Application of the Notional Accounts Model to the Civil Pension Scheme in Morocco

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ABSTRACT
The decline in the mortality rate and lengthening of life expectancy undermine now the sustainability of pension schemes worldwide and weigh heavily on their functioning and financial equilibrium. This article seeks to optimally manage longevity risk that runs the Civil Pension Moroccan fund financed by pay-as-you-go (PAYG), by proposing a reform that will take this effect into account, we will show that this correction can be realized by adopting the technique of notional accounts.
1. Introduction

The issue of longevity is the subject of several public debates throughout the world. Indeed, the factors of the decline in fertility and the improvement of the life expectancy of the individuals are the cause of the aging of the populations.

Despite being the main long-term determinant of the size of pension transfers, longevity has tended to be ignored in most existing literature assessing the sustainability and reform of pay-as-you-go pension schemes.

The phenomenon of longevity negatively affects the balance of pension systems, requiring them to pay pensions for longer and longer periods. In this context, several countries have introduced reforms to their pension systems in order to adapt them to the demographic changes that are affecting their populations.

As in the case of these countries, Morocco has undergone a demographic transition: with a life expectancy at birth reaching 76.71 years and a mortality rate of 4.81‰ in 2014. As a result, the civilian pension system has been affected by this longevity.

Thus, the goal sought in this paper is to highlight the challenges of life expectancy gains at the expense of the Civil Pension Scheme and adopt the notional accounts model to deal with the problematic of longevity risk and guarantee the social sustainability of the regime.

The Notional Accounts (NDC)\(^1\) method consists in introducing mechanisms for the correlation of parameters with demographic and economic variables. Thus, any change in the demographic or economic situation automatically implies a rebalancing of pension schemes parameters. Countries adopting this technique are no longer obliged to intervene each time to adjust the parameters of the pension plan\(^2\).

After an introduction, the rest of this article is organized as follows. The second section presents a brief review of the literature on the risk of longevity. Similarly, a theoretical framework relating on notional accounts technique will be presented. The third section is devoted to the implementation of a methodology based on data from the civil pension system. Thus, after analyzing the demographic situation of our pension scheme and defining the assumptions and parameters to be retained, we simulate our model from the year 2017 and

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\(^1\) Notional Defined Contribution

\(^2\) Experts from the World Bank (Holzmann et al, 2013), encourage countries to transform their basic plan to a defined contribution plan managed by distribution. This pension scheme goes with the variable pensions, which are strongly related to longevity.
present the results and the discussions in the fourth section. Finally we will conclude with recommendations.

2. Review of the Literature

In this section, discussions and philosophical trends around longevity and inherent risk will be cited with the aim of showing interest in this issue. Similarly, a theoretical framework in the following discussions and philosophical trends around longevity and the risk involved will be cited in order to show the great interest on this issue. Similarly, a general framework for technical notional accounts will be presented.

2.1. Theoretical Framework of Longevity

The risk of longevity can be defined as the financial risk arising from the possibility that the expected life expectancy for retirees is less than their real life expectancy. However, this risk of longevity is, for the insurance industry and pension plans, a risk that is difficult to diversify; it is systematic in nature since it affects the entire population.

Several recent studies have demonstrated a high uncertainty regarding the future demographic change and its consequences for the financing of pension expenditure, according to Plane (2007) and Alho-Borgy (2007).

Tuner (1997), Anderson (2005), Whitehouse (2007), Chornik and Whitehouse (2010) than the others have demonstrated a strong relationship between changes in demographic indicators such as fertility, the birth rate of the population, life expectancy, the dependency ratio of the elderly and the financial viability of pension systems in countries around the world. Persson (2000) argues that the problem of aging only arises for the public system.

The two systems of financing (pay as you go and funded plan) are exposed in a parallel way to demographic shocks, the superiority of one model over the other is assessed by its ability to withstand the shock, while ensuring equity between generations.

Indeed, in a pay-as-you-go system, the increase in the number of pensioners per worker implies an increase in contributions or a decrease in benefits.

Several authors argue that funded scheme is preferable because it is not sensitive to demographic shocks. Marques (2000) believes that funded scheme is better equipped against the aging of the population.
The increase in the volume of the total savings in a funded Scheme plan ensures a higher level of consumption for the future employees as future pensioners, according to Auerback, Kotlikoff and Hagemann (1989).

In a funded pension scheme, the accumulated capital must be greater to ensure an equivalent pension, which translates by an increase in contributions. In addition, longevity expectancy reduces life annuity yields.

However, according to Davis (1997), the funded scheme can reduce the vulnerability of pensions to demographic shocks by the diversification of risk through international investment.

For Dupont and Sterdinyak (2000), extending the life span increases expenditure, regardless of the type of financing.

The study conducted in 1994 by the World Bank (Averfing the old age crisis) estimated that switching from a pay-as-you-go plan to a funded plan would avoid a financial crisis due to demographic aging for pension schemes.

The modeling of longevity risk has recently evolved considerably, leading to the integration of demographic models within the stochastic processes commonly considered in finance (the Lee-Carter model and its extensions).

These advances in modeling have made possible the construction of mortality tables for pension plans. In addition, the development of financial products (bonds, swaps, derivatives, etc.) and the adoption of a model of notional accounts are intended to cover the risk of longevity.

2.2. System of Notional Accounts (NDC)

Appeared in the mid-1990s, the notional account system Vernière (2001), which is also called a virtual capitalization or notional defined contribution scheme, is considered as a revolution in system for retirement pensions.

The origin of "notional accounts" went back to the work of Buchanan (1968) who was inspired by reflections on the creation of schemes in points in France and Germany. These thoughts were then supplemented by Boskin and al (1988) as well as by the preparatory work for the reform of the Swedish system between 1990 and 2003.

One of the first to establish documents in this sense was Verniere (1999, 2000). The debate on this issue has recently been fueled by an article by Bozio and Piketti (2008).
Edward Palmer, one of the architects of the Swedish reform, argues that the fundamental characteristics of virtual defined contribution system is that it is fair. According to him, this equity is reflected well in the reality of the fact that two people of the same age receive pension benefits proportional to the amount they have paid to the fund.

For Disney (1999) and Williamson-Williams (2003), notional accounts are more sustainable than pay-as-you-go schemes.

3. Methodology and Data

We then simulate and evaluate a reform based on the technical of notional accounts, which is inspired by the one adopted in Sweden in 1994 and Italy in 1995 for the civil pension scheme, during the period 2017-2030 and according to a progressive transition scenario.

3.1. Data and Assumptions

The magnitude of the effects associated with setting up a notional accounts system largely depends on the choice of parameters. Thus, in our simulations, we retain a constant contribution rate of 20% (observed in the current system) over the projection period in order to keep constant the contribution rate under the old system constant at the transition start date.

The other two key parameters of the system are the rate of return on contributions and the pension discount rate applied at the Liquidation time. To ensure the sustainability of the system, these two parameters must be less than or equal to the growth rate of the wage bill.

In this scenario, we take for the contributions paid on date \( t \) the average growth rate \( r_j \) of the payroll for the same period. This rate is \( s = 4.5\% \) was stopped following a study carried out in 2005 on the occasion of the voluntary departure operation.

The annual salary of the plan member’s assets evolved as follows:

\[
S(x) = S_0 \cdot (1 + s)^{x-x_0}
\]

The rate used for discounting is \( i = 4.5\% \) in nominal terms, gross inflation, tax and management fees.

The evolution of pensions will necessarily follow the evolution of the wages of the contributing assets over the same period. We take for the revaluation of pensions a rate \( g = s = 4.5\% \).
Similarly, we will deal with the case where pensions are indexed to the rate of 1% (the indexation rate of pensions adopted by the CMR). We assume that the current parameters remain unchanged until 2030.

The general principle of the proposed system, which we simulate starting in 2017, can be illustrated with the example of an employee who was affiliated to the scheme at the age of 28 (the average age of affiliation for the Population scheme) in 2004, and who retires in 2046 at age $x_r = 60$, (which is currently the official retirement age for plan members) and who receives an initial monthly salary of 2300 Dhs.

The age at liquidation is flexible between 57 and 65 years. The divisors between 57 and 65 years of age were established using the adjusted life table TD 88-99 (beyond age 60).

3.2. Principle and Model Formula NDC

The basic principle is based on capitalization. Each active insured person creates an individual account in which his or her employer's pension contributions are credited each year. The capital of the account will be revalued each year according to a rate determined by the managers of the plan.

The capital is virtual and the account serves only as a calculation intermediary. Indeed, the contributions of the insured will not be saved but are used to finance the pensions of the current pensioners according to the principle of the pay-as-you-go. The balance only exists in the accounts of the organization which manages them, hence the name of the "notional" accounts.

On liquidation, this fictitious capital is converted into a life annuity by applying a divisor called the "conversion coefficient".

The virtual capital $CV$ accumulated by an individual on the date of his retirement is expressed as a discounted sum of the contributions paid during his career.

$$CV = \sum_{x=x_0}^{x_r-1} \pi \cdot S(x) \cdot \left\{ \prod_{j=x}^{x_r-1} (1 + \tau_j) \right\}$$  \hspace{1cm} (1)

- $x_0$ : Affiliate age of the insured person in the pension scheme;
- $x_r$ : The retirement age;
- $\pi$ : The contribution rate of pension scheme assumed constant;

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3 Vernière L. (2001), “Sweden: Recent Developments in Reform of the Pension System”, Retirement Issues No. 43
- $S(x)$ : The annual salary of an individual;
- $r_j$ : The revaluation rate of the virtual capital assumed constant.

To facilitate our study, we will take an annual virtual interest rate that is fixed. Subsequently, the virtual capitalization factor becomes: $\prod_{j=x}^{x_r-1} (1 + r_j) = (1 + r)^{x_r-x}$

The pension retirement age $P(x_r)$ is calculated as a life annuity: the present value of pension flows that will be received during the retirement period, must be equal to the virtual capital, or (in the absence of survivor's pension for simplicity).

$$\sum_{x=x_r}^{\omega} \frac{P(x_r) \times (1 + g)^{x-x_r}}{(1 + i)^{x-x_r}} \times p(x_r, x) = VC \quad (2)$$

- $i$ : The discount rate (the expected rate of return of the virtual capital);
- $g$ : The revaluation rate of pension $P(x_r) \times (1 + g)^{x-x_r}$ corresponding to the pension paid at $x$ age.
- $p(x_r, x)$ : The probability of survival between $x_r$ age and $x$ age.
- $\omega$ : The highest age of the mortality table.

The pension at the age of retirement $P(x_r)$ is thus proportional to the virtual capital according to the proportionality coefficient $G$ which is called the conversion coefficient.

$$P(x_r) = VC \times G$$

The conversion coefficient is determined in such a way as to ensure equality for each generation between the discounted cumulative contributions and benefit.

$$G = \frac{1}{\sum_{x=x_r}^{\omega} \frac{(1 + g)^{x-x_r}}{(1 + i)^{x-x_r}} \times p(x_r, x)}$$

In the NDC system, the coefficient of conversion (annuitization divisor) is the main element of financial stability. This coefficient of conversion $G$ depends on the probability of survival estimated at retirement age, the rate of revaluation of pensions $g$ and the discount rate $i$. In particular, if the revaluation rate of the pension $g$ is equal to $i$ then the conversion factor is equal to the inverse of life expectancy at retirement age and the pension of liquidation is equal to the virtual capital divided by the life expectancy.$^4$

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$^4$ Life expectancy at age $x_r$ is the sum of the probabilities of survival to each age group: $EV(x_r) = \sum_{x=x_r}^{\omega} p(x_r, x)$
This coefficient will evolve generation after generation. This method thus naturally induces consideration of longevity risk, and unlike conventional pay-as-you-go technique.

\[
\sum_{x=x_0}^{x_r-1} \pi \cdot S(x) \cdot \left\{ \prod_{j=x}^{x_r-1} (1 + r_j) \right\} = \sum_{x=x_r}^{\infty} \frac{P(x_r) \times (1 + g)^{x-x_r}}{(1 + i)^{x-x_r}} p(x_r, x)
\]

In addition to the calculation assumptions previously set, our formula become:

\[
P(x_r) \times \frac{1}{G} = \sum_{x=x_0}^{x_r-1} \pi \times S_0 \times (1 + s)^{x-x_0} \times (1 + r)^{x_r-x}
\]

\[
P(x_r) = G \times \pi \times S_0 \times \sum_{x=x_0}^{x_r-1} (1 + s)^{x-x_0} \times (1 + r)^{x_r-x}
\]

The annuity rate in a pension scheme is a very important parameter and its stability over the generations remains a sought objective. It is therefore interesting to specify, in the case of a notional accounts system, the expression of this rate, particularly its dependence on the demographic and economic context.

We recalculate the level of new pensions with the new system, by representing the pension of the individual by the formula (while remaining in distribution):

\[
P(x_r) = t_a \times N \times S_f \quad (3)
\]

- \( t_a \) = annuity rate

- \( N = x_r - x_0 \) : number of years of activity

- \( S_f = S_0 \times (1 + s)^{x_r-x_0-1} \) : final salary

We obtain for the case \( g = s \)

\[
t_a = \frac{G \sum_{x=x_0}^{x_r-1} \pi (1+g)^{x-x_0} (1+r)^{x_r-x}}{N (1+g)^{x_r-x_0-1}} \quad (4)
\]
4. Results and Discussions

4.1. Demographic Results

The number of contributors of civil regime in 2015 decreased by 1.5% compared to 2014, from 672,036 to 661,923 affiliates.

The current demographic structure of the population of civilian assets indicates a clear distortion of the age pyramid observed mainly between 45 and 55 years following the aging of the population of assets.

At the end of 2015, the total number of beneficiaries amounted to 313,195 of which (223,214 main pensions) compared with 291,691 in 2014, an increase of 7.37% compared to the previous year. Reversal beneficiaries in 2015 are 75,648.

Figure 1: Evolution of the number of members and beneficiaries of the civil pension scheme between 1996 and 2015

![Graph showing evolution of members and beneficiaries from 1996 to 2015](image)

Data of the Moroccan pension fund

The average age has increased by 10 points in 29 years. It has grown from 35 in 1986 to 39 in 1997 and 45 in 2015.

The study on the mortality of the population covered by the civil regime showed that life expectancy at age 60, the legal retirement age, has gradually improved. It is estimated today at 21 years against 18.5 years in 1985.

4.2. Results of the Reform Scenario Simulations (NDC)

The first analysis will be made by taking a rate of valuation of pensions equal to that of rate of revaluation of wages. In this case, the conversion coefficient corresponds to the inverse of the life expectancy of the affiliate.
Table 1: New Reform Simulations (NDC) for ($g = s = 4.5\%$)

<table>
<thead>
<tr>
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<th>57</th>
<th>59</th>
<th>60</th>
<th>61</th>
<th>62</th>
<th>63</th>
<th>64</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pension</td>
<td>2871.60</td>
<td>3430.77</td>
<td>3762.78</td>
<td>4139.06</td>
<td>4569.09</td>
<td>5065.28</td>
<td>5644.17</td>
<td>6328.32</td>
</tr>
<tr>
<td>Virtual Capital</td>
<td>654724.16</td>
<td>699877.55</td>
<td>722454.25</td>
<td>745030.95</td>
<td>767607.64</td>
<td>790184.34</td>
<td>812761.03</td>
<td>835337.73</td>
</tr>
<tr>
<td>Last Salary</td>
<td>7888.31</td>
<td>8614.23</td>
<td>9001.87</td>
<td>9406.96</td>
<td>9830.27</td>
<td>10272.63</td>
<td>10734.90</td>
<td>11217.97</td>
</tr>
<tr>
<td>Replacement Rate</td>
<td>36.40%</td>
<td>39.83%</td>
<td>41.80%</td>
<td>44.00%</td>
<td>46.48%</td>
<td>49.31%</td>
<td>52.58%</td>
<td>56.41%</td>
</tr>
<tr>
<td>Rate of Annuity</td>
<td>1.30%</td>
<td>1.33%</td>
<td>1.35%</td>
<td>1.38%</td>
<td>1.41%</td>
<td>1.45%</td>
<td>1.50%</td>
<td>1.52%</td>
</tr>
</tbody>
</table>

The replacement rate, which is the ratio between the pension and the last salary of our affiliate, is 80%, and that of early retirement for the member in question is 58% under the current system. The transition to the new regime in notional accounts therefore results in a gradual decline in these replacement rates ($t_a \times N$, between 36.40% and 56.4%), which is considerably greater than that observed in the base (by pay-as-you-go).

In all cases, the annuity rate is between 1.30% and 1.52%. This decrease is due to the effect of the application of the notional accounts, where the calculation of the pension and more particularly the annuity rate takes account of the increase in the longevity of the generation of beneficiaries in question.

Another aspect revealed by this decrease, is the cost borne by the plan due to the improvement in the average life. This cost is unfortunately very expensive, by comparing the calculated $t_a$ at the rate defined by the scheme.

We note that pensioners receive almost double what they actually deserve, taking into account their life expectancy at retirement age.

We can observe (in the case where the rate of wage adjustment is different from that of the indexation of pensions) that the conversion coefficient follows an increase with the retirement age, which is logical because according to its formula, it must decrease with the life expectancy at the age of retirement.
Table 2: New Reform Simulations (NDC) for \( (g = 1\% \text{ et } s = 4.5\%) \)

<table>
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<tr>
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<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion Coefficient ‘G’</td>
<td>4,928%</td>
<td>5,411%</td>
<td>5,675%</td>
<td>5,956%</td>
<td>6,254%</td>
<td>6,571%</td>
<td>6,909%</td>
<td>7,270%</td>
</tr>
<tr>
<td>Pension</td>
<td>2688,47</td>
<td>3155,88</td>
<td>3416,69</td>
<td>3697,64</td>
<td>4000,59</td>
<td>4327,00</td>
<td>4679,16</td>
<td>5060,62</td>
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<tr>
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<td>10272,63</td>
<td>10734,90</td>
<td>11217,97</td>
</tr>
<tr>
<td>Replacement Rate</td>
<td>34,082%</td>
<td>36,636%</td>
<td>37,955%</td>
<td>39,308%</td>
<td>40,697%</td>
<td>42,122%</td>
<td>43,588%</td>
<td>45,112%</td>
</tr>
<tr>
<td>Rate of Annuity</td>
<td>1,217%</td>
<td>1,221%</td>
<td>1,224%</td>
<td>1,228%</td>
<td>1,233%</td>
<td>1,239%</td>
<td>1,245%</td>
<td>1,253%</td>
</tr>
</tbody>
</table>

In the second situation, the replacement and annuity rates increase but less rapidly than in the first case. Nevertheless, they both remain lower than those calculated in the initial scheme.

It is important to note that these forecast replacement rates are given here only to facilitate comparison with the current system. In terms of equity, the correct indicator to take into account is not the replacement rate (which is the result of many factors, especially the salary career profile) but the rate of return on contributions, which in the system proposed is the same for all.

Similarly, an increase in the rate of contributions degrades the balance of a system by notional accounts because of a parallel increase in the value of pensions, linked to the purely contributory nature of the new system.

The interest of a proposed system of notional accounts lies in the introduction of self-regulating mechanisms for calculating the amount of the liquidated pension (taking into account life expectancy and the rate of future growth of the contribution base), Which ensure the long-term financial equilibrium of the pension plan.

The transition to the system (NDC) does not eliminate the current deficit of the system. By construction, notional accounts automatically absorb part of the funding requirement related to aging. On the other hand, the consequences of the baby boom are not financed.

This reform is likely to be the most appropriate reform for the regime to facilitate the transition to a mixed system insofar as it will be able to cope with the costs generated by the planned addition of a funded pillar to our system. In addition, it will make it easier to join the population than in the case of a sudden transition between the two regimes.
If such a technique is introduced in the civil pensions system, it would then be necessary to decide both, the method of investing the capitalized amounts and the pooling mechanisms. For the civil regime, however, it may be preferable, initially, for a centralized financial management to optimize the type of placement.

5. Conclusion

This study focused on the uncertain evolution of future life expectancy and the risk arising from this uncertainty, which is the risk of longevity.

In this direction, we simulated a reform based on the technique of notional (NDC) that allows to overcome the purely financial logics and to draw a departure from the top of the current crisis of pension system, by putting in place a system democratically more transparent, financially more solid, and socially more just.

In order to carry out our research, we will be able to set up derivative products, especially forwards and longevity swaps.

Similarly, we will need to develop stochastic models to construct prospective life tables that will be used to evaluate liabilities and capture the risk of longevity.

Finally, the implementation of a Liability Driven Investment (LDI) strategy is very important in order to resolve the risk of longevity of pension funds.

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