PENSION REFORM AND MACROECONOMIC IMPACT: SIMULATION FOR THE CASE OF TUNISIA VIA OVERLAPPING GENERATIONS MODEL

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Abstract: *The aim of this paper is to study the macroeconomic effects of a few scenarios reforms of the pension system Tunisian who correspond respectively to the increase of the contribution rate, to the reduction of the replacement rate, and finally to the introduction of a dose of funded in our pension system. In other word, we will examine the evolution of consumption, saving, capital accumulation through a general equilibrium model of overlapping generation similar to DEGER (2011).*
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INTRODUCTION

In Tunisia as in the majority of countries of the world, the structure of the population pyramid tend more toward the bottom during these past few years. This trend of age pyramid toward the higher age classes will worsen the financial situation of our pension system either in the public sector and the private sector. In the vision of mitigating the impacts of this demographic change, it is essential to pose of reforms affecting some parameters of our pension system.

Thus, several studies have investigated the consequences of various reforms that are parametric or structural at micro-economic or redistributive level as Harding (1996), Nelissen (1999) and Cremer et al. (2007). However, in our paper, we focus essentially on the impact of various reforms that we propose at the macroeconomic level. The major criterion chosen for the macroeconomic analysis of the impacts of reform is the effect on capital accumulation via the consequences on the behavior of savings. In fact, we propose three scenarios for reform from a general equilibrium model with overlapping generations in order to study their effects on the profile of consumption and savings of households on the one hand, on the other hand on the accumulation of capital stock by retaining the 2010 as the reference year and the projection will be projected up to 2030.

This paper is organized into four sections. The second section explains the model structure. The third section represents the calibration phase and simulation results. Finally, the analysis ends with conclusions in a fourth section.

2. THE MODEL

The model structure is similar to that of paper Deger (2011). This presented modeling considers specifically the interdependencies between decisions of households, producers and state.

The model includes a set of equations attached to household behavior, the production sector and the state represents only the pension system. The model takes place in the context of an economy closed with the assumption of exogenous labor supply.

The behavior of households

The households in the model are presumed rational and having a perfect forecast on one hand. On the other hand, the children are totally dependent on their parents since the birth up to the age of 20 years with which the individual begins to work. Thus, we choose to divide household into six age classes. These six age classes are divided into four during the working phase and two during the retirement phase. The first five age classes are composed of ten years, but the last age group includes individuals who are age 70 and older. Besides, in the model, the households did not receive the inheritance and do not leave voluntary legacies after their death.

The instantaneous preference of household is represented by the following version of the constant relative risk aversion:

$$\frac{(c_{t+a-1}^{a})^{\eta}-1}{1-\eta} \quad (1)$$

The subscript t represents time and a = 1,2, ..., 6 is the age group of the household. The parameter η of the function represents the measure of relative aversion of risk and would be interpreted as the inverse of the intertemporal elasticity of substitution.

The utility of a representative household for the duration of life is represented as follows:

$$\sum_{a=1}^{6} \beta^{a-1} \frac{(c_{t+a-1}^{a})^{1-\eta}-1}{1-\eta} \quad (2)$$

Thus, β represents the discount factor. According to this utility function, there is no arbitrage between consumption and leisure or work and leisure because the retirement age is exogenous, which is fixed at 60 years.

In the phase of work, each household offers a quantity of work inelastic which reported to him the salary which will be divided between consumption, savings and the payment of a levy corresponds to a contribution, which implies the budget constraint:

$$c_t^a + s_{t+1}^{a+1} \leq (1+r_t)s_t^a + (1-\tau_t)w_t \quad (3)$$

For a = 1, ..., 4 ; s_t^a represents savings of a household for an age group at time t. The saving of the household is seen as a basic instrument for the intertemporal redistribution of resources. The interest rate is noted r_t, w_t is the market wage rate and τ_t is the contribution rate.

During the retirement phase, sources of income for pensioners are pension benefits received from the pension system and savings accumulated during periods of work. Thus, the budget constraint during this phase is written as follows:

$$c_t^a + s_{t+1}^{a+1} \le (1+r_t)s_t^a + p_t \quad (4)$$

Where a = 5,6 ; with p_t represents the pension benefits.

Due to the similarity of preference structures, the problem of optimizing a single household corresponds of all households despite the heterogeneity that we introduced in term of age classes. The maximization of utility function (2) under the two budget constraints (3) and (4) allows us to determine for each age class his level of consumption over time. Thus, the problem of utility maximization under both budget constraints gives the following optimality condition:

$$\frac{c_{t+1}^{a+1}}{c_t^a} = \left[\beta(1+r_{t+1})\right]^{\frac{1}{\eta}} \quad (5)$$

This equation (5) shows us that the permanent income of an individual is divided between its consumption in the work phase and the retirement phase. This condition of optimality represents the consumption Euler which concerned the choice of consumption in consecutive time. In the case where the right part of this equation is greater than one, a profile of increasing consumption would be observed for the representative agent.

The firm

The set of firms in the model is assimilated to a representative firm that operates in a competitive context. The firm produces a single good that can be both consumed or invested as physical capital, whose price is equal to unity. This production function is Cobb-Douglas with constant returns to scale:

$$Y_t = K_t^{\alpha} L_t^{1-\alpha} \quad (6)$$

Where Y_t corresponds to the level of output at time t, K_t indicates the stock of physical capital, L_t represents the number of workers and α described the part of the capital in the production. The firm determines its demand for factors of production by solving the following program to maximize its profit:

$$\max \pi = Y_t - w_t L_t - (r_t + \delta)K_t$$

Under the technological constraint: $Y_t = K_t^{\alpha} L_t^{1-\alpha}$

The conditions of the first order for maximization are the following:

$$r_t = \alpha K_t^{\alpha-1} L_t^{1-\alpha} - \delta \quad (7)$$

$$w_t = (1-\alpha) K_t^{\alpha} L_t^{-\alpha} \quad (8)$$

With r_t real interest rate at time t, δ the capital depreciation rate and w_t the wage rate.

The government

The government in this model is confined to its function as administrator of the pension system. This pension system is financed by taxes levied on the income of the workers. These taxes are distributed to the beneficiaries of the pension system. So, for every person belonging to the pension system, pensions are as follows:

$$p_t = rem(1-\tau_t) w_t \quad (9)$$

Thus, the pension which is received by pensioners is equivalent to the product of the replacement rate (rem) and the wage rate for the current period (w_t). For any period of time t, the budget of the pension system can be written as follows:

$$\tau_t w_t N_t = \sum_{a=5}^{6} p^a \quad (10)$$

The closure of the model

To ensure that the model is logically coherent, it must the existence of equilibrium conditions respectively on the labor market and the goods market. In fact, these equilibrium conditions ensure the closure of the model.

On the labor market, the total supply of labor at time t is equal to the labor supply of all cohorts:

$$N_t = \sum_{a=1}^{4} n_t^a \quad (11)$$

The equilibrium on the goods market is defines as follows:

$$K_t^{\alpha} N_t^{1-\alpha} = \sum_{a=1}^{6} c_t^a + K_{t+1} + (1-\delta)K_t \quad (12)$$

According to this equation, the production which is on the left side is absorbed by the overall consumption and investment or investment includes additions to capital stock and depreciation. In this equation, the only term not related to capital stock is consumption. But according to the budgetary constraints, we visualize that the consumption is in fact as a function of savings, which is ultimately linked to the stock of capital, and that the prices of the factors are in function of the capital stock from equations (7) and (8).

Therefore, given the inelastic labor supply, the budget constraint of the household and maximization profit of firms, the dynamics of capital is rewritten:

$$K_t = \sum_{a=1}^{6} s_t^a \quad (13)$$

3 THE CALIBRATION AND SIMULATION

3-1 The calibration parameters

The calibration of the parameters weighs in a significant way on the simulation results of the model. The values used for these parameters are either econometric estimate derived from other studies, of values acquired from international comparisons, arbitrary values which were not based on any data observations of the economy studied. In what follows, we will expose the determination of parameters relative to the utility function, the production function and the pension system.

Concerning the utility function, the discount factor is determined by the use of first-order conditions of the consumer maximization program while respecting the constraint relating to the aggregation of consumption. For the production function, the income share of capital in total income of factors α is established through the expression of the marginal productivity of factors on the one hand, on the other hand the value of the wage rate in the base year which is 2010. About the pension system, the contribution rate and the replacement rate correspond respectively to 20% and 70% be the average between the general regime of the NPSIF[1] of the public sector and the SNAE[2] of the private sector. Thus, the values of the parameters calibrated for our model are summarized in the Table 1.

Table 1 Model parameter values

Parameters	description	value	source
β	Discount factor	0.9	Heer and Maussner (2005)
η	The coefficient of risk aversion	2	Heer and Maussner (2005), Borsch-supan et al. (2006)
δ	The depreciation rate of capital	0.05	Tunisian Institute of Competitiveness and competition studies
α	The share of capital in production	0.228	calculation author
Rem	Replacement rate	0.7	Center of Studies and research economic and social
τ	The rate of contribution	0.2	Center of Studies and research economic and social

Simulation of various reform policies (2010-2030)

Our contribution is illustrated in the study of impacts of various reforms of the pension system on economic aggregates. For this, we consider three main parts of simulation that are performed with Matlab 2010-2030. In the first, we study the evolution of the economic variables of the model such as consumption, saving and the capital stock in case of the absence of reforms of the pension system Tunisian, this means that the contribution rate and the replacement rate correspond respectively to 20% and 70%. The second part focuses on the analysis of the effects of certain parametric reforms namely the decline of the replacement rate and the increase of the contribution rate. Finally, in the third part, we perform an extension of this model that consists to introduce a funded pillar beside the PAYG pillar. Thus, few economic contributions interested to the analysis of a mixed pension system as Brunner (1996), Samwick (1999), Sinn (2000) and Poterba (2001). They noted that the introduction of funded leads to increase the capital stock.

3-2-1 the case of unchanged legislation of the pension system

We refocus to determine, first, the profile of consumption and saving for each age class 2010-2030. We begin by the consumption which represents a variable of flow. According to our simulation results, we find that the level of consumption is in continuous increase during the six age classes. Moreover, for a representative household during its life, the consumption profile reaches its maximum at the end of life. These results found for the profile of consumption are in agreement with the theory of the life cycle since such an increase of the consumption profile is possible only if the right hand side of the equation of Euler is greater than one.

Also, we notice that the saving increases gradually from the first age to the fourth age while acceding a maximum to the fifth age. In fact, at any time period t, the household must do actually choose between present consumption and the level of saving preserved at the following period. Thus, this choice leads the household to increase the level of saving when it approaches the retirement phase. In other word, during the last period spent in work, the chosen value of the stock of saving for the next period, which will be the first period of retirement, would be the

[1]NPSIF : National pension and social insurance fund
[2]SNAE : Scheme for non-agricultural employees

highest value of the savings over the life cycle. Consequently, the figure of saving reaches a peak during the 5th period of household life. But in the last period, the level of saving decreases. From the saving profile, the level of capital stock will correspond during the projection period 1.27.

Table 2 Consumption and saving according to age class 2010-2030

Age class	Consumption	Saving
[20-29 ans]	0.14	0.0077
[30-39 ans]	0.193	0.077
[40-49 ans]	0.233	0.122
[50-59 ans]	0.361	0.19
[60-69 ans]	0.389	0.241
70 ans et plus	0.421	0.184

3-2-2 Reduction of the replacement rate

The first scenario tends to reduce the generosity of the pension system by reducing the replacement rate of 70 per cent to 65 per cent but at a contribution rate and legal age of retirement unchanged. This implies that the available income of the pension system is identical to the original level while pension spending decrease since the pension paid to each retiree decreases.

According to the results of the simulation, the first fallout of this measure is to change the level of household consumption. Thus, a decrease of 5% of the replacement rate led to a fall of 1.55 per cent of the level of consumption for the six age classes during the period of simulation compared to the scenario of legislation unchanged of the pension system. This decrease is explained by the change in inter-temporal income. The decrease in this consumption causes the higher savings. Indeed, this behavior is predictable because the households are obliged to increase their level of savings in order to mitigate the lack of income once arrived at retirement.

Following the change of the level of the behavior of saving, the interest rate is dropped. As well, the increase in saving on the one hand, on the other hand lowering the eviction effect engenders then an increase of capital accumulation. This is verified by our simulation results since the coefficient of capital stock for this scenario corresponds to 0.0857. In other word, the decrease of 5% of the replacement rate causes an increase in the capital stock of 0.4285% during the period of simulation.

3-2-3 Increase of the contribution rate

The second reform scenario predicts that the financial effort is approved by the age classes of workers whose increased contributions led to raise the recipes of the pension system. Thus, in the context of this scenario, the contribution rate increases by 1 percentage point respectively for 2011 and 2012 to attach to the threshold of 22% from this date until the end of the projection period.

The simulation results reveal that the increase of 2% of the contribution rate produces a decrease of 0.144% of consumption. In effect, the increase of the contribution rate reduces the wage rate in a first time and subsequently the profile of consumption of individuals of first four classes of age decrease by same. Therefore, this implies a moderate rise in the profile of saving. This moderate increase of saving is transmits to the investment which corresponds to the capital stock because the latter is fully financed by the saving. Thus, the capital stock follows the same evolution described in the first scenario, but at a level less important which corresponds to 0.08%.

Introduction a dose of funded

We model the introduction of funded that would continue to finance the pension at long-term for future retirees. In other words, this third scenario is to introduce a funded pillar at a contribution rate which corresponds to two. Thus, this scenario of reform involves the modification of the budget constraint for the work phase:

$$s_{t+1}^{a+1} + c_t^a \leq (1+r)s_t^a + (1-\tau_t - \sigma)w_t \quad (14)$$

σ represents the contribution rate for the funded pillar.

In the retirement phase, household savings to the funded pension is remunerated to a return r^c. Similarly, the budget constraint in the phase of retirement is modified:

$$s_{t+1}^{a+1} + c_t^a \leq (1+r)s_t^a + p_t + (1+r^c)\sigma w n_t^a \quad (15)$$

r^c represents the return rate of funded

Thus, the modification of the household budget constraint during the working phase and retirement phase involves even the change in the dynamics of capital which can be rewritten as follows:

$$K_t = \sum_{a=1}^{6} s_t^a + \sigma w_t n_t^a \quad (16)$$

We assume that the performance of funded pension is equivalent to the interest rate of the market. In the first place, the results of simulations show no change at the level of the variables in the model, only for voluntary saving s_t^a. The latter will diminish by an amount which corresponds to the value of the tax for the funded pension. This can be reasoned by the fact that the compulsory savings resulting from the compulsory tax of funded pensions is replaced totally to the voluntary savings. In the second place, the results of simulations indicate that this third scenario has no effect on the capital stock between 2010- 2030. This is interpreted by the fact that the sum of the two types of savings following the introduction of a dose of funded 2% is identical to the value of saving for the scenario legislation unchanged pension system. Therefore, the capital stock does not vary. Thus, this results informs that the introduction of funded in our pension system causes a neutral macroeconomic effect since our financial market has not reached the phase of development.

CONCLUSION

In this paper, we have developed a general equilibrium model with overlapping generations with presence of a PAYG pension system in Tunisia. With this modeling, we proposed three reform scenarios in order to study their effects on capital accumulation.

According to the simulation results, we found that the scenario of increase of the contribution rate generates a moderate increase in capital accumulation which is caused by the distortion. This distortion comes from the decrease of the disposable income of workers and elsewhere of their savings capacity.

Regarding the scenario of reduction in the replacement rate, the simulation results we have indicated that this is a positive effect on the saving profile of consumers. In other words, the reduction in the replacement rate allows the increase of the capital stock during the projection period 2010-2030. This increase in the capital stock is economically interpreted as anticipation of reduced pension led young age groups to increase savings and therefore to promote the growth of the capital stock.

The two reform scenarios presented above are of parametric nature, but the third scenario is of structural reform. This structural reform is the introduction of a dose of funded of which we are have assumed that the market interest rate is identical to the rate of return of funded. According to the simulation results, this scenario has a neutral impact on the capital stock because it will have substitutability between the voluntary savings and the compulsory savings through of the funded.

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