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Pension reform in emerging countries: Simulations on the Tunisian case

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Abstract: This paper discusses the impact of aging on the financial equilibrium of the Tunisian retirement system and the macroeconomic implications of reform and introduces capitalized pillars. Using a stylized, closed economy, overlapping generation model to analyze the impact of the introduction of a multi-pillar system combining pay-as-you-go (PAYG) and funded elements (both temporary and permanent funded elements), the analysis is focused, on the one hand, on the saving response to the reform in the aggregate level and, on the other hand, on accumulation and consumption profile per cohort. The reform leads to an important crowding-out effect, limiting the increase of capital accumulation. The simulations show also that the burden of the reform is unequally supported by the different cohorts.

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Pension reform in emerging countries: Simulations on the Tunisian case[1]

Mehdi Ben Braham

Introduction

An aging population and its impact on the retirement system is not only the concern of developed countries. During the nineties, pension reform has been implemented in many emerging countries. There is a strong tendency today to reform existing pension systems in the direction of increased actuarial fairness. For example, based on the World Bank's model, several Latin American (Chile, Bolivia, Peru) and Eastern European countries (Poland, Hungary) have introduced a multi-pillar system combining pay-as-you go (PAYG) and funded elements in order to avoid financial imbalances of their retirement systems. In a PAYG system, pensions for retired workers in a given year are totally financed by currently employed workers' contributions. This model is based on intergenerational transfers. A capitalized (or funded) system works differently, since each worker contributes for his own pension by accumulating savings managed by a pension fund in order to provide income during retirement.

A large pension literature has analyzed macroeconomic impacts of this reform, especially on private savings. The first works studying the impact of social security on savings are the empirical investigations of Feldstein M. (1974) and Munnell A. (1974) for the United States.[2] Theoretical studies suggest that PAYG programs negatively affect national saving rates through a crowding-out effect. By contributing to a PAYG pension system, individuals will reduce their savings for retirement. In contrast, in a context of population aging, individuals (who have rational expectations) expect a tax increase and then save more (Ricardian equivalence). So there is no clear implication that PAYG systems decrease national savings. In fact, pension saving is often considered as a factor increasing national saving (James E., 1996; Holzman R.; 1997, Samwick A.; 1999). This result depends on a certain number of elements, particularly a crowding-out effect. Individuals prefer to reduce

[1] I am grateful for useful comments and discussions from Thomas Weitzenblum, John Tatom, Marie-Eve Joël and Jérôme Witwerr.

[2] Exhaustive reviews of the literature can be found in Congressional Budget Office (1998) and in Kohl and O'Brien (1998).

their ordinary saving when they contribute to a pension fund. While much work has been done on modeling and reform scenarios in developed countries and a few developing countries, little is known on this topic for Tunisia.

In this paper, the Tunisian situation is analyzed. The Tunisian pension system works as a PAYG system divided into different schemes (private sector/public sector; agricultural sector/nonagricultural sector; employed/self-employed workers; see Appendix 1A and 1B for a detailed presentation). Whereas the other North African pension systems still suffer from low cover rates (population covered by a pension system in proportion of working age population), the Tunisian pension system has largely improved the cover rate by precise legislation and important control and supervision[3] during the past twenty years. However, the pension system will face another type of problem. In Tunisia, the demographic evolution shows an increase, in the medium term, in the dependency ratio, which is defined as the number of people aged 65 and older divided by the number of people aged between 20 and 64. This result is very important for the Tunisian pension system. This demographic evolution means that pension expenditures will grow more rapidly than contributions, thus creating financial imbalances in the PAYG pension system.[4]

Therefore, reform is necessary if Tunisia wants to keep the same level of pension for future retirees. Using an Overlapping Generation Model (OLG) as developed by Auerbach & Kotlikoff (1987), a baseline scenario shows the necessity of reform for the Tunisian pension system. This scenario consists of keeping the rules of the actual retirement system unchanged but recalculating the contribution rate evolution, in order to maintain the financial balance of PAYG. The results reveal the need for an important increase in the equilibrium contribution rate. Simulated scenarios of structural reforms that introduce a funded pillar (see appendix 2 for a presentation of pillars system) serve to limit this contribution level increase. Two types of reform are taken into account: a temporary smoothing fund and a permanent fund pillar. This paper focuses only on a capitalized pillar introduction and keeps the PAYG parameters unchanged (retirement age, replacement rate, etc.). The simulated reforms are inspired by the World Bank model (1994), which is characterized by a multi-pillar system. This paper can contribute effectively to the creation of policy-relevant information in Tunisia in two important ways: first, by highlighting the necessity of reform for the Tunisian pension system,

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[3] Coverage problems remain in the agricultural sector, where the amount of informal work is relatively large, but this sector represents a small share of the total number of contributors to the pension system.

[4] Under a PAYG system, pension financing is determined by the following relationship:
Contribution rate = Replacement rate x Dependency ratio, where the contribution rate is the ratio of required contribution to the taxe base (GDP), and the replacement rate is the ratio of average income that is replaced by the average benefit.

it gives an idea of the effort contribution needed to balance the PAYG system. Second, it analyzes the macroeconomic impacts of pension funds in a developing country like Tunisia. These impacts are different in emerging countries compared to developed countries, since in emerging economies an aging population is expected for the medium or long term and the macroeconomic context is characterised by a low level of GDP which increases at a high rate. This paper is organized as follows. Section 2 introduces the demographic projections. Section 3 presents the model. Section 4 looks at the reform scenarios introducing capitalization. Section 5 presents the calibration, section 6 presents the different results, and section 7 concludes.

2. Demographic projections

The model economy consists of overlapping generations of agents, entering the labor market at the age 20, and living a maximum of 14 model periods (corresponding to 90 years). Individuals face a death hazard with probability m_j^t increasing with their age j. The "m_j^t" probabilities regularly decrease during the transition period. Similarly the flow of entry into the labor force (and therefore the economy) varies from 2003-2040, according to demographic data and projections by the *INS* (*Institut National de Statistiques*), and stabilizes after, allowing for a stationary demographic steady state. The date of retirement is mandatory, thus exogenous. The replacement rate is calibrated on Tunisian data for 2003 and is supposed constant thereafter.

Life expectancy at age j+1 and time t+1 is linked to life expectancy at age j and time t and the mortality rate as follows:

$$LE_j^t = (m_{j+1}^{t+1}) + (1 - m_{j+1}^{t+1})(1 + LE_{j+1}^{t+1}) \qquad (1)$$

After simplification, the formula is: $LE_j^t = 1 + (1 - m_{j+1}^{t+1})(LE_{j+1}^{t+1})$ (2)

As new data becomes available in five year increments, the equation (2) becomes:

$$LE_j^t = 5 + (1 - m_{j+1}^{t+1})(LE_{j+1}^{t+1}) \qquad (3)$$

then, $$m_{j+1}^{t+1} = -\frac{LE_j^t - 5}{LE_{j+1}^{t+1}} + 1 \qquad (4)$$

This overlapping generation (OLG) model is composed of 14 age classes coexisting in each period *t*. Table 1 represents the different age classes used in the model, with people entering the labor market at 20 years old.

Table 1: The different age classes used by the model

C (1)	20-24	**C(8)**	55-59
C(2)	25-29	**C(9)**	60-64
C(3)	30-34	**C(10)**	65-69
C(4)	35-39	**C(11)**	70-74
C(5)	40-44	**C(12)**	75-79
C(6)	45-49	**C(13)**	80-84
C(7)	50-54	**C(14)**	85-90

In order to make projections of the Tunisian population, projected fertility rates are imported to the Spectrum software database used to calculate the first age class of the Tunisian population "c'1" (which is not corresponding to the first age class used by the model).

$$pop(c'1)_{t+1} = f(pop(c'1)_t, f_t) \qquad (5)$$

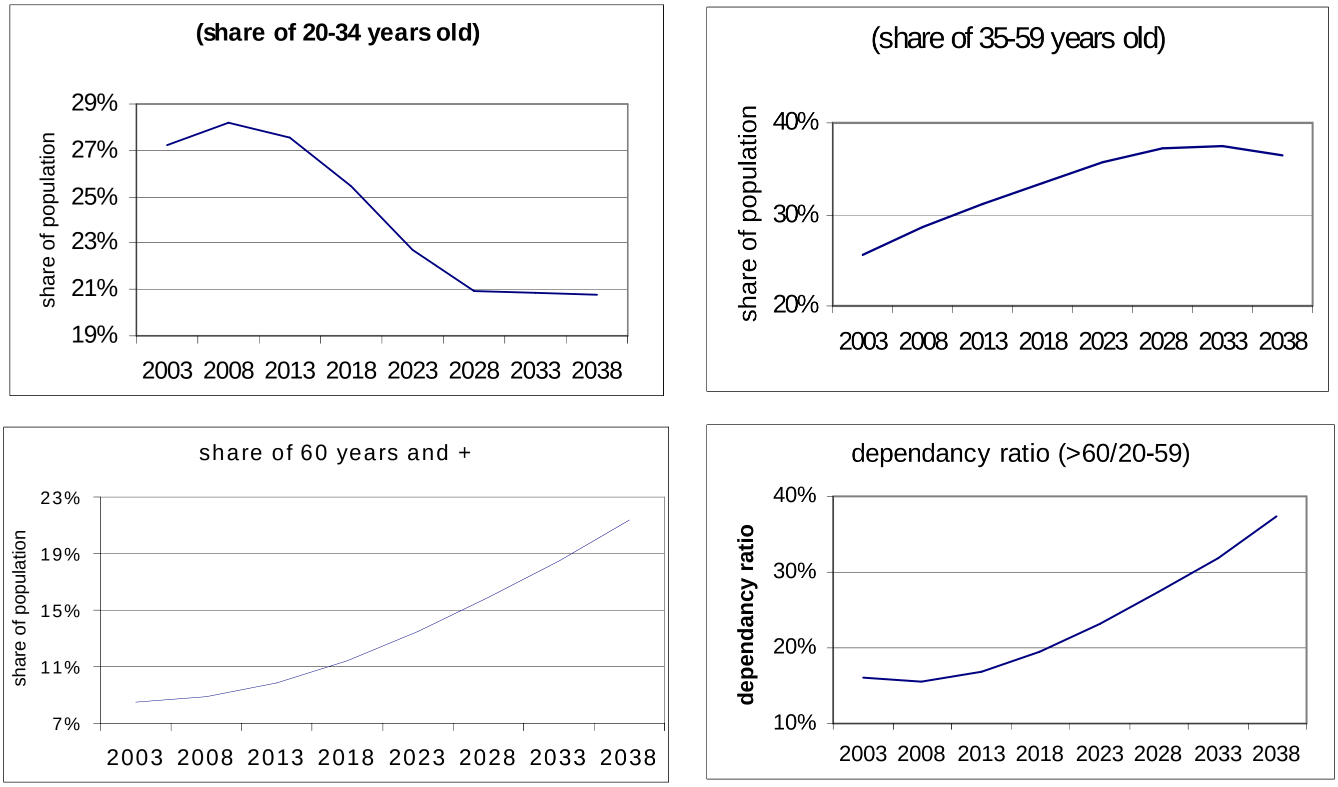
The equation (5) shows that population in the first class age at time "t+1" depends on population in this class age at time "t" and the net fertility rate " f_t " (average number of children that a woman will give birth to during her lifetime or during her reproductive years: 15-49 years of age).

Then, population in the age class j+1 at date "t+1" depends on population from the age class "j" at time "t" times the probability to survive at time "j+1" (no migration is taken into account, its impact is very small).

$$pop(c_{j+1})_{t+1} = pop(c_j)_t s(c_{j+1})_{t+1} \qquad (6)$$

Figure 1 presents demographic projections in Tunisia (2003-2040).

Figure 1: Demographic projections (INS, 2003)



The dependency ratio (population +60 years/ population 20-59) is expected to climb from 16% in 2003 to 35% in 2040, in Tunisia. The increase in the proportions of the elderly will have a number of significant economic consequences. These include the possibility of overwhelming the pay-as-you-go retirement system if no reform is undertaken. For this reason, this paper simulates a reform scenario of the tunisian pension system in order to maintain its financial equilibrium (pensions distributed equal contributions). This simulation requires demographic projections and the modeling of household behavior, firms equilibrium and finally capital accumulation in the pension system.

3. The model

The model is based on the life-cycle theory of saving behavior. In the model, there are 15 generations living side by side at each point in time and each new generation is allotted 14 periods to live, each period corresponding to 5 years. The structure of the model is similar to that of Auerbach and Kotlikoff (1987) and Auerbach *et al* (1989), with the exception that labor supply is exogenous. Households are assumed to be rational and have perfect foresight, the production technology is given by a standard Cobb-Douglas function, and the one-good economy is assumed to be closed. Although the closed economy feature of the model does not correspond to the Tunisian situation, this paper's model chooses to simulate the pension reform with this hypothesis in order to measure the impact of the reform on the capital return, which would othewise be determinated by the model.

3.1 Household behavior

For given incomes and mortality risk, individuals determine their consumption level for each period and therefore their asset holdings by maximizing their intertemporal utility, under an intertemporal[5] budgetary constraint. Individuals save in activity periods and consume these savings during retirement. Individuals do not support borrowing constraints. The budgetary constraint is given by:

$$y_t^j(1-\tau_t)+T_t+\frac{y_{t+1}^{j+1}(1-\tau_{t+1})+T_{t+1}}{1+r_{t+1}}+....+\frac{y_{t+s-j}^{s}(1-\tau_{t+s-j})+T_{t+s-j}}{\prod_{n=1}^{s-j}(1+r_{t+n})}=C_t^j+\frac{C_{t+1}^{j+1}}{1+r_{t+1}}+...+\frac{C_{t+s-j}^{s}}{\prod_{n=1}^{s-j}(1+r_{t+n})} \quad (7)$$

where y_t^j is the income in period t and at the age j.

C_t^j is the consumption in period t and at age j ; r_t represents the interest rate in period t; τ_t is the equilibrium contribution rate of the retirement system in period t ; T_t is the transfer received in period t (there is no bequest motive[6] and inheritance tax revenues are redistributed through lump-sum current transfers); s represents the maximal age that can be reached by individual who belongs to generation t.

Moreover, individuals have the same utility function:

$$U=\ln(C_t^j)+\beta(1-m_{t+1}^{j+1})\ln(C_{t+1}^{j+1})+...+\beta^s\ln(C_{t+n}^{j+n})\prod_{n=1}^{s-j}(1-m_{t+n}^{j+n})) \quad (8)$$

where:

m_{t+1}^{j} is the mortality rate at age j+1 and in period *t+1*and

β is the psychological discount factor.

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[5] The intertemporal budgetary constraint is strictly verified for individuals reaching the maximal age. Individuals who die before this maximum age can leave a positive debt.

[6] This paper does not model bequest motives. With the absence of liquidity constraint at each date, individuals who die can leave involuntary inheritance (positive or negative). This amount is distributed to all the population. All the simulations verify that the difference between positive bequests and negative ones (debts), calculated for all dead individuals, is positive.

The optimal program requires the maximization of the utility function under the budgetary constraint.

Maximization of equation (8) under budgetary constraint (7) gives the first order condition:

$$C_{t+1}^{j+1} = \beta(1 + r_{t+1})(1 - m_{t+1}^{j+1}).C_t^j$$

(9)

and the intertemporal budgetary constraint :

$$C_t^j = \frac{1}{V_t}\left[Y_t^j(1-\tau_t) + T_t + \frac{Y_{t+1}^{j+1}(1-\tau_{t+1}) + T_{t+1}}{1+r_{t+1}} + \ldots + \frac{Y_{t+s-j}^{s}(1-\tau_{t+s-j}) + T_{t+s-j}}{\prod_{n=1}^{s-j}(1+r_{t+n})} \right] \quad (10)$$

with

$$V_t = 1 + \beta(1 - m_{t+1}^{j+1}) + \ldots + \beta^s \prod_{n=1}^{s} (1 - m_{t+n}^{j+n})$$

(11)

In addition, household assets accumulation (household savings) follows this dynamic:

$$A_t^j = (1+n)\left[A_{t-1}^{j-1} + Y_{t-1}^{j-1}(1-\tau_{t-1}) - C_{t-1}^{j-1}\right] \quad (12)$$

with A_t^j assets accumulated by households in period t and at age j.

τ_{t-1} is the equilibrium contribution rate of the retirement system in period t-1.

Accumulation at period t depends on accumulation made until the beginning of period t-1 plus accumulation made during the period t-1. The result is augmented by interests.

3.2 Production sector

The economy's production technology is represented by a simple Cobb-Douglas function (with constant return to scale):

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha} \qquad (13)$$

where *Y* represents real output, *K* is the real value of the capital stock, *L* describes the effective labor force, α is the share of the capital and *A* is a scaling variable. Companies operate in a perfectly competitive market. Factor demand and output are determined by the two first order conditions for maximum profit (see appendix 3 for further details).

3.3 Equilibrium of the PAYG system

The financial equilibrium of the PAYG retirement system is defined by the following equation (17). Contributions must be equal to distributed pension at each time "t."

$$\tau_t(MS_t) = (1 - \tau_t)PR_t \qquad (17)$$

where pensions *PR = Gross salary . replacement rate, MS* represents total wages and τ_t is the contribution rate in period t. This equation allows us to maintain the net replacement rate.

Concerning the pension system, asset accumulation depends on its constraints as follows:

$$AP_{t+1} = (1+r_{t+1})AP_t + prél_t - prest_t \qquad (18)$$

AP_{t+1} : public assets in period t+1; $prél_t$: the contribution level in period t; $prest_t$: pensions distributed by the retirement system in period t. Equation (18) shows that public accumulation (or accumulation in the pension system) in period t depends on public accumulation in period "t-1" and the difference between contributions and pensions distributed in period t.

In order to measure the evolutions which are not due to the growth rate, we refine variables as detrented. Allowing for a constant productivity trend $(1+g)^t$ [7], we redefine variables on a time stationary basis (detrended variables, for a given variable X, the detrended varaiable is $\tilde{X}_t = X_t / (1+g)$) and then the accumulation in the pension fund becomes:

$$(1+g).\tilde{AP}_{t+1} = (1+r_{t+1})\tilde{AP}_t + p\tilde{r}el_t - p\tilde{r}est_t \qquad (19)$$

In the baseline scenario, I calculate the pension level and then the contribution rate that allows them to reach the necessary contribution level.

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[7] $Y_t = AK_t^{\alpha}(H_t L_t)^{1-\alpha}$ with $H_t = (1+g)^t H_0$; H_t represents technological progress

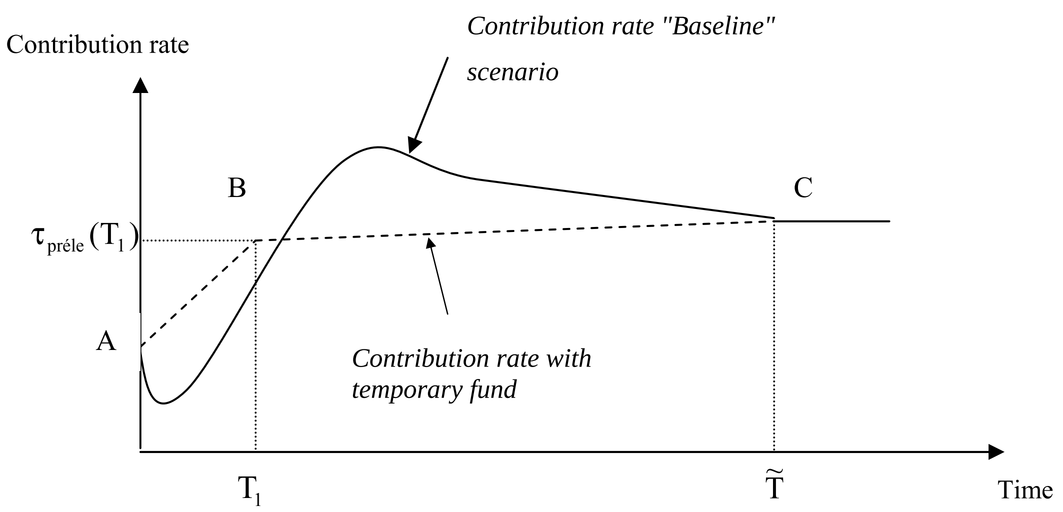
4. The reform scenarios introducing capitalization

To characterize pension reform, we have first to define a baseline, non-reform case, where the present rules are kept unchanged (see appendix 1 for a presentation of the Tunisian retirement system). The baseline scenario considers a pure PAYG retirement system with a contribution rate calculated in order to obtain a balanced budget pension system for each period. This scenario is very important since it gives us an idea on the contribution rate evolution, and then the necessity or lack thereof for pension system reform. Simulations of reform considered do not change the generosity of the system but rather change the way future pensions are financed.

Then, alternative financing scenarios introduce some components of funding. The first scenario of reform is a smoothing component with a "reserve fund" to be used in the 2003-2050 period to mitigate the increase in the contribution ratio (see figure 2). The second one is a "funding component" with the accumulation of a permanent funded pillar designed in the long run to cover 10% of the overall cost of pensions inspired by the McMorrow and Roeger (2002) proposal[8] (figure 3).

4.1 Introduction of a "Temporary Fund"

Figure 2: contribution rate with the "Temporary fund" scenario



[8] They have proposed for the European Union Members countries, a pension reform consisting in creating a permanent funded pillar which will cover on the long run a certain percentage of the total pension costs.

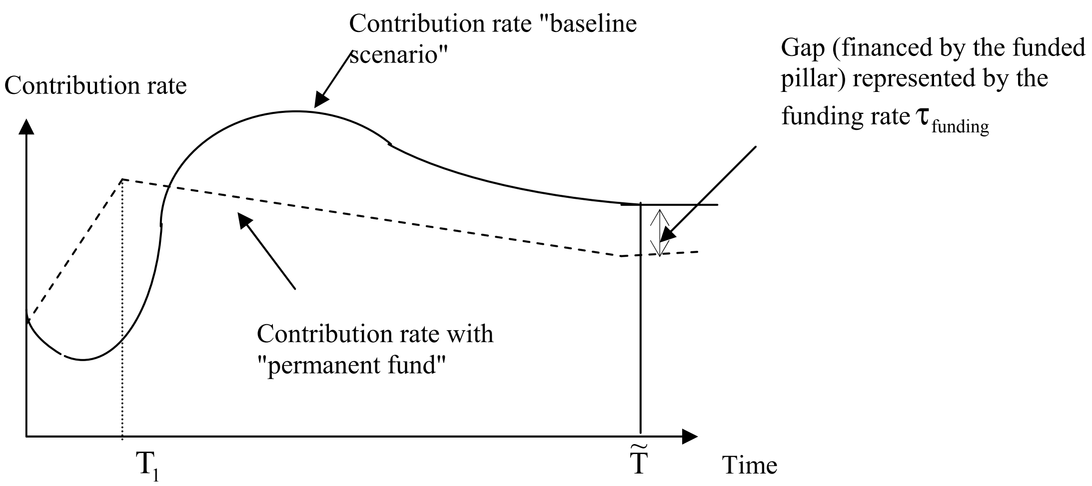
In order to smooth the time profile of the contribution rate, there are multiple paths satisfying the intertemporal budget constraint. To construct a specific time profile of the contribution rate for the temporary funding, three points are needed. The long run contribution rate is equal to that of the PAYG equilibrium (point C in the figure 1). In addition, we consider the same contribution rate in the first period (point A). Then I fix a date T1 from which the growth rate of the contribution rate decreases, compared to the first period (and converge to zero in $\tilde{T}$). At this fixed date, there is only one contribution rate $\tau_{prélev}(T_1)$ verifying the intertemporal equilibrium of the pension system (point B in the figure 1).

4.2 Introduction of a "Permanent Fund"

The permanent fund is used in this model in order to finance 10 percent of the pension expenditures of the retirement system ($\tau_{funding}$=0.1) with an endogenous capital return.

As depicted by figure 3, this model chooses to contribute more in the first years of the reform in order to converge to a lower contribution rate in the long run.

Figure 3: contribution rate evolution with a "permanent fund" scenario



The funding rate is defined as follows:

$$r_t.A_t = \tau_{funding}.\sum PExp._t \qquad (20)$$

where: r_t is the real interest rate in period t, A_t assets accumulated in period t and $\sum PExp._t$ total pension expenditures in period t. The funding rate represents the share of the pension expenditures financed by the funded pillar. Its value is fixed to 10%.

5. Calibration

The parameters of the model have been calibrated consistently with literature and in order to reproduce the main ratios. The model is calibrated through the value of the ratio K/Y and the real interest rate "r". The discount factor β is determined in order to obtain a capital to income ratio K/Y = 3. The factor "α" is fixed with the objective to converge to a real interest rate near 6%.

Concerning the PAYG retirement system parameters, I consider a replacement rate τ_{repl} of 60%, corresponding to the mean between public sector and private sector replacement rates for 2003 (Tunisian social security data, 2003). The share of capitalization in financing the pension system is fixed by hypothesis to 10% ($\tau_{funding} = 10\%$). I do not take into account the reserves accumulated until now in the PAYG system because the effective contribution rate was higher than the equilibrium contribution rate during many years. This hypothesis does not change notably the results. This accumulation is relatively weak compared to the accumulation of the reserve funds in the temporary funding scenario.

The exogenous growth rate "g" is set at 8% (for each period of 5 years). This value corresponds to the growth rate of the minimum salary (*SMIG*) for the last 10 years in Tunisia (*INS* data, 2003). There are no statistics on the age-wage profile for Tunisia. For this reason, I choose a growth rate of 7.5% each five years. The parameter values used in the calibration of this model are summarized in Table 2.

Table 2: Values of parameters after calibration

Variables		Values
Household:		
Psychological discount factor	β	0.995
Age-wage profile (growth rate)		7.5%/5 years
Firms:		
Rate of capital depreciation	δ	0.3 (each 5 years)
Scaling variable	A	0.8
Share of capital	α	0.3
Productivity growth rate	G	0.08 (each 5 years)
Retirement system:		
Legal retirement age		60 years
Funding rate	$\tau_{funding}$	0.1
Period from which the growth rate of the equilibrium contribution rate decrease	T_1	6
Replacement rate	$\tau_{repl.}$	60%

6. Simulations Results

6.1 Impact on the Contribution Rate

The presentation of simulation reforms begins with the contribution rate evolution. In the baseline scenario, the contribution first decreases for a few years until 2006. This result reveals a period of good demographic evolution between 2003 and 2006. But after this date, the contribution rate is predicted to increase continuously to reach a peak of 29% in 2053 (about three times its initial level). This result shows the necessity of reforming the Tunisian pension system in order to avoid an important increase in the contribution level. Figures 4.1 and 4.2 (Appendix 4) show the evolution of the contribution rate under the "temporary fund" and the "permanent fund" scenarios respectively.

Compared to the baseline scenario, the "smoothing" scenario is effective in limiting the increase of the contribution rate in the year 2035-2085 at the cost of an extra contributive effort of 2 percentage points in the years 2010-2030. Then, the scenario converges in the long run to the same level of contribution (nearly 26 percent).

The funding scenario introducing a permanent funded pillar illustrates the long rate efficiency gain from such a fundamental reform. Compared to the baseline scenario, the contribution rate is higher in the first years of the reform (the difference reaching a maximum level of 5 percent between 2003 and 2030), but this effort is compensated by two advantages: on one hand, the projected maximum level of the contribution rate is lower than in the baseline scenario (26 percent in the PF-funded, while it reaches 29 percent in the baseline scenario). On the other hand, this reform allows convergence at a permanent lower level of contribution in the long run (24 % versus 26.5 %). This analysis raises the question of the impact of the saving response to the reform.

6.2 Macroeconomic Implications of the Reforms

→Accumulation in the baseline scenario

To separate the aging population impact on the macroeconomic variable from the impact of the reform, I first analyze projections under the baseline scenario. Then, the results of the two types of reforms (smoothing fund or permanent fund) are added. Under the baseline scenario, the private saving increases significantly during the period 2003-2035 (Appendix 5, figures 5.1 and 5.2). Two factors could explain this evolution: the increase in life expectancy induces a longer retirement period and leads to more savings in order to maintain the consumption level. In addition, individuals save more because they fully anticipate the increase of the contribution level (reproduced in appendix 4, figure 4.1 or 4.2) and the reduction of their disposable income. This increase translates into a reduced return to capital (see Appendix 8, figure 8). Starting from 2033, the private saving decreases. This evolution occurs precisely when the capital rate of return reaches a minimum level (Appendix 8, figure 8). In the period 2060-2075, individuals continue to save less whereas the interest rate increases. Anticipating the decrease of the contribution rate in this period, individuals have less incentive to increase their savings.

→ Accumulation in the reform scenarios introducing capitalization

In this case, I distinguish between public accumulation (represented by the "reserve" fund), private accumulation and total accumulation (public + private). The public accumulation increases in the first years of the accumulation since the contribution rate is higher than necessary, compared to the baseline scenario. The reserve fund grows until 2030 and then begins to decrease, distributing more pensions compared to the collected funds (contributions + returns on the funds already accumulated).

Under the temporary fund scenario, private saving is lower than in the baseline case. It increases in the first years for the same reason as in the baseline scenario (expectation of contribution rate increase), but it decreases in the period 2030-2050. This evolution is explained by the high level of accumulation reached in this period and the decrease of the interest rate. The increase in the last period before reaching the long run level is due to the increase of the interest rate. The importance of the crowding-out effect (nearly 98%) is depicted in figure 7.1 (Appendix 7). The total accumulation does not increase very much compared to the baseline scenario. Three factors could explain this result: firstly, the absence of liquidity constraint, secondly the rational anticipation and the thirdly, an endogenous interest rate.

Since the contribution to the funded system is permanent, the second scenario of reform induces different impacts in term of private saving response. As depicted in figure 7.2 (Appendix 7), the public accumulation is higher compared to the "temporary" fund case (Appendix 7, Figure 7.1). This is explained by the high level of contribution in the first years of the simulation. The private saving decreases (like in the "temporary" fund), illustrating an important crowding-out effect of 87 percent (Appendix 6, Figure 6.2). But the total accumulation under this scenario is higher in the long run compared to the other cases (Appendix 7, Figure 7.2). So, this reform is characterized by two advantages:

- A lower contribution rate in the long run, due to the higher return of the funded pillar compared to the PAYG system.
- An increase in the total capital accumulation (despite a crowding-out effect), which is an important issue for economic growth especially in emerging countries.

→ Impact of the reform on the different cohorts

Beyond the aggregate savings effects, the impacts of the reform in term of consumption and savings on the different cohorts are also analyzed. The results show that the burden is unequally supported by the different cohorts. Figure 9 (Appendix 9) illustrates the results concerning the wealth profile of different generations. A certain number of representative generations are chosen. Generation 8 (born in 1953) is near the retirement age at the moment of the reform (year 2003). Generation 14 (born in 1983) corresponds to the generation entering the labor market when the reform is implemented. Generation 24 (born in 2043) allows us to analyze the impact of the reform on the profile accumulation and consumption in the long run (near the steady state situation).

Figure 9 (Appendix 9) shows that the wealth profile of generation 8 remains the same since the period of contribution under the reformed pension system is not very long. Due to the contribution to the funded system, the other generations save less (compared to the baseline scenario). This difference disappears in the long run for the "temporary" fund and remains important for the permanent fund scenario. As we have already noticed, the pension reform creates an important crowding-out effect. Figure 10 (Appendix 5) illustrates the consumption profile of different cohorts under the three scenarios. The results show that, under the scenario assumptions, a Pareto-improvement cannot be obtained through the reform introducing capitalization.

The analysis can be divided into two periods. First, in the period in which the reform induces a higher contribution rate compared to the baseline scenario, a capitalized fund will have negative implications for the consumption profile. For example, in figure 10 (Appendix 10), generation 8 completely supports a high level of contribution and will reduce its consumption profile. Unsurprisingly, the impact is higher in the "permanent" fund since the contribution rate is higher in the period 2003-2030 (compared to the "temporary" fund).

Second, from 2030, the reform scenarios induce a lower contribution rate (even if the impact is temporary for the first reform scenario). In that case, the consumption profile is shaped by two conflicting forces. On the one hand, the active population benefits from the reform. The positive impact is due to an increase of the disposable income. This result is especially evident for generations 18 and 24, since they increase their consumption during their working life (until period 8, which corresponds to the end of the working life). On the other hand, workers reduce their consumption in the retirement period. This result is also illustrated in figure 10 for the generations 18 and 24 (between the periods 9-14). This negative effect is explained by the decrease of the pension's level due to the important decrease of the rate of return of the funded pillar.

7. Conclusion

In this paper, I have analyzed the consequences of population aging on the Tunisian retirement system and the macroeconomic implications of a fundamental reform introducing a funded pillar through two scenarios: a temporary fund and a permanent fund. The first result of the simulation reveals that the public pay-as-you-go pension system operating in Tunisia would become financially unsustainable in the medium term, if the present rules are kept unchanged. The reform scenarios simulated in this model allow limitation of the increase of the contribution rate and convergence to a lower level of contribution in the "permanent" fund case. The permanent fund reform induces a higher level of capital accumulation despite an important crowding-out effect.

Moreover, the impact of the reform is different from one generation to another. The introduction of a funded pillar is not Pareto-improving, since certain generations consume and save less compared to the baseline scenario. So, the reform could create an intergenerational equity problem.

The results derived from our model depend strongly on the assumptions of the simulations. For example, the crowding-out effect could be reduced if there is no assumption of rational behavior, which could be unrealistic. But it is difficult to quantify the importance of deviation from the rationality assumption (myopia degree).

The closed economy assumption also has an important impact on the results. This assumption exaggerates the negative impact of the capital accumulation on the interest rate. The OLG model is stylized. Some important mechanisms are not taken into account. It would be interesting to explore, for example, the impact of a decrease in the unemployment rate on the financial equilibrium of the pension system. Tunisia's economy suffers from a high unemployment rate (15% of the active population). Resolving this problem could counter-balance, in part, the negative impact of aging on the financial equilibrium of the PAYG pension system.

This work has shown the necessity to reform the Tunisian pension system in order to maintain its financial sustainability. A funded pillar introduction could be a partial, but not complete, solution. This reform can be mixed with parametric reforms such as an increase in the retirement age or a less generous replacement rate. Future research could be done in this direction.

References

Auerbach A.J. and Kotlikoff L.J. (1987), *Dynamic Fiscal Policy*, Cambridge University Press.

Auerbach A.J., Kotlikoff L.J., Hagemann R.P. and Nicoletti G. (1989), “ The economic dynamics of an ageing population:The case of four OECD countries”, OECD Economic Studies 12, 97-130.

Baillu H., Reisen H. (1997), “Do funded pensions contribute to higher aggregate savings? A cross country analysis," OECD, Technical paper n°130.

Belan, P., Ph. Michel, and P. Pestieau (1998), "Pareto-Improving Social Security Reform," *Geneva Papers on Risk and Insurance Theory*, 23, 119-125.

Ben Braham M. (2004), « L’avenir du système de retraite tunisien : leçons des exprériences étrangères », EURIsCO working paper, n°2004-6.

Blanchet D. “Retraites et croissance à long terme: un essai de simulation”; Economie et Prévision n°105 1992-4 pp 1-16.

Börsch-Supan, A. and J. Winter (2001), "Population Aging, Savings Behavior and Capital Markets", Working Paper No. 8561, National Bureau of Economic Research, Cambridge.

Börsch-Supan, A., Heiss F., Ludwig A., Winter J. (2002), “Pension reform capital markets and the rate of return," National Bureau of Economic Research, Washington D.C.

Breyer, F. (1989), "On the Intergenerational Pareto Efficiency of Pay-as-you-go Financed Pension Systems," *Journal of Institutional and Theoretical Economics*, 145, 643-658.

Catalan, M., G. Impavido and A. R. Musalem, (2000), "Contractual savings or stock market development: which leads?" Social Protection Discussion Paper Series No. 0020; The World Bank.

Chan-Lau J.A. (2004), “Pension funds and emerging markets", IMF working paper n°04/181

CNSS (1999), « Annuaire statistiques 1999 » ; Directions des études, Caisse Nationale de la Sécurité Sociale.

Diamond P. (1999), "Issues in Privatizing Social Security", MIT Press, Cambridge Mass, London, England, 1999.

Feldstein, M. S. (1974), “Social Security, Induced Retirement, and Aggregate Capital Accumulation,” *Journal of Political Economy*, vol. 82 (September-October), pp. 905-26.

Feldstein M.S. (1998), *Privatizing Social Security*, University of Chicago Press.

Henin P.Y. & Weitzenblum T. (2003) "Private saving responses to public pension reforms" September, CEPREMAP, Paris.

Holzman R.(1997), « Pension reform, financial market development and economic growth : Preliminary evidence from Chile, IMF, Staff papers, June, 149-178.

INS (1996), "projections de la population 1995-2030 niveau national," volume 1, Juillet Institut National de la Statistique.

INS (2002), Rapport statistique, Institut National des Statistiques, Tunisie.

INS (2003), Rapport Statistique, Institut National des Statistiques, Tunisie.

James E. (1996), " Providing better protection and promoting growth: A defense of averting the old age crisis" ISSA Review.

Kotlikoff, L.J. (1998), "Simulating the Privatization of Social Security in General Equilibrium", in: M. Feldstein (ed.), *Privatizing Social Security*, the University of Chicago Press, Chicago, 265-312.

Kotlikoff L.J. (1998), "The A-K model: its past, present and future," Working paper n°6684, National Bureau of Economic research, Washington D.C.

Mc Morrow K. and W. Roeger, EU pension reform - An overview of the debate and an empirical assessment of the main policy reform options, European Commission, Economic Papers n□ 62, January 2002

Ministère Tunisien des Affaires Sociales ; « rapport sur la réforme des régimes de retraite » ; Octobre 1998.

Munnell A.H. (1974), *The effect of social security on personal saving*, Cambridge M.A, Ballinger Publishing.

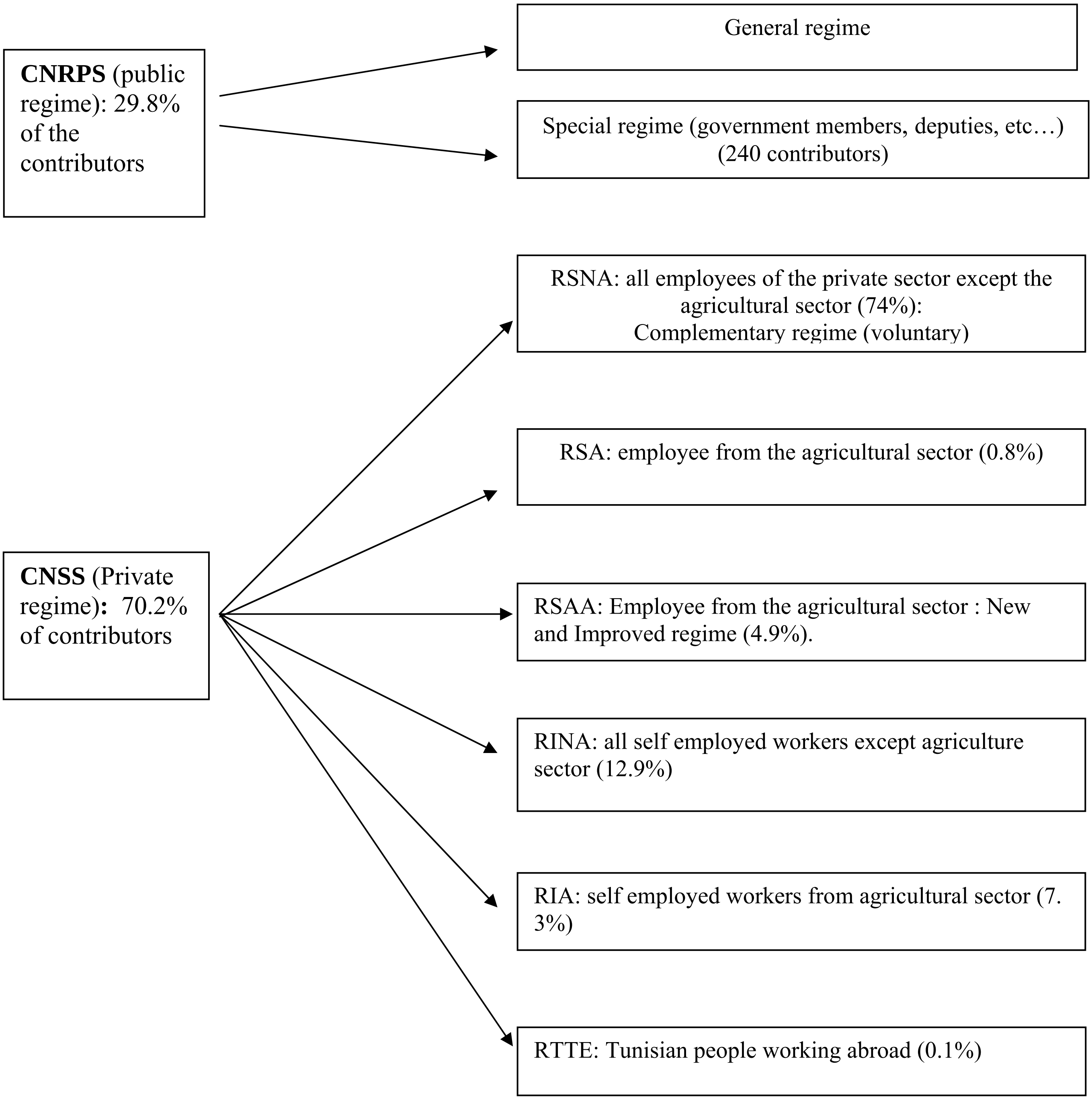
Samwick, A. (1999), "Is Pension Reform Conducive to Higher Saving?," November; The World Bank.

Sinn H.W., (2000) "Why a funded pension system is needed and why it is not needed," *International Tax and Public Finance*, 7, 389-410.

World Bank, (1994), "Averting the old age crisis: policies to protect the old and promote growth," The World Bank, Washington DC.

Appendix 1A

Tunisian pension system organization



(%): percentage of the total number of contributors in the *CNSS in 2001*

Appendix 1B: Tunisian pension system's parameters

Table 3: Characteristics of the Tunisian retirement system

<table>
<tr><th colspan="2" rowspan="2"></th><th rowspan="2">Legal retirement age</th><th rowspan="2">Minimum period of contribution</th><th colspan="3">Contribution rate</th></tr>
<tr><th>Employer</th><th>Employee</th><th>Total</th></tr>
<tr><td colspan="2">CNRPS</td><td>60 years</td><td>15 years</td><td>8.2%</td><td>6%</td><td>14.2%</td></tr>
<tr><td rowspan="5">CNSS</td><td>RSNA

Complementary Regime</td><td>60 years</td><td>60 months minimum</td><td>7.01%

3%</td><td>4.49%

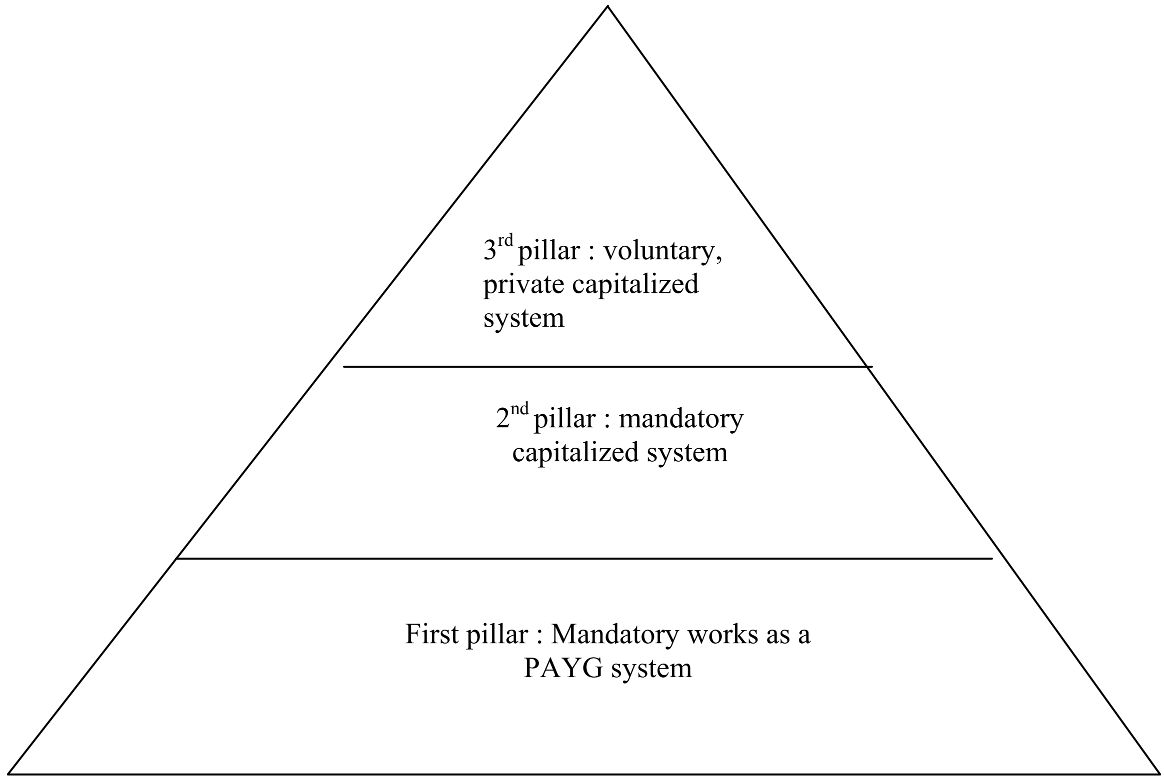
1.5%</td><td>11.5%

4.5%</td></tr>
<tr><td>RSA (law 81-6)</td><td>60 years</td><td>10 years</td><td>3.5%</td><td>1.75%</td><td>5.25%</td></tr>
<tr><td>RSAA (law 89-73)</td><td>60 years</td><td>10 years</td><td>5%</td><td>2.5%</td><td>7.5%</td></tr>
<tr><td>RINA</td><td>60 years</td><td>10 years</td><td></td><td></td><td>7%</td></tr>
<tr><td>RIA</td><td>60 years</td><td>10 years</td><td></td><td></td><td>7%</td></tr>
</table>

Source: Social Security Ministry

Appendix 2: The World Bank model: a multi-pillar system

A World Bank publication (*Averting the Old Age Crisis*, 1994) advocates reforming the traditional pay-as-you-go system to a multi-pillar system, including an unfunded mandatory pillar, a funded mandatory pillar, and a voluntary private pillar.



Appendix 3: Production sector equilibrium

First order conditions: factor remuneration is equal to marginal productivity

$$w_t = F_l' = A(1-\alpha)K_t^{\alpha}L_t^{-\alpha} \tag{14}$$

$$r_t = F_k' - \delta = A\alpha K_t^{\alpha-1}L_t^{1-\alpha} \tag{15}$$

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

From Equ. (12), (13) and (14) we can rewrite the production function as follows:

$$Y_t = A\left(\frac{\alpha Y_t}{r_t + \delta}\right)^{\alpha}\left(\frac{(1-\alpha)Y_t}{w_t}\right)^{1-\alpha} \tag{16}$$

Appendix 4: Impact of the reform on the contribution rate

Figure 4.1: Contribution rate, baseline and "reserve fund" scenario

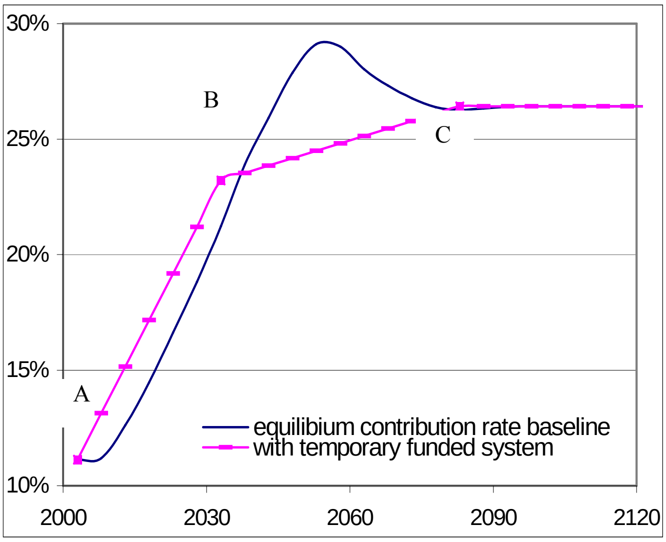
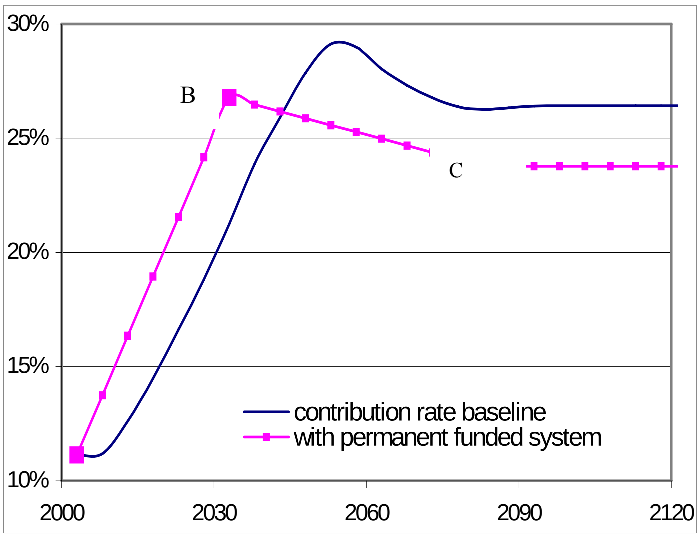


Figure 4.2: contribution rate baseline/ permanent funded system



Appendix 5 :Capital accumulation

Figure 5.1: private, public and total capital accumulation in the "Temporary fund"

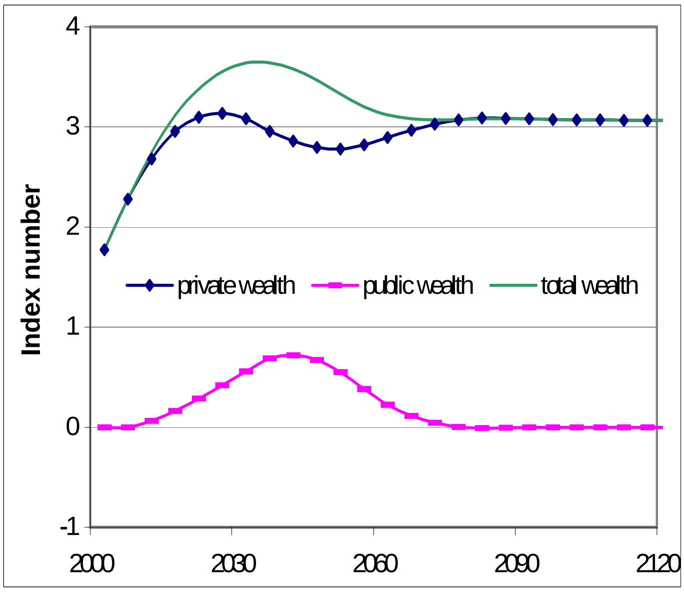
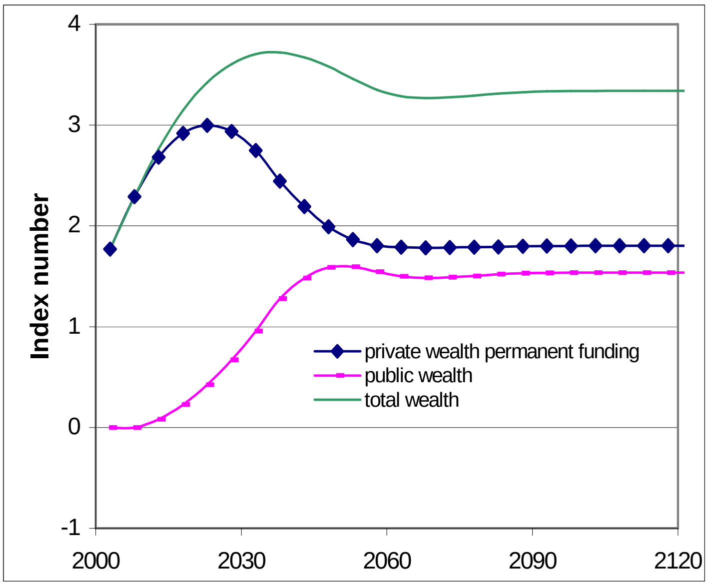


Figure 5.2: private, public and total capital accumulation in the "Permanent fund"



Appendix 6: Private accumulation

Figure 6.1: Private Accumulation Baseline/ Temporary fund

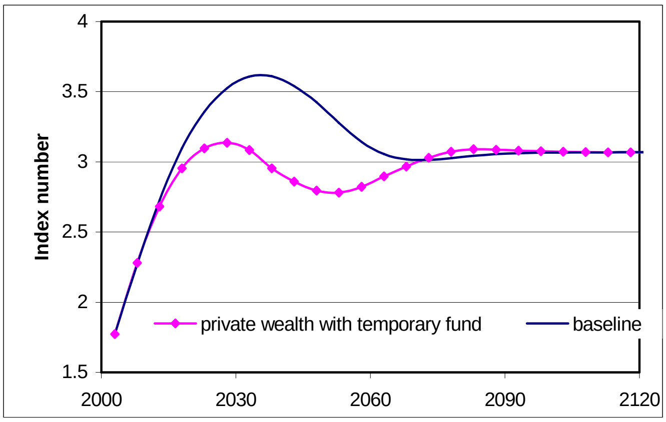
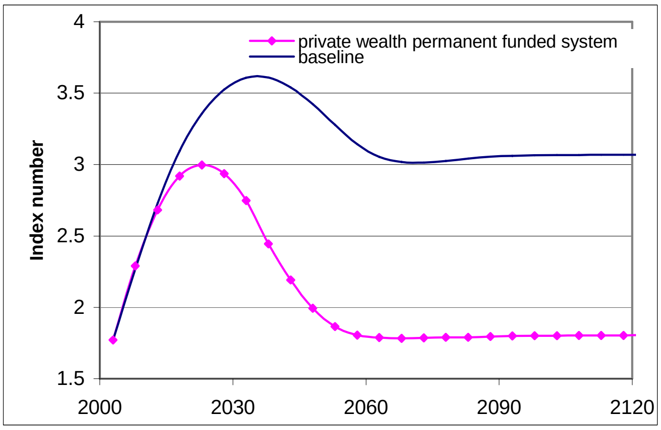


Figure 6.2 : Private Accumulation Baseline/ Permanent fund



Appendix 7: Total wealth evolution

Figure 7.1: Total wealth baseline/temporary fund

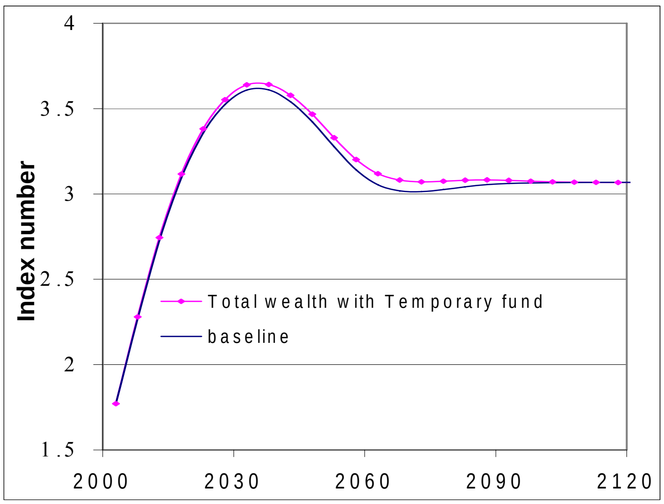
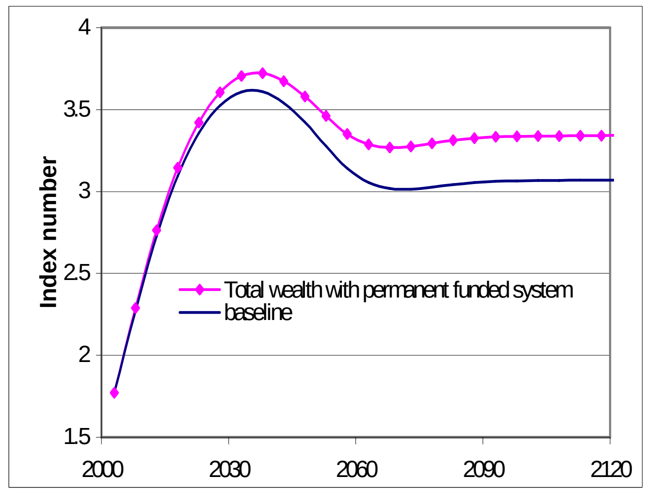
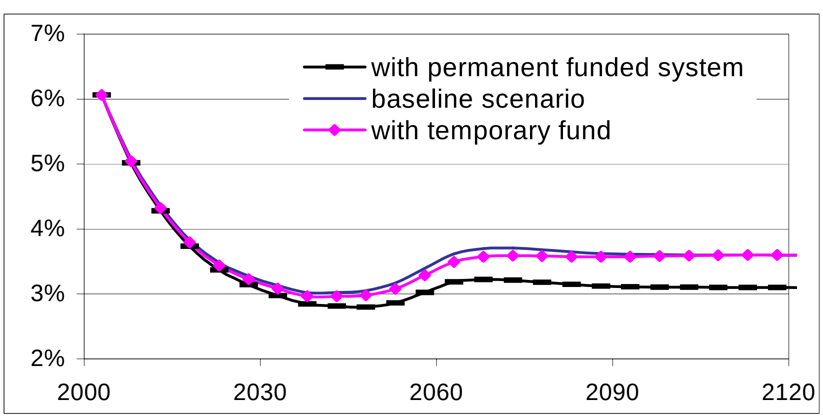


Figure 7.2: Total wealth baseline/permanent fund



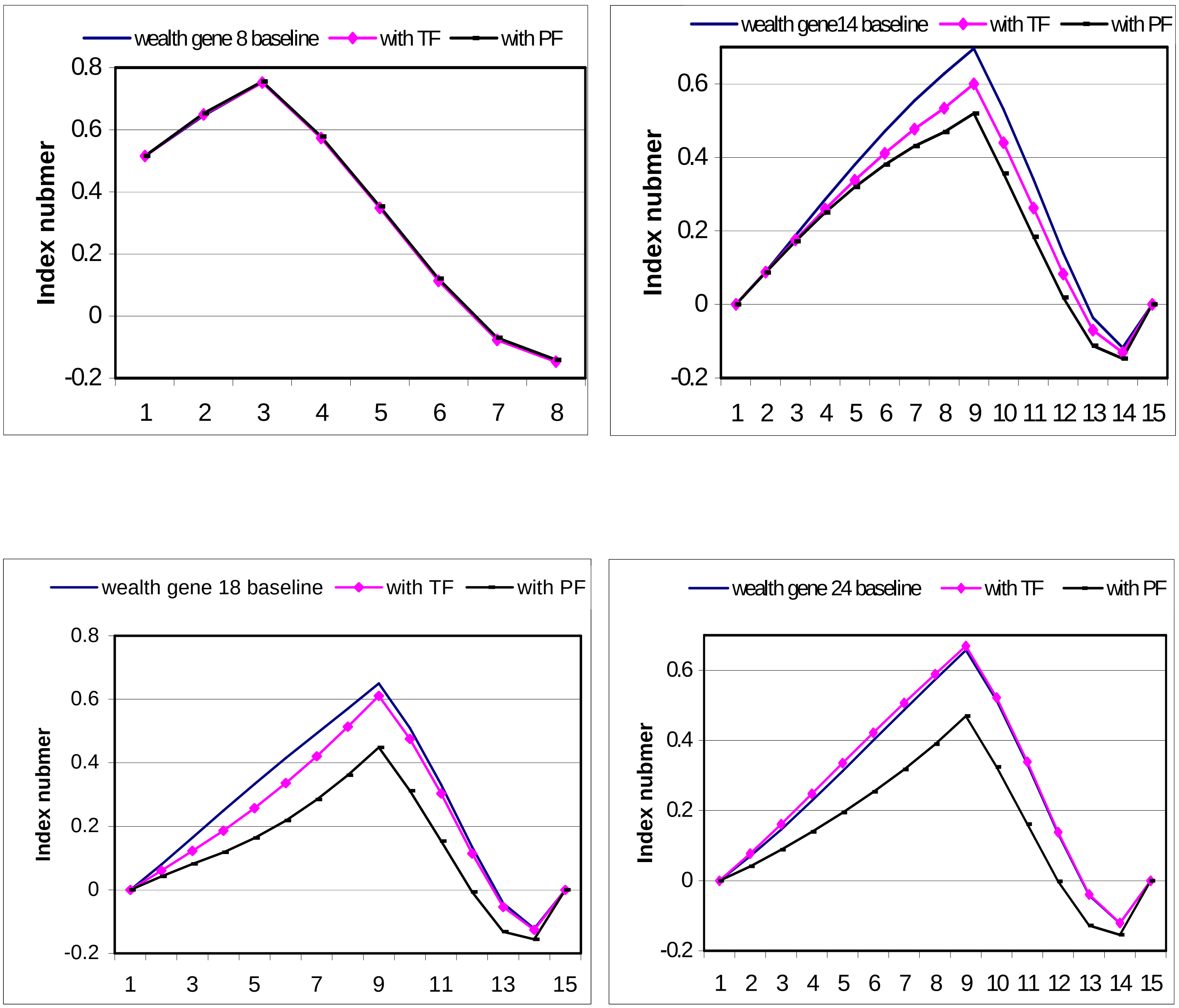
Appendix 8: Interest rate evolution

Figure 8: Interest rate evolution baseline/ temporary fund/permanent fund



Appendix 9: Wealth profile per cohort

Figure 9: Wealth profile per cohorts: baseline/ temporary fund/permanent fund



Appendix 10: Consumption profile per cohorts

Figure 10: Consumption profile per cohorts: baseline/ temporary fund/permanent fund