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Abstract

We have developed a general equilibrium overlapping generations' model to evaluate the effects of demographic transition in Tunisia and to discuss the impacts of pension reforms. Simulations consider two scenarios: a benchmark scenario (without reforms) and a policy change scenario including a set of pension reforms: contribution rate increase, pensions' level reduction, rise of the retirement age and finally the introduction of a complementary fully funded system. The latter incorporates a specific hypothesis consisting in differentiated returns for free saving (private) and compulsory (pension funds). Simulation results indicate that population ageing could have a major impact on saving rate, factors prices, and economic growth. However, they also inform that policy reforms could reduce negative effects.

ملخص

لقد قمنا بتطوير نموذج للتوازن العام لتداخل الأجيال لتقييم آثار التحول الديمغرافي في تونس ومناقشة الآثار المترتبة على إصلاحات المعاشات التقاعدية. المحاكاة تعتبر سيناريوهين : السيناريو المرجعي (بدون الإصلاحات) وسيناريو تغيير السياسات بما في ذلك مجموعة من الإصلاحات للمعاشات : زيادة نسبة المساهمة، وخفض مستوى الرواتب التقاعدية وارتفاع سن التقاعد، وأخيرا إدخال نظام متكامل ممول بالكامل. هذا الأخير يتضمن فرضية محددة تتمثل في عائدات متميزة للمدخرات الحرة (خاصة) والإلزامي (صناديق التقاعد). نتائج المحاكاة تشير إلى أن شيخوخة السكان يمكن أن يكون لها تأثير كبير على معدل الادخار، وأسعار العوامل ، والنمو الاقتصادي. ومع ذلك ، فإنها تشير أيضا الى أن إصلاح السياسات يمكن أن تقلل من الآثار السلبية.

1. Introduction

The sustainability of pay as you go pension systems has become a major concern for governments subsequent to the deterioration of their financial situation. These regimes are in fact affected by budgetary problems relating to, among others, unfavorable economic conditions: high unemployment, low wage growth, and inflation. Financial problems are likely to be exacerbated in the coming decades in respond to demographic mutations underway in several countries of the world: fertility decline, increased life expectancy and therefore the ageing population. These changes create a distortion in the age pyramid and may even influence economic variables as some economic decisions are highly correlated with the age structure of economic agents, in particular consumption and labor supply.

Given this demographic trend, PAYG pension systems are subject to considerable financial pressure. Indeed, the ageing population increases the number of elderly compared to that of workers which creates budget disequilibrium if pension system had to maintain the same levels of benefits. Budget equilibrium can be restored with some measures, but these are not without effect on the rest of the economy. To address these problems a great debate took place about the need to reform or at least adapting these regimes to the observed circumstances.

The approach currently preferred to analyze the pensions issue rests on computable general equilibrium model with overlapping generations structure (CGEM-OLG), given the magnitude of intergenerational transfers and changes in population structure. CGEM-OLG has a theoretical foundation based on the deepening of the Solow 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"[1]. Strong microeconomic foundations and macroeconomic closure are present in such models. The model takes into account explicitly the interactions between the decisions of economic agents. Initial versions of CGE-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 models, some technical aspects have changed by taking into account uncertainty, endogenous technical progress, open economy, individual heterogeneity. Several models, in line with the work of Auerbach and Kotlikoff (1987) were used to analyze the pension systems evolution.

Using a CGE-OLG model, we examine the issues of balancing Tunisian budget pension system and their macroeconomic effects, in particular on saving, capital accumulation and economic growth. Proposed reforms to ensure sustainability of the pension system are fourfold: rate of contribution increase, the pensions' level reduction, retirement age rise and introduction of a complementary fully funded system. For the latter scenario, the literature usually assigned the same rate of return on pension saving and on free one. Our study incorporates a specific feature, which consists in differentiating this rate of return; three possible cases are then considered according to the relation between free saving rate of return and that of pension saving.

This document is organized into six sections: the second section presents the main characteristics of Tunisia pension system. The third section explains the model structure. Simulation scenarios and results are detailed in the fourth section. We carry out sensitivity analysis in a fifth section. Finally, the analysis ends with conclusions in the sixth section.

[1] J.Le Cacheux and V.Touzé (2002)

2. Tunisian pension system: a retrospective study

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 private sector. The Tunisian pension system is a PAYG defined benefit scheme.

2.1 Financial Position Evolution of Pension Funds

Data on technical balance evolution (difference between contributions and benefits) of N.P.S.I.F general pension scheme show that contributions exceeded benefits in 1992. From that date, the pension situation has undergone several changes. In 1993, the benefits exceeded contributions resulting in a financial deficit. The balance between contributions and benefits has been restored and stabilized by increasing contribution levels. The financial position remains favorable until 2000 when new budget deficits appeared in 2001 until 2005 (Figure 1); NPSIF general pension scheme is in deficit despite contribution rates increase at different times. [2]

The review of NSSF financial situation for the general pension scheme (RSNA) reveals a financial surplus in early 1990s (1990 and 1991). It turned deficit from 1992 and peaked in 1993 with a deficit of 26.9 million dinars. Government decided then to increase employees' contribution rate gradually, over a three year's period. To further strengthen the financial position of its general pension scheme, the NSSF decided at the end of 1995, to transfer a large amount of reserves of other branches to retirement branch. Through these measures, the financial position was significantly improved to the point of achieving a surplus of 49 million dinars in 1997. However, after 1997, the surplus is shrinking and from 2002, RSNA is entering a phase of deficit (Figure 2).

2.2 Explanatory Factors

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 the expenditure on the other hand, create an imbalance in the financial position of pension schemes. Several factors are behind this evolution.

* *Demographic factors*

- The faster growth of pensioners relative to 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 (Figure 3).

The increase of life expectancy (Figure 4). Thus, the pension benefits period continues to lengthen. In 2005, life expectancy was estimated at 71.6 years for men and 75.5 for women, whereas in the early 50s it was estimated at 47 years. This continuous increase of the pension benefits' period involves additional financial burden and intergenerational transfers of income in the PAYG.

* *Other factors:*

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

Deficits are likely to be intensified in the future, following forthcoming demographic changes. In Tunisia, as in many other countries, the structure of the population pyramid has changed deeply. Fertility, the main component of population growth, has

[2] Our simulations considered 2005 as the base year, for this reason, our retrospective analysis of the pension system stops this year.

been marked by an important decrease. Similarly, mortality has decreased significantly.

Population projections highlight the two following features (Figure 5): - a continuous decline in the proportion of young persons in the total population. - a higher proportion of older people.

Given these evolutions, we propose, in the following, to simulate the effects of demographic change and the macroeconomic impacts of various reforms of Tunisian pension system. But, first, let's present the model structure.

3. The Model

Various prospective quantitative tools have been developed to answer questions raised by the future of pensions in response to the ageing population and to propose an evaluation of 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."[3] The dynamics of the economy is explained by the behavior of rational optimizing agents.

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

Complexity of economic interactions generally prohibits considering individual heterogeneity. Some recent works try to integrate heterogeneity of individual trajectories, distribution of wealth and aggregate variables (Hairault, Langot and Sopraseuth 2004). However, the extreme complexity of numerical calculation induce to oversimplify some key macroeconomic behavior and mechanisms, otherwise it is impossible to solve. These works then lose their virtue in terms of quantitative forecasting. The use of the 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 are dependent on the size of retired age groups.

Model structure is similar to that of Kotlikoff and Auerbach pioneering article (1987) and of Rasmussen and Rutherford (2004). The model developed takes into account explicitly interactions between decisions of households, producers and government. The model can be represented by a set of equations related to household's behavior, production sector, pension system (state) and equilibrium conditions. Economic agents operate under a closed economy with exogenous labor supply[4].

The version of the model used here with exogenous labor supply neglects the distortive effects on labor supply, in particular, scenarios which adjust the contribution rate or the replacement rate. The use of an endogenous labor supply allows taking into account the consequences of the different reforms on labor behaviour. However, bearing in mind that in an aging economy labor becomes scarcer, so its price increases, the positive effect of this

[3] G.Dupont, C.Hagneré et V. Touzé (2003)

[4] 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. Nevertheless, as the transition will not happen so perfectly synchronous, we consider the case of a small open economy in section 5.

wage increase may offset the negative impact associated with a possible increase in the contribution rate or a decrease in the replacement rate. Gonand.F (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.

3.1 Household behavior

Households are assumed to be rational and have perfect foresight. This is a usual assumption but a strong one; it neglects the myopia of economic agents. Some studies have examined the consequences of the introduction of the myopia assumption in the context of an overlapping generation's model with two periods (De la Croix and Michel 2002). In the case of several periods, it is possible to introduce this hypothesis using a hyperbolic discount rate. Nevertheless, this more realistic assumption would have altered levels of variables but much less their overall dynamics. This doesn't matter for our analysis since we are interested in comparing the macroeconomic effects of different scenarios of pension reforms.

At each date t, N +1 generations coexist. Thus a household lives N +1 periods. Each model period covers five years. Children are supposed to be totally dependent on their parents since birth until the age of 20 years when the individual begins working life; he works during the first R periods of his life, until age of retirement. These periods of work will be followed by N +1- R periods of retirement. At each period of five years, 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 an age of retirement equal to 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 that represents its intertemporal preferences. This function is supposed logarithmic[5]:

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

where $c_{g,t}$, is the consumption of an individual member of age-group *g* at time *t*, ρ is the pure rate of time preference. At time[6] t, when the agent is active, he pays on his gross salary Wt contributions to PAYG pension system at rate τ_t and to complementary funded plan at rate σ_t. The free saving is noted e_t. At its first period of retirement, the agent receives all of its benefits[7] under the funded pension plan (Cap), plus interest at rate[8] r_t^c, in addition to a PAYG pension (Pen). During the periods following retirement he receives only the benefits from the PAYG system.

The intertmporel budget constraint is written as follows:

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

[5] In sensitivity analysis, we have changed this form of utility function to take into account various values of intertemporel elasticity of substitution.

[6] When a variable is independent of the agent birth date, it is not indexed.

[7] There may be another procedure in which a pension is paid monthly throughout the period of retirement.

[8] r_t^c is the rate of return on retirement saving. In simulations we will distinguish three possible cases: r_t^c higher, lower or equal to r_t.

This implies that the value of expenditure is less than or equal to the value of discounted income. With:

$$Pen_t = \mu_t W_t$$

μ is the replacement rate.

$$Cap_{t+g+R} = \sum_{t=g}^{g+R-1} (1 + r_{t+1}^{c})\sigma_t W_t$$

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

$$c_{g,t+1} = c_{g,t}(\frac{1}{1+\rho}) \prod_{j=g+1}^{g+N} (1 + r_{t+j})$$

The representative consumer behaviour 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:

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

3.2 The production sector

The 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 is the real value of the capital stock, Le describes the effective labour force, α stands for the capital income share and Φ is a scaling variable.

$Le_t = Lt\ A_t$

Where L_t is the number of workers, A_t Technical Progress which is assumed to be exogenous and labour augmenting; it grows at a constant rate gpp: $A_t=A_{t-1}(1+gpp)$.

Factor demand and output are determined by the two first-order conditions of profit maximization:

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

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

Where r_t is interest rate, δ the rate of capital depreciation and *w* the wage rate per unit of effective labour.

The capital stock evolves over time according to the following equation:

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

3.3 Pension system

It is a system with two schemes: PAYG regime and complementary funded plan.

3.3.1 PAYG regime:

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

$$COT_t = \tau_t SM_t L_t$$

Where: $L_t = (1 + gap_t)L_{t-1}$

SM_t : Average wage; gap_t : the growth rate of workers in period t.

The benefits are: $Prest_t = \mu_t SM_t L_t^{Ret}$

L_t^{Ret} is the number of retirees: $L_t^{Ret} = (1 + gop_t) L_{t-1}^{Ret}$

gop_t the growth rate of retired population in period t.

3.3.2 the complementary funded plan:

The total amount levied in respect to funded plan, at time t is:

$CAP_t = \sigma_t SM_t L_t$

3.4 Equilibrium conditions

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

Labor market:

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

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

Capital market:

$I_t = S_t + CAP_t$

S_t : aggregate free saving.

Composite good market:

$Y_t = C_t + I_t$

Where $C_t = \sum_{g=0}^{N} c_{g,t} H_{g,t}$

3.5 Calibration

The parameters of CGE models are not all observable in reality. Unless there is an adequate econometric study, it is often necessary to use a calibration[9]. In the following we describe the choice of parameters related to preferences, production function, pension system and finally demographic parameters[10].

3.5.1 Preferences

Time preference rate ρ is determined by the calibration procedure. It is calculated using the first order conditions of maximization program of consumer and respecting a constraint on the aggregation of household consumption[11].

3.5.2 Production function

Capital income share, α, is determined from the expression of marginal productivity of factors and respective values of Y and labor income for the base year[12]. Depreciation rate is calibrated, once fixed interest rate, from observed values of the initial capital stock and capital income.

3.5.3 Pension system

The 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 private (NSSF) and public (NPSIF) systems. PAYG contribution rate is determined so that it provides a balanced budget for

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[9] The model was solved by using General Algebraic Modeling System (GAMS).

[10] The selected values for model parameters and the results of the calibration are reported in table 4.

[11] See Ramussen.T.N and T.Rutherford (2004).

[12] The value found joined the econometric estimates made for Tunisia.

pension system. Contribution rate for complementary funded plan is considered zero in baseline scenario.

3.5.4 Demographic parameters

Some data on demographic variables and their rate of growth were derived from projections of the NSI[13]; others[14] were exploited from the projections made by the United Nations[15] and, to complete the missing information[16] , we made assumptions for long-term evolution.

4. Simulations of different policy reform (2005-2060)

To illustrate impacts of different pension system reforms on agent's behavior, pension system balance and on economic aggregate variables, we consider three main parts of simulations. In the first we study the consequences of the demographic shock. The second part focuses on analyzing the effects of parametric changes: rise in the rate of contribution, reduction in the level of pensions, rise in the retirement age. Finally, we examine, in a third part, the introduction of a complementary funded pillar beside the PAYG system.

4.1 Effect of the demographic shock

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

In Tunisia, the age group 15-59 years reached a high peak between 2004 and 2009, then it decreases at a low rate; besides, the proportion of population aged 60 years and over, is relatively low during the same period (9.5% of the total population), but continues to increase thereafter to represent 19.8% of the total population in 2034. The faster growth of people aged 60 years and over compared with persons aged 15-59 years, generates lower dependency ratio (figure 6), this results in faster growth of benefits compared to contributions and a growing pension system deficit.

We pass now to simulate the ageing effects and to quantify the economic consequences. In this scenario, equilibrium balance of the pension system is provided by contribution rate adjustment: a hypothesis to balance the pension system, in case of deficit.

4.1.1. Impact on contribution rates

The simulation results show that the contribution rate is influenced directly by changes in the demographic structure. Indeed, there was a slight decrease during the first simulation period thanks to a marked progression for age group 15-59 years compared to that of 60 years and over. This demographic shift, in favor of pension financial situation, will experience a subsequent reversal implying a continuous growth till the end of the simulation period. In fact, and compared to its value in the base year, the contribution rate will double during the period 2030-2035 (28%), then reach a peak in 2060 (35%), to stabilize at a long term level close to 28% . Simulated values concerning equilibrium contribution rates may seem fairly alarming compared to those projected in some developed countries, but in analyzing the macroeconomic impact on the rest of the economy over the medium and long term, the situation is worrying.

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[13] Population projection , 2004-2034. INS, June 2007.

[14] For the year 2039-2050

[15] http://esa.un.org/unpop/

[16] From 2055 to 2060.

4.1.2. Impact on saving and investment

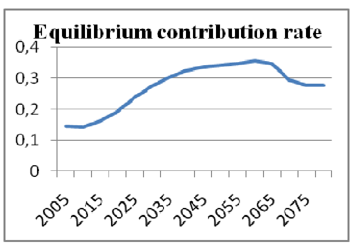
The contribution rate increase exerts a downward pressure on the net wage rate which affects savings negatively, getting to a considerable drop: simulation results show that saving increases during the first three periods then a decline phase is observed.

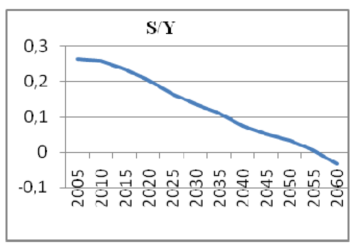
Demographic changes described above lead to, under the assumptions of the life cycle, absence of altruism, certain date of death, increasing share of income spent on consumption when there are more and more elderly among the population. Actually, population structure change, specifically the ageing, alters the composition of consumption-savings. Since retirees are considered dissaving, workers are rather savers; the increase of the former over the latter induces increased dissavers compared to savers. This explains the phenomenon of dissaving seen at the end of the simulation period.

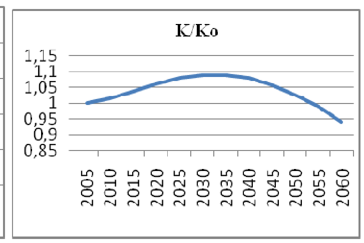
Fall of savings passes to investment, entirely financed by savings. We see then a fall in the investment to GDP ratio which in turn affects the accumulation of physical capital, whose growth rate turned negative in 2035. With ageing population, scarcity of physical capital leads to an increase of its price, showed by an increased interest rates level.

4.1.3. Impact on Economic Growth

Given these developments, the growth rate will be considerably affected. It goes through a decline until the year 2060. After that it becomes negative, denoting a severe recession.







4.1.4.Summary of Findings

The simulations developed, based on assumptions regarding our analysis, lead to the main following conclusion: pension system, as currently defined, cannot survive to changes in the demographic structure predicted in coming years. Maintaining the same parameters values (replacement rate, length of contribution, contribution rates) involves inevitable budget deficit. Furthermore, adjusting contribution rates to avoid deficits entails serious economic consequences. This medium and long term worrying situation requires some reform measures implementation. In what follows we simulate two types of reforms:

-Parametric reforms, namely contribution rate increase, pension level reduction, rise of retirement age.

-Structural reform, introducing a second funded pension pillar beside the PAYG system, leading to a mixed system.

4.2. Pension system reforms

Reforms outlined above have been mentioned in the economic literature and treated in several empirical simulations[17]. Our model departs from these various works by the introduction of the second pillar of funded pension. In fact, this reform is often treated by using the same interest rate to remunerate free saving and retirement one. We differentiate, here, these two types of performance and treat three possible cases, r>, <or = r^c. [18]

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[17] To our knowledge, there is not a CGEM-OLG on these reforms that has been applied in Tunisia.

[18] The interest rate for pension saving, r^c is considered exogenous.

The difference in return rates between the free saving and that of funded pension can be explained by capital market imperfections:

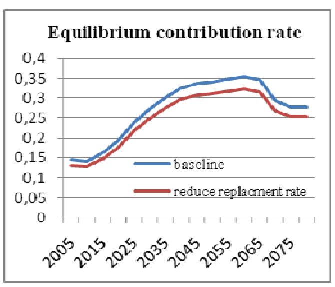
- Information asymmetry: financial intermediaries have more information on the investment risk then savers. Thus they can increase the expected return on investments by increasing the risk. For this reason, legislation may impose a remuneration on pension saving that is different from that of private saving, by requiring the investment of pension saving in riskless assets which offer lower returns than the market. The objective is to avoid massive losses due to a stock market crash.

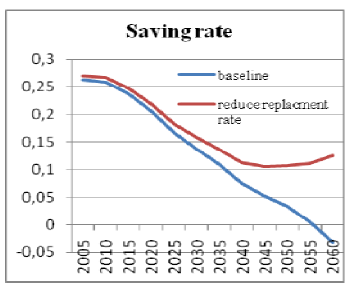
- Fiscal incentive: government can grant a fiscal incentive to pension savings, and this is equivalent to increase their rate of return. Fiscal incentives are intended to encourage such savings to reduce the burden on PAYG system and contribute to economic growth.

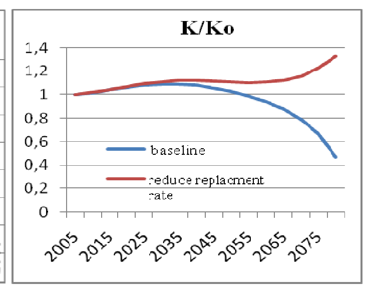
4.2.1. SCENARIO 1: Replacement rate decrease

The assumption assumed is that replacement rate will be decreased by 5% from the base year. This measure first consequence is to change household consumption level; in fact, simulations show that household consumption profile throughout the life cycle has been reduced. This decline reflects the change in the intertemporal income (by reducing replacement rate). Consumption decline is beneficial to saving, which increases. This behaviour is actually expected since households are forced to increase their saving to compensate for the lack of income once they reach retirement. The results also show a lessening of the gap between benefits and contributions, manifested by a decrease, compared to the baseline, of contribution rate: it reaches a maximum of 32% and long-term value fixed at around 25%.

Following this change in saving behavior, the interest rate is decreasing (compared to baseline), which is the result of increased capital accumulation. The stock of physical capital recorded a precarious decline during the period 2045-2055 then it resumed growth.





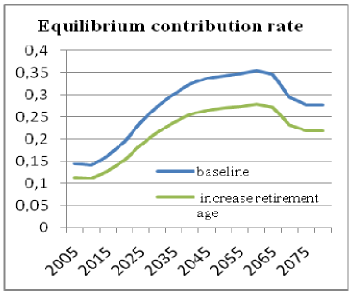


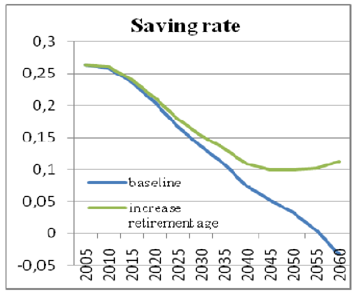
Simulations presented here suggest that a reduction in the generosity of the PAYG pension system would alleviate the economic repercussions linked to the problem of ageing population in two ways: first, through a direct reduction in the fiscal burden of future pension liabilities; second, through an increase in national savings and hence in future output.

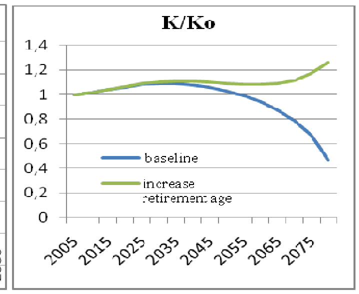
4.2.2. SCENARIO 2: Legal retirement age increase

This measure increases the pension system income and therefore reduces the deficit of the scheme. We assume here that, from the base year, the age of retirement becomes 65 instead of 60 years. Increasing age of retirement implies a higher intertemporal income, because on the one hand, households are now working for a longer period than the baseline scenario, on the other hand, tax burden of pension system is weakened by lower contribution rates, which recorded a decline compared to baseline: the maximum value is 27.7% and binds to a long term value close to 21.7%.

Anticipating an increase in income over the life cycle and a shorter retirement period, we expect households to reduce savings, though remaining higher than in the baseline. This can be explained by the significant gain in terms of intertemporal income due to lower pension contribution rates[19]. From 2035 until 2055, the saving recorded a decrease (although all levels remain well above those of the baseline). In fact, during this period the levies to be used for retirement, which is manifested by the increased contribution rates[20], wipe out the savings effort. After 2060, savings continue to rise permanently. This increase is mainly caused by lower contribution rates, compared to baseline, in this period. Changes described for savings lead to maintaining the investment levels well above those of the baseline. Capital accumulation is positively affected, enhancing economic growth. We do not observe a decline over the capital stock at the end of the simulation period and hence, no recession.







4.2.3. SCENARIO 3: Introduction of a complementary funded pillar

To highlight the pure effect of this reform, we proceeded in a first step, to simulate this scenario with no change in PAYG benefits, that is, we maintained the same replacement rate of the baseline. In a second step, we assumed that the introduction of the funded pillar will be accompanied by 5% decrease of benefits.

a- SCENARIO 3-1 Introduction of complementary funded pension + Maintenance of PAYG pensions:

From the base year, funded contribution rate is assumed to increase from 0 to 1%. The amount collected is used, near-free saving, to finance investment. Let's recall that household savings into funded pension system is remunerated at a rate r^c which can be equal, more or less than the market interest rate r.

Case N°1: $r^c = r$

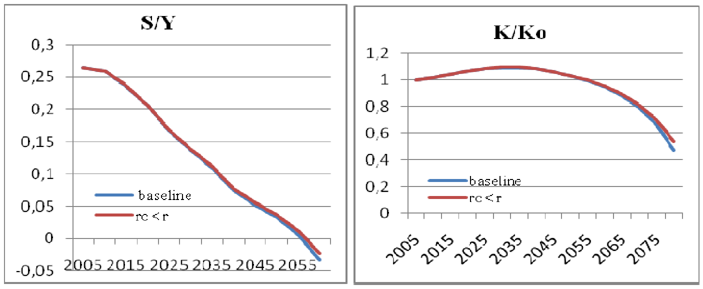
Simulation results show no change in the model variables, except for free saving. It decreases, exactly, by a value equal to the amount taken for funded pension plan. This is explained by the fact that free saving decrease has been replaced entirely by compulsory saving increase. We verify that the sum of the two types of saving after funded pillar introduction is equal to the value of saving without reform, thus the capital stock remains unchanged.

Case N°2: $r^c < r$

Funded pension saving is assumed here to be remunerated below market rate: $r^c = r-1\%$. Simulation results show decreasing free saving; the overall saving, however, increases. We note that there is not, therefore, substitution between free and retirement saving. Instead, the pension saving is added to free one. The total saving increases and consequently the capital stock also increases, compared to baseline. We can then conclude that recessionary effects of higher contribution rates are reduced by stimulus impacts of funded pension pillar. Despite these improvements, the stock of physical capital, in this scenario, decreases from the year 2040; therefore the negative demographic shock is more important than the positive effect of introducing complementary funded pension pillar with a contribution rate equal to 1%.

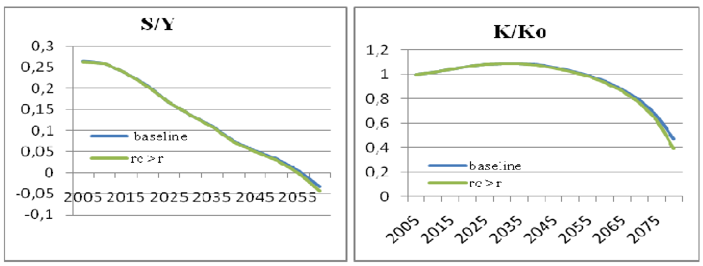
[19] In the baseline scenario the initial contribution rate is 14.4% then it passes sequentially to 14.1%, 16.2% and 19.4% while the rate with increasing age of retirement is around 11.4% initially (because of reduced retiree and increased workers) then takes the following values: 11.1%, 12.7% and 15.3%.

[20] These rates are still lower than those of the baseline.



Case N°3: $r^c > r$

The same contribution rate for pension fund as the previous case (1%) is adopted here, with a rate of return r^c = r +1%. Contrary to previous results, simulations reveal a drop of free saving, total saving and total stock of physical capital (compared to baseline): consumers are encouraged, in this case, to increase savings via pension fund at the expense of free saving. This crowding out effect was so great to cause a decline in total saving, so decline in capital stock, in comparison to baseline. According to simulations, decline in saving was favorable to consumption since it increases compared to baseline.



b- SCENARIO 3-2 Introduction of complementary funded pension + PAYG pensions decrease:

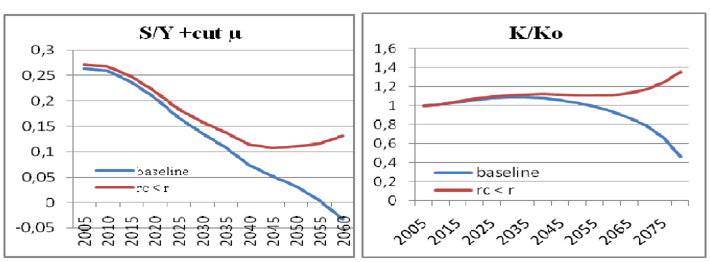
In this scenario we assume complementary funded pension accompanied by 5% decrease of PAYG pension benefits, with also three possible cases.

Case N°1: $r^c = r$

Simulations show the same results as scenario 1, with a 5% lower replacement rate. Thus no additional effect

Case N°2: $r^c < r$

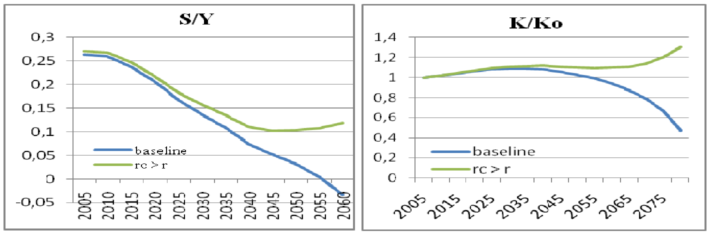
Effects induced by reduction of PAYG benefits here are consolidated by the positive effect of complementary funded scheme. Economic activity is further boosted; physical capital reaches higher levels but consumption, compared to scenario 1, decreases slightly.



Case N°3: $r^c > r$

The crowding out effect caused by remunerating pension saving more than free saving softens the impacts induced by the decline in pension benefits on capital stock. However, it generates positive effect on consumption which increases in this scenario[21] (compared to the scenario of reduced benefits).

Compared to baseline, results of the three cases presented above, show a better situation.[22]

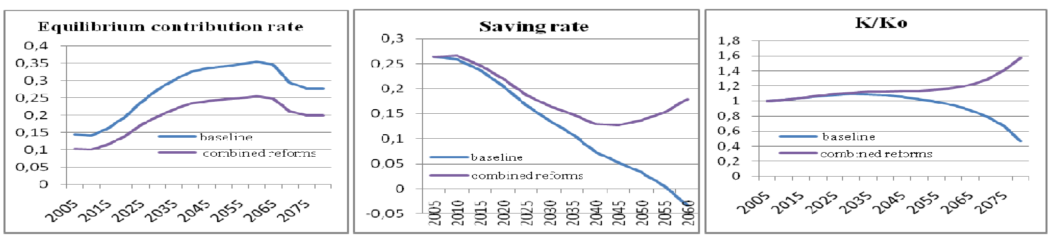


4.2.4. SCENARIO 4: combined Reforms

This scenario simulates all possible combinations of reforms. The best combination turns out, always keeping as evaluation criteria the effect on capital stock and therefore economic growth, the one that combines at the same time:

- A 5% replacement rate reduction,
- Retirement age increase for a period,
- Introduction of a funded pillar with a 1% contribution rate, and a return lower than free saving.

With this mix, the effect of the demographic shock is completely offset (only a slight decrease during periods of shock), no recession and the PAYG contribution rate reaches a maximum of 25.5% and a stationary value of 19.9%. Finally, if the latter scenario is the best, it is far from being accepted because of political and social considerations[23].



Simulations implemented suggest some general observations:

- Increase in pension contribution rate and decline in national saving, are inevitable, with or without the simulated policy reforms.
- Retirement age increase seems to be most effective in reducing the need for higher future contribution rates.
- No solution can cope with the financial imbalance of the pension system and at the same time have no negative effects on the rest of the economy. According to the assumptions considered, reforms may alleviate the pension system burden, but have different macroeconomic impacts.

The following sensitivity tests evaluate the results sensitivity to crucial assumptions made in behavioral activity and technical progress growth rate.

[21] Crowding out effect decreases here total savings so this frees a certain proportion of income that will be dedicated for consumption.

[22] We recall that the criterion of analysis is the impact on economic growth and on financial situation of PAYG pension plan.

[23] This scenario is better in terms of physical capital accumulation.

5. Sensitivity Analysis

5.1 Key parameters

In this section, we will conduct a sensitivity analysis with respect to the key parameters and examine the robustness of the above-mentioned model properties. Focus is made on sensitivity simulation with respect to:

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

Runs were first carried out for different values of productivity growth rate. Results indicate that the higher gppt is, greater is the reduction of macroeconomic negative demographic shock effects. In response to population ageing and relatively high pension equilibrium contribution rates, if the benchmark model was selected to reflect a higher productivity growth rate, gppt=1,5% instead of 1%, there would be saving rates reduction only during the transition period. Thus the saving behavior responses would yield, comparatively to the scenario where gppt=1%, an increase in the second period aggregate capital (after transition). Nevertheless, gains from productivity do not influence contribution rates to pension system since revenues and expenditures of the pension system are affected in the same direction (see table 1). As scenario with gppt=1,5% avoids the decrease of capital stock to very small levels in the last simulation periods, we consider this scenario as reference case for sensitivity analysis, for the reason that it keeps the model away from irresolution when some sensitivity tests are carried out (especially those which produce a greater decrease in capital stock).

The second group of sensitivity tests concern the remaining parameters (δ, α, ρ and $\bar{r}$). As interaction between parameters modifies some parameters values, we recalibrate the model, where necessary, to match the Tunisian economy. Table 1 presents these results.

Simulation results for alternative values of key parameters suggest that qualitative results are remarkably stable with respect to these parameters. The slight sensitivity result to capital income share comes from the following mechanism. Namely, when the capital income share becomes larger (lower), the labor income share becomes lower (larger) which gives individuals a disincentive (incentive) to save less (more), which in turn lowers (increases) the saving rate. However, the sensitivity of results to changes in the assumed value of capital income share, α, remains sufficiently low not to raise serious concerns about the usefulness of the previous discussion, since saving rates decline in the transition period, and equilibrium pension contribution rates are insensitive to these changes. In particularly, sensitivity tests indicate that pension contribution rate dynamics is robust to realistic parametric changes, even those affecting considerably saving rates, since real wage changes affect the 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, the absence of alternative population and workforce projections prevented us from carrying out sensitivity tests for changes in projected population and workforce series here. This, however, is one of the directions our research is planned to take in near future.

Two more variants of the modeling are tested below: the country as a small open economy, with fixed interest rate, and another form for the utility function.

5.2 A small open economy

All simulations presented above are based on the assumption of a closed economy. This assumption is obviously very restrictive but if one considers that population ageing transition will be very similar in most countries and financial constraint will be severe to these countries too, we can say it is less unrealistic than it seems at first sight. We may nevertheless add that the transition will not happen so perfectly synchronous and thus interest rates trends differ, making it useful to study the case of open economy. In the following, the model is modified along this line: wages and interest rates are exogenously determined by the international situation.

In fact, the model structure is changed so that international trade flows induced by demographic changes have no feedback effect. Let's recall that production optimization implies that capital/labor ratios remain fixed. This means that any changes taking place, on the domestic front, in capital/labor ratios generate capital inflows or outflows which maintain relative factors returns to their previous level. Hence, economic growth rates evolve according to PGF and labor growth rates. Capital intensity is exogenously determined by the world interest rate. Consequently, any deficit of national saving relative to investment is financed by automatically capital inflows.

Given this new structure, financial market equilibrium is ensured by the amount B (t) of debts (claims) incurred by residents with foreign agents. The following expression provides the clearing condition for the goods market: gross domestic product is equal to domestic absorption and the current account surplus:

$$Y_t = K_{t+1} - (1 - \delta)K_t + C_t - B_{t+1} + (1 + r^*)B_t$$

The simulation leads to this main result: borrowing financed by foreign capital can offset negative effects on the economy. However, it should be noted that population ageing will necessarily have a negative impact on the long-term growth rate which does not exceed 1.1% per year by 2060 (see table 2). This is explained by the drop of labor amount automatically resulting from population ageing.

Moreover, it appears that pension system contribution rates are not modified by open economy assumption. This is because pensions are indexed to real wage increases. Pension system revenues and expenditures are then affected by real wage in the same direction.

As for saving rates, they increase significantly[24] relatively to basic scenario: compared to the case of a closed economy, the movements of capital support necessary investment and prevent the change in wage and interest rates; this enhances the ability to save[25].

Besides these effects, one must keep in mind that open economy assumption may induce an important debt[26], and the model doesn't cope with its impacts on economic growth.

Let's consider now another trend for interest rate: it follows an exogenous trend similar to the endogenous one (closed economy case) but lower; in this scenario we note the following effects:

- the rate of saving decreases only during the period 2025-2040,

[24] The results reported in the case of a small open economy depend heavily on certain assumptions in this scenario including: perfect capital mobility, the world is able to absorb all capital movements caused by the demographic transition and the world interest rate is not influenced by the ageing population.

[25] It is obvious that the balance of capital flows of a country is influenced by many factors (fiscal and monetary policy, controls on capital movements, differences in rates of capital taxation practiced by various countries) so that the results presented here should be regarded as reflecting a very hypothetical possibility. Nevertheless, the simulation identifies the pressures that could carry the ageing population.

[26] debts reach unsustainable values : B/GDP=1,06993529 in 2040.

- a more negative impact on the long-term growth rate which does not exceed 0.2% per year by 2060 (see table 2),
- an almost stable contribution rates and growing debts (but lower than the previous scenario).

Finally, we can summarize the sensitivity analysis findings: the interest rate movement hypothesis influence strongly the results; with closed economy the recessive effects are enhanced in the long term.

5.3 Intertemporal Elasticity of Substitution:

In this paragraph, we conduct a sensitivity analysis with respect to the utility function structure and examine the robustness of the simulation results. By changing the logarithmic form, we can examine the dynamics of the model for various values of intertemporel elasticity of substitution. The new utility function is:

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

where $\frac{1}{\theta}$ is the intertemporal elasticity of substitution[27]. All other parameters are as previously defined. Maximizing this utility function under the intertemporal budget constraint (2) gives the optimal consumption of a household, belonging to the generation g, at each period of his life cycle, according to the consumption of the previous period:

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

Simulation results show that a change in intertemporal elasticity of substitution has a big impact on the aggregate variables. The saving rates and GDP growth rates become larger, as intertemporal elasticity of substitution becomes smaller: $\frac{1}{\theta} = 0.75$ instead of 1 (the inverse of intertemporal elasticity of substitution becomes larger: $\theta = 1.3$ instead of 1). (Table 3)

Two reasons may explain this sensitivity result:

- Time preference rate value has changed: varying the preference parameter θ requires a recalibration of the model; we have recalibrated the model and we found ρ= 2.2%: individuals weight less present consumption than future consumption, which gives them an incentive to save (consume) more (less), raising in turn the growth rate of physical capital.
- Substitution effect and income effect work in opposite directions, therefore, interest rate changes effect on savings behavior depends on the relative size of the two effects: if the substitution effect is greater than the income effect (i.e., the individual reacts strongly to an increase in the price of current consumption), then an increase in the interest rate will lead to a current consumption reduction and an increase in savings. If the substitution effect is lower than the income effect, the opposite will be true. In our case, the net effect on savings is positive since the smoothing motive (income effect) is weak with the current value of θ. Simulations done for other different values of θ, give the main following result: agents are less responsive to interest rate increase (and so in increasing savings) when the smoothing motive becomes stronger.

Thus, these mechanisms contribute to a higher economic growth rate, compared to baseline scenario. However, simulation results bring out a decline in saving rates from 2015 until 2040

[27] θ is the inverse of the intertemporal elasticity of substitution.

and so in GDP growth rates, the reason being the increase in contribution rates; actually simulation shows that the need for higher contribution rates is always the same.

Simulations highlight again the magnitude of the demographic shock on the pension system financial situation and consequently on the rest of the economy.

6. Conclusion

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

Population ageing and volatile economic environment, within unchanged parameters of pension system lead to financial pressure and growing deficits. This raise the issue of availability of public actions to restore the pension systems financial equilibrium and which, in the same time, avoid economic distortions caused by the reform strategies, particularly on capital accumulation;

For this analysis, we have developed a general equilibrium overlapping generations' model to examine the measures of balancing Tunisian pension system budget and their macroeconomic effects, particularly on saving, capital accumulation and economic growth. Proposed reforms to ensure sustainability of the pension system are fourfold: rate of contribution increase, the pensions' level reduction, retirement age rise and introduction of a complementary fully funded system. For the latter scenario, we incorporate a specific feature, which consists in differentiating saving rate of return; three possible cases are considered according to the relation between free saving rate of return and that of pension saving.

Simulation results indicate that population ageing could have a major impact on saving rate, factors prices, and economic growth. However, they also inform that policy reforms could reduce negative effects. If the objective is less distortion on the consumers, raising the retirement age contributes more than the other scenarios to the tax relief. If the analysis criteria are effects on the capital accumulation, decrease of benefit rate (by 5%) associated with introduction of a complementary funded pension, with a return rate lower than the market's, represents the best scenario, with a capital stock higher than ones in all other scenarios. Nevertheless, our model does not evaluate the impact of such measures on welfare, since the extension of working hours induces a loss of leisure time, and lower pensions reduces the purchasing power of retirees.

Given these results, a thorough reform of PAYG pension system is inevitable, in order to prevent dramatic increases in future contribution rates. But it is necessary to adopt the right mix between the various alternatives to distribute the burden of reforms across all generations. We support that an appropriate combination of PAYG pension system and complementary funded plan constitute a suitable approach to finance a national pension scheme: a general reduction in benefits could usefully be supported by partial "privatisation" pension system, this reforms can be consolidated by the removal of incentives for early retirement and a slight increases in contribution rates and/or in legal retirement age.

It is obvious that even a model as complex as this one leaves out some important features of the real world. Even though the model and resulting simulations necessarily involve the adoption of restrictive assumptions, sensitivity analysis suggest that qualitative results are remarkably stable. In spite of the uncertainties attached to the size of the effects, the simulations presented here show that there is no easy way to reduce the burden of ageing population.

Let's recall that the proposed reforms have been studied in terms of their effects on capital accumulation. An extension of our work is to choose among the reforms most favorable to the growth those which show the redistributive features the most desirable. In this expansion feasible path, we plan to review the implications of the model in case of endogenous labor supply, endogenous technical progress and several different socioeconomic groups within each generation. These alternatives will be the subject of future research providing that they are not limited by the unavailability of data.

References

Allais.M (1947) : Economie et intérêt, Paris : Imprimerie Nationale.

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

Arrau.P et 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. and L.J. Kotlikoff (1987) : "Dynamic Fiscal Policy", London: Cambridge University Press.

Auerbach A.J., Kotlikoff.L.J, Hagemann.R.P et Nicoletti.G (1989): "Conséquences du vieillissement démographique pour l'évolution de l'économie: une étude sur le cas de quatre pays de l'OCDE", Revue Economique de l'OCDE, 12, pp. 111-147.

Blanchet.D (1992) : "Retraites et croissance à long terme: un essai de simulation", Economie et Prévision, 105, 1-16.

Chekki.H (2010) : " Réformes du financement des systèmes de retraite : analyse théorique et application au cas tunisien. Thèse de doctorat en sciences économiques, FSEG Tunis.

Creedy.J et Guest.R (2008) :" Changes in the taxation of private pension: macroeconomic and welfare effects", Journal of policy modelling: vol 30, Issue 5, September-october 2008, 693-6712.

De la Croix.D (1998) : "L'avenir de la sécurité sociale au siècle prochain: Réflexion sur différents outils d'analyse", Note du Service d'analyse économique.

De la Croix.D and Michel.P (2002): "Myopic and perfect foresight in the OLG model", Economics Letters, 67.

Diamond.P (1965) : "National Debt in a Neoclassical Model ", American Economic Review. Vol.55, pp 1126-1150.

Dupont.G, Hagneré.C et Touzé.V (2003) : "Les modèles de microsimulation dynamique dans l'analyse des réformes des systèmes de retraites : une tentative de bilan", Economie et prévision. La Doc.française. N°160-1612003/4, 167-191.

Gonand.F (2007) : "Essays on payg pension systems reform: Modelling and policy choices, PhD thesis CECO, EP - CECO Laboratoire d'Econometrie, EP/X p.219. Board of examiners: Blanchet.D, Legros.F, De la Croix.D, Wigniolle.B, Pestieau.P and Picard.P.

Hairault.J.O, Langot.F and Sopraseuth.T (2004): " Retraites choisie et réduction des déficits", Revue Française d'Economie, 2004, Janvier.

Lau.M. I, Palhke.A, et Rutherford.T.F (2002): "Approximating infinite-horizon models in a complementarity format: a primer in dynamic general equilibrium analysis", Journal of Economic Dynamics and Control, 26, 577-609.

Le Cacheux.J et Touzé.V (2002) : "Les modèles d'équilibre général calculable à générations imbriquées: Enjeux, méthodes et résultats", Revue de l'OFCE N°80 2002/1, 87-113.

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

Rutherford.T.F (1995) : "Extensions of GAMS for Complementarity Problems Arising in Applied Economics", Journal of Economic Dynamics and Control, , 19 (8),1299-1324.

Rutherford.T.F (1999) : "Applied General Equilibrium Modelling with MPSGE as a GAMS Subsystem: An Overview of the Modelling Framework and Syntax", Computational Economics, 14, 1-46.

Samuelson.P.A (1958) : " An exact consumption-loan model with or without the social contrivance of money", Journal of Political Economy, N°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.

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

Figures

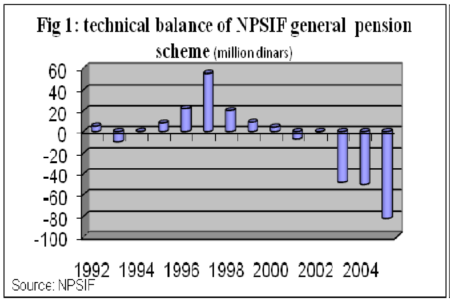


Fig 1: technical balance of NPSIF general pension scheme (million dinars)
60
40
20
0
-20
-40
-60
-80
-100
1992 1994 1996 1998 2000 2002 2004
Source: NPSIF

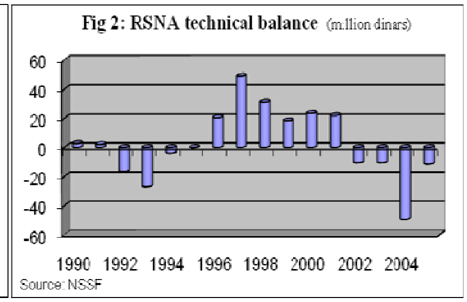


Fig 2: RSNA technical balance (million dinars)
60
40
20
0
-20
-40
-60
1990 1992 1994 1996 1998 2000 2002 2004
Source: NSSF

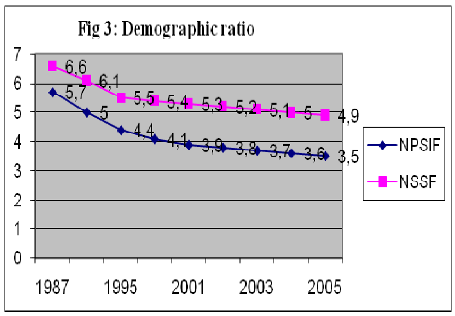


Fig 3: Demographic ratio
6,6
6,1
5,5
5,4
5,3
5,2
5,1
5
4,9
5,7
5
4,4
4,1
3,9
3,8
3,7
3,6
3,5
NPSIF
NSSF
1987 1995 2001 2003 2005

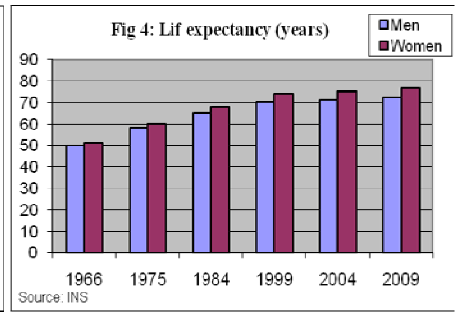


Fig 4: Lif expectancy (years)
Men
Women
1966 1975 1984 1999 2004 2009
Source: INS

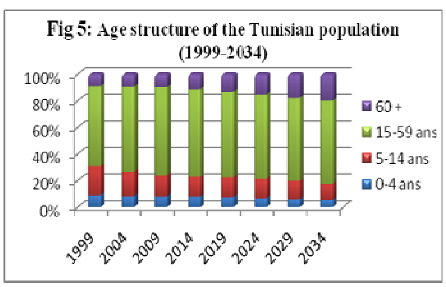


Fig 5: Age structure of the Tunisian population (1999-2034)
100%
80%
60%
40%
20%
0%
60 +
15-59 ans
5-14 ans
0-4 ans
1999 2004 2009 2014 2019 2024 2029 2034

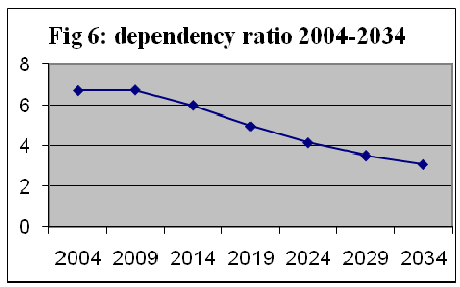


Fig 6: dependency ratio 2004-2034
8
6
4
2
0
2004 2009 2014 2019 2024 2029 2034

Table 1: Sensitivity Analysis to Key Parameters

Variable **Parameter**	**Deviation from basic scenario** **Saving rate**
Productivity growth rate : gppt= 1,5 %	
2020	0,01776976
2040	0,0898009
2060	0,35482961
Depreciation rate : δ = 8 %	
2020	0,00047005
2040	-0,01047703
2060	-0,03345579
Depreciation rate : δ = 6 %	
2020	-0,00545815
2040	-0,00506705
2060	-0,00743865
Capital income share: $\alpha=0,42$	
2020	-0,02683663
2040	-0,09138184
2060	-0,36335094
Capital income share: $\alpha=0,35$	
2020	0,11112857
2040	0,25024971
2060	0,31967513
Rate of time preference: ρ=3,2%	
Interest rate in calibration process: $\bar{r}$=5,5%	
2020	-0,02476215
2040	-0,07757111
2060	-0,27031926
Rate of time preference: ρ=2,5%	
Interest rate in calibration process: $\bar{r}$=4,5%	
2020	0,02491
2040	0,06435669
2060	0,1128387

Table 2: Sensitivity Analysis to a Small Open Economy

Variable **Year**	**GDP growth rate (%)** **Closed Economy**	**GDP growth rate (%)** **Open Economy**	**GDP growth rate (%) Open Economy** **(exogenously trend)**
2020	1,8	2,7	2,3
2040	0,7	1,3	0,5
2060	0,2	1,1	0,2

Table 3: Sensitivity Analysis to Intertemporal Elasticity of Substitution

Variable **Parameter**	**Deviation from basic scenario** **Saving rate**
Intertemporal Elasticity of Substitution θ = 0,75; (ρ=2,2%)	
2020	0,03123426
2040	0,11668148
2060	0,37003481

Table 4:

Parameters set	
n (baseline)	0.01
r (baseline)	0.05
R	60
σ (baseline)	0
calibrated parameter	
ρ	0.028
A	0.828
δ	0.07
α	0.4
τ (année de base)	0.14
µ	0.67