section as shown in figure 32. The user can find the graph of each subindicator by clicking the picture of it as shown in figure 31.

Figure 32. Graphical display for PIB réel



I. SIMULATION WORKFLOW SAMPLE

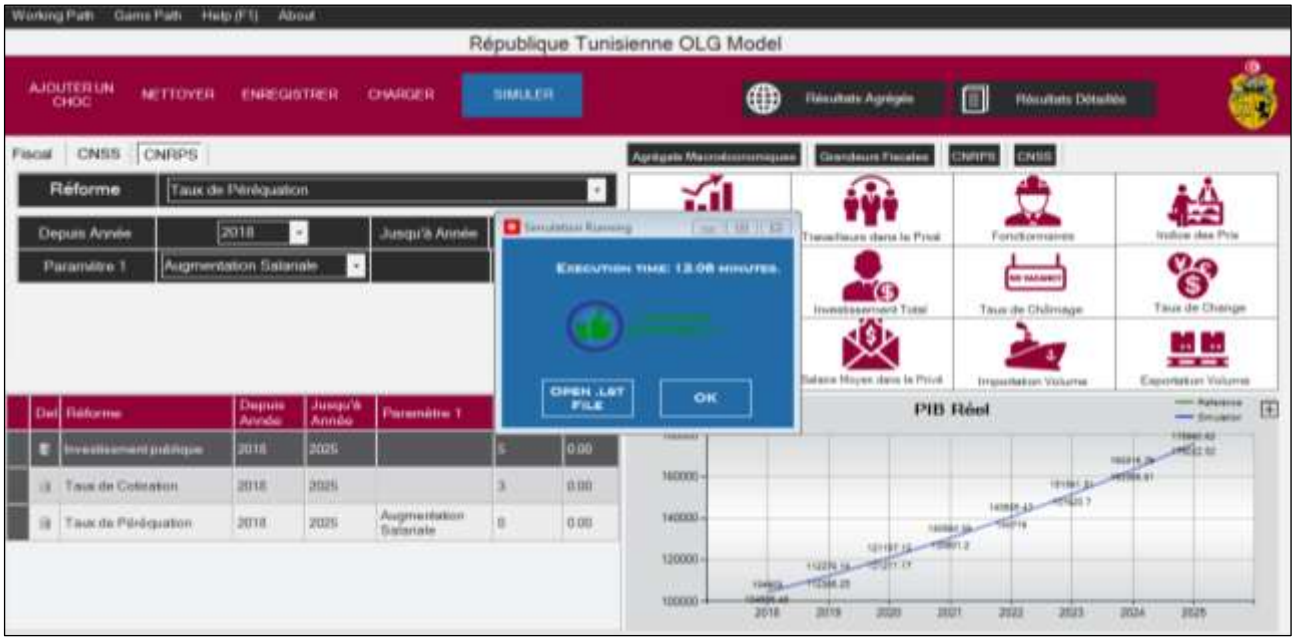
The user must start the OLG interface by double clicking on the executive file. The interface then opens for the user to select the type of reform and specify the parameters. After adding a shock or multiple ones, the user can run the simulation, wait for it to converge and then check the outputs of the simulation.

To illustrate, the following policies have been selected and added to the shock grid: *Investissement publique (Public Investment)*, *Taux de Cotisation (Contribution rate)*, and *Taux de Péréquation (Equalization rate)*. The user can click the *SIMULER (Run)* button to run the application and check the simulation progress through a dialogue box showing an animated image in the middle of the screen as shown in figure 33.

Figure 33. Running simulation example

As shown in figure 34, the simulation was successfully completed. The user can click results buttons at the right corner to check the aggregate results or separate subindicator buttons to check the graphical results.

Figure 34. Successfully completed simulation example



V. CONCLUSION

Pension reforms are not neutral in terms of growth, fiscal sustainability and redistributive impacts. The illustrative simulations conducted in this paper show that each type of reform produces different results in terms of growth, job creation, fiscal deficit among and between generational redistribution. Since the pension system also interacts with the rest of the economy, any change in its parameters could affect the cost of labour, the government's fiscal position, social disparities and economic growth. For this reason, pension reforms should not be an accounting exercise in which the sole objective is to find the parameters that insure the financial equilibrium. Policymakers should conduct an *ex ante* assessment of the possible implications of any change in legislation and find the optimal reform that has the best economic and social implications.

The model presented in this report allows a comprehensive assessment of a large range of pension reforms. It takes into consideration the demographic and socioeconomic characteristic of the population and a detailed description of the pension system including the non-linearity of pension formulae. By simulating some "prototypical" parametric reforms, we showed that official retirement age increase, contribution rate increase and replacement rate reduction are reforms that enhance the financial situation pension funds, but have differentiated impacts in terms of growth, job creation and intergenerational distribution.

The user-friendly interface allows policymakers to easily simulate any combination of these parametric reforms. It also allows the simulation of other parametric or non-parametric reforms such the change of the pension actualization formula or the increase of the coverage ratio. It could also assess some non-contributive reforms and introduce some fiscal instruments (direct or indirect taxation) to enlarge pension funds' revenues. The interface should be fine-tuned in terms of design, language and functionalities.

This mode is applicable to all ESCWA member countries. For each country, the following data are required:

- A gender-desegregated demographic projection by yearly cohorts;
- A full description of the socioeconomic characteristics of the population;
- An in-depth explanation of the pension system including a description of the pension calculation;
- A macroeconomic Social Accounting Matrix;
- A projection of the macroeconomic framework.