

Financial Sustainability of the Algerian Retirement System : a perspective analysis of the 50 coming years

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Abstract

Maintaining retirement systems stability becomes a big challenge for all countries. Such sustainability is widely related to a set of time varying elements as population structure, longevity, employment and affiliation to social security. For the case of Algeria, public retirement works according to the pay-as-you-go principle and equilibrium is maintained by public subsidy. But, population is now aging, and longevity is improving. The retired population is supposed to grow faster than the population at working age. Consequently, it will be harder to keep equality between retirement incomes and outcomes in such conditions especially if we consider the weakness of the demand for social security. Affiliation to social security remains widely depending on public employment; the employees of the private sector are less covered. In the present paper, we aim to simulate the future evolution of the demographic and economic factors affecting the stability of the Algerian system in order to show their long run effect. As a result, we found that it will be impossible to keep the Algerian retirement system sustainable within its current design. The accelerating aging process imposes to undertake heavy reforms in the near future.

key-words: Retirement, pay-as-you-go, experience mortality, contribution rates, aging, longevity.

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1 Introduction

As a part of the social security system, a pension system aims to guarantee for elderly a basic income to satisfy their vital needs. The functioning of pension systems combines social protection and insurance principles (OECD, 2005). This combination aims to integrate two main objectives: smoothing retirement benefits to individual saving efforts and to keep equity between individuals within the same population (MERTON et al., 1987) for which we can add poverty alleviation (BOVENBERG and VAN EWIJK, 2011). The insurance component is set to cover people from the risk to survive to an advanced age. Aging results in reducing physical and intellectual capacities of people (ILMARINEN and TOUMI, 1992) which implies a loss of competitiveness in the labor market called loss of earning power (WANG et al., 2014). Longevity improvement weighs too heavy for pension funds especially if not associated with a parallel improvement of the healthy life expectancy (BOVENBERG and EWIJK, 2011). Thus, the necessity to keep a pension plan sustainable is not only related to financial issues but more likely to protect the low earning people (poverty reducing). That is why the intervention of the State in the framework of its social policy is needed.

The allowance of the contributions to pay the pension benefits can be managed in different ways. Pay-As-You-Go system (PAYG) is the most classical way for pension schemes financing. This system was first founded in Germany starting from 1889 (HENKE, 2002; LUI, 1998; WONG, 2015). England followed up starting from 1892 (WANG et al., 2014). Following WONG (2015), a PAYG pension system can be defined as “a plan in which the current pension welfare of the elderly is financed by contributions from the current working population”. The stability of a PAYG system is widely based on some proportionality of the population of retirees in regard to the contributing population. In 2015, The part of the population aged 60 and over in the world population is estimated at 12.3%. According to the projections of the United Nations Organization (UNO, 2015), this part is expected to increase to 21.5% in 2050 and to 28.3% in 2100. This aging process is threatening the stability of pension schemes financed by PAYG system. The number of people at working age which are theoretically supposed to contribute for one individual at retirement is falling down permanently. Thus, the design of pension schemes all over the world must undergo deep reforms. The World Bank, being conscious of the fact that PAYG systems will not resist face to the pressure of population aging for the long run (HOLZMANN et al., 2008), proposed in 1994 a general framework of reform (WB, 1994). The world Bank discussed a set of key elements in concern of the design of pension systems in order to satisfy the basic functions of a pension system under the new economic and demographic constraints. In this sense, the main recommendation was to pass from a one-pillar system to a multi-pillars system. The one-pillar systems have the disadvantage to do not allow a good perfection in terms of the different functions of a pension system which are not well correlated. In the beginning, a three pillars system was proposed :

1. First pillar : Mandatory, wages-linked, Defined Benefit system, Publicly managed;
2. Second pillar : Mandatory, funded schemes, Defined Contributions system, privately managed;
3. Third pillar : Voluntary, fully funded and privately managed;

Each pillar is conceived to serve a well-defined function. The first pillar has the objective of poverty

alleviation, it can be an universal system offering a minimum income for the whole older population or a limited benefit system based on some eligibility criteria : needs-linked or employment-related incomes. The second pillar may endorse the saving- incomes smoothing. Then, it encourages individual saving and economic capital accumulation. This second pillar can take two forms : individual saving plan or occupational plan. The third pillar allows to persons with high wages to augment their saving effort in the intention to receive more incomes at retirement. All these three pillars are contributory. Later, the World Bank added two additional non-contributory pillars ([HOLZMANN and HINZ, 2005](#)) :

- Zero-pillar: It is a contributory universal system which deals directly with the vulnerable old population by offering them a minimum protection level;
- Fourth Pillar : is an Informal old age protection system based on the intra family solidarity, not necessary based on financial supports : social supports, housing, health care;

According to the suggestions of the World Bank, a Multi-pillars system is very suitable with a multi-objectives pension system ([HOLZMANN and HINZ, 2005](#)). The formal one-pillar system is less flexible in this sense. Also, the World Bank does not propose a standard solution to be used in all circumstances but just a general framework to be adapted with the specificity of each country ([HOLZMANN et al., 2008](#)).

In order to ensure the long run sustainability of a pension system, the underlying risks must be well known and well evaluated. Firstly, the nature of the risks to manage within a pension plan depends widely on the structure of the system itself. The PAYG system is very sensitive to demographic changes. Population aging results in an unbalance between the working population and the population at retirement age; Longevity is traduced by the extension of the retirement age compared to the working age; also, the mortality function of retirees can be significantly different from that of the global population. In such a case, the use of the global population life tables for actuarial calculations can lead to a king of mis- estimation of the risk function. On the other side, risk can be generated by a set of economic factors related to changes in the economic growth between the working period and the period of retirement : Wages, Unemployment, Affiliation to social security, inflation ... etc.

The Algerian pension plan is still based on a single pillar system (Pillar 1), as it is mostly the case in the Middle East and North Africa (MENA) region. Pension systems in MENA region are still in an early maturation stage. For a long time, contributing population has been much more important than the population of retirees in this region. Considering the financial equilibrium of the system from the cash-flows point of view is not a good idea in all since it does not assess the sustainability of the system for the long run. [ROBALINO et al. \(2005\)](#) focused on the structural problems that include pension systems in MENA region and averted the emergency to proceed to deep reforms. According to the same author, even without taking into account the effects of population aging, the actual pension design in MENA region suffers some permanent inefficiencies ([ROBALINO et al., 2005](#)):

- 1) The first problem is the abusive generosity of the system: while the replacement rate of the working

age income is almost 50% in average, MENA's pension system offers a replacement rate of around 75%. The problem is that the promised pension benefits are large and seem to be unsatisfied without a significant intervention of the public treasury. [BEN BRAHEM \(2009\)](#) discussed the pension systems generosity in North African Countries (Tunisia, Algeria, Morocco) and confirmed that the high generosity of the pension systems in the cited countries can not be kept for the long run because of population aging.

2) The second element consists in how these systems were designed. The way that benefits are defined distorts labor market supply and saving decision. Linking benefits to the final wage rather than to the average earning conduces to systemic generous benefits and then to some manipulation in salary definition along the working career. The configuration of the system encourages evasion and discourages the individual saving efforts and makes working population to prefer early retirement. For the case of Algeria for example, even if the age for retirement is fixed at 60 years by the regulation, an important part of workers get retired long before. Also, the current system leads to generate some inequalities in terms of notional benefits distribution in intra and inter generations ([MENDIL, 2014](#)).

3) The weakness of the administrative efficiency;

4) The modesty of coverage rates;

The fact that pension systems represent a long term commitment requires an efficient planing at all sides. It will be very difficult for MENA countries, including Algeria, to pay the promised benefits under the new demographic challenges mainly represented by population aging. A parametric reforms will not be sufficient to keep the long run stability of the system. It is not easy to extend social security among the working population in a short period. Such an alternative must focus on the determinant of social security demand in the actual circumstances ([MEROUANI et al., 2016](#)). A significant augmentation of the contribution rates for social security will encourage evasion and will affect the existing labor market equilibrium. Reforms must be oriented to pass from a one-pillar to a multi-pillars pension system, by reducing the incidence of the unfounded schemes and to complete it by a funded scheme ([CHOUROUK, 2003](#)).

The main objective of the present work is to address the effects of longevity, aging and the retirees specific mortality on the stability of the Algerian pension plan. The evaluation of the future engagement of the pension fund under PAYG system is directly related to the estimation of the mortality function of the pensioners and to predict its future reduction. In concern of the economic factors, we will suppose them to stabilize at their recent observed level or to continue evolving according to the recent observed trend. For this, we will start by presenting the elements which may affect the financial long run stability of the Algerian pension system. The projection of retirement Incomes/ outcomes must be based on a population forecast. Unfortunately, Algeria does not have a population projection for the period beyond 2030. In a first part, we do a population forecast by forecasting mortality and fertility while assuming a null migration balance . For mortality, we do a coherent mortality forecast by using the Ratio-Product-Method proposed by ([HYNDMAN et al., 2013](#)). For fertility, we use the Lee-Carter model adapted for fertility ([LEE, 1993](#)) while supposing that the Total Fertility Rate will full down from 3 births per woman in 2015 to 2.5 in 2070. On the basis of the

population forecast, we will define the expected evolution of the contributors and retirees numbers. Then, we fix a scenario about salaries and pension amounts evolution. The mortality schemes of the retired population is supposed to be defined by the dynamic life tables calculated by (FLICI and PLANCHET, 2016). In final, the evolution of total expenses and total incomes are projected. On the basis of the obtained results, a set of recommendation are formulated.

2 Short presentation of the Algerian Pension system

The Algerian pension system is mandatory, financed by PAYG system, earning-linked Defined Benefits, Publicly managed. The pension regime dedicated for the self-employed population (employers and self-employed) is managed by “Caisse d’Assurance Sociale pour les Non Salaries - CASNOS” while the employee’s regime is managed by the “Caisse Nationale des Retraites - CNR”. Here, we will focus on the second regime concerned by the employees.

The monthly contribution is defined as a part of the salary. The retirement age was fixed at 60 years for employees. Retirement benefits are defined in function of the average of the 60 final wages \bar{W} (or the average of the 60 best wages if more advantageous) and in order to attribute for each working year a validation rate of 2.5%. The Pension Benefit (PB) is calculated as follows:

$$PB = \bar{W} * n * 2.5\% \quad (1)$$

With a number of contribution years n equal or higher to 32, the formula above leads to a replacement rate of 80% of the average of the best (/last) 60 mounts wage. This replacement rate is higher than the average in the Middle East and North Africa (MENA) region which is evaluated at 70-75% and much more higher than its level in developed countries (ROBALINO et al., 2005).

In the sense of the law, a working year is validated to give part in the pension benefits if it have led to, at least, 6 months of contribution. This last element with the fact of considering the best (or last) wages rather than the whole career average wage to define the retirement benefits endorses the evidence of the relative high generosity which marques the Algerian pension system already highlighted by (BEN BRAHEM, 2009). In addition, some bonuses are provided for some categories :

- A minimal pension equal to 75% of the national guaranteed minimal wage (NGMW);
- A bonus of 5 years is given for women with one additional year for each raised child with 3 as a limit;
- A bonus of 5 years is accorded for Moudjahidine (Former combatant of the Algerian liberation war 1954-1962). Years of participation in the war are double counted with a validation rate of 3.5% rather than 2.5%, a replacement rate of 100% and a minimum equal to $2.5 * NMGW$;
- A pension complement is provided for one spouse in charge;
- An early retirement for workers under nuisance conditions;

In addition to the Normal Age Retirement (NAR), many other types of preretirement were proposed in order to smooth individual decisions and economic circumstances:

- Proportional Retirement (PR): this type was introduced in 1997 to allow workers who want to retire before fulfilling the basic conditions. Only 20 years of activity and a minimal age of 50 years are required;
- Early Retirement (ER) : This formula was introduced in 1994 to suit the case of workers who lost their job consequently to the economic crisis of the 90's. The pensioner must be 50 years old and having accumulated 20 years of activity and 10 years of contribution at least. Also, the decision of getting retired must be supported by the employer who must pay the right-opening contribution which is defined in function of the number of anticipated years;
- Retirement Allowance (RA): The retirement allowance was proposed to allow those who have reached the age of 60 without fulfilling the requirements to access to retirement, in order to benefit a minimal earning for a minimum of 5 years of contribution.
- Retirement without Age Condition (RAC): When 32 years of contribution are accumulated, a worker can enjoy his retirement before reaching the regulatory age of retirement. To compensate for the loss resulted from his early retirement since he is still able to improve his final wage, his replacement rate is augmented by 2% for each year below age 60 years in the limit of 5 years.

The five type of retirement presented above can be grouped into one main category : the Direct Retirement DR. Additionally, survivors benefits are provided for the family members after the death of the insured worker/pensioner. We can distinguish two types of survivors benefits : Survivors pension (for NAR, PR, ER and RAC) and survivors allowance (for RA). Survivors benefits are provided to:

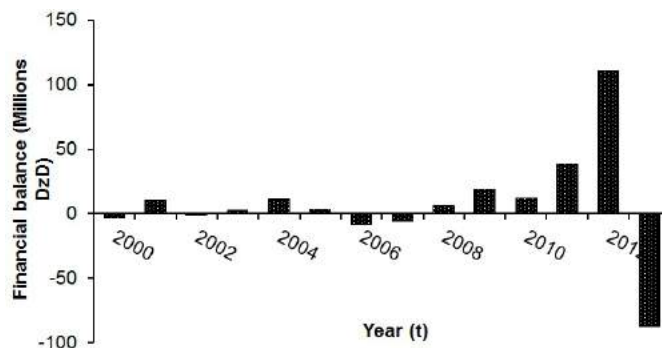
1. The spouse : In case of remarriage, the pension is transferred to the other rights holders;
2. Orphan: for males until 18 years old or 21 years if they are still studying; for females until occupation or marriage;
3. Parents: only if their own pension is under 75% of NGMW;

The aim of DB systems is to preserve the purchasing power of pensioners against inflation. For that, retirement pensions and allowances are annually reevaluated, and also adjusted to salaries growth.

3 Pension plan financial balance : Evolution review

From 2000 to 2013, the global expenses of the CNR have grown from 117 to 687 billions *dzd* with an annual exponential growth rate of 13.7%. On the other hand, the global incomes have passed from 114 in 2000 to 599 billions in 2013 with an annual exponential growth rate of 12.8%. Figure 1 draws their differential evolution.

Figure 1: Pension Plan Incomes Vs. Outcomes (2000-2013)



Source :CNR (2014)

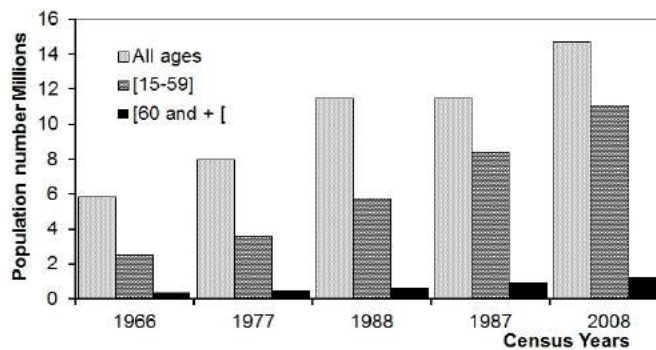
This evolution resulted from a combination of a set of factors, principally the differential evolution of the populations of retirees and that of contributors and also the improvement of salaries and pension benefits.

First, we start by giving a short review of the evolution of the Algerian population structure from the independence in 1962 till now. Within a PAYG system, changes in the population structure is the main determinant of the financial unbalance, the economic factors effect come second.

3.1 Population growth and structure

The Algerian population has grown from about 11 millions in 1962 to across 40 millions in 2016. The evolution of the population at working age compared to that at retirement age allows to give an indication about the theoretical ratio of contributors to retirees. In this sense, a comparative evolution for the Algerian population is shown in Figure 2 according to population censuses data.

Figure 2: Population at working age Vs. population at retirement age



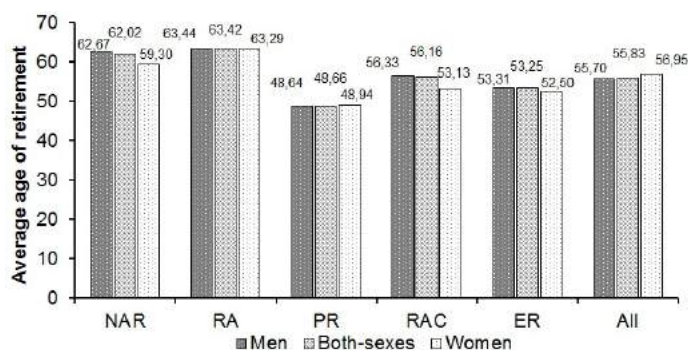
Source: Algerian population censuses: 1966, 1977, 1987, 1998 and 2008.

The ratio of the population at working age on the population at retirement age was at around 6.7 in 1966, 8 in 1977 and have been varying between 8 and 9 starting from 1987.

3.2 Average age of retirement

Even if theoretically, the age of retirement is fixed at 60 years, many options exist to allow people getting retired earlier. These options bring down the average age of retirement. Figure 3 shows the average age of retirement for the Direct Retirement types (NAR, RA, ER, PR and RAC) in 2013 (CNR, 2014). There is no detailed data for other years.

Figure 3: Average retirement age for Direct Retirement (2013)



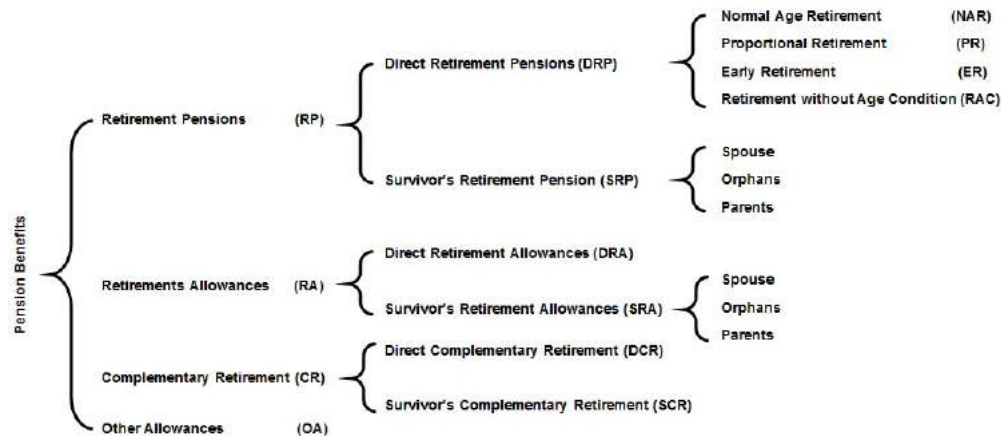
Source : Calculated from data provided by CNR (2014)

For NAR and RA, for which a minimum age of 60 years is required, the average age of retirement in 2013 was respectively 62 and 63.4. For the other types, this age was equal to 48.7, 56.5, 53.2 for PR, RAC and ER respectively. A slight difference is observed between men and women. Men retire later than women in all retirement formulas except for PR where the average retirement age for women is slightly higher than that of men : 55.7 for men and 57 years for women. When considering all the direct retirement types, it turns out that the average retirement age is 59 years for men and 57 for women.

3.3 Pension plan outcomes

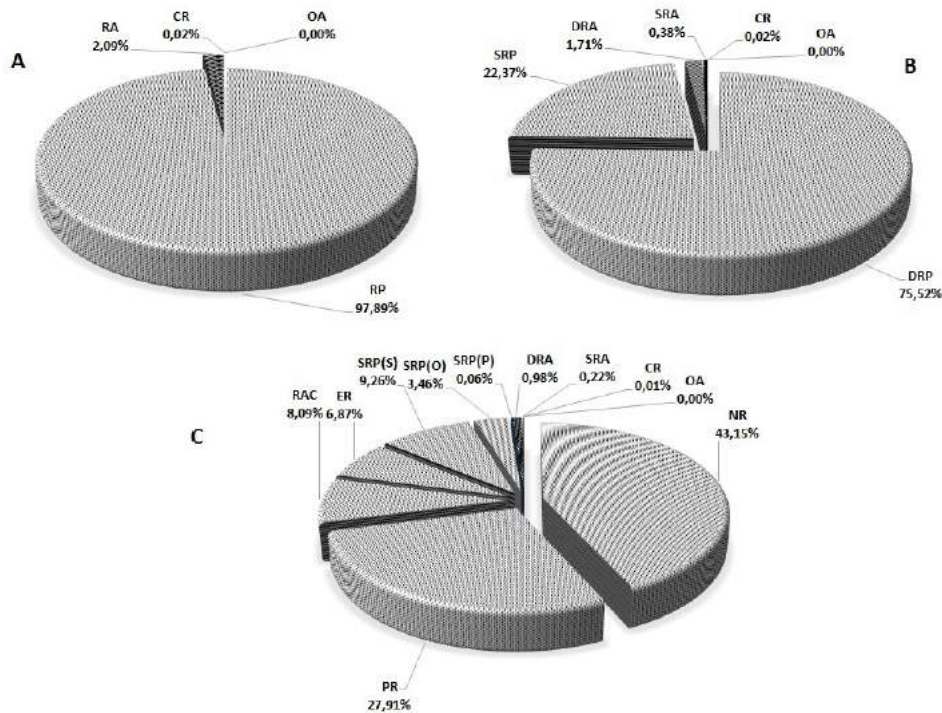
A detailed analysis of the retirement expenses evolution requires analyzing two main elements: the evolution of the population of beneficiaries and the pension benefits amounts. Before all, we give; in Figure 4, a summary about the types of retirement within the Algerian retirement system.

Figure 4: Retirement Benefits types provided by the Algerian Retirement System



According to Figure 4, Retirement Benefits in the Algerian System can be gathered into 4 main categories: The Retirement Pensions (RP), the Retirement Allowances (RA), Complementary Retirement (CR) and Other Allowances (OA). Each Category comprises Direct and Survivor's Benefits. There is no available details in concern of the "Other Allowances" which represent a part of nearly 0% from the direct retirement expenses as it is shown in Figure 5.

Figure 5: Retirement expenses average distribution by retirement type (2000-2013)



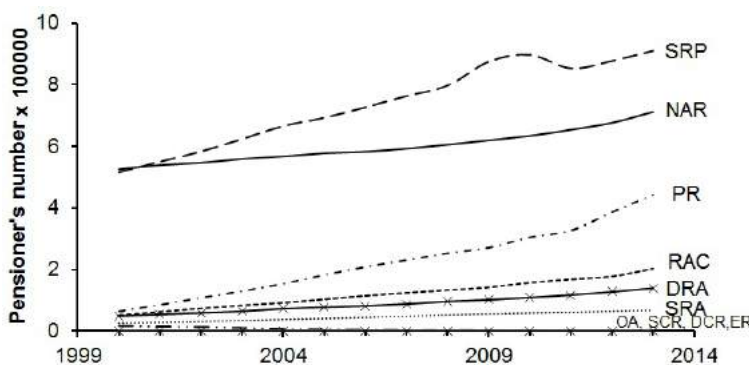
Source : Calculated from data provided in CNR (2014)

Figure 5 shows the retirement expenses distribution by type of retirement. According to the item (A), around 98% of retirement expenses are used to pay Retirement Pensions while only 2% go for Retirement Allowances. The Complementary Retirement and the Other Allowances parts are near to 0%. Item (B) provides more details about this distribution, 75.5% are served as a Direct Retirement Pensions, 22.4% as a Survivor's Retirement Pensions. Item (C) redraws the parts of NAR, PR, RAC and ER which represent respectively 43%, 28%, 8% and 7% of retirement expenses.

3.3.1 Evolution of the pensioners numbers

The total number of pensioners passed from 1.25 millions in 2000 to 2.48 in 2013 and to 2.77 millions in 2015. Figure 6 shows this evolution by type of retirement.

Figure 6: Evolution of the number of pensioners by type of retirement (2000-2013)



Source :CNR (2014)

The numbers of NAR and SRP beneficiaries are very important compared to the other type of retirement. NAR beneficiaries passed from 525000 in 2000 to more than 712000 in 2013. For SPR, the evolution was from 515000 to 910000 beneficiaries. The PR beneficiaries number has grown from 64000 in 2000 to 442000 in 2013. In 2013, the RAC, DRA and SRA beneficiaries recorded respectively 203000, 140000 and 67000 beneficiaries. The part of the ER, CR and OA are much smaller with less than 70000 beneficiaries in 2013. In concern of the distribution of pensioners between pensions and allowances, we observe that in 2013, RP takes a part of 91.4% from the total number of pensioners (54.7 for DRP and 36.7 for SRP) against 8.35% for RA.

3.3.2 Part of retirees among the population at retirement age

Access to retirement requires contributing for social security during a minimum number of years varying from 5 years for the case of RA to 32 years for the case of RAC. To benefit a NAR pension, a minimum of 15 years is required against 20 years for PR and ER. Contributing period can vary in duration and in

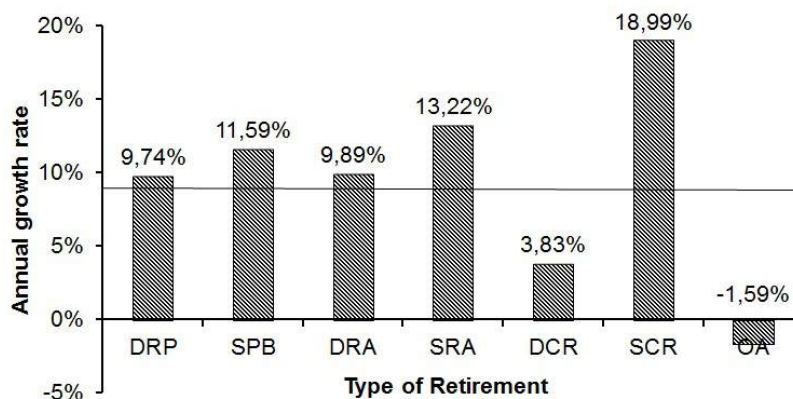
nature (continuous/ discontinuous) according to the employment conditions, individual preferences and social security design. Thus, the notion of coverage is different for workers and for people at retirement age. Social security coverage at working age determines retirement coverage but there is no mathematical relationship between the two. In other words, if we know only how is the affiliation rate for social security, we can not expect the number of retirees in the future. A part of the actual contributors will not be acceded to retirement if their whole contribution period falls down the required minimum. For that, in the absence of an individual contribution history, it is not evident to determine exactly the number of future retirees among a given generation.

3.3.3 Pension benefit average amount evolution

The monthly pension benefit is defined by a combination of a set of elements : The final wage, the number of years of contribution, the annual revaluation rate and the validation rate of each year of contribution. The average benefit amount by type of retirement is affected by the age structure of the retirees portfolio. For that, its time evolution is affected by the entrance / exit movement in each portfolio. When wages are growing in time, it results that the younger retirees have higher pension benefits than the older ones. In order to reduce the gap between the succeeding generations in term of purchasing power, an annual revaluation of pension benefits is applied to the old pensions. In terms of time evolution of the average retirement benefits over time, some differences can be observed between the different types of retirement. Figure 7 shows clearly these differences.

According to Figure 7, it turns out that the average benefits in DRP have grown with an annual growth rate of 8.75%. For the other types, having relatively lower benefits, the annual growth rate was slightly much important because of the additional revaluation provided in order to guarantee the minimum level for the low earning categories. The average growth rate for all types was around 9.28%.

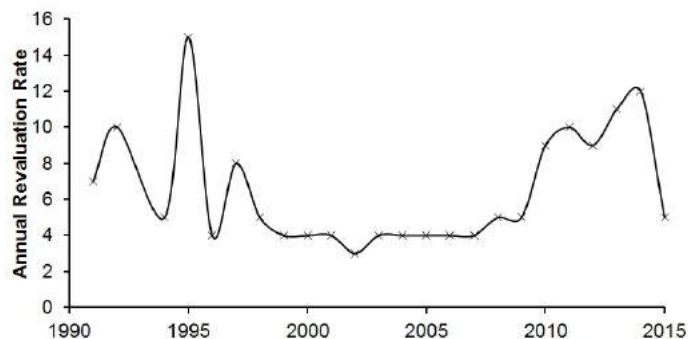
Figure 7: Annual growth rates of pension benefits in average (2000-2013)



Source :CNR (2014)

The annual growth of pension benefits is not only resulted from the annual revaluation which aims to protect pensioners against inflation. Some additional advantages are provided to keep in line the low benefits with a defined minimum. Figure 8 gives a review about the annual revaluation rates applied to pension benefits.

Figure 8: Annual Pensions Benefits revaluation rate



Source : from 1991 to 2013 (CNR, 2014), For 2014, 2015 : Official Journal of Republic of Algeria, n : 2014/25, 2015/24 (www.joradp.dz)

The annual revaluation rates has stagnated during the period 1998-2009 between 4 and 5%. Starting from 2010, this rate passed beyond 8% and reached an exceptional level of 12% in 2014. Because of the new budgetary constraints imposed by the recent decline of oil prices, the revaluation rate was set at 5% in 2015 and at 2.5% in 2016.

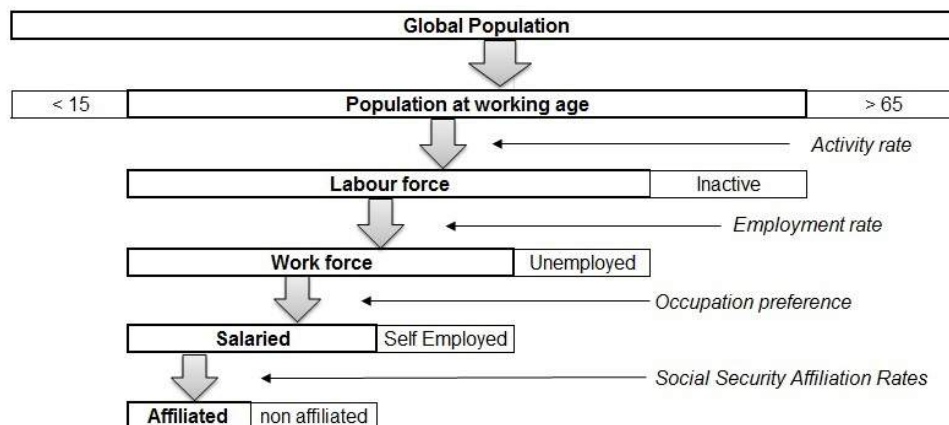
3.4 Pension plan incomes

In a PAYG system aiming poverty reducing, the public intervention is needed to adjust the financial unbalances. The resources of the Algerian pension plan come mainly from the contributions of the affiliated employees with a part of 75.6%. Public transfers represent around 23.6% while less than 1% only come from the investment of contributions.

3.4.1 The population of contributors

Figure 9 shows a scheme of the process that goes from the global population to the contributing population passing through the labor market and social security system.

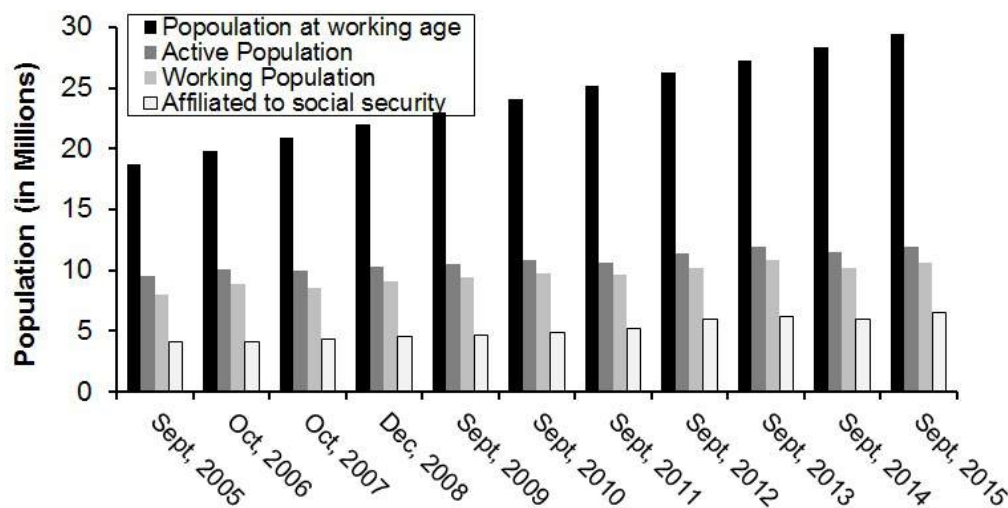
Figure 9: Affiliation scheme



It is not all people aged [15-60] who participate in the labor force. The total labor force records the number of individuals, aged of 15 years and + whose are supplying labor for the production of goods and services and it comprises the “work force” and the “unemployed population”. The working population contains employees and employers / self employed. At the end, only the affiliated employees whose contribute for CNR.

Figure 10 shows a comparative evolution of the population at working age, the active, the working and the affiliated populations in Algeria from 2004 to 2015.

Figure 10: Population at working age, active population and affiliated population in Algeria



Source : Population at working age was calculated by interpolation / extrapolation based on 1998 and 2008 census data. Other indicators are issued from ONS (2015)

During the whole observation period, the part of population at working age contributing for social security has fluctuated in between 20.15% and 22.75% with an average of 21.28%. That means that for 5 persons at

working age, there is only one who contributes for social security. Even if men and women have equal parts in the population at working age, the participation in the labor force and the work force are different and males have the most important parts. In 2015, the participation rate in labor force is evaluated at 65% for men and only 15% for women. The employment rate was at 90% for men and 83.5% for women. Unfortunately, data about affiliation to social security are not available by sex, and we suppose for simplification issues that affiliation rates are same for men and women.

3.4.2 Monthly wage

In a wage-related Defined Benefits pension plan, contributions are not flat-rates but are calculated as a part of the monthly wage. This last varies in function of a set of elements. The National Guaranteed Minimal Wage (NGMW) can maybe have a significant effect on the evolution of the monthly average wage. The NGMW is fixed by authorities in order to protect people earning a very low salaries and it represents a guidance for the general evolution index of the other wages categories. The evolution of the NGMW in Algeria is represented in Table 1.

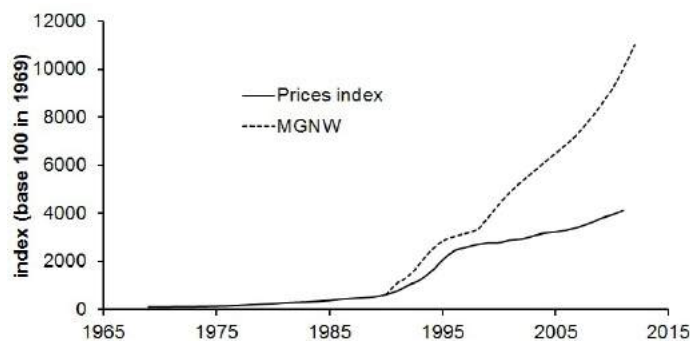
Table 1: Evolution of the NGMW in Algeria (1962 until now)

Revision date	MGNW (in <i>dzd</i>)
01/01/1990	1000
01/01/1991	1800
01/07/1991	2000
01/04/1992	2500
01/01/1994	4000
01/05/1995	4800
01/01/1998	5400
01/09/1998	6000
01/01/2001	8000
01/01/2004	10000
01/01/2007	12000
01/01/2010	15000
01/01/2012	18000

Source: ONS ([2012b](#))

As shown in Table 1, the NGMW has been revised many times between 1990 and 2012 and has grown 18 times along that period. This augmentation is supposed to allow the low wages earners to save their purchasing power against inflation. To show this relationship that we suppose to exist between the NGMW and the prices index evolution, Figure 11 illustrates two curves representing simultaneously the evolution of the two indicators.

Figure 11: Comparative evolution of the prices index Vs. NGMW Index in Algeria



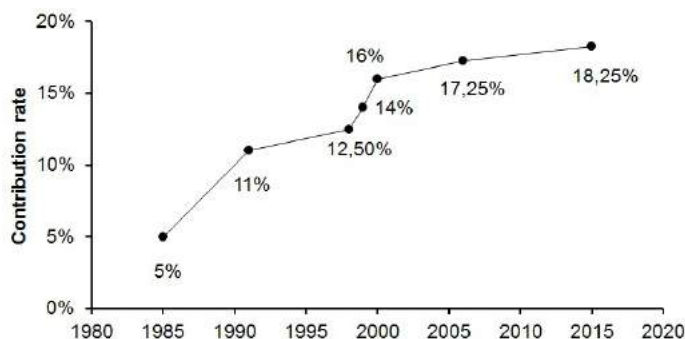
Source : Calculated from : 1) Prices index : ONS(2012a) 2) NGMW: ONS (2012b)

The NGMW has grown 4 times faster than prices. When prices grow up, low wages are usually supposed to be more sensitive to the loss of purchasing power. So, the observed growth rate in the NGMW compared to that of the prices index is more oriented to protect the low wages rather than the higher wage classes.

3.4.3 Contribution rates

The contribution rate represents the part of the salary which is dedicated to pay the contribution for retirement. This last is payed as a part of the contribution for social security. The contribution rate for social security in Algeria has marked many revisions from 1985 till today. In 2015, the social security contribution rate has been fixed at 34.5% of the monthly wage. 25% are supported by the employer, 9% by the insured himself and 0.5% represents a public subsidy. The contribution for retirement represents almost 50% of the contribution for social security. Its evolution over time is shown in Figure 12.

Figure 12: Evolution of the contribution rate to retirement in Algeria



Source : Official Journal of Algeria, different editions www.joradp.dz

The contribution rate for retirement (CRR) has marked important augmentations from 1985 to 2015 by

passing from 5% to 18.25%. Two augmentations were highly significant; the revision of 1991 brought up the CRR from 5% to 11%. The three consecutive revisions of 1998, 1999 and 2000 allowed to augment the CRR to 16%. This fast augmentation has had for objectives to keep the pension plan financial balance.

4 Population projection

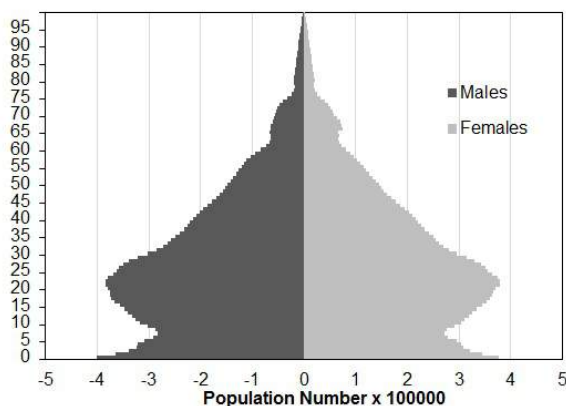
We intend to study the stability of the Algerian pension plan during the 50 coming years. First, a population forecast is needed. Then, the populations of contributors and retirees can be deduced by assuming some hypotheses about activity, occupation and affiliation to social security.

Population projection is based on a set of hypothesis regarding the future trends of fertility, mortality and immigration. The recent changes of life expectancy evolution and the Total Fertility Rates (TFR) in Algeria need a longer time length to be assessed and it is so difficult to assess if the recent observed trend will be kept in the upcoming years or it will diverge from the general trend observed since the late 70's. Conscious of all these elements, we do a population forecast until 2070 only in the intention to evaluate the stability of the Algerian pension plan without addressing any critical view of the goodness of the forecast itself.

4.1 Basis of the forecast

Population structure is mainly given by population censuses. Data recorded in civil statue allows drawing the year-to-year population evolution. For population forecasts purposes, an initial population structure is needed. In this sense, we prefer to use the data issued from the latest Algerian population census of 2008 as a basis of our forecast, rather than using the population structure published by the ONS in 2015 or 2016.

Figure 13: Single ages population pyramid - Algeria 2008



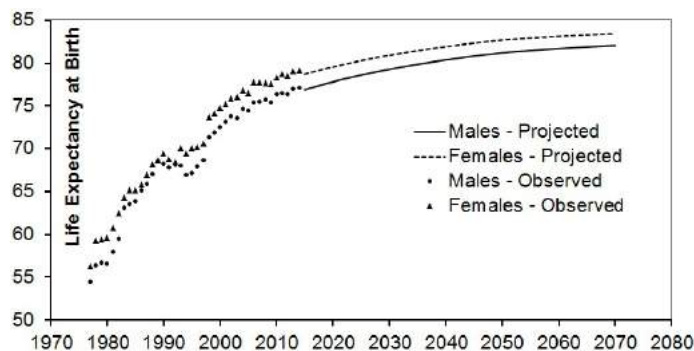
Source : General Population census 2008, single ages numbers were interpolated by karup-king method.

Figure 13 shows the single age pyramid of the Algerian population according to the 2008's census. Note that the population aged 75 years and + was broken-out by a linear interpolation between 70 and 100 years, while the number of population aged 100 years and over is supposed to be equal to 0.

4.2 Mortality forecast

To project the Age Specific Mortality Rates to the future, we achieved a coherent mortality forecast. Throughout our application, it turned out that the use of the Lee & Carter model (LEE and CARTER, 1992) to project mortality rates independently for males and females leads to some incoherence regarding the mortality sex ratio by the horizon of the forecast (FLICI, 2016c). The use of the coherent approach allows to avoid this kind of incoherence. In another work (FLICI, 2016b), we compared two coherent mortality models: The product Ratio method proposed by HYNDMAN et al. (2013) and the Lee-Carter model with an additive common component for males and females proposed by LI and LEE (2005). It turned out that the first model leads to better results regarding the Goodness of fit and the coherence. The same paper (FLICI, 2016b) has been used in the official population forecast for Algeria at the horizon of 2030 (forthcoming). Here, we extend the projection until 2070 by using the same parameters used to project mortality until 2030. Figure 14 shows the evolution of life expectancy at birth for males and females.

Figure 14: Life expectancy coherent forecast for men and women



Source : (FLICI, 2016b)

4.3 Fertility forecast

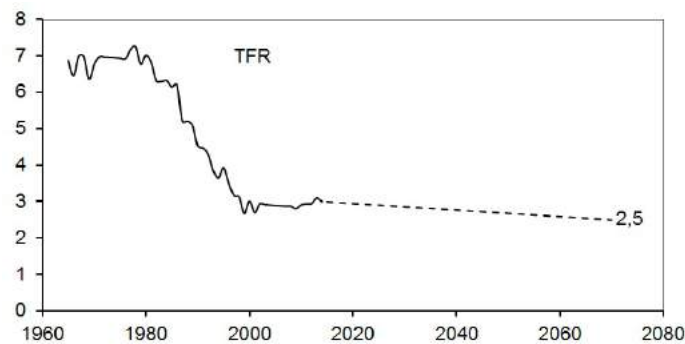
To fix the future scenarios of fertility rates evolution in Algeria during the upcoming half century, we consider the views of experts rather than a probabilistic forecast. We aim to keep the population forecast results obtained in the present work within the framework of the National official projection methodology. Currently, the final report has not been published yet. But the framework of the projection was discussed and fixed in the meeting of the population forecasts subcommittee of the National Committee for Population (NCP)

which depends from the National Health Ministry.

Experts of the NCP judged that fertility rates are expected to keep slightly decreasing in the coming years toward a level of 2.5. Since the projection results was greatly depending of these underlying hypothesis which present a kind of weakness over time, the projection's horizon was limited to only 2030 for the National Population forecast.

In order to keep working within these hypothesis while extending the projection's horizon until 2070 to suit the objective of the present work, we keep the same level to be expected at 2070 rather than 2030 as in the national projections. Results are shown in Figure 15.

Figure 15: Total Fertility Rate forecast

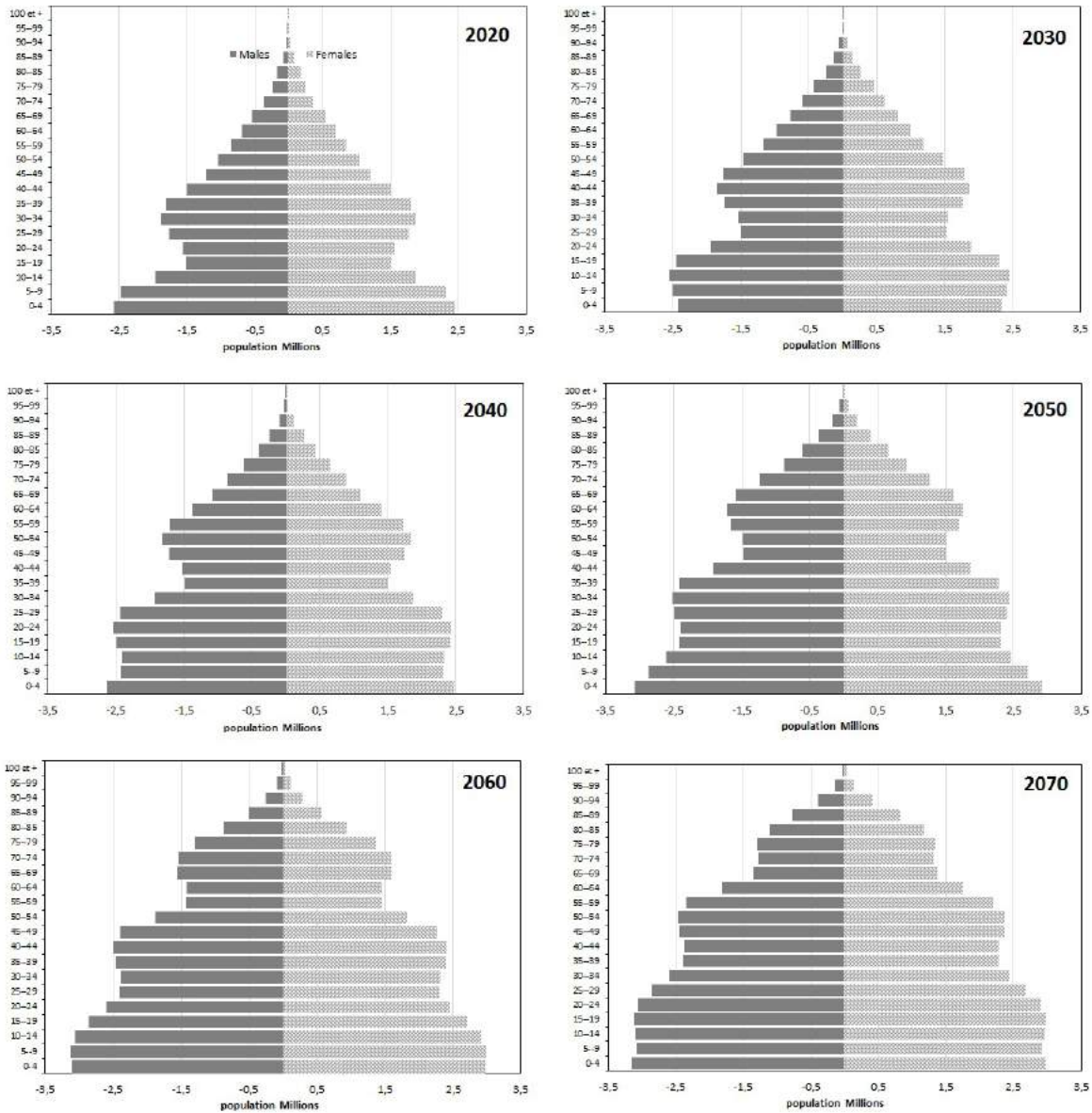


Source : from 1964 - 2014 : Algerian Official publications (Various).for [2015 - 2070] : the future evolution scenario is issued from the working meetings of the National Committee for Population / population projection Sub-committee.

4.4 Population forecast results

Because immigration's data are missed or not available in the required format, we suppose that the immigration flow is equal to 0. The combination of the age specific mortality and fertility rates applied to the population structure given by the 2008 population census allowed us to obtain the global population evolution and its age and sex structure for the period 2015-2070. The population pyramids for the years 2020, 2030, 2040, 2050, 2060 and 2070 are shown in figure 16.

Figure 16: Population pyramids by 2020, 2030, and 2070

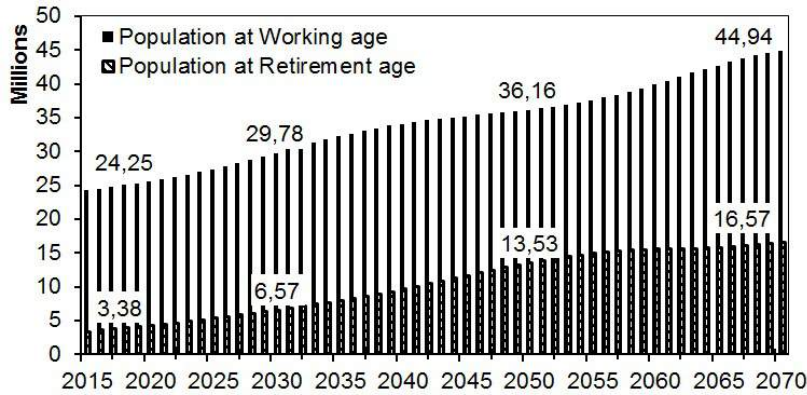


When we observe the transformation of the population pyramid from 2020 to 2070, we can deduce that the top of the pyramid is expected to enlarge faster than the basis of the pyramid. That reflects the aging process of the Algerian population during the 50 upcoming years. The part of the population aged 60 and over is expected to increase from around 8% in 2015 to keep around 20% starting from 2050.

4.5 The evolution of the populations at working and at retirement ages

The population forecast allows to deduce the populations at working age [15-59] and the population at retirement age [60 and +]. Figure 17 shows this evolution from 2015 until 2070.

Figure 17: Population at working age Vs Population at Retirement age expected evolution



These results combine males and females. The segmentation by sex does not lead to any significant difference. The whole population is equally divided between males and females. The population aged [15-59] is expected to grow from around 24 millions in 2015 to 30 in 2030, and to 45 millions by 2070. On the other hand, the population aged 60 and over is expected to grow from 3.4 millions in 2015, and to about 16.5 millions by 2070.

The analysis of this evolution in absolute terms does not highlight the effect which may have the population aging on the financial balance of the pension plan. Figure 18 shows the expected evolution of the ratio of the population aged [15-59] on the population aged [60 and +] which represents the number of individuals at working age corresponding to 1 theoretical retiree.

Figure 18: Number of working people for 1 theoretical retiree - forecast results

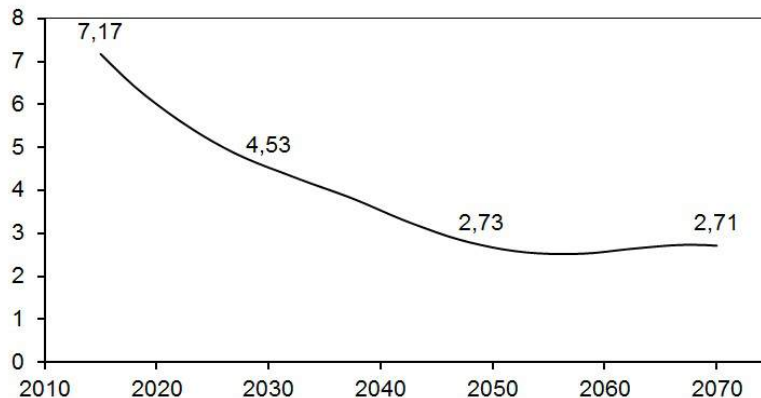


Figure 18 lets appear the expected decrease in the ratio of the population at working age on the population at retirement age. In 2015, we have more than 7 individuals at working age corresponding to 1 individual at retirement age. This ratio is expected to fall to 4.5 in 2030 and to stabilize around 2.7 starting from 2050. If it is difficult to keep equilibrium between incomes and outcomes of the pension plan under a theoretical ratio of 7, it will be more difficult to keep it under a value of 2.7. The main challenge will be to make a great part of the population at working age in occupation and than within the social security system. In the following parts, we will try to consider these two last elements in order to define the long term sustainability of the pension plan.

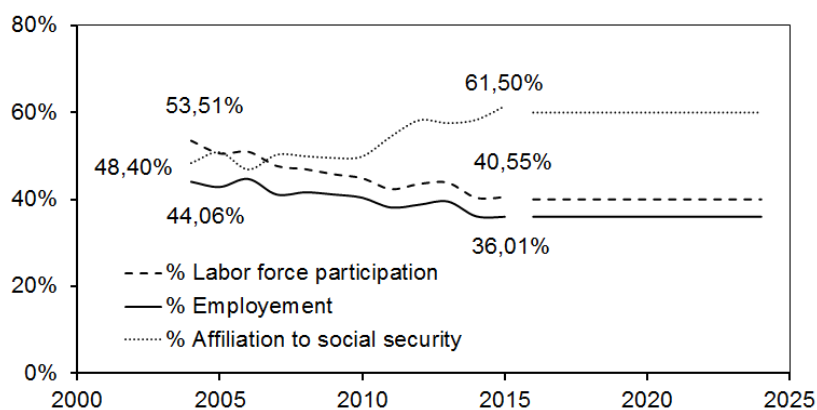
5 Economic factors future evolution scenarios

For the economic scenarios, we suppose that all elements will keep constant over the projection period: Activity rates, employment rates, occupation statue preference and also the affiliation to social security. Salaries will be supposed to continue their recent observed growth rate.

5.1 Labor force, workforce, and affiliation to social security

During these last years in Algeria, there is only 40 % of the population at working age whose are offering their work force on the labor market. This rate was around 53% in 2002. The employment rate has decreased from 44% in 2002 to 36% in 2015. 38.5% of the employed population is still not affiliated to social security. Figure 19 summarizes the recent evolution of these three elements.

Figure 19: Activity, employment and affiliation to social security rates



Source: calculated from data provided by ONS (2015).

For the needs of the present work, we will keep a simplest hypothesis about the economic scenarios. Accordingly, the labor force participation rate will be kept constant at the level of 40%. The employment

rate will be supposed to be around 36% and the affiliation to social security will be fixed at 60%.

Affiliation rate for social security allows to determine the population of contributors among working people while retirement coverage allows determining the population of retirees among the population at retirement age. These two elements can not be supposed to be fully dependent since the access for retirement requires to pay contributions during a minimal number of years. According to that, a retirement coverage among a generation is directly related to the number of years of contribution among the same generation. An active person has to contribute during a minimum of 5 years during his whole working age to get access for retirement when he is 60 years. During the working age length of a generation, especially when social security coverage is low, it is evident to have an important flow into/from social security system. In the absence of individual data about contributing history, it is not evident to fix any relationship between contribution rates and retirement coverage in a given generation. The future number of retirees is supposed to be more important than the average number of contributors among the same generation, because contribution rate represents just an average which does not address entrance and exit into/from the population of contributors. We conclude that even if we can estimate approximately the evolution of the number of contributors from year-to-year among a generation, we can not easily conclude the future number of individuals who will be retired when they reach the retirement age. To avoid this mis-estimation problem, we proceed as following :

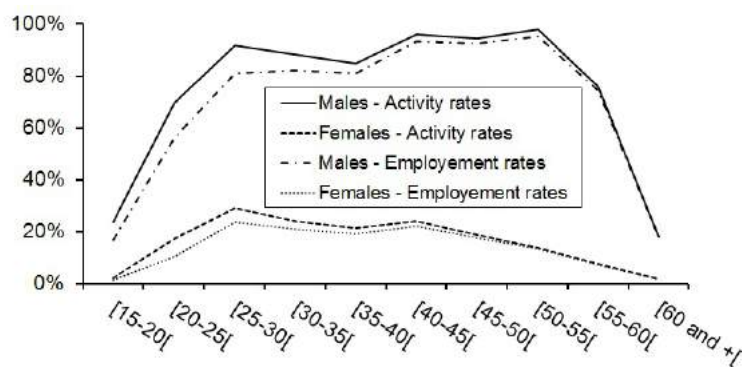
- All the population at working / retirement ages will be supposed to be potential contributors / retirees. Hence, the evolution of the population number among the same cohort is only defined by the survival function.
- Data concerning activity, employment, occupation statue preference (employees or self- employed) and affiliation to social security will be used to estimate, for each five age group and for each sex, the chance to be affiliated as an employee for all the individuals aged 15 to 60.
- The population forecast combined with the expected evolution of the average wage, the contribution rate, and the chance to be affiliated as an employee is supposed to allow estimating the expected evolution of total contributions.
- The age distribution of the probability to contribute for CNR (affiliated employee) allows to estimate the expected number of contribution's years. Combined with the final wage, this allows to estimate the average pension benefit. Multiplied by the potential population of retirees, that allows to estimate the total expenditure allocated to pay Direct Retirement Pensions at time "t".
- Because survivor's benefits require specific models and data without being our main objective in the present work, the survivor's pension total expenditure is calculated as a part from the direct pensions expenditure. The sum of the two gives the total retirement expanses.
- The administrative fees are calculated as a percentage of the retirement expanses. The total gives the global pension plan incomes.

In what follows, the elements cited above will be presented in more details.

5.2 The affiliation rate among the population at working age

By supposing the population at working age to be potential contributors for the CNR. The idea is to calculate, at each single age from 15 to 59, the rate to be affiliated as an employee among the population at working age. This implies to consider the activity rates, the employment rates, the part of employees among the working population and the affiliation rates among employees. The workforce survey conducted by the ONS in 2013 (ONS, 2014a) provides the data needed in our calculations. Data about activity and employment are arranged by sex and five age groups starting from [15-20[until [60 and +[. Activity rate represents the ratio of the labor force on the population at working age. The employment rate is calculated by the working population divided by the population at working age. Activity and employment rates in Algeria in 2013 are presented in Figure 20.

Figure 20: Activity and employment rates by 5 age groups - 2013



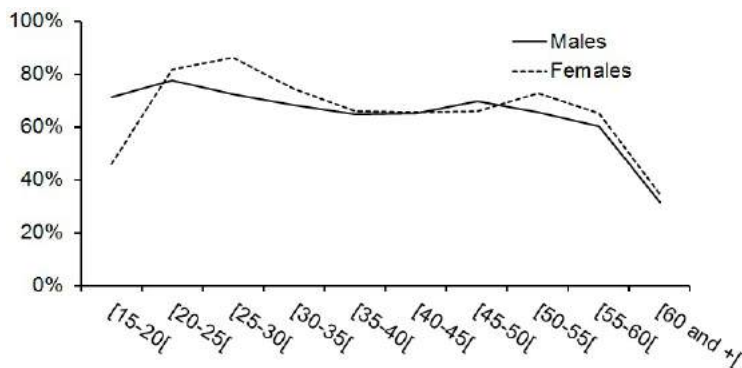
Source :ONS (2014a)

The activity rate was around 44%, 71% for males and 16.6% for females. Between 25 and 55, men are the most active during their working age with a rate of 92% while women are more active between 25 and 45 with an average activity rate of 21,5%. The curve representing employment follows nearly the shape of the curve of activity with a slight gap at young ages narrowing gradually with age. The employment rate for men is 65%, for women is about 14%. In concern of workers distribution by occupation statue (employees and self-employed), the part of salaried is about 69% of workers, 68% for men and 73% for women. The part of salaried among workers by age is shown in Figure 21.

Data about affiliation to social security is given by type of occupation: employees or self-employed by sex but without age ventilation. Affiliation rate to social security for the whole working population is 57.5%, 54% for men and 72% for women. Employees are well covered than the self-employed. The affiliation rate of employees is 70%, 65% for men and 92% for women. This difference is mainly due to the nature of the employer (private or public) and to the occupation statue (employees or self employed). Salaried women work more in the public sector compared to men with a respective parts of 83% and 54%. Self employment

takes a part of 31% among men and 24% among women. The automatic affiliation to social security in the public sector makes the affiliation rate of the public employees equal to 100%. The coverage in the private sector is supposed to be much lower. These information are unfortunately missed in the ONS report.

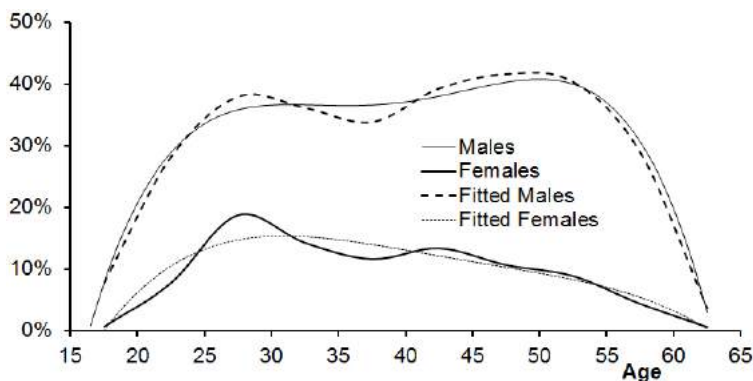
Figure 21: Part of employees among workers by five age groups - 2013



Source :ONS (2014a)

By using all these presented information, the part of the contributors for CNR (affiliated employees) among the population at working age can be deduced. The obtained results are shown in Figure 22.

Figure 22: Probability to contribute for CNR by age - 2013



Source : Calculated from data provided in (ONS, 2014a)

Figure 22 represents the part of contributors for CNR among the population at working age by age for men and women. The interpolation at single ages was done by a polynomial fitting : a 5-degrees polynomial for men and a 4-degree polynomial for women. Then, the fitted curves shown in that figure show the affiliation rates at single ages from 15 to 65 years, that we note $AS_x^{m,f}$ with x representing the age, m and f denotes males or females. This indicator can be used to estimate the contributors distribution by sex

and age among a given population. In the unavailability of a data series allowing to forecast this structure in the future, we suppose simply that it will remain constant. Then, for each cohort, the evolution of the number of contributors over age can be deduced. If we intend to estimate the expected number of years of contribution to CNR during the working career of each individual, that we note $EC^{m,f}$, we can simply do an approximation based on the ratio of the whole contributed years on the population at working age, which can be simply approximated by the sum of the affiliation rates between 15 and 65 years. This can be written as: $EC^{m,f} = \sum_{x=15}^{65} (AS_x^{m,f})$. It turns out that the expected period of contribution to CNR is equal to 15 and 4.6 years for males and females at working age.

Then, the number of the future retirees among a generation can be deduced from the population at retirement age. If we consider a common retirement age of 59 years for men and 57 for women, then all the population reaching this age will be supposed to be a potential retired population. Hence, the average retirement benefit amount will be calculated on the basis of the expected duration of contribution and the final wage. That will makes possible to estimate the total retirement benefits.

5.3 Evolution of the average contribution

The evolution of the average monthly contribution is directly related to the wages' evolution and the contribution rate. For the needs of this present work, the contribution rates will be supposed to keep constant. Wages are supposed to evolve following the recent observed trend. If we consider the period 2009 - 2013, the average growth rate of the net wages is 9.5%. From 1990 to 2013, the crude average wage has evolved by an annual growth rate of 10.7%. Here, we prefer take the recent observed trend since there was not a significant difference among the whole period.

In 2013, the contribution rate for social security was at 34.5% including 17.25% for retirement, 10% are payed by the employer, 6.75% by the employee itself and 0.5% by the government. Stating from 2015, the part of the employer passed to 11% and the contribution rate for retirement became 18.25%.

The contribution is calculated by multiplying the average crude monthly wage (50211dzd) by the contribution rate for retirement. That leads to an annual contribution in 2013 of :

$$50211 \times 17.25\% \times 12 = 103957.8 \text{ dzd} \quad (2)$$

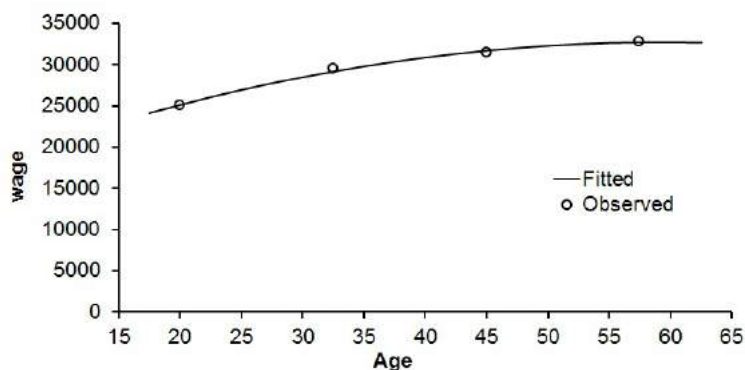
For a number of contributors of 5 173 000, the total contribution to CNR during the year 2013 is evaluated at 537 773 825 900,68 dzd. The total income of CNR in 2013 is about 599 billions dinars, 430 billions come from the contributions of the affiliated employees, 12 as investment returns and 121 as public transfers. If we compare only the theoretical and the effective total contributions, we can conclude that CNR may suffers a recovery problem evaluated at around 20%. It seems that some employers are not regular in paying the contributions of their employees. Also, the fact to validate a full year of contribution when only 6 months of real contribution are proofed may contribute to the cited gap between theoretical and real incomes.

5.4 Evolution of the average retirement benefit

The evolution of the average retirement benefit results from the evolution of the number of contributed years, the annual revaluation rate, and the final wage evolution. The evolution of the net wage with age reveals that in 2011, wage at [55-60[represents 1.11 of the average net wage. To make the relationship between salaries and age, we proceeded to a polynomial fitting based on the data provided in ONS (2014b) which gives the evolution of the wages by large age groups <25; [25-39[, [40-49[and [50 and +[. The obtained results are shown in Figure 23.

The retirement benefit amount is directly related to the average wage of the last 5 years of the working career. If we admit that the average age for retirement is 59 years for men and 57 for women, the wage to be considered in the calculation of the retirement benefit corresponds to the average wage between 54 and 58 for males and 52-56 females.

Figure 23: Wage Vs. Age (2011)



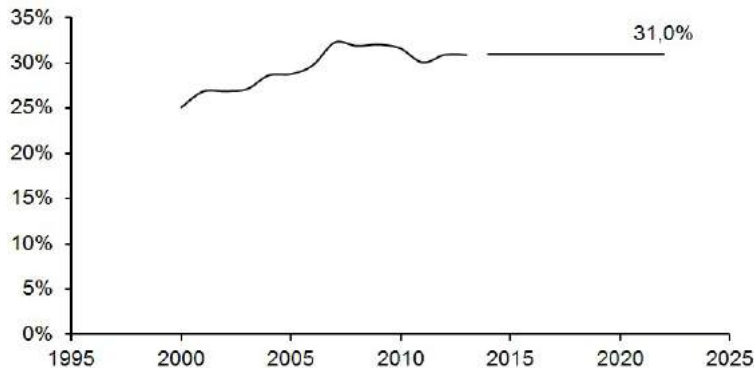
Source : Calculated from ONS (2014b)

In addition, the evolution of the retirement benefit amount is also affected by the annual revaluation as shown in Figure 7. By including all the factors affecting the evolution of the average retirement benefit amount, we have shown in Figure 6, that the average growth rate is evaluated at 9.28% during the period 2000 - 2013.

5.5 Survivor's retirement expanses and administration fees

In addition to the direct retirement benefits, CNR provides survivors benefits for : spouses, orphans and also parents. Modeling the expenses evolved by survivor's benefits is complicated and can be separately treated by another work. Our idea is to consider the survivor's benefits expenses as a percentage of the direct benefits ones according to the recent observed trend. The evolution of the ratio of survivors benefits expenses on the direct benefits expenses during the period 2000-2013 is shown in Figure 24.

Figure 24: Evolution of the ration of the survivors benefits on direct benefits expenses



Source : Calculated from data provided by CNR (2014)

The part of survivor's benefits expenses represented 25% of the direct benefits expenses in 2000. This part has evolved to stagnate at around 31% starting from 2006. For the needs of the present work, we will suppose that this report will keep turning around this value during the upcoming years.

In addition to retirement expenses (Direct and survivor's benefits), the total outcome of CNR comprises administration fees. These expenses represent in average between 2006 and 2013 a proportion of 1.5% from the retirement expenses and we suppose it to keep at this level during the upcoming years.

6 Incomes - Outcomes projection

In order to expect the future evolution of incomes and outcomes of the employee's pension scheme, we preferred to separate in our calculation the portfolio already in payment and the future generations including that of the current contributors. The actual portfolio of retirees will firstly be supposed to be closed for new entrances. Then, the late entrances will be addressed. In contrast, the current contributors' portfolio can undergo some exits and entrances depending on the affiliation behavior of the working population. For that, calculation concerning this category will be done as part of the future generations.

The age of departure for retirement will be supposed to be equal to the average age observed in 2013 which is 59 for men and 57 for women. Parallel to this, the working age will be extended until 65 years in order to take into account the individuals whose keep working beyond the average age of retirement.

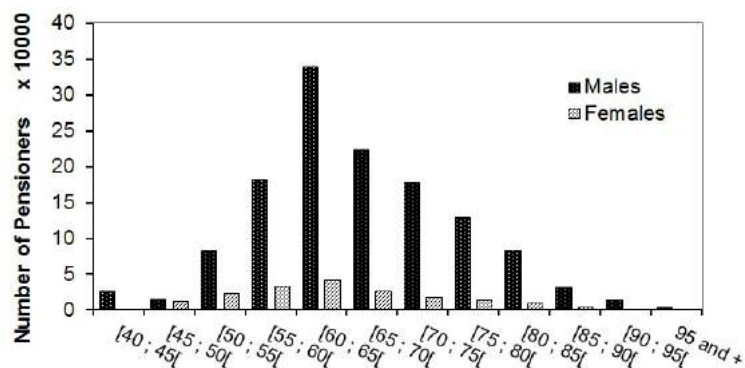
We remind that in the present work, the specificity of the retired population compared to the global population in term of mortality will be considered in the outcomes projection. As shown in [FLICI and PLANCHET \(2016\)](#), the prospective experience life tables were constructed and projected on the basis of the mortality experience of retirees. It will be more coherent to use these tables to describe the mortality of retirees rather than the use of the global population life tables.

As we mentioned above, the minimal number of years of contribution which allows to get access to retirement is 5 years (retirement allowance), while 32 years of contribution allow to benefit a full retirement. Such a detail is not addressed in our calculation and we suppose simply that workers contributing less than 5 years are compensated by those having contributed for more than 32 years.

6.1 Portfolio in payment phase

In first, we will estimate the future distribution of pensions to be payed for the portfolio of retirees in payment phase according to the 2013 closing situation. The distribution by age groups and sex of the direct retirement beneficiaries in 2013 is shown in Figure 25.

Figure 25: Distribution by sex, age of direct retirement beneficiaries - 2013



Source :CNR (2014)

We observe that the age group [60-65[contains the most important number of retirees. Even if the minimal regulatory age for retirement is fixed at 50 for men and 45 for women, we observe that some men have retired before this age. This case represents an exception compared to the general rule. During the terrorism decade that Algeria knew during 90's, the government created a security institution to protect the rural areas. After the end of the terrorism events, this institution became useless and a part of the fired agents has benefited an exceptional early retirement starting from 2011.

The objective of the present part is to expect the time evolution of the total benefits of the presented portfolio. This evolution will results from the evolution of 2 parameters : 1) The survival function of the concerned retirees and 2) The evolution of the average retirement benefits. The evolution of survivals among the population of retirees is described by the experience prospective life table (EPLT - 2013) constructed by FLICI and PLANCHET (2016) . In concern of the second element which consists in the evolution of the average pension benefits, we will suppose that this last will keep growing with a rate of 5%.

Formulation:

Let $l_{x,t}^s$ denotes the surviving retirees at age x and year t of sex $s =$ males or females. Until now, the population of retirees is arranged by five age groups. To obtain the single age distribution, we use the Karup-King method to break-out the five age populations into a single age populations. This method is well explained in FLICI (2016a). The open age group [95 and +[is supposed to be closed at 100 years. The weakness of the number of retirees in this age group permits a such hypothesis without affecting significantly the final results. Let also ${}_n p_{x,t}^s$ denotes the surviving probability between ages x and $x+n$ between the year t and $t+n$ (EPLT 2013), and let R to be the annual average direct pension benefit growing with a rate $r=9\%$. The total pension benefits at year t related to the portfolio in payment can be calculated as :

$$TPB(1)_t^s = \sum_{x=x_0}^w l_{x,t} \cdot R(1+r)^{t-2013}$$

Note that the number of surviving retirees is evolving from a year to another following the relationship $l_{x+1,t+1}^s = l_{x,t}^s \cdot p_{x,t}^s$. The total retirement expenses covering the global population is calculated by summing the male's and female's retirement expenses:

$$TPB(1)_t = TBP(1)_t^{males} + TPB(1)_t^{females}$$

6.2 Next generation of contributors - retirees

The projection of the future incomes - outcomes related to the future generations of contributors and retirees must be principally based on the population forecast. As we mentioned it earlier, all the population at working age will be considered as a potential population of contributors. Then, the probability to be affiliated as an employee combined with the expected evolution of wages will allow to estimate the average contribution by a single age between 15 and 64 years. Proceeding similarly, the population at retirement age will be considered as potential retirees. Then, the average duration of contribution combined with the expected final wage will allows to estimate the average pension benefit. we remind that the expected duration of contribution is 15 years for men and 4.6 years for women at working age.

6.2.1 Expected contributions

The expected contributions are calculated on the basis of the evolution of the population aged [15-65] issued from the population forecast. The number of the population at age x at time t is denoted $\Lambda_{x,t}^s$ with $s =$ males, females; $t \geq 2014$ and $x = 15, 16, \dots, 64$. The probability to be affiliated as an employee which represents also the probability to contribute for CNR at age x is noted AS_x^s (see Figure 26). From 2009 to 2013, the average crude wage in the public sector has grown with an annual rate of 9.5%. The same annual evolution rate was observed on the average net wage between 2009 and 2013 all sectors included. For that, we suppose

that wages will keep growing with the same rate during the future years. It gives:

$$\bar{W}_t = \bar{W}_{2013}(1 + 9,5\%)^{t-2013}.$$

The total contributions during the year t (noted TC_t) is calculated by summing the contributions to be paid by different cohorts during the same year noted C_{xt} . The formula can be written as:

$$TC_t = \sum_{x=15}^{65} C_{xt} = l_{xt} \cdot AS_x \cdot \bar{W}_t \cdot 18.5\%$$

6.2.2 Expected pension benefits

The calculation of the expected pension benefits for the future generations of retirees returns to expect the average duration of contribution, the final wage evolution, the age of retirement and the annual revaluation rate of pensions benefits. The average age of retirement is 59 for men and 57 for women. We suppose that the departure for retirement will be fixed around these averages during the upcoming years. Then, the last 5 working years wages serve to calculate the pension benefit. Here the wages between [54-58] and [52-56] respectively for men and women will be considered in Pension Benefits calculation. For simplification issues, we replace the age intervals by the central ages. It means that the average wages corresponding to 56 and 54 years ($W_{56,t}$ and $W_{54,t}$) will be considered respectively for men and women. Because these details are not provided on the ONS publication, we will proceed to estimate $W_{56,t}$ and $W_{54,t}$ from \bar{W}_t according to the polynomial function shown in Figure 19. We obtain $W_{56,t} = 1.107 * \bar{W}_t$ and $W_{54,t} = 1.104 * \bar{W}_t$. The expected duration of contribution is supposed to be 15 years for men and 4.6 for women. The annual revaluation of pension benefits amounts will be supposed to keep around 5%. In first, it convenes to calculate the annual pension benefit corresponding to the first year of retirement that we denote $\bar{P}B_{m,t}$ (m denotes the retirement age) and calculated by:

$$\bar{P}B_{m,t} = W_{m,t} * EC * 2.5\%$$

Then, the time and age evolution of the annual pension benefit is supposed to keep growing with a constant annual revaluation rate of 5%:

$$\bar{P}B_{m+n,t+n} = \bar{P}B_{m,t}(1 + 5\%)^n$$

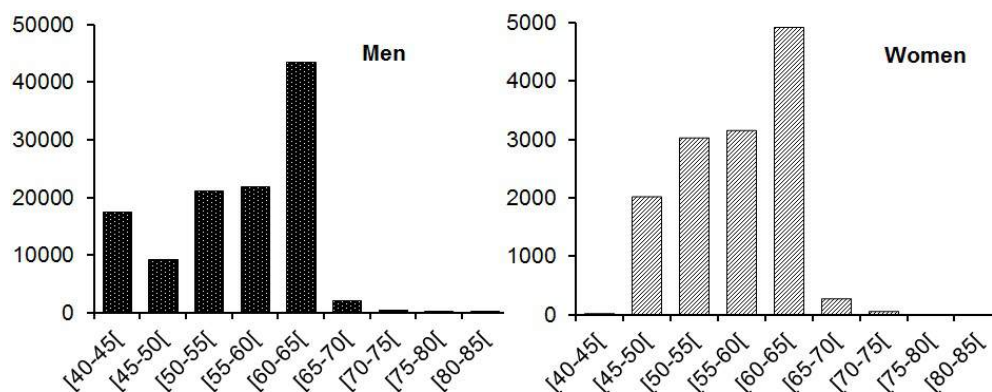
The total pension benefits during a year t is calculated by multiplication on the population number in each generation. If we consider $\Lambda_{m,t}$ as the population number at the age of retirement m during the year t issued from the population forecast, the survival function of this starting population will be estimated in the basis of the life table EPLT-2013. The total PB during a year t can be calculated by :

$$TPB(2)_t = \sum_{x=m}^w \bar{P}B_{x,t} * \Lambda_{xt}$$

6.3 The whole system stability

The evolution of the total pension benefits should be calculated by summing the pension benefits of the portfolio in payment and the pension benefits that will be distributed to the future generations. Here, there is a risk of double counting or an omission in concern of certain categories of retirees. We remind that the first group is observed by the end of 2013 and it is constituted by retirees aged 40 and over. The second group is constituted by the generations who will get retired starting from 2014 when reaching the age of 59 for men and 57 for women. The risk of double computation concerns the individuals who are already retired before reaching the average age of retirement. Those retirees will be computed again in the second group when they reach the average age of retirement. To avoid this double computation, we remove the retirees aged below the average retirement age from the first group. On the other hand, the current portfolio in payment is not supposed to be closed for new entrances among the oldest generations not already retired. If the workers aged below the average age of retirement will be computed with the future generations, those aged beyond the average age of retirement in 2013 and not already retired yet, are for now excluded from any consideration. For that, the future entrances in the current portfolio of retirees between the average age of retirement and 65 years must be estimated and added into account. The population aged between m and 65 years in their evolution over time must be augmented by the future workers to be retired. To do that, a distribution of the probability of getting retired among the working population must be calculated for each age. Then, the retirement schedule will be dressed. The CNR report (CNR, 2014) provides the distribution of workers getting retired in 2013 by five age groups as it is shown in Figure 26.

Figure 26: Distribution of workers getting retired in 2013 by sex and age

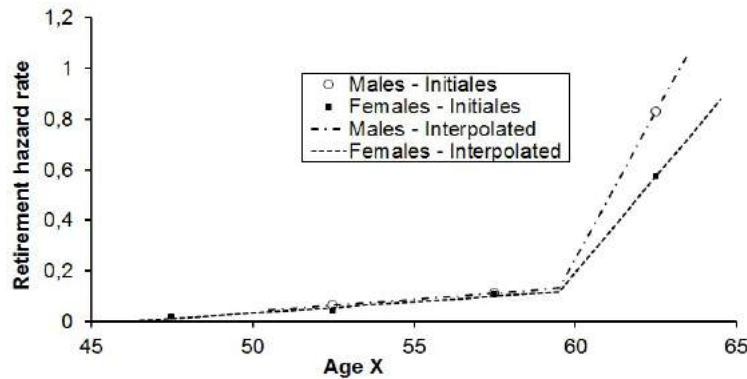


Source :CNR (2014)

The total number of the new retirees in 2013 is evaluated to 129000, 90% are men and only 10% are women. We can observe that an important part of the total number of departure for retirement has occurred at 60-65 for men and women. Beyond the age of 65, the proportions are much less important. The numbers

that we can observe between 40 and 50 for men represent a special case in concern of the years 2012 and 2013 (fired municipal guards). If we consider that the minimal age of retirement to be 50 for men and 45 for women and 65 year to be an extension of the normal retirement age which is 60, the probability of getting retired at each age between $[45-65]$ and $[50-65[$ can be calculated.

Figure 27: Probability of retirement by age -2013



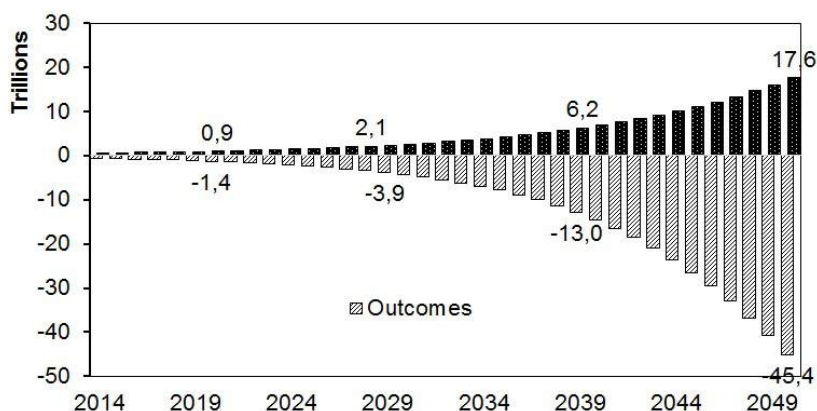
COSTA (1998) tried to approximate the probability of retirement at single age from studying the labor force participation rates issued from censuses data. Here, we simply estimate this probability (rate) by dividing the number of workers getting retired in 2013 by the number of the affiliated employees during the same year with a distinction by sex and age. In subsection 5.2, we approximated the distribution of the affiliated employees by age and sex. The ratio of the number of workers getting retired in 2013 at each age group $[x, x + 5[$ divided by the structure of the affiliated employees by age gives the hazard rate of retirement for workers not yet retired as it is represented in Figure 27.

Initial calculations gave the hazard rate for getting retired by five age groups between 50 and 65 for men and 45 - 65 for women. For our application's needs, a description by single ages is needed. For that, we proceeded to an interpolation of the rates at single ages. A change point can be observed starting from age 60 because the regulatory retirement it fixed at that age, and the use of a unique interpolation function along the whole age range may leads to unsatisfactory fitting quality. The use of a junction of two linear functions allowed to escape this disadvantage. However, and in order to make the interpolation results more adapted to reality, the junction point was extended until 60 years rather than to be the center of the age group $[55-60[$ as it is shown in Figure 27. In other words, is more realistic that the probability to retire starts to rise starting from the age of 60 than starting from the age of 57.

In the rest of this application, the retirement probability age pattern is supposed to keep constant during the upcoming years. That allows passing from an annual to a generational description of the retirement probability age pattern. These calculated retirement schedules will be used to estimate the future entrance in the portfolio already retired by the end of 2013. According to that, the evolution of the number of retirees in each generation among the portfolio in payment is defined by the death and the decision of retirement.

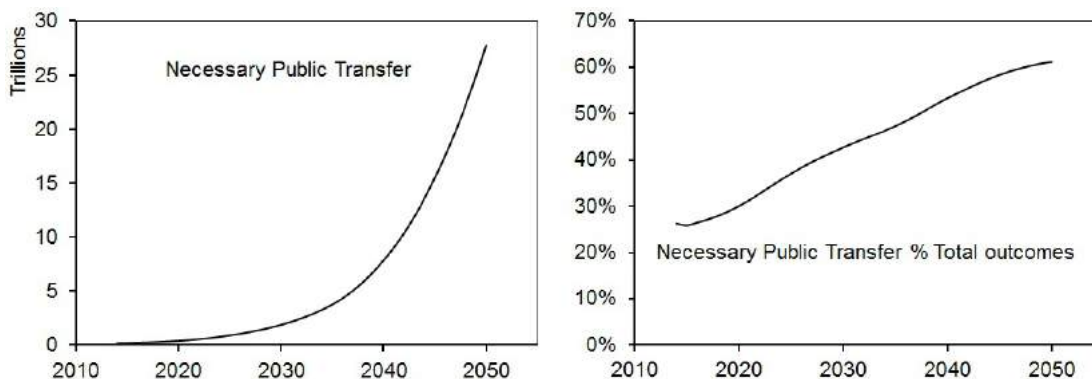
The projection of the financial balance of the Algerian pension plan returns to project separately total incomes and total outcomes. Total outcomes are constituted from the total retirement expenses augmented by 1.5% representing the administration fees. Retirement expenses groups the direct retirement benefits plus 31% representing the survivor’s benefits. The total incomes are principally constituted from the contributions of the affiliated population augmented by an investment returns of about 2.5%. We remind that there is a difference between the theoretical total contributions and the real contributions of about 20%. The difference between the total incomes and the total outcomes are covered by public transfers. Figure 28 shows the projected total income and outcomes.

Figure 28: Projected incomes - outcomes



According to the projection results, total incomes in 2014 are evaluated at 519 trillions *dzd* against 703 trillions for total outcomes. Public transfers cover 26% of the total outcomes. By 2030, the part of the public transfer which is needed to keep the financial balance passes to around 43% from total incomes and to 61% by 2050 as shown in Figure 29.

Figure 29: Projection of public transfer in pension plan incomes



The financial deficit of the CNR in 2013 was at 23% and it is covered by public transfers. It is supposed to reach a total value of 27.7 trillions *dzd* in 2050 which means 60% of the total outcomes. In such conditions,

we wonder if the government can support this permanent growing gap for the long run and ensure equality between the actual and the future generations.

7 Conclusion

The importance of pension plans in poverty reducing and old population protecting highlights the need to study their financial sustainability for the long run. Even if in most of pension schemes pension benefits are somehow related to the payed contributions following the insurance principle, public transfers are necessary to preserve the low earning population in a social protection context. However, there is no evident optimal combination between these two principles and there is not an evident way to design a pension system adapted to the whole population. A preference for the insurance principle will disadvantage the low earning population and the adoption of a pure solidarity system will pucks the high earners out of the system. Maintaining the stability of the system for the long run needs a public managing. In some particular conditions, the private sector can not support the temporary losses. The government may support the temporary deficit in order to save the well being of the low earning population and to encourage economic development for the long term.

In Algeria, the financial balance of the pension plan is still maintained by public transfers. The actuarial return rates of pension contracts is almost superior to the return rates in financial markets ([MENDIL, 2014](#)). Even if the public budget is expected to recover the future unbalances, that must be equally distributed between the different generations. Admitting a fixed level of the State contribution in pension plans incomes, this last must be periodically evaluated and updated in order to ensure the viability of the pension system. The generosity of the Algerian pension plan, as in north African countries, is supposed to fall down during the upcoming decades with the increase of the number of retirees and the relative decrease of the public incomes ([BEN BRAHEM, 2009](#)). In such conditions, it will be difficult, but necessary, to ensure equality between the actual and the future generations.

We have shown in this work that the effect of longevity and aging on the pension plan sustainability is permanent and not temporary. The financial deficit is expected to rise continually until a level of 61% by 2050. For that, a parametric reforms can not be sufficient to ensure the long run sustainability of the system. Augmenting the contribution rate or the retirement age can not be sufficient to reduce the financial gap for the long term. A large reform of the whole system is needed. If we intend that it will be possible to keep the public transfers at around 25% of the total outcomes, the constancy of this part will improve equity between the actual and the future generations. For the long run, it will be necessary to revise the actuarial contributions - pensions linkage. Longevity improvement does increase the duration of payment of pension benefits. If the retirement age is not augmented, that leads to an unbalance between the working career duration and the retirement duration. Population aging provokes a fall in the ratio of the population at working age on the population at retirement age. To keep total incomes at the level of total outcome in a PAYG system, it will be necessary to ask more contribution efforts to working people while moderating the

benefits distributed to retirees.

According to all these findings, it will be necessary to pass from one-pillar to a multi-pillars system as it was suggested by the World Bank (WB, 1994). That will allow to reduce the financial deficit of the whole system and restrict public transfers in a way to ensure the long run sustainability. It will be important to keep the actual system with some adjustment and to dress a second pillar, mandatory fully funded and privately managed. The first pillar is to be re-designed in order to manage the public transfers and ensure more equity while the second aims to encourage the individual contribution efforts. However, this second pillar needs to a strong financial market to invest the contributions of the affiliated workers.

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