TUNISIAN PENSION SYSTEM SUSTAINABILITY: TOWARDS A MULTIDIMENSIONAL REFORM

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Abstract - *Using a computable general equilibrium model with overlapping generations we found that accounting reforms of the Tunisian pension system led to a dead end. The results point to the ineffectiveness of the reforms based only on changing pension parameters to ensure sustainability of the system. The effect of such measures will be limited, even in the short term. Such restricted impact can be attributed to the massive increase of pension system deficits, indicating that the pension situation is an undeniable urgency. Therefore, a wide-range reform of the current pension system is inevitable. In the medium and long term, a structural reform should be adopted. A new and fruitful direction of reform would consist in diversifying financing sources by expanding the contribution base for pension financing beyond labor income.*

Key words - PAY-AS-YOU-GO PENSION SYSTEM, FUNDED PENSION, AGEING POPULATION, OVERLAPPING GENERATIONS

JEL Classification - D91, H55, J26

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1. INTRODUCTION

The Tunisian pension system is under considerable financial pressure, threatening its viability and ability to honor its commitments to current and future retirees. This system is in fact affected by the confluence of long-term reasons and conjunctural factors: demographic mutations following fertility decline, increased life expectancy, resulting in ageing population; on the other hand, unfavorable economic conditions with high unemployment, low wage growth, and inflation. If pension schemes are expected to maintain current levels of contributions and benefits, financial deficit would be unsustainable and income security of future retirees would be challenged. Thus, the expected financial pension perspective requires some thinking and alternative working-out of appropriate reforms to ensure its viability.

Various prospective quantitative tools have been developed to answer the questions raised by the future of pensions to cope with ageing population and growing financial deficits. Different reform options are conceivable. The multiplicity of contradictory assessment options requires the use of a consistent quantitative modeling, based on explicit and credible assumptions. The approach currently preferred to analyze the pensions issue rests on the computable general equilibrium model with an overlapping generations structure (CGEM-OLG), given the magnitude of intergenerational transfers and changes in population structure. As for theoretical foundation, CGEM-OLG stands on the Solow (1956) model, the overlapping generations' model initiated by Allais (1947), Samuelson (1958) and developed by Diamond (1965). This theoretical framework integrates "the accumulation of productive wealth, demography and life-cycle hypothesis" (Le Cacheux and Touzé, 2002, p. 92). Strong microeconomic foundations and macroeconomic closure are present in such models. The model explicitly takes into account the interactions between the economic agents decisions. Initial versions of CGEM-OLG models date back to the early 1980s with Summers (1981) and Seidman (1983). In 1987, Auerbach and Kotlikoff provided a full numerical model with 55 generations, certain life period, exogenous technical progress and endogenous labor supply. Thereafter, depending on the models, some technical aspects have changed by considering uncertainty, endogenous technical progress, open economy, and individual heterogeneity. Several models, in line with the work of Auerbach and Kotlikoff (1987) were used to analyze pension systems evolution.

In Tunisia some studies, amongst our previous work, examined this issue:

- Ben Braham (2007) considered the introduction of a complementary funded pillar to finance 10% reduction of a pay-as-you-go (PAYG) pension benefits. The paper measured the impacts on consumption and saving profiles of households and therefore the effects on capital accumulation. Simulation results highlighted an important crowding out effect and a non Pareto-improving reform, in the sense that the burden of the reform was unequally supported by different generations. In such study, held with a 2003 data base, there are no parametric reforms, only a complementary funded pillar.

- Abdessalem & Chekki Cherni (2010 and 2016) considered parametric reforms and introduction of complementary funded pillar. Simulation results allowed comparing the opportunity of different reforms implementation according to particular targets. These studies were calibrated on a 2005 social accounting matrix.

- Ayed Zambaa & Ben Hassen (2013 and 2014), had a totally different approach from that of the two papers mentioned above: it is not a matter of computable model (no social accounting matrix and no calibration procedure for a base year). An analytical solution is driven from a theoretical overlapping generation model, simulated then by assigning values to the equation variables and parameters.

The present work differs from those above, mainly by taking into account the impact of 2011's turmoil through a reduction of both labor force and Total Factor Productivity (TFP) and a pension expenditure increase. More details on how simulations integrated these facts are explained in calibration paragraph. Therefore, the main objective of this paper is to draw a prospective analysis of relevant reform policies for the Tunisian pension system. This analysis could guide public action for effective pension reform. It is proposed to investigate, using a CGEM-OLG model, pension financing options, their effects on the system's financial stability and their socio-economic impacts.

The paper is organized as follows: section 2 presents a diagnosis of the current situation of the Tunisian pension system. Section 3 explains the model's structure. Simulation scenarios and results are detailed in section 4. Sensitivity analysis is carried out in section 5. Finally, we conclude in section 6.

2. DIAGNOSIS OF THE CURRENT SITUATION

In Tunisia, pension plans are managed according to sector activity, by two separate agencies: National Pension and Social Insurance Fund (NPSIF) for the public sector and National Social Security Fund (NSSF) for the private sector. The pension system has a PAYG benefit scheme. The two main schemes, which involve employees in the public sector and non-agricultural employees (SNAE) in the private one, have been experiencing financial difficulties for several years. Others, such as schemes for agricultural employees, have always been structurally in deficit. Emergence of deficits depends on the comparative evolution of contributions and benefits. A slowdown in the growth rate of revenue on the one hand, and an acceleration of expenditure on the other hand, created an imbalance in the financial position of pension schemes. There are several factors explaining this evolution.

2.1. Demographic factors

Two main factors are involved:

- Faster growth of pensioners from affiliated workers: this implies a deterioration of the demographic ratio, defined as the number of affiliated workers for a single pension beneficiary. Indeed, this demographic ratio, observed for the two social security funds, is in steady decline.

- Increase in life expectancy. Thus, pension period is lengthened. In 2012, life expectancy was estimated at 71.8 years for men and 76.3 for women, whereas in the early 60s it was estimated at 41.06 years for men and 43.01 for women. This continuous increase in pension period entails additional financial burden and intergenerational transfers of income in the PAYG.

2.2. Economic factors

Tunisia suffers from slow economic growth and high unemployment, in particular youth unemployment. Both factors negatively affect social security contributions by reducing the taxable earnings base. Financial difficulties were also heightened by privatization and the expansion of the informal sector, depriving the social security system from due contributions.

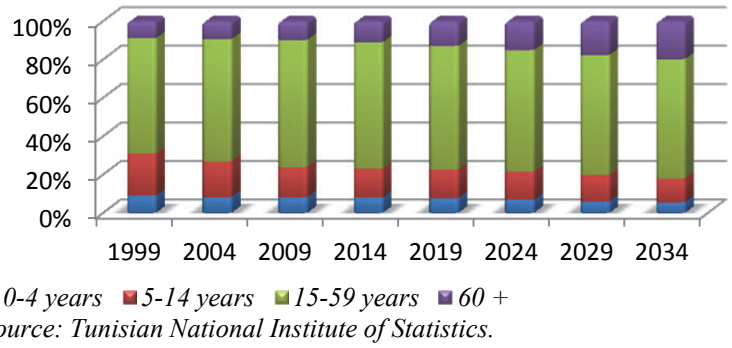
2.3. Other factors

These are mainly high replacement rates, which can reach 90% of gross wages in the public sector and 80% in the private sector, and increase in early retirement cases.

2.4. Quantitative indicators

Tunisia, as many other countries, has experienced a deep change in its population's pyramid structure. Fertility, the main component of population growth, has significantly decreased, as well as mortality. The pattern for population increase includes the following two features (Figure 1):
- A continuous decline in the proportion of young people in the total population.
- A higher proportion of older people.

Figure 1. Age structure of the Tunisian population (1999-2034)



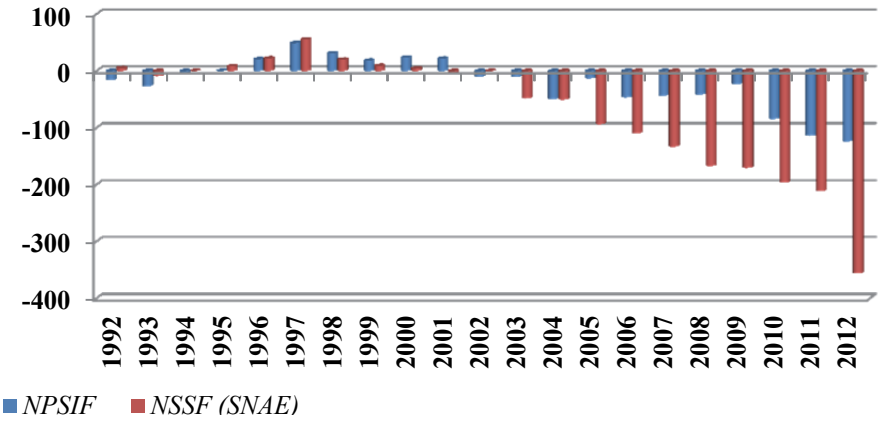
Source: Tunisian National Institute of Statistics.

The pension system deficit continued to widen (Figure 2), despite repeated reforms based on adjustment of key parameters (contribution rate, pension level and retirement age). Forthcoming demographic evolution is likely to exacerbate this trend.

Furthermore, post-revolution socio-economic conditions of the country add to threats on pensions. Indeed, social security resources depend on economic

growth pace and on formal employment level. The political, social and economic upheavals the country is experiencing have serious impacts on the general economic situation and on that of pensions in particular. If these schemes are expected to maintain the same levels of contributions and benefits, financial deficit would be unsustainable and income security of future retirees would be challenged.

Figure 2. Technical balance evolution of pension schemes (Million Dinars)



Technical balance: contributions - benefits.
Source: Research and Social Studies Center.

Hence, and given these evolutions, we propose, in the following, to simulate the effects of demographic change and the macroeconomic impacts of various feasible reforms of the Tunisian pension system. We present, first, our model's structure.

3. THE MODEL

Various prospective quantitative tools have been developed to answer questions raised by the future of pensions in response to ageing population and to propose an assessment of the different reform options. The computable general equilibrium models with overlapping generations (CGEM-OLG) appear particularly more appropriate to treat such a problem. Indeed, "all sectors of the economy are taken into account: cohorts of households, firms and public sector." (Dupont et al., 2003). The dynamics of the economy is explained by the behavior of rational optimizing agents.

In CGEM-OLG, a representative agent of the entire cohort maximizes his welfare. This latter is modeled by a utility function on his entire lifecycle. His optimal choice (savings, consumption, labor supply) depends on prices (wages, interest rates), expectations, different taxes, retirement age and other economic policy measures. Therefore, changes in economic policy modify the optimal behavior of consumers in each generation.

Our model's structure is similar to that of Kotlikoff and Auerbach presented in their pioneering paper (1987) and of Rasmussen and Rutherford (2004). The

model developed explicitly takes into account interactions between decisions of households, producers and government. The model can be represented by a set of equations designing household's behavior, production sector, pension system (state) and equilibrium conditions. Economic agents operate under a closed economy with exogenous labor supply[1].

Complexity of economic interactions generally prohibits considering individual heterogeneity. Some works tried to integrate heterogeneity of individual trajectories, distribution of wealth and aggregate variables (Hairault, Langot and Sopraseuth, 2004). However, the extreme complexity of numerical calculation induces to oversimplify some key macroeconomic behaviors and mechanisms, otherwise it is impossible to solve. These works then lose their virtue in terms of quantitative evaluation. The use of individual heterogeneity is more appropriate with micro-simulations studies. Despite the one representative agent hypothesis, the CGEM-OLG model provides a rich description of the population generational structure, dividing population into different age-groups. Hence, aggregate labour supply is based on the size of the working-age population while pension expenditures depend on the size of retired age groups.

The model's version used here with exogenous labor supply neglects the distortive effects on labor supply, in particular for scenarios which adjust the contribution rate or the replacement rate. Using endogenous labor supply allows counting the different reforms' impacts on labor behavior. However, bearing in mind that labor becomes scarcer in an aging economy, increasing therefore its price, the positive effect of this wage increase may offset the negative impact associated with a possible contribution rate rise or a replacement rate decrease. Gonand (2007), in a simulation comparison of pension reform scenarios with exogenous and endogenous labor supply, shows that the use of an endogenous working time does not significantly change the macroeconomic dynamics of the model.

CGEM-OLG are not predictive models, their main objective being to draw a prospective analysis of relevant reform policies and to evaluate quantitatively socio-economic impacts. In this context, the use of CGEM-OLG aims to quantify, in a global coherent framework, the consequences of various measures of pension reforms and to assess how these reforms proceed to support financing pension system viability, within some schedule of constraints and targets. Numerical results reveal the magnitude of different economic variables' changes, compared to a baseline scenario. Thus, it is possible to draw conclusions that could help governments in their feasible financing reforms of pension system.

3.1. Household behaviour

Households are assumed to be rational and have perfect foresight. This is a usual assumption but a strong one; it neglects myopia of economic agents.

[1] Even though closed economy characteristic of the model prevents the evaluation of international effect of pension reforms, it is most likely a reasonably credible illustration of most countries given that the ageing process is widespread: all countries will face similar demographic trends.

Some studies have examined the consequences of myopia assumption in the context of an overlapping generation model with two periods (De la Croix and Michel 2002). In the case of several periods; it is possible to introduce this hypothesis using hyperbolic discount rate. Nevertheless, this more realistic assumption would have altered levels of variables but much less their overall dynamics. This does not matter for our analysis since we are interested in comparing macroeconomic effects of different pension reforms scenarios.

At each date t, N +1 generations coexist. Thus a household lives N +1 periods. Each period covers five years. Children are supposed totally dependent on their parents since birth until the age of 20 years when the individual begins working. He works during the first R periods, until retirement age. These working periods will be followed by N +1- R retirement periods. At each five-year period, the oldest generation dies (without leaving a bequest or inheritance) and a new generation enters its first period of activity.

In our modeling, we consider N = 10 which means that each generation lives 74 years, R = 8 which corresponds to a retirement age of 60 years. An individual of generation g, born at the beginning of the year t = g, lives N+1 periods and maximizes a utility function representing his intertemporal preferences. The utility function is of constant elasticity of substitution (CES) type:

$$U_{g,t}(c_{g,t}) = \sum_{t=g}^{g+N} \left(\frac{1}{1+\rho}\right)^{t-g} \frac{c_{g,t}^{1-\theta}}{1-\theta} \qquad (1)$$

where $\frac{1}{\theta}$ is the intertemporal elasticity of substitution[2], $c_{g,t}$ the consumption of an individual member of age-group *g* at time *t*, ρ the pure rate of time preference. At time[3] t, when the agent is active, he pays on his gross salary Wt contributions to the PAYG pension system at rate τ_t. Saving is noted e_t. During the periods of retirement, he receives a PAYG pension (Pen).

The intertemporal budget constraint is written as follows:

$$\begin{aligned} & c_{g,g} + \sum_{t=g+1}^{g+N} \prod_{j=g+1}^{g+N} (1 + r_{t+j})^{-1} c_{g,t} \\ & \leq W_g(1 - \tau_g) + \sum_{t=g+R-1}^{g+R-1} \prod_{j=g+1}^{g+N} (1 + r_{t+j})^{-1} W_t(1 - \tau_t) \\ & + \sum_{t=R+g}^{g+N} \prod_{j=g+1}^{g+N} (1 + r_{t+j})^{-1} Pen_t \end{aligned} \qquad (2)$$

[2] θ is the inverse of the intertemporal elasticity of substitution.
[3] When a variable is independent of the agent's birth date, it is not indexed.

This implies that expenditure value is less than or equal to the discounted income value, with:

$Pen_t = \mu_t W_t$

μ being the replacement rate.

Maximizing the utility function (1) under the intertemporal budget constraint (2) gives the optimal consumption of a household, belonging to generation g, at each period of its life cycle, according to the consumption of the previous period:

$$c_{g+1,t+1} = c_{g,t}\left[\left(\frac{1+r_{t+1}}{1+\rho}\right)\right]^{1/\theta}$$

The representative consumer behavior of each generation will be completely determined by its intertemporal budget constraint and the set of equations describing the optimal choice for consumption and thus for saving:

$e_{g,t} = e_{g,t-1}(1+r_t) + W_t(1-\tau_t) - c_{g,t}$

3.2. The production sector

Firms operate in a perfectly competitive market. They produce a single composite good whose price is equal to unity. The production function is specified as Cobb-Douglas with constant returns to scale:

$Y_t = \Phi K_t^{\alpha} Le_t^{1-\alpha}$

where Y represents real output, K the real value of the capital stock, Le the effective labour force, α stands for capital income share and Φ a scaling variable.

$Le_t = L_t A_t$

where L_t is the number of workers, A_t Technical Progress assumed to be exogenous and labor augmenting; it grows at a constant rate gpp:

$A_t = A_{t-1}(1+gpp)$.

Factors and output are determined by the two profit maximization first-order conditions:

$r_t = \Phi\alpha K_t^{\alpha-1} Le_t^{1-\alpha} - \delta$

$w_t = \Phi(1-\alpha) K_t^{\alpha} Le_t^{-\alpha}$

where r_t is the interest rate, δ the capital depreciation rate and w the wage rate per unit of effective labor.

Capital stock evolves over time according to the following equation:

$K_{t+1} = I_t + (1-\delta)K_t$

where I_t is gross investment.

3.3. The pension system

At each date t, the total amount of contributions collected is:

$\mathrm{COT_t} = \tau_t \mathrm{SM_t L_t}$ where $\mathrm{L_t} = (1 + \mathrm{gap_t})\mathrm{L_{t-1}}$

$\mathrm{SM_t}$: average wage; $\mathrm{gap_t}$: growth rate of workers at period t.

The benefits are:

$\mathrm{Prest_t} = \mu_t \mathrm{SM_t L_t^{Ret}}$

$\mathrm{L_t^{Ret}}$ is the number of retirees; $\mathrm{L_t^{Ret}} = (1 + \mathrm{gop_t})\mathrm{L_{t-1}^{Ret}}$ where $\mathrm{gop_t}$ denotes the growth rate of retired population at period t.

3.4. Equilibrium conditions

To ensure the logical consistency of the model, three equilibrium conditions of labor market, capital market and composite good market should be met. These equilibrium conditions guarantee the closure of the model:

The Labor market:

$$\mathrm{L_t} = \sum_{g=0}^{R-1} \mathrm{H_{g,t}}$$

$\mathrm{H_{g,t}}$ is the number of workers in age-group *g* at period *t*.

The Capital market:

$\mathrm{I_t} = \mathrm{S_t}$

$\mathrm{S_t}$ denotes aggregate saving.

The Composite good market:

$\mathrm{Y_t} = \mathrm{C_t} + \mathrm{I_t}$ where $\mathrm{C_t} = \sum_{g=0}^{N} \mathrm{c_{g,t} H_{g,t}}$

3.5. Calibration

The parameters of CGE models are not all observable in reality. Unless there is an adequate econometric approach, it is often necessary to use a calibration[4].

In the following, we describe the choice of parameters related to preferences, production function, pension system and finally demographic parameters[5].

3.5.1. Preferences

Time preference rate ρ is determined by the calibration procedure. It is calculated using the first order conditions of the consumer's maximization pro-

[4] The model was solved using the General Algebraic Modeling System (GAMS), Anthony, Kendrick, Meeraus and Raman (1998).

[5] The selected values for the model's parameters and the results of calibration are reported in the appendix.

gram and respecting a constraint on the aggregation of household consumption (See Ramussen and Rutherford, 2004).

3.5.2. The production function

Capital income share, α, is determined from the expression of marginal productivity of factors and the respective values of Y and labor income for the base year[6]. Depreciation rate is calibrated, once interest rate is fixed, from observed values of the initial capital stock and capital income.

3.5.3. The pension system

Replacement rate, μ, is chosen to reproduce the value of the benefits for the base year. The value found is 0.67%, which is an average between the private (NSSF) and the public (NPSIF) systems. PAYG contribution rate is determined in order to provide a balanced budget for the pension system.

3.5.4. The demographic parameters

Some data on demographic variables and their rate of growth are taken from NSI's forecasts[7]; others (for the year 2034-2040) are taken from the United Nations' forecasts[8] and, to complete missing information, we made assumptions for long-term evolution.

3.5.5. The exogenous shock

Since the model was calibrated with a social accounting matrix for 2005, we introduce, in our present simulations, an exogenous shock in 2011 representing the Tunisian revolution. This shock consists in a reduction of both labor force and total factor productivity (TFP), because of social and economic turmoil. These modifications allow reproducing observable data in 2011, after the revolution, as well as taking into account future evolutions along with new Tunisian socio-economic challenges:

- In our previous publications (2010 and 2016) A_t is technical progress which is assumed to be exogenous; it grows at a constant rate gpp: $A_t=A_{t-1}(1+gpp)$. In this paper, gpp rate has been changed to take account of total factor productivity' decrease.
- We changed the growth rate of workers (gap_t), taking into account the unemployment increase after 2011.
- Due to the political decision of general amnesty, making early retirement for many officials, and the invalidity and death of many workers, pension expenditure increased. To deal with these facts, we changed L_t^{Ret}, the number of retirees and their growth rate gop_t.

4. SIMULATIONS OF DIFFERENT POLICY REFORMS (2015-2040)

To illustrate impacts of different pension system reforms on agent's behavior, pension system balance and on economic aggregate variables, we consider two main sections of our simulations. First, we study the consequences of de-

[6] The value found is consistent with the econometric estimates made for Tunisia.
[7] Population forecast, 2004-2034. INS, June 2007.
[8] http://esa.un.org/unpop/

mographic shock. The second section focuses on analyzing the effects of parametric changes: rise in contribution rate, reduction in pension level, rise in retirement age, and a combined reform.

4.1. Pension system perspectives under unchanged structure

What is the future of the Tunisian pension system under unchanged legislation? This investigation concerns the evolution of the current operating pension system, and provides the benchmark to compare various reform measures.

The basic scenario explored in this context allows for studying the viability of the pension system under future demographic evolution. Demographic shock is characterized by a change in age pyramid, represented mainly by an increase in the size of age groups over 60 years and the narrowing of the 20-59 years age cohort, in response to declining fertility rates and increasing life expectancy. This induces an increase in dependency ratios.

According to this scenario, it seems that pension system deficit would continue to increase very substantially throughout the analysis period. It would increase from 0.8% of the GDP in 2015 to 3.7% in 2020 and 10.6% in 2030. These numbers are significantly higher than those of a recent study of the Research and Social Studies Center (RSSC), which predicted 2.2% and 6.2% respectively[9]. The difference may result from the retroactive effects on investment taken into account in our study. Our analysis shows, for example, that in 2020 investment would be reduced by 16% compared to its value in 2015. This decrease is explained by the existence of a crowding out effect that comes from a diversion of a part of savings to the pension system to cover its financial deficit. In fact, our scenario assumes that financing requirement would be insured by borrowing from the financial market[10].

The pension system as currently defined could not survive demographic, economic and social developments expected in the coming years. Keeping the same parameters (replacement rate, length of contribution, contribution rate) involves an inevitable budget deficit. This worrying situation needs an implementation of reforms in order to sustain the pension system and alleviate the burden of its financial deficit on the rest of the economy. In what follows, we simulate parametric reforms, namely contribution rate increase, pension level reduction and rise of retirement age, and a combined reform.

4.2. Pension system reforms

4.2.1. SCENARIO 1: Contribution rate increase

Contribution rate increase could balance the financial situation of the pension system but at the cost of a significant reduction in savings. The equilibrium contribution rate should follow an increasing pace reaching unsustainable levels exceeding 36% in 2030 and 40% in 2040.

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[9] Demographic and Financial Projection of RSSC, Internal memo (2012).

[10] See Abdessalem & Chekki Cherni (2010) and (2016) for more details on the modeling procedure.

Contribution rate increase pushes downward the net wage rate which negatively affects savings and therefore investment. For example, in 2020 investment would be reduced by 14% compared to its value in 2015. In the long term, savings would show a considerable drop, savings rate would be reduced from 16% of GDP in 2012 to 7% in 2040 and GDP growth rate would be greatly affected.

4.2.2. SCENARIO 2: Replacement rate decrease

The assumption assumed is that replacement rate will decrease by 5% from the base year. This scenario's first consequence is to change household consumption level. In fact, simulations show that household consumption profile throughout life cycle has been reduced. This decline reflects a change in intertemporal income (by reducing replacement rate). Consumption decline is beneficial to savings, which increase in turn. This behaviour is actually expected since households are forced to increase their savings to compensate for a lack of income once they reach retirement.

Replacement rate reduction by 5% from the base year could alleviate the pension system deficit, but it is not sufficient to balance the financial situation. We suppose that contribution rate will increase to achieve the need to finance pensions. Simulations results show that negative effects on savings and on the equilibrium contribution rate would be relatively reduced compared to the two other scenarios (scenario 4.1 with no reforms and scenario 4.2.1 with contribution rate increase). Investment decline would be 12% during the same period, and the equilibrium contribution rate would be 26% and 30% respectively in 2025 and 2030. However, these levels are reached at the expense of retirees' purchasing power.

4.2.3. SCENARIO 3: Legal retirement age increase

This measure increases pension system income and therefore reduces the scheme's deficit. We assume here that, from the base year, retirement age becomes 65 instead of 60 years. Increasing retirement age implies a higher intertemporal income, because, on the one hand, households are now working for a longer period, and on the other hand, equilibrium contribution rates are lower. They recorded a decline compared to those of replacement rate decrease and contribution rate increase scenarios. Increasing retirement age, influencing both resources and expenditure, contributes significantly in alleviating social contribution burden. This measure would have the least negative impact on employees' purchasing power and on firms' competitiveness. The equilibrium contribution rate is the lowest compared to the other scenarios, it would be 23.8% and 27.3% respectively in 2025 and 2030. Nevertheless, recourse to contribution rate increase is still high, reaching 32% in 2040.

4.2.4. SCENARIO 4: a complementary funded pillar

Besides the assessment of parametric reforms of PAYG system, we add here a complementary funded pillar scenario. The simulations results are presented, and also arguments drawn for why such a reform is not appropriate for Tunisian

pension system in the ongoing and expected context (see Arrau & Schmidt-Hebbel (1993), Feldstein & Samwick (1997) and Feldstein (1995)).

Let's first point out that current situation of financial markets and the weak economic growth, after the recent turmoil, make the business climate too fragile, and considering a complementary funded pillar is very risky. For this, the financial system should be, first of all, reformed and reinforced.

Then, investigating this alternative solution, simulation results show that the financial problem is far from to be solved. In this scenario we assume a complementary funded pension accompanied by 5% decrease of PAYG pension benefits (for more details on implementation see Abdessalem and Chekki Cherni (2010) and (2016)). A crowding out effect is highlighted; investment falling by 11% in 2020 compared to 2015 level; the only positive effects, on capital accumulation, being long term impacts, need several years to be achieved.

4.2.5. SCENARIO 5: a combined reform

In this scenario we combine all the previous reform measures. But this is not the better option, for political and social reasons, especially in the current post-revolution Tunisian situation. As for a threshold level for the contribution rate, when we simulate such a scenario, the replacement rate decrease needed to balance the financial situation of pension system, could not be sustainable given the magnitude of deficits.

The combined reform scenario simulates the above mentioned measures together:

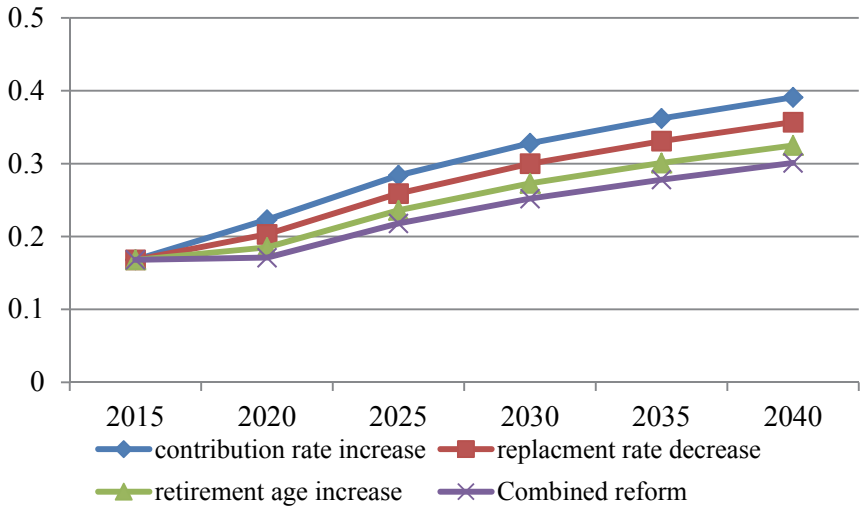
- A 5% replacement rate reduction,
- Retirement age increase for a period of 5 years,
- Introduction of a funded pillar with a 1% contribution rate,
- Contribution rate increase to ensure the financial equilibrium.

With this mix, the effect of the demographic shock is largely offset and the PAYG equilibrium contribution rate could reach 25% and 30% respectively in 2030 and 2040. In 2020 investment would be reduced by 2.4% compared 2015 level. However, if the latter scenario seems to be the best in the short term (in the medium and long term, the equilibrium contribution rate is still unsustainable), it is far from to be accepted because of political and social considerations as it's now the case about increasing retirement age for example. All simulations suggest that this reform should be compulsory, to alleviate the burden of pension deficits. But after union's protest the way would be rather optional.

Overall, these results confirm the dead end of the accounting reforms modifying system settings. The effect of such measures will be limited, even in the short term, given the extent and the massive increase of deficits (see Figure 3). Faced with the ineffectiveness of reforms based on changing pension parameters – even supplemented by funded pillar – to ensure the sustainability of the system, the pension situation remains an undeniable urgency. That's why other structural reforms are needed, specifically those expanding the financing base

(contribution relying on all incomes, not only wages; various feasible taxes...) considered as multidimensional reforms.

Figure 3. Equilibrium Contribution rate according to different reforms



Let's now mention a technical remark: despite the high internal consistency of CGEM-OLG, this approach is not above all criticism. The main weakness comes from the calibration method. Some model parameters cannot be supplied by the econometric estimation but at the end of a calibration procedure. Therefore, they remain highly dependent on observed base year data. At this level, sensitivity tests of parameter values are typically used to overcome this deficiency. The following sensitivity tests evaluate the results' sensitivity to the crucial assumptions made on behavioral activity and technical progress growth rate.

5. SENSITIVITY ANALYSIS

We focus on a sensitivity simulation of the following parameters:

- productivity growth rate (gpp_t)
- capital depreciation rate (δ),
- capital income share (α),
- rate of time preference (ρ)
- value of interest rate in the calibration process ($\bar{r}$).

Tests were first carried out on different values of the productivity growth rate. The results indicate that the higher gpp_t is, the lower are the macroeconomic negative demographic shock effects. We proceeded by including the various reforms discussed on productivity gains. These latter could mitigate widely, in the short and long term, the negative effects of demographic changes and those of various reforms.

The simulation results for the alternative values of the key parameters indicate that the qualitative results are remarkably stable with respect to these parameters. The slight sensitivity to capital income share comes from the following mechanism. Namely, when capital income share becomes larger (lower), labor income share becomes lower (larger) which gives individuals a disincentive(incentive) to save less (more), which in turn lowers (increases) savings rate. However, sensitivity to changes in the assumed value of capital income share, α, remains sufficiently low, thus not raising serious concerns about the usefulness of the previous discussion, since saving rates decrease in the transition period, and equilibrium pension contribution rates are insensitive to these changes. In particular, the sensitivity tests indicate that the pension contribution rate dynamics are robust to realistic parametric changes, even though affecting considerably saving rates, since real wage changes affect revenues and expenditures of the pension system in the same direction.

While alternative assumptions about the nature of demographic transition and workforce participation behavior are also likely to affect results, absence of alternative population and workforce forecasts prevented us from carrying out sensitivity tests on changes in forecast population and workforce series. This, however, is one of the directions our study plans to take in near future.

6. CONCLUSION

This study aimed to contribute to the debate on pension reforms. A set of measures dealing with the financial problems of the PAYG pension schemes have been simulated. The results are used to specify the magnitude of changes in the various economic variables. Thus, it is possible to draw conclusions useful for policy making targeting pension system reforms.

Population ageing and the volatile economic environment, under no change in pension system parameters, lead to financial pressure and growing deficits. This raises the issue of the availability of public actions to restore the pension system's financial equilibrium and, at the same time, to avoid economic distortions caused by reform strategies, particularly those on capital accumulation.

In Tunisia some studies, amongst our previous work, examined this issue. The present work differs from those analyses, mainly by taking into account the impact of 2011's turmoil. We introduce in our present simulations, an exogenous shock in 2011 representing the Tunisian revolution. This shock consists in a reduction of both labor force and Total Factor Productivity (TFP) and a pension expenditure increase because of social and economic turmoil. These modifications allow reproducing observable data in 2011, after the revolution, as well as taking into account future evolutions along with new Tunisian socio-economic challenges. The main finding, making a difference from the existing studies, highlights the additional difficulties to cope with the massive increase of pension system deficits.

For this analysis, we have developed a general equilibrium overlapping generations model to examine the measures of balancing the Tunisian pension system's budget and their macroeconomic effects, particularly on savings and therefore on investment. The proposed reforms to ensure sustainability of the

pension system are, increase in contribution rate, decrease in pensions' level, increase in retirement age and a combined reform.

Implemented simulations suggest the following results:

- Increase in pension contribution rate and a decline in national savings are inevitable, with or without the simulated policy reforms.

- Increase in retirement age seems to be the most effective in reducing the need for higher future contribution rates.

- No solution can solve the financial imbalance of the pension system and at the same time may have no negative effects on the rest of the economy. According to the considered assumptions, reforms may alleviate the pension system burden, but have different macroeconomic impacts.

The results point to the ineffectiveness of the reforms based only on changing pension parameters to ensure sustainability of the system, even supplemented by funded pillar, indicating that the pension situation is an undeniable urgency. A wide-range reform of the current pension system is inevitable. But immediately, the growing trend of deficits should be controlled. Our previous diagnosis points out the benefit of an increase in retirement age, as this is the less difficult solution. However, according to those advocating a substitution of youth employment with that of seniors, this could stand against reducing youth unemployment, because lengthening retirement age does not free up space for younger workers. This view bears on the erroneous belief in a fixed amount of work. Economists call this the "lump of labor fallacy" (Jousten et al., 2008, p. 9), i.e. removing older workers from the labor market reduces unemployment. Several economic studies reject this vision of labor market and propose empirical assessments of the correlation between retirement and employment (Layard et al., 1991, and St Paul, 2004). The results show, among others, that there is no significant negative effect on employment or youth unemployment. On the contrary, it seems that all youth participation goes together with that of the elderly. Youth employment is more affected by structural and institutional features of a given country.

In the medium and long term, a structural reform should be adopted. A direction of fruitful reform consists in diversifying financing sources by expanding the contribution base for pension financing beyond labor income, or using taxation. This approach considers that taking care of seniors in aging societies is a public service to be provided by the community at large.

APPENDIX 1. PARAMETERS VALUES

Parameters set	
θ	0.75
n (baseline)	0.01
r (baseline)	0.05
R	8

calibrated parameter	
ρ	0.022
A	0.828
δ	0.07
α	0.40
τ (base year)	0.14
μ	0.67

REFERENCES

Abdessalem T., Chekki Cherni H., 2010, “Pension Systems Reforms: Theoretical Essays and Empirical Analysis”. Ph.D., University of Tunis. 2010.

Abdessalem T., Chekki Cherni H., 2016, Macroeconomic effects of pension reforms in the context of aging populations: overlapping generations model simulations for Tunisia, *Middle East Development Journal*, 8, 1, 84-108 .

Allais M., 1947, *Economie et intérêt*, Imprimerie Nationale, Paris.

Anthony B., Kendrick D., Meeraus A., Raman R., 1998, "GAMS: A Users Guide", GAMS Development Corporation, 1998.

Arrau P., Schmidt-Hebbel K., 1993, "Macroeconomic and Intergenerational Welfare Effects of a Transition from a Pay-as-You-Go to a Fully Funded Pensions", Working Paper, World Bank.

Auerbach A.J., Kotlikoff L.J., 1987, *Dynamic Fiscal Policy*, London: Cambridge University Press.

Ayed Zambaa A., Ben Hassen L., 2013, The pension Reform Proposal for Tunisia: the case of the general NPSIF scheme”, *Journal of Economics and Business Research*, 2, 154-166.

Ayed Zambaa A., Ben Hassen L., 2014, Pension reform and macroeconomic impact: simulations for the case of Tunisia via overlapping generational models, *Journal of Public Administration Finance and Law*, 6, 131-138.

Ben Braham M., 2007, Impact de l’introduction d’une dose de capitalisation en Tunisie: simulation à l’aide d’un modèle à générations imbriquées, *Economie et Prévision*, 180, 4, 189-199.

De la Croix D., Michel P., 2002, "Myopic and perfect foresight in the OLG model", *Economic Letters*, 67, 53-60.

Diamond P., 1965, "National Debt in a Neoclassical Model ", *American Economic Review,* 55, 1126-1150.

Dupont G., Hagneré C., Touzé V., 2003, "Les modèles de microsimulation dynamique dans l'analyse des réformes des systèmes de retraites : une tentative de bilan", *Economie et prévision*, 160, 167-191.

Feldstein M., Samwick A., 1997, "The Economics of Prefunding Social Security and Medicare Benefits ", NBER Working Paper N° 6055.

Feldstein M., 1995, "Would Privatizing Social Security Raise Economic Welfare?", NBER Working Paper 5281.

Gonand F., 2007, "Essais sur la réforme des retraites, son impact sur la croissance et ses effets redistributifs", Thèse de Doctorat, CECO, Laboratoire d'économétrie de l'École polytechnique.

Hairault J.O., 2004, Langot Fand Sopraseuth T., 2004, "Retraites choisie et réduction des déficits", *Revue Française d’Economie*, 18, 75-136.

Jousten A., Lefèbvre M., Perelman S., Pestieau P., 2008, "The Effects of Early Retirement on Youth Unemployment: The Case of Belgium", IMF Working Paper, WP/08/30, 1-31.

Layard R., Nickell S., Jackman R., 1991, *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press.

Le Cacheux J., Touzé V., 2002, Les modèles d'équilibre général calculable à générations imbriquées: Enjeux, méthodes et résultats. *Revue de l'OFCE*, 80, 87-113.

Ramussen T.N., Rutherford T.F., 2004, "Modelling overlapping generations in a complementarity format", *Journal of Economic Dynamics and Control*, 28, 1383-1409.

Samuelson P.A., 1958, "An exact consumption-loan model with or without the social contrivance of money", *Journal of Political Economy*, 66, 467-482.

Siedman L., 1983, "Social security and demographics in a life cycle growth model", *National Tax Journal*, 36, 2, 213-224.

Solow R., 1956, "A contribution to the theory of economic growth", *Quarterly Journal of Economics,* 70, 65-94.

St Paul G., 2004, "Why are European Countries Diverging in Their Unemployment Experiences?," *Journal of Economic Perspectives,* 18, 49-68.

Summers L.H., 1981, "Capital taxation and accumulation in a life cycle growth model", *American Economic Review*, 71, 4, 533-544.

LA SOUTENABILITÉ DU SYSTÈME TUNISIEN DE RETRAITE : VERS UNE RÉFORME MULTIDIMENSIONNELLE

Résumé - *En utilisant pour la Tunisie un modèle d'équilibre général calculable à générations imbriquées, nos résultats soulignent l'inefficacité des réformes fondées uniquement sur la modification des paramètres de retraite pour assurer la viabilité du système. L'effet limité de ces mesures, même à court terme, peut être attribué à l'augmentation massive des déficits du système de retraite. Vu la situation, une réforme de grande portée du système de retraite actuel paraît inévitable à moyen et long terme. Nos simulations attestent qu'une voie de réforme prometteuse consisterait dans la diversification des sources de financement en élargissant l'assiette de contribution des régimes de retraite au-delà des revenus du travail.*

Mots-Clés - RÉPARTITION, CAPITALISATION, VIEILLISSEMENT DÉMOGRAPHIQUE, GÉNERATIONS IMBRIQUÉES