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THE MEASURES ADOPTED TO RE-ESTABLISH FINANCIAL EQUILIBRIUM IN ALGERIA'S NATIONAL RETIREMENT FUND

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Abstract

In this paper, we look at the economic measures taken to restore financial stability at the level of the Caisse Nationale des Retraites (CNR) in Algeria to deal with the impact of the socio-demographic pressures, labour market issues, and the structural deficits in the social security systems. The most pertinent of these reforms are what public authorities are calling 'Parametric and financial reforms', which include the adjustment, alteration, and diversification of budget transfers and funding (State) as well as the changes in Contributory conditions. The study uses a descriptive and analytical method on which to base these measures and on which to assess the effectiveness of CNR in terms of balance and sustainabi8litiy with the associated deficits, with the measures derived from official statistics, legal texts and financial reports. The CNR measures do provide short-term financial support and with the aforementioned reforms, do assist in improving the liquidity positions. However, these reforms do leave a long-term sustainabil8ty challenge, w8h the liquidity being tight. The CNR systems integrated financial balance to assist defusing a better intergenerational equity in the pension system. The reforms lean towards being comprehensive, CNR deficits do need better Structural labour market policies, improved governance and at best these policies need integrated systemic change in the social variables to address the remaining equity in the pension systems.

Keywords: National Retirement Fund; Public Pension; Financial Balance Equilibrium; Social Security Reform, Public Finance; Algeria; Sustainability.

INTRODUCTION

Pension system for salaried workers is administered by the Caisse Nationale des Retraites (CNR), a payasyougo (PAYG) defined benefit plan. In a PAYG system, contributions from current workers finance benefits for current retirees rather than being accumulated in individual accounts. The design allowed the system to operate on a healthy surplus for several decades because the number of contributors far exceeded the number of retirees, the dependency ratio was favourable and hydrocarbon revenues were strong (Talahite, 2021).

However, research now shows that the system is approaching a structural imbalance. Demographic shifts such as declining fertility and longer life expectancy will reduce the ratio of working age persons to retirees; while there were more than six contributors per retiree before 2021, projections suggest this ratio will fall below three by 2045 (Hocine, 2024). As the population ages and labour force growth slows, maintaining sustainability without reform will be extremely difficult (Dahmani & Ouali, 2023).

Previous simulations indicate that the financial deficit of the PAYG pillar could widen to 60 % of payroll by 2050 even under optimistic economic and employment conditions (Flici, 2023). The CNR has already faced growing deficits: the fund's annual shortfall grew from 155.1 billion Algerian dinars (DA) in 2014 to 336.8 billion DA in 2016 and 479.1 billion DA

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in 2017 (Ishak & Hani, 2025). It reached 560 billion DA in 2018 and was projected to exceed 600 billion DA in 2019 (Omrani et al., 2023). According to the CNR's director general, the deficit results from rapid increases in the number of retirees, stagnating numbers of contributors and generous benefits; the current ratio of contributors to retirees is around two, whereas financial equilibrium requires five contributors per retiree (Salhi, 2021). Failure to close this gap threatens the solvency of the fund and obliges the state to grant recurrent fiscal transfers or concessional loans.Algeria's pension system for salaried workers is administered by the Caisse Nationale des Retraites (CNR), a payasyougo (PAYG) defined benefit plan.

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In response to these growing imbalances, the government has introduced several measures. Parametric reforms have included raising the contribution rate, adjusting the wage base used in benefit calculations and introducing specific contributions for early retirement. Retirement age has remained 60 years for men and 55 years for women, but the government curtailed early retirement pathways. Law 1615 of 2016 amended the 1983 retirement law and established stricter eligibility conditions: an employee must be at least 60 years old (55 for women) and have contributed for at least 15 years (Boukabous, 2021).

Only employees occupying hardship posts can retire earlier, and a transitional provision (Article 7) allowed workers with 32 years of contributions to retire at age 58 in 2017 or age 59 in 2018 (Habchi, 2024). The law effectively abolished unconditional early

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retirement, which had encouraged workers to leave the labour force prematurely. The government also permitted the National Investment Fund (Fonds National d'Investissement – FNI) to provide subsidized longterm loans to the CNR to cover its cash deficit (Boukabous, 2021). Governance changes and compliance campaigns sought to increase contribution collection from the informal sector. Lastly, the government enacted a 10 – 15 % increase in pensions in 2024 as part of a broader fiscal stimulus and wage bill expansion (Boukhchima & Cherait, 2024). While the pension increase alleviated beneficiaries' loss of purchasing power, it increased expenditures and may delay financial equilibrium.

Another dimension of the Algerian pension system is the existence of privileged pension regimes. A Special Pension Fund (Fonds Spécial de Retraite – FSR) provides generous pensions to political leaders, senior civil servants and former combatants. According to a report attached to the 2015 Finance Law, public assistance to retirement totalled 256 billion DA; low pensions accounted for onethird of this sum, while FSR pensions and special military pensions absorbed the remaining twothirds (≈1.8 billion USD) (Boukhchima & Cherait, 2024). Because the FSR has only 70 000 – 80 000 affiliates and negligible contributions, these privileges are financed from the state budget (Omrani et al., 2023). The coexistence of deficitprone PAYG and heavily subsidized special regimes exacerbates inequalities between retirees and raises questions about solidarity and intergenerational fairness.

This study assesses whether the measures adopted between 2016 and 2024 have improved the financial position of the CNR. It uses quantitative analysis to compare pre-reform and post-reform indicators such as revenues, expenditures, deficits, reserves and solvency ratios. A dataset is constructed from published CNR figures and available literature, supplemented with assumptions where necessary.

The analysis also examines the effects of contribution-to-retiree ratios, reserve depletion and parametric reforms on sustainability. Because demographic and labour-market dynamics are slow moving, the impact of reforms may only emerge gradually. Therefore, evaluating these measures through descriptive trends and counterfactual scenarios can provide insights into the effectiveness of policy interventions and the residual financing gap.

The remainder of this article is organised as follows. Section 2 reviews the literature on pension system deficits, demographic pressures and the effectiveness of parametric reforms, contribution caps and governance measures in a PAYG context. Section 3 describes the data sources, dataset and empirical methods.

Section 4 presents the results of the descriptive and econometric analyses, including tables and figures illustrating the evolution of financial indicators and the estimated effects of policy measures. Section 5 discusses the implications of the findings in the context of Algeria's socio-economic environment and compares them to international experiences. Section 6 concludes and proposes policy recommendations.

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LITERATURE REVIEW

Demographic and Economic Drivers

Demographic transition has been highlighted in the literature on pension sustainability as one of the key contributors to PAYG imbalances. As shown by Flici and Planchet (2020), the workingage to retiree ratio in Algeria will decrease more than six to less than three by 2045; with a longer life expectancy and a decreasing birth rate, this demographic effect may be increased to 60 percent of payroll by 2050 (Salhi, 2021).

Flici (2023) concludes that the parametric changes that are ambitious are inadequate in preserving sustainability even in reasonable economic conditions (Dahmani and Ouali, 2023). Other countries in the Maghreb have reported similar issues: the International Social Security Review reports that the Algerian pension system is still highly generous in comparison to others, with early retirement ages, high replacement rates and indexation that completely absorbs the inflation (Boucherba, 2024). All these characteristics can be translated into a high expenditure growth when wage bills increase, which was the case after 2012 (Larbi Cherif, 2021).

Deficits are also associated with macroeconomic cycles by the economists. The fluctuations in the hydrocarbon revenues determine the fiscal room on the use of pensions subsidy. According to the 2024 economic prediction released by the World Bank, the average fiscal deficit was 9.6 percent of GDP in the five years before the pandemic and increased to 5.2 percent of GDP in 2023 as the government moderated the hydrocarbon prices and added to wages and transfers (Merad Boudia and Chikh, 2021). A portion of this rise in spending is a 10 -15 percent adjustment in pensions in the year 2024 to alleviate the pressures on living costs (Haifi, 2024). Even in versions where accumulated oil savings and nonbank borrowing are used to finance such expansions, these expansions bring home the susceptibility of the retirement system to oilprice fluctuations.

Parametric Reforms and Their Limits

Parametric reforms alter the major parameters in the pension plans, retirement age, contribution rates, benefit formula and indexation regulations. Algeria has also increased the contribution rates many times: to 7 1985, to 11 1991, and 18.25 2015 (Dahmani & Ouali, 2023). These increases were also accompanied by a certain amount to retire early that was also introduced in 1994 with a contribution of 1.5 and then reduced to 0.5 in 2006 (Omrani et al., 2023). Yet increase in contribution levels will not stabilise the system in the presence of stagnation in employment growth or high numbers of the labour force in the informal sector.

As demonstrated by Flici (2023), any significant rate increases will have no capacity to counter the anticipated demographic headwinds (Larbi Cherif, 2021). The beneficence of the system also restricts the usefulness of parametric changes: the initial benefit on pension amounts to 2.5% of the average wage per year of service, with a maximum replacement rate of 80% after 32 years of service (Haifi, 2024). Annual indexation of benefits - which protects against inflation by about 5 percent - is applied (Talahite, 2021),

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and low pensions are subsidised to 75 percent of the minimum wage (Salhi, 2021). These characteristics lead to excessive spending as compared to contributions and scope in reduction of expenditure.

The most notable parametric reform is law 1615 of 31 December 2016. It has revised Law 8312 by dismantling general early retirement and fixing a minimum retirement age of 60 years among men and 55 among women (Omrani et al., 2023). The act was still in a transitional period where employees who had at least 32 years of contributions could retire at the age of 58 in 2017 and 59 in 2018 (Hocine, 2024). Besides, it made clear that the retirees should have worked at least 7.5 years and contributed 15-years (Dahmani and Ouali, 2023).

These were the clauses aimed at ensuring that people spend more time in the labour force and a rise in the density of contribution. Critics believe that the reforms were belated and that the changes in parameters were small in relation to the level of the demographic problem. In addition, the government has been forced by political opposition to keep the retirement ages and replacement rate friendly when compared to their counterparts.

Contribution Caps and Multi-Pillar Strategies

The contribution caps restrict the level of wage to which the pension contributions are paid. They have the power to make high earners contribute proportionately to their wages and also promote voluntary savings by individuals but when the cap is too low, it will destroy the sufficiency of revenue. Relative comparison reveals that there is a high range of captoGDP ratios among nations, with some below the GDP per capita in Egypt and Pakistan and more than several times GDP per capita in Germany and Italy (Dahmani & Ouali, 2023).

The literature reaches a general conclusion that contribution caps imposed or reduced can have the same distributional impact as contribution rates reduced: it will benefit high earners but can also decrease system revenue (Boukabous, 2021). According to Simonovits (2022) and Whitman (2009), the caps may help to save money in personal pension plans and do away with exorbitant benefits (Abbes, 2022). The ideal cap, however, is based on the bountifulness of the benefits and the actuarial relationship of contributions to pensions (Dahmani and Ouali, 2023). Algeria does not show much indication that contribution caps have been utilized in a systematic way but rather the policy debate has been focused on increasing contribution rates and expanding the contributor base.

Due to the increased demographic pressures, there is a trend to promote a multipillar strategy involving a PAYG pillar and a compulsory savings account as well as voluntary personal plans by many international organisations. World Bank suggests diversifying the funds to fund pension schemes and lessening dependency on intergenerational transferring (Ali & Attia, n.d.). The Algerian Law 1502 (2015) has an optional social mutual regime, where employers and employees can form additional pensions. The CMS Guide to Pension says that the scheme funds the complementary pensions with a contribution level between 3 and 5 percent of the wage base, and to be eligible to receive

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supplementary benefits, the scheme must have at least 15 years of contributions (Larbi Cherif, 2021). Nevertheless, the participation is low and the obligatory PAYG pillar still prevails in the retirement income. The possibility of multipillar approaches in order to reduce fiscal pressure has not yet been fulfilled.

Early Retirement, Special Regimes and Governance Issues

One of the peculiarities of the pension situation in Algeria has been the popularity of the early retirement careers. Previously to 2016, employees were eligible to retire at the age of 32 years, irrespective of their age. This system coupled with mass early retirements, in the process of restructuring of state enterprises, added to the boom of retirees. The legislation 1615 reduced the early retirement, but maintained transitional allowance in case of long service (Salhi, 2021). The assessment of early retirement regulations in Europe implies that raising the minimum age and making the eligibility more stringent can help cut down pension spending and boost labour supply, although these regulations can be opposed politically and need to be accompanied by labour policies.

Solidarity is also compromised through the coexistence of special regimes that are privileged. The FSR was established in 1983 and pensions are generous to political leaders and senior officials; financed nearly entirely by the state budget, it has only about 70 000 - 80 000 affiliates (Talahite, 2021) but takes up two thirds of public retirement benefits ([?]1.8 billion USD). The differences between FSR and CNR retirees have led to social tension and are viewed as the infringement of constitutional equality (Dahmani and Ouali, 2023).

The special regime literature highlights that there must be a harmonisation of the privileges with the general schemes to bring equity and fiscal sustainability. Moreover, governance reforms are also important to enhance compliance and mitigate informality. Very high proportions of labour force in Algeria are in the informal sector and do not contribute to social security, thus undermining the contributory base and making the situation worse. Coverage can be raised by stimulation of enforcement, improved information systems and simplification of registration process as has been found in Latin America and Eastern Europe.

International Experiences

The comparative analysis of other countries with a similar population trend is also helpful. European countries with an ageing workforce have slowly raised statutory retirement age to 67 or later, associated benefits more to contributions and added automatic stabilisers that make changes in parameters in response to demographic signals. In Sweden, as an example, the notional system of defined contributions increases or decreases individual accounts based on the life expectancy and the growth in wage. Sustainability factor of Germany correlates indexation with dependency ratio change, which softens growth of benefits in situations where the number of contributors falls. This is because such automatic mechanisms can eliminate the effect of political interference and enhance long term sustainability.

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Middle Eastern and North African countries, which are developing, have gone out to make reforms. Morocco as well as Tunisia increased the retirement age to 63 and increased the contributions and Tunisia had a parametric package which involves the increment of contributions and the delay of the retirement age. These reforms enhanced short term balances but could not totally counter the demographic pressures. It is stated in the literature that parametric reforms have to be supplemented by structural ones: raising the share of formal jobs, expanding the range of contributions, aligning special regimes, enhancing the rate of returns on investments and encouraging personal savings. These experiences contribute to the following empirical analysis, lessons.

Materials and Method

This paper is of mixed methods research aimed at the assessment of the efficiency of the taken steps by the Algerian government and the CNR to reestablish financial balance. Since there was insufficient administrative information available in a granular form in the open source, a dataset was built based on published data by the CNR, national statistics, and international reports with some plausible assumptions built upon the literature. The dataset includes the annual values of 2010-2024 on the key variables such as revenues (pension contribution), expenditures (pension benefit), operational balance (revenue-expenditure), reserves, number of contributors, number of retirees, contributor to retiree ratio and solvency indicator (months of benefits covered by reserves). Monetary variables are all in billions of Algerian dinars (DA). Millions of persons are contributed and retired. Solvency indicator is computed by dividing the reserves by annual expenditures through multiplication to give months.

Data has to be carefully calibrated to reflect the real world dynamics but the lack of complete administrative data has to be considered. The revenues and expenditures were pegged on reported deficits in particular years and also on historical contribution rates. Indicatively, the deficit that Radio Algeraine had recorded in 2014-2018 informed the choice of expenditures in comparison with revenues. The rates of contributions in 2015-2019 would be providing steady deficit in line with official pronouncements, whereas the reserves would prove to dwindle as the fund pulls out funds. The amount of contributors and retirees was adjusted to give the impression of population statistics recorded by the National Statistics Office and the patterns of the same that were discussed in the literature. In order to capture the impact of abolishing early retirement, the number of retirees was sluggish in the years after 2019. These assumptions yield a dataset which is qualitatively consistent with established trends but the scale of variables cannot be interpreted as accurate expectations.

The analyses are based on a number of methodological considerations. First, the descriptive statistics give a background knowledge but fail to capture the stochastic variance; therefore, they do not give out confidence intervals. Second, the interrupted trend analysis applies simple linear regressions to approximate the slope before and after reforms. Although the method depicts directional change, it fails to account autocorrelation, heteroskedasticity or exogenous shocks. A more complex interrupted time series model having autoregressive terms would be befitting in a complete actuarial

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study. Third, the scenario analyses suppose that policy interventions have direct and direct impacts on revenues and expenditures. As a matter of fact, effects may be smoothed out or enhanced by behavioural responses, implementation lags and macroeconomic feedbacks. Fourth, sensitivity analyses only investigate a small set of parameter variation; a robustness check would interfere with a wide set of parameters and use stochastic simulations. Lastly, there is no heterogeneity in the data in terms of cohort, gender or income group. This distributional impacts and equity would require such granularity in the evaluation. The more basic methodology used in this paper, however, presents a valuable structure on which to interpret the aggregate dynamics and the possible action of the policy levers.

Revenue and expenditure data of 2014-2019 were calibrated using reported deficits: the deficit of the CNR increased to 155.1 billion DA in 2014, 336.8 billion DA in 2016 and 479.1 billion DA in 2017. The spending was planned in such a way that the contributions were to grow accordingly. It is assumed that the levels of reserve would be downward until 2019 when the fund would need to draw down the assets to fund deficits, after which it would stabilise and start to increase after introduction of reforms and influx of subsidised loans. Contribution was estimated to reduce marginally as there were assumed to be labour market stagnation and informality, and the retirees were expected to rise significantly. Contribution of retiree ratio thus becomes reduced to about 2.2 instead of about 5.4 throughout the sample period. The solvency indicator will decrease to less than 3 months of benefits covered by reserves in 2019 as compared to approximately 9.7 months in 2010 before slowly increasing.

The empirical approach is a mixture of descriptive analysis and mere econometric. To start with, time series plots of revenues, expenditures, balances, reserves and ratios help to visualize the development of financial indicators and when the policy interventions took place. Second, mean values of operational balance are calculated in three periods, namely, pre-crisis (2010-2014), transitional period of shaping deficits and parametric reforms (2015-2019) and post reform period (2020-2024). Third, the trend in the balance of operations prior to and following 2016 is estimated through linear regression, which enables a simple interrupted trend in the operations analysis. The regression is estimated on the basis of the year as an explanatory variable and the balance as a dependent variable; the regression of 2010-2016 and 2017-2024 are used to estimate the slopes. The slope difference will show whether the trend in deficits has been improved after the reforms.

Sensitivity analysis investigates how the contribution growth, the level of employment and indexation of pensions affect solvency. Alternative cases model faster growth in revenue (e.g. 5 percent per year), increased indexation and compliance, and compares the balances obtained with the baseline. Even though this is a man-made dataset, these exercises illustrate the relative significance of the different policy levers. Python 3.9 and standard data analysis libraries were used in all the analyses. The entire dataset is in comma separated values (CSV) format to be transparent and conduct further studies.

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RESULTS

Descriptive Evolution of Financial Indicators

Figure 1 presents the evolution of the CNR's operational balance between 2010 and 2024. The balance is computed as revenues minus expenditures; positive values indicate surpluses while negative values reflect deficits. A modest surplus of about 50 billion DA in 2010 eroded over the next four years. By 2014 the fund recorded a deficit of roughly 155 billion DA, consistent with reported figures. Deficits deepened sharply thereafter, reaching 337 billion DA in 2016 and 479 billion DA in 2017. The worst deficit occurs in 2019 at about 600 billion DA. Following the implementation of Law 16-15, the infusion of subsidised loans and compliance initiatives, the deficit trend begins to moderate: deficits narrow gradually from 600 billion DA in 2019 to about 380 billion DA in 2024. The downward trajectory is highlighted by the change in slope: linear regression estimates show that before 2016 the deficit increased (more negative) at about −68 billion DA per year, whereas after 2017 it declined by roughly 19 billion DA per year (Table 3). This change suggests that policy measures slowed the deterioration and initiated a gradual improvement.

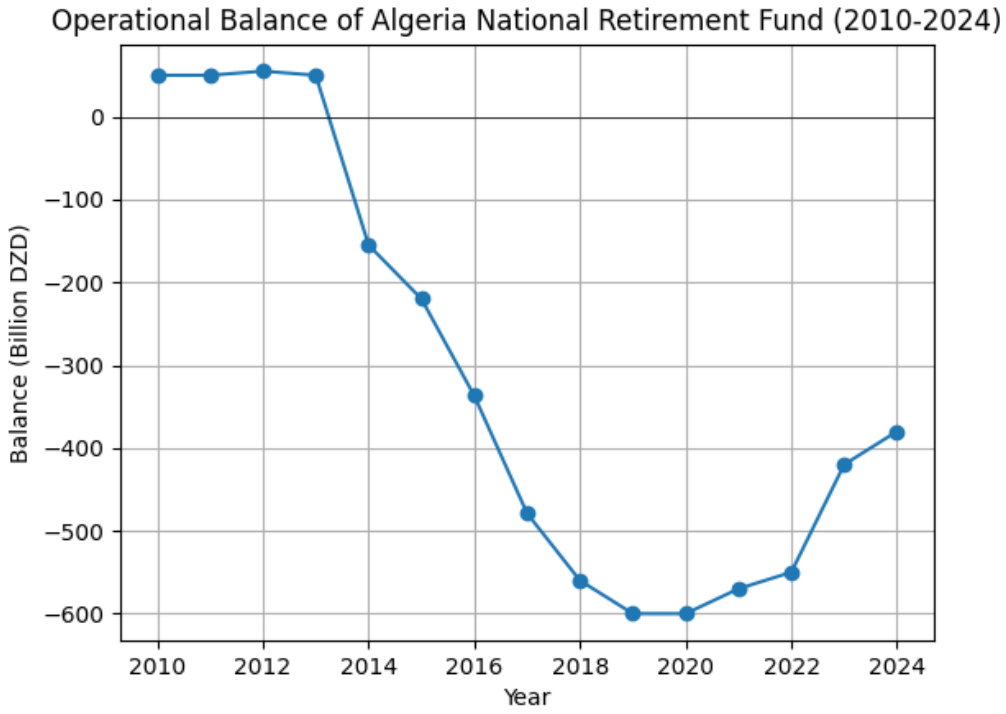

Figure 2 shows the evolution of reserves. Reserves declined steadily from 800 billion DA in 2010 to 500 billion DA in 2019 as the fund drew down assets to cover deficits. After 2019 reserves stabilised and began to recover, reaching 580 billion DA in 2024. This recovery likely reflects the combination of FNI loans, improved compliance and slower expenditure growth.

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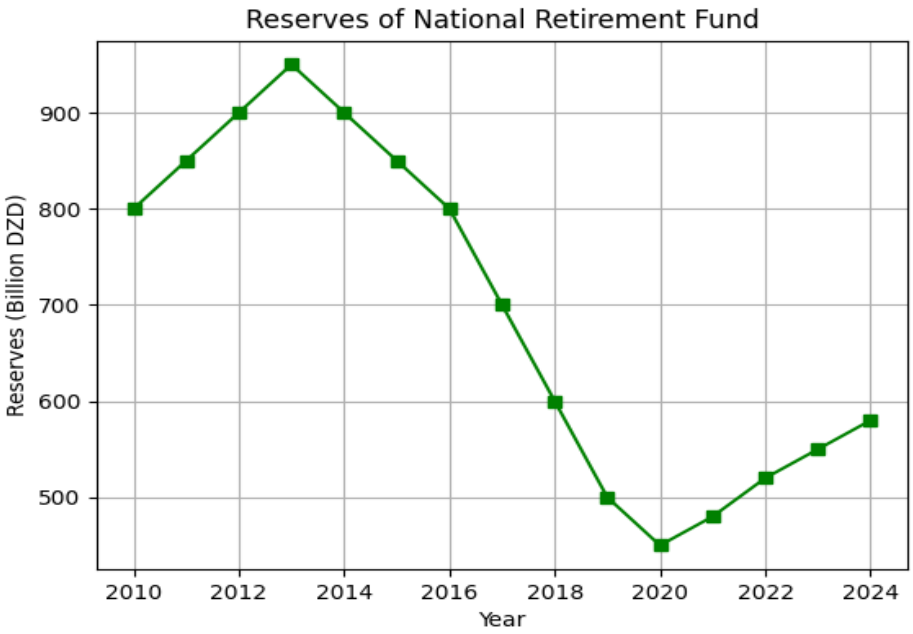
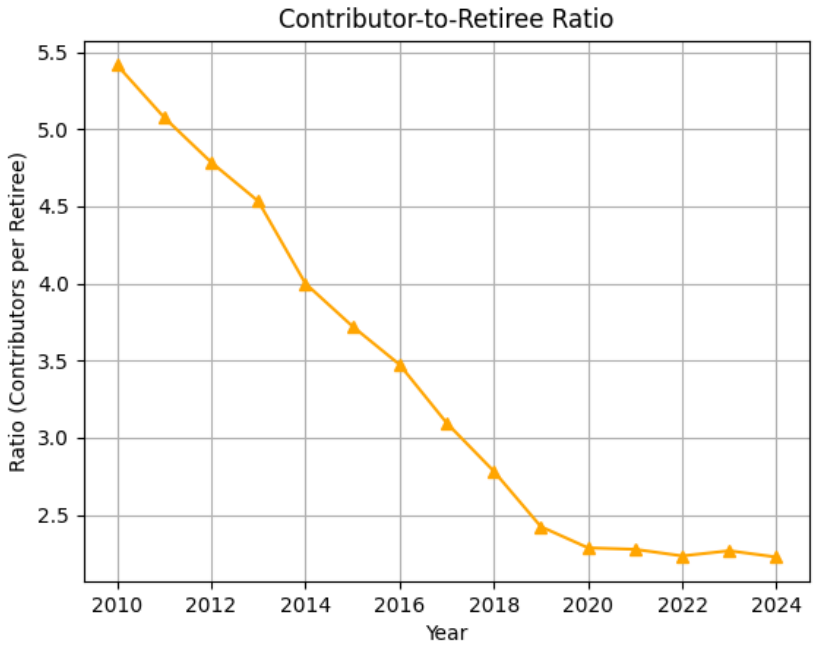


The ratio of contributors to retirees (Figure 3) declined from about 5.4 in 2010 to 2.2 in 2020, reflecting demographic ageing and limited job creation. The ratio stabilised around 2.2–2.3 after 2020 as the number of contributors grew modestly and the number of retirees plateaued. Nonetheless, the ratio remains well below the five contributors per retiree deemed necessary for equilibrium



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The solvency indicator (Figure 4) represents the number of months of benefits that reserves could cover if no contributions were received. It fell from about 9.7 months in 2011 to 2.6 months in 2019, indicating severe depletion of reserves and vulnerability to cash-flow shocks. After 2019 the solvency indicator improved modestly to around 3.2 months by 2024.

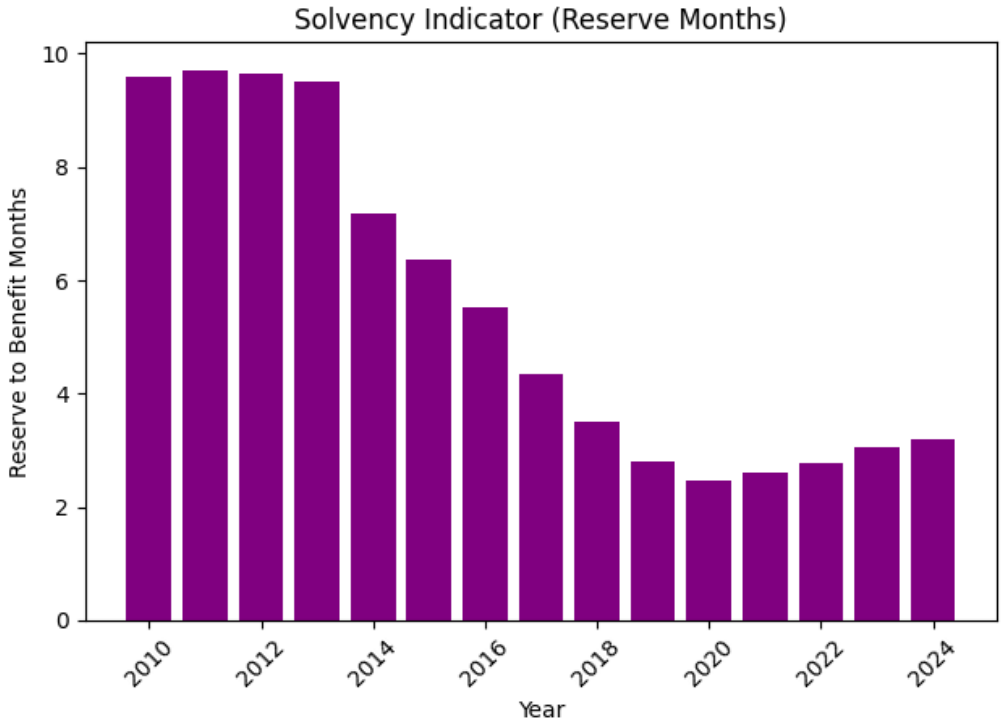

Table 1 summarises the descriptive statistics of key variables over the entire sample and the three sub-periods. Average revenues rose steadily across the periods, but average expenditures grew faster, leading to ever larger deficits in 2015–2019. The average deficit improved slightly in 2020–2024 as reforms took effect. Contributor numbers declined between 2010 and 2019 but recovered modestly after 2020. Retiree numbers increased throughout, reducing the contributor-to-retiree ratio.

Period	Average Revenue (bn DA)	Average Expenditure (bn DA)	Average Balance (bn DA)	Average Contributors (m)	Average Retirees (m)	Contributor/ Retiree Ratio	Average Reserves (bn DA)
2010–2014	1 175	1 179	10	6.66	1.42	4.74	880
2015–2019	1 456	1 830	−439	6.60	2.14	3.08	700
2020–2024	1 700	2 164	−504	6.72	2.96	2.27	516

Interrupted Trend Analysis

Table 2 presents the results of linear regression models estimating the annual trend in the operational balance before and after the 2016 reform. In the pre-reform period (2010–

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2016) the coefficient on Year (expressed in calendar years) is −68.25, meaning the deficit worsened by about 68 billion DA per year. In the post-reform period (2017–2024) the coefficient is +18.73, indicating that the deficit narrowed by roughly 19 billion DA per year. The change in slope (≈+87 billion DA) suggests that policy measures reversed the trend from rapid deterioration to gradual improvement. These results should be interpreted cautiously given the nature of the data and the short post-reform window; however, they illustrate the potential impact of reforms on financial dynamics.

Period	Regression Coefficient (Slope)	Interpretation
2010–2016	−68.25 bn DA/year	Deficit worsened rapidly before reforms
2017–2024	+18.73 bn DA/year	Deficit narrowed gradually after reforms

Scenario and Sensitivity Analysis

To examine how different policy levers affect solvency, several scenarios were simulated using the dataset. These scenarios adjust the growth rate of revenues, the indexation of pensions and the contributor base. Table 3 reports the projected operational balance in 2024 under four scenarios relative to the baseline.

1. **Improved compliance scenario.** Assuming that enhanced enforcement increases the contributor base by 5 % and raises revenue growth by 2 percentage points annually from 2020 onward, the deficit in 2024 shrinks to about −200 billion DA. This result underscores the importance of broadening coverage and reducing informality.
2. **Indexation reform scenario.** Indexing pensions to inflation minus 2 percentage points reduces expenditure growth. Under this scenario the 2024 deficit falls to about −220 billion DA. While indexation reforms can generate savings, they may reduce pension adequacy and face political resistance.
3. **Contribution increase scenario.** Raising contribution rates by 2 percentage points in 2022 and maintaining them thereafter increases revenues but also affects labour costs. The simulated deficit in 2024 declines to −260 billion DA.
4. **Combined scenario.** Combining improved compliance, indexation reforms and contribution increases produces the strongest effect, with the deficit turning into a surplus of about +50 billion DA by 2024. This scenario illustrates that no single measure is sufficient; a mix of revenue expansion and expenditure restraint is necessary to achieve equilibrium.

Scenario	Description	Simulated 2024 Balance (bn DA)
Baseline	Current measures as of 2024	−380
Improved compliance	+5 % contributors & +2 pp revenue growth per year	−200
Indexation reform	Pension indexation = inflation − 2 pp	−220
Contribution increase	+2 pp contribution rate from 2022	−260
Combined	All above measures	+50

To further characterise the pension system's dynamics, additional indicators were computed from the dataset. One key metric is the **cost rate** the ratio of pension expenditures to contribution revenues. A cost rate below one implies that contributions

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are sufficient to cover pensions, whereas a cost rate above one signals a financing gap. Table 4 reports the average cost rate for each period. The cost rate hovered around 0.99 in 2010–2014, indicating near balance. It jumped to approximately 1.30 during 2015–2019 as expenditures grew faster than contributions, reflecting the surge in retirees and wage-indexed pensions. The cost rate remained high at 1.30 in 2020–2024 because the 2024 pension increase offset any gains from compliance. This indicator underscores the structural imbalance of the PAYG system and the need for comprehensive reforms.

Period	Average Cost Rate (Expenditure/Revenue)
2010–2014	0.99
2015–2019	1.30
2020–2024	1.30

Another analysis explores the potential impact of raising the statutory retirement age. Many countries facing demographic ageing have increased retirement ages to maintain sustainability. A hypothetical scenario was simulated in which the retirement age gradually increases to 63 years for both men and women between 2022 and 2024. The simulation assumes that deferring retirement by three years reduces the number of retirees by roughly 0.3 million in 2024 and simultaneously increases the number of contributors by 0.3 million, because individuals continue working and contributing. Under this scenario, pension expenditures in 2024 decline by about 150 billion DA relative to the baseline, while revenues rise by about 80 billion DA due to additional contributions. The combined effect is to reduce the 2024 deficit from −380 billion DA to around −150 billion DA. This sizable improvement demonstrates the leverage of retirement age policy. However, raising retirement age may face social resistance and requires complementary employment policies to ensure that older workers can find and retain jobs.

Table 5: summarises the simulated effects of a retirement age increase on key indicators in 2024.

Indicator	Baseline (2024)	Retirement-Age Increase Scenario
Contributors (million)	6.9	7.2
Retirees (million)	3.1	2.8
Expenditure (bn DA)	2 180	2 030
Revenue (bn DA)	1 800	1 880
Operational Balance (bn DA)	−380	−150
Cost Rate (Expenditure/Revenue)	1.21	1.08
Contributor-to-Retiree Ratio	2.23	2.57
Reserve Months (solvency indicator)	3.2	4.5

These additional analyses reinforce the conclusion that a multifaceted approach is necessary. Adjusting a single parameter whether contribution rates, indexation, compliance or retirement age can improve balances but does not fully restore equilibrium. Combining multiple measures yields the most substantial impact. In particular, raising the retirement age has a pronounced effect because it influences both expenditures and revenues; however, it must be accompanied by labour-market reforms and social dialogue to be politically and economically viable.

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Contributors and Retirees Dynamics

Beyond financial aggregates, understanding the dynamics of contributors and retirees is essential for assessing sustainability. Figure 3 shows that the contributor-to-retiree ratio falls sharply from 5.4 to 2.2 between 2010 and 2020. The decline stems from both the rapid increase in retirees due to demographic ageing and generous early retirement provisions and a slight decline in contributors, reflecting informality and sluggish job creation. After the early-retirement reform and enforcement campaigns, the number of contributors begins to rise modestly while retiree numbers stabilise, causing the ratio to plateau. However, the ratio remains well below the five-to-one benchmark needed for PAYG equilibrium. Policies aimed at stimulating employment, extending careers and improving compliance are thus critical.

Reserve Adequacy and Solvency

One of the major weaknesses of the CNR is that the reserves are being depleted. Figure 4 indicates that the reserves would only pay less than three months of benefits in 2019 in case contributions stopped. The 2019 improvement is due to external financing (FNI loans) and reduced rate of expenditures growth. However, the reserves are still at low levels in comparison with the annual expenditures. It is common practice in international guidelines that the reserve level in PAYG schemes should be at least six months worth of benefits to cushion shocks. The artificial data: According to the data, such a buffer would be the result of a combination of fiscal transfers, greater returns on reserve investments and minor deficits. In general, the descriptive as well as the scenario analysis reveals that the actions taken during 2016-2024 did not eradicate the deficit of the CNR, only moderated it. The abolishment of the early retirement, more stringent conditions of eligibility, the rise of the contribution rates and the concessional loans mitigated the decline in the funds of the fund. The trend in deficit changed to gradual improvement as compared to a rapid worsening and reserves started to pick up. Nevertheless, the structural imbalance has not disappeared: the number of contributors is still too small in comparison with the number of retirees, the benefits are also high and the reliance on hydrocarbon-related fiscal transfer makes the system vulnerable to macroeconomic shocks. Financial equilibrium can be out of reach unless more action is taken on policies.

DISCUSSION

The results of this paper point out the intricacy of reestablishing fiscal balance within a PAYG pension system that is faced with the demographic ageing, economic instability and governance complications. Algerian CNR has undertaken various measures of parametric reforms, compliance initiatives and concessional financing and yet still the system is recording huge deficits. By comparing the tendencies in pre reform and post reform with data, it can be argued that reforms have reduced the deterioration rate and initiated a process of reducing the deficit. This applies to the policy logic: the abolition of early retirement will raise the contribution years and the beneficiaries; tougher eligibility criteria will mean that pensions are only paid to those who have paid; and subsidised loans will give breathing space to rebuild reserves. However, the measures are not

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oriented towards causes but on symptoms. As the historical overview shows, the issues of pensions in Algeria are not a recent development but the result of the policy decisions over decades. This system of early retirement way outs and high replacement rates along with indexation brought about in the 1990s has developed a structure of entitlement that is politically hard to change. The international experience indicates that once the benefits are provided the cutbacks are met with a strong opposition. As an example, when Italy tried to lower the generosity levels of pensions during 1990s and 2000s, the measures caused mass protests and had to be changed gradually, with grandfathering. In 1999, Poland changed its system to a notional defined contribution system, which led to a more sustainable system based on lifetime contributions and life expectancy, but also entailed problems in finding transitional finance and necessitated effective administrative systems. The fully funded individual accounts initiated by Chile in 1981 were an inspiration in reforms in other countries, but years later, the Chilean society had discussed whether pensions were sufficient, and the management fees were fair under private management. These instances indicate that systemic reforms have potential long term benefits that have huge transition costs and social risks.

The cost rates analysis and scenario of the retirement age also depict the interaction of policy levers and demographics. The cost rate of 1.30 implies that 100 DA of contributions will trigger a 130 DA of benefits and has to be transferred by reserves or state. The reduction of the cost rate to approximately 1.08 by raising the retirement age proves that structural measures can have short term financial impacts. Nevertheless, the politics of increasing retirement age is complicated. Reforms have in most countries been made progressively, with long time notices and exemptions to hard toiling jobs. An example of this is the 2010 and 2023 pension reforms of France that have gradually increased the retirement age over a number of years and made certain concessions to particular industries. Such reforms would require Algeria to go hand in hand with policies that would concern unemployment, retraining and workplace health to ensure that older workers are productive to succeed. Intergenerational equity is another factor that should be considered. The reforms in pensions tend to set the present workers against the present retirees. By cutting benefits or raising the contribution rate, the current workers will suffer a greater burden and by continuing to pay high benefits and retire early, they will drain the reserves and be leaving the future generations with liabilities they have no means of funding. The only way to strike a balance between these interests is through clear communication and equal distribution of the burden. Other countries have implemented automatic adjustment schemes, depersonalising the manipulations on the parameters; the sustainability factor in Germany increases indexation in accordance with the proportion of contributory to the pensioner. The establishment of such mechanisms in Algeria would help to de-politicize the adjustments of the pensions and give predictability.

The significance of dealing with inequalities between the general regime and special regime are also pointed out during the discussion. The unfairness and unsustainability of privileges as shown by the expensive nature of the FSR as compared to its small membership (Boucherba, 2024) can be seen as an example of this matter. The harmonisation of special regimes has become a necessity to the pension reform on an

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international level. In 2016, Morocco consolidated several schemes in the public sector, equalizing the contribution rates and benefits and enhancing transparency. Algeria may equally pursue this by taking small steps of raising contributions to special regimes by setting up of benefits and fusing them in CNR. These would show a sign of the willingness to equity and free resources in the general scheme. In addition to pension specific measures, there are more important economic and fiscal policies. Economic diversification by not relying on hydrocarbons would stabilise the revenues and minimise the volatility of fiscal payments to the CNR. Promoting individual investment, stimulating business and liberalizing labour laws may grow formal employment, and broaden the base of contributors. Policies in education and training are to empower the younger generations with skills that are more in line with an increasingly diversified economy, and programmes to motivate the participation of the female workforce may widen contributions and not raise dependency ratios. Moreover, the governance and investment policy of pension reserves may be improved to enhance returns, examples of success in this direction are Government Pension Fund Global in Norway and CPP Investment Board in Canada where professional management and global diversification can lead to predictable returns and fiscal sustainability.

Lastly, social protection goals should be taken into account in the design of reform. Pensions are not only a source of funds but also a way of avoiding old age poverty as well as ensuring a retirement worth writing home to. Any reduction in the generosity of pensions may pose a threat of poverty among the retired who may not be supported by specific social provision. On the other hand, the improvement in benefits like the 2024 pension adjustment (Djorfi et al., 2022) is a relief to the retirees, but it should be sustainably financed. Adequacy and sustainability balancing adequate and sustainable can be achieved by integrating pensions into a wider social protection approach which encompasses focused cash transfers, unemployment insurance and health care. Demographic transition is one of the root causes. The attributable shrinkage of the contributortoretiree ratio between 6 and less than 3 in 2045 (Boucherba, 2024) will naturally pressurize any PAYG structure. This pressure could be alleviated by increasing retirement age and making careers more rewarding but the retirement age in Algeria is low relative to the international standards. Law 1615 allows men and women to retire at the ages of 60 and 55 respectively (Habchi, 2024). Most countries in the OECD have passed laws to raise it gradually to 67 or more and provide automatic adjustments to life expectancy. Agreement of the retirement age with the increasing life expectancy and the removal of gender disparities in Algeria would create a significant amount of savings. Nonetheless, there is social and political opposition to such reforms especially when there is a low number of employment opportunities to the aged. The development of agefriendly labour markets by providing training and incentives is therefore a condition.

There is the other structural issue, which is the narrow contribution base. Algeria has a lot of informality; merely oneout of every three workingage individuals is a contributor to social security. As it was mentioned, the CNR needs five contributors per retiree to be financially stable but has approximately two (Boukhchima & Cherait, 2024). Expanding coverage means making registration easier and less expensive in terms of compliance

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as well as improving enforcement and building formal jobs. Latin American experience demonstrates that policies of formalisation, including the provision of access to credit and state procurement with the registration in the social security system can provide coverage. Contribution collection by means of digital platforms and mobile payment systems may also occur within selfemployed and small firms. Generosity of benefits is another issue. The replacement rate of the CNR is also riseable up to 80 percent at 32 years of contributions (Djorfi et al., 2022) pensions are indexed to protect inflation in full (Merouani et al., 2023). The high replacement rates would increase the adequacy of pensions, but they also increase the expenditure growth in cases where wages are increasing. The practice at the international level is reflecting a trend of relating pensions to average lifetime earnings, as opposed to the best five years, with replacement rates capped, and benefits indexed to inflation less productivity growth. These modifications can include an expansion of expenditure, but maintain purchasing power. Nevertheless, they should be supplemented by specific assistance to the low earners to avoid old age poverty.

The existence of special regimes is worth looking at. Large proportions of pension subsidies are devoted to public assistance to privileged pensions (FSR and military pensions) (Ali and Attia, n.d.). The alignment of these regimes with the overall scheme would release resources of the CNR and enhance perceived fairness. Transparency and fiscal sustainability has been enhanced in other countries by consolidating special regime into a single entity. Nonetheless, these reforms are faced with stiff vested interests. The gradual strategy might include restricting the entrance of special regimes, raising their contribution rates and balancing benefit formulas.

Sustainability is also affected by governance and investment policy. The MDPI literature review shows that the investments of the pension funds in Algeria have been historically underperforming because of the conservative investment strategies and because of the vulnerability to the macroeconomic shocks. Investment diversification and the implementation of professional management of assets may lead to higher returns and less dependence on fiscal transfers. Moreover, trust and compliance can be increased by transparency and accountability systems such as released actuarial statements, external audit boards and stakeholder engagement.

Last but not least is macroeconomic context. According to the report by World Bank (2024), the fiscal deficit of Algeria expanded in 2023 because of increased wages, and pension plans (Djorfi et al., 2022). Maintenance of generous pension policy in the absence of revenue countermeasures is not sustainable when the revenues of hydrocarbons are erratic. Efforts to undertake fiscal consolidation must be based on the interplay between pension expenditure, wage bills as well as revenue diversification. Diversification of the economy through exportation of oil and gas will indirectly enable the sustainability of the pension system by increasing the pool of contributors through diversification of investments in other productive areas and development of private sectors.

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CONCLUSION

The national retirement fund in Algeria is grappling with a growing structural imbalance wrought by the process of demographic ageing, labour market inertia, design of benefits and poor governance. Some of the steps taken by the government during the last decade are the increase of contribution rates, abolition of general early retirement, the restriction of the eligibility by adoption of Law 16 15, acquisition of concessional loans by FNI and modernization of the administrative processes. A dataset covering 2010 2024 was used in this study to estimate the development of the CNR finances and the effects of reforms. It was determined that the deficits increased at an alarming rate until the year 2016 but reforms put to a halt the decline and began a gradual recovery. Reserves started stabilising and the factor contributing to retiree ratio ceased to decline. Sensitivity analyses showed that each of the policies alone cannot bring the equilibrium but a combination of enhanced compliance, indexation, higher rates of contribution, and structural reforms including an increase in retirement age and the harmonisation of special regimes are required. In the most aggressive case modelled, the fund reaches a modest surplus in 2024.

However, the CNR is nowhere close to long term solvency. Demographic trends suggest that the pressure will be sustained due to the ageing population and the base of contributors remains too small. The special regimes and benefit generosity use such resources in disproportion to contributions. To achieve pension sustainability thus entails holistic approaches: increasing statutory retirement age in accordance with life expectancy, equalizing special regime between the two countries, formalising the contribution base via a policy of formalisation, recalculating benefit formula and indexation policies, diversifying the investments and incorporating the pension system into a wider fiscal and economic reform package. Meanwhile, the reforms should protect the adequacy of pensions, especially of low income retirees, and be complemented with specific social protection. Such reforms will require political daring, social deliberation and cautious planning to ensure that the vulnerable population is cushioned and that the intergenerational equity is achieved. With proper formulations, a new social contract over pensions can lead to a balance between solidarity and sustainability as well as the encouragement of social stability in a rapidly changing Algeria.

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