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# Sustainability of the French first pillar pension scheme (CNAV): assessing automatic balance mechanisms

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## ABSTRACT

In this paper, we apply two types of automatic balance mechanism (ABM) to the French first pillar pension system for private sector employees (CNAV). One is based on a tax gap ratio (TGR-ABM) and the other is the smooth ABM (S-ABM) developed by Gannon, Legros and Touzé (2013). Two long-run forecast scenarios over the period 2014–2063 are analysed. The first is optimistic (“benchmark”) and assumes a 4.5% unemployment rate and a 1.5% productivity growth rate in the long run. The second is more pessimistic (“prudent”), with a 7.5% unemployment rate and a 1% productivity growth rate in the long run. For the benchmark (respectively prudent) scenario, a TGR-ABM requires, now and for the next 50 years, a 2.8% (respectively 6.3%) decrease in pensions and a 2.9% (respectively 6.7%) increase in the tax rate. An S-ABM requires, for the benchmark (respectively prudent) scenario, an immediate 1.5% (respectively 3.6%) decrease in pensions and a 1.4% (respectively 3.5%) increase in the tax rate. In the long run (50 years), an S-ABM requires a 4.5% (respectively 9.1%) reduction in pensions and a 4.5% (respectively 9.1%) increase in the tax rate.

## KEYWORDS

pension scheme sustainability, automatic balance mechanism

## 1 INTRODUCTION

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The French pension system for private sector employees is based on two pillars. The first pillar is a basic social security plan (*Caisse Nationale d'Assurance Vieillesse, CNAV*). It is a pay-as-you-go (PAYGO) scheme that provides pensions on a defined benefit rule. The pension is proportional to the average wage computed over 25 years ("reference wage"), based on wages bounded by a maximum, called the "social security ceiling" (see appendix). The second pillar includes two additional schemes: ARRCO for all workers and AGIRC for executives. Both pay pensions on a defined contribution rule and are also pay-as-you-go pension schemes. These two pillars are operated under different rules. The CNAV is managed by the social security administration, whereas the second pillar schemes are managed by social partners, but some parameter changes of the complementary pension schemes (for instance, the pensionable age) are directly governed by the social security system.

Significant deficits in these plans stem from the current economic crisis (lower growth combined with higher unemployment). However, these deficits arose well before expected as a result of the ageing of population.

In France, pension reform is subject to a harsh political debate (Blanchet & Legros 2002), which often leads governments to adopt reforms only when they no longer have a choice. These ad hoc reforms (Turner 2009) induce inconsistency in the choice of pension funding. This blurs the planning of their future by different generations of workers because they do not know how their contribution rates and pension amounts will be changed. To tackle this problem, automatic adjustment mechanisms (AAMs) could be implemented, relying on rules (Turner 2009) that define how different pension calculation parameters must be adapted according to changes in observed variables (for example, life expectancy, consumer price index). When these adjustments fail to ensure financial sustainability, it may be wise to follow countries such as Sweden (Settergren 2001; Capretta 2006; Andrews 2008; Vidal-Melia et al 2009; Scherman 2011; Gannon et al. 2013; Sakamoto 2013) and to use an automatic balance mechanism (ABM).

This paper proposes to assess how the use of ABMs could guarantee the solvency of the CNAV.

Section 2 outlines CNAV's financial forecasts up to 50 years. Two scenarios will be analysed, one, optimistic; the other more conservative one. These will mainly be used in order to generate the data required for the second part of the paper.

Section 3 is dedicated to the use of ABMs. First, we present a way to address the issue of long-term credit through the concept of unfunded obligations, such as defined by the US Social Security administration, and the concept of tax gap ratio. Next, two types of ABM are used. One is based on a tax gap ratio (TGR-ABM), the other is an application of the smooth ABM (S-ABM) developed by Gannon et al (2013). Compared with using a tax gap ratio, using an S-ABM allows for a gradual adjustment in the contribution rates and the pension levels. However, the drawback of this implementation is that it distorts the principle of generational equality. In effect, the S-ABM relies on a parameter of public preference for present. That can be viewed as a kind of procrastination.

## 2 TWO SCENARIOS FOR THE FUTURE OF THE FIRST PILLAR PENSIONS SCHEME OF PRIVATE SECTOR EMPLOYEES (CNAV)

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Structurally, two main macroeconomic variables have significant impact on the solvency of CNAV pension scheme: the unemployment rate and the GDP growth rate. We briefly describe the mechanisms at stake and the forecast built on two scenarios.

Unemployment rate (Figure 1a) is usually thought to play a crucial role in financial balancing through the increase in contributions.

This is true in the short run, because receipts increase when the unemployment rate decreases but, in the long run, the net effect may be ambiguous. First, according to the Phillips curve (Phillips 1958), which historically shows an inverse relationship between unemployment and wage increase rates, a decrease in the unemployment rate implies an increase in wages. This, in turn, increases the short-run effect on overall contributions. Second, in the long run, pension liability depends upon careers and, therefore, lifelong wages. Then, pension liability increases as the unemployment rate decreases.

As far as France is concerned, the 2003 reform (see appendix for the details) puts an end to the independence of unemployment insurance and the pension system by stipulating that the surplus of

unemployment insurance (UI, hereafter) adds to the financing of the pension scheme, if required. This introduces a clear and positive relationship between the unemployment rate and the pension scheme balance.

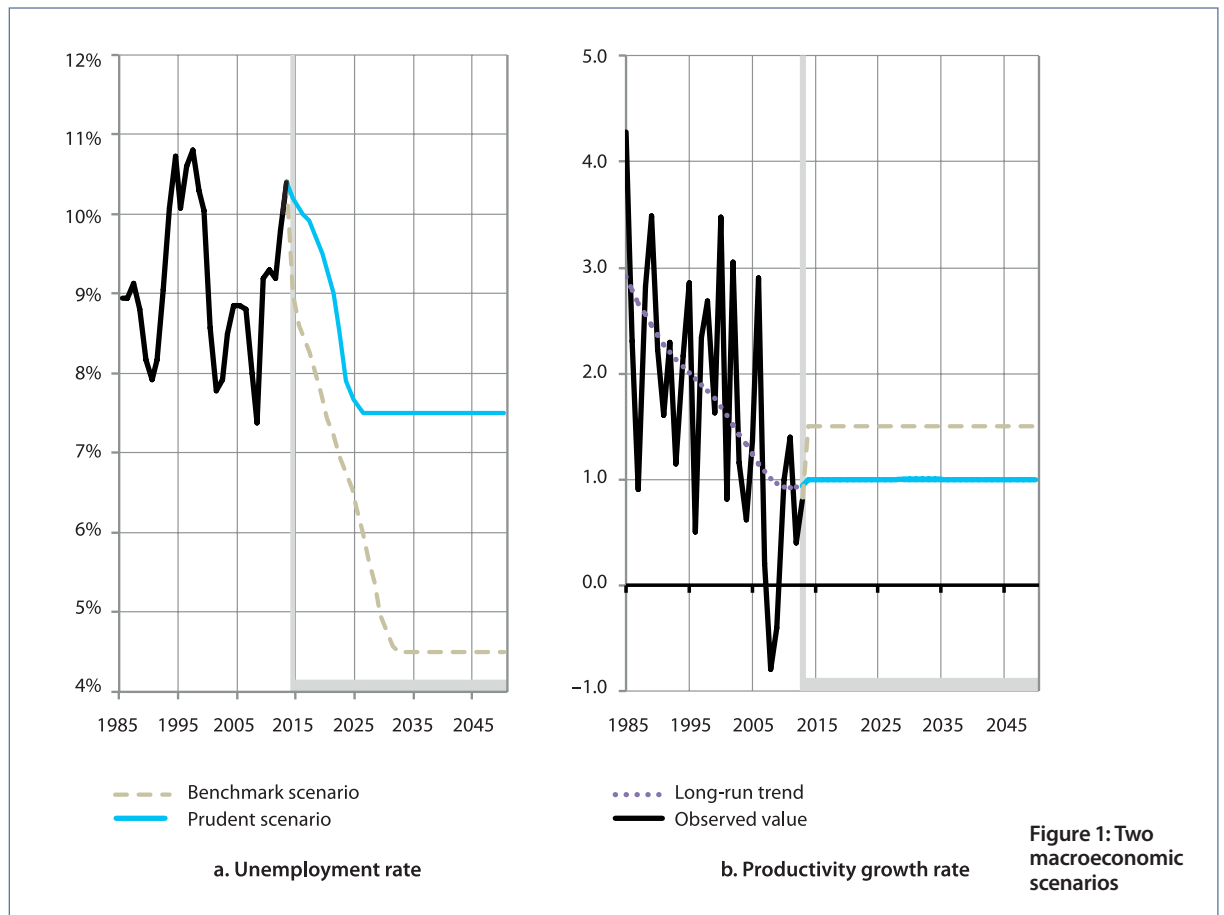
When the unemployment rate falls below a 7% threshold (Hamayon & Legros 2007), the UI generates a surplus. It follows that a wise forecaster should be cautious in his assumption of long-run unemployment rate, to avoid any overestimate of the pension scheme resource resulting from a possible UI surplus.

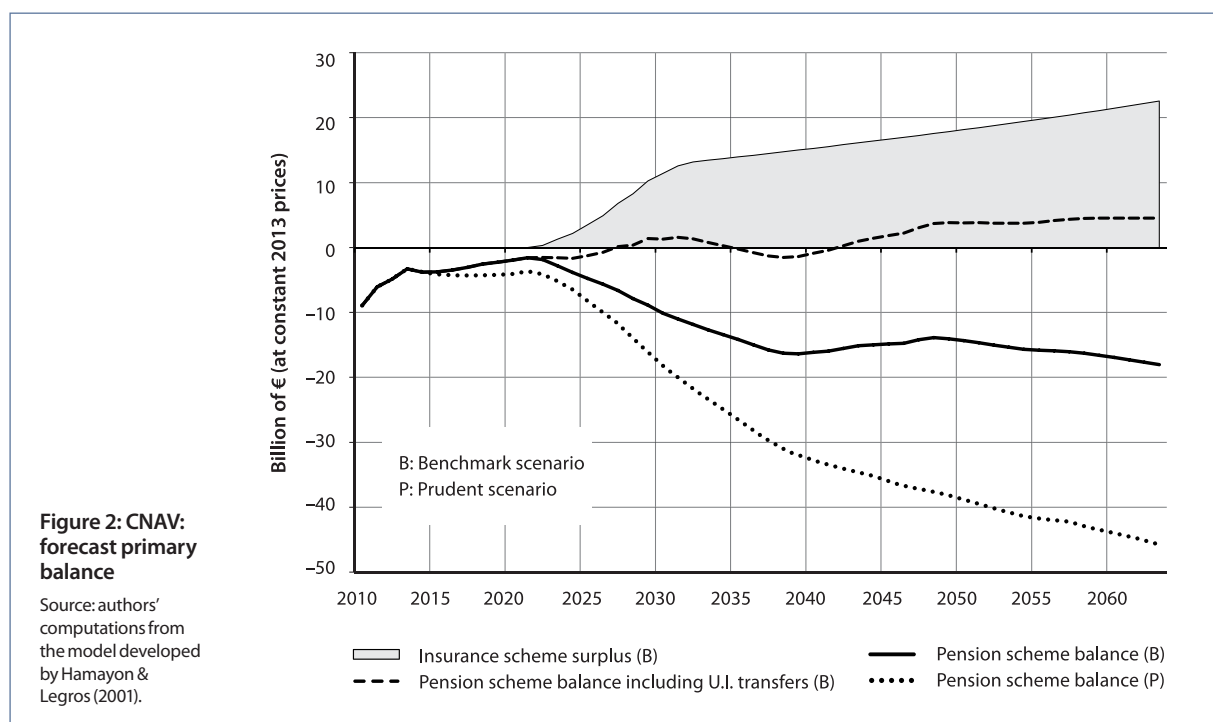
The economic growth rate (Figure 1b) is also a crucial variable. In the case of positive economic growth rate, expenditures grow less than receipts. This is due to the pension rules (see appendix): both the wages used for the “reference wage” and pensions are indexed on inflation and not on the economic growth rate. This indexing rule helps improve the balance of the pension scheme as soon as the nominal economic growth exceeds the inflation rate. The part played by the productivity growth rate (Figure 1b) to balance the pension scheme would be inoperative if the pensions and reference wages were indexed on the nominal wages (supposed to be indexed on the economic growth rate). However, with such a rule, retirees’ purchasing power would be maintained. In other words, when benefits are adjusted according to changes in the consumer price index, retirees pay an implicit tax, thus improving the pension scheme’s financial balance.

This paper suggests two scenarios, simulations of which are based on a demo-economic model with a detailed description of the French pension scheme (Hamayon & Legros 2001).

The first scenario (the “benchmark”) is based upon the double assumption of a low unemployment rate (4.5% after 2030) and a productivity rate of 1.5% (Figure 1). This scenario is similar to the government’s, which is worked out by the Conseil d’orientation des retraites (COR, Pension Orientation Council, which reports to the Prime Minister).

The second scenario tests an alternative and more conservative approach, described hereafter as “prudent” (Figure 1). It assumes that the unemployment rate will progressively reach 7.5% in 2030 and that the productivity growth rate will remain at 1% (as forecast by Artus & Caffet 2013). These different assumptions appear in Figure 1 showing that the “pessimistic” alternative scenario is directly determined by trend observation.





The results (Figure 2) are twofold and, of course, highly contrasted. First, the impact of the unemployment rate is confirmed. In the benchmark scenario (with a low unemployment rate), the sharp decrease – less than 7% – in the unemployment rate after 2020 leads to a large transfer from the unemployment insurance scheme towards the pensions: this transfer reaches 2.2 points of UI contribution, or 18 billion constant euros (B€).<sup>1</sup> The overall deficit of the pension scheme is nearly nil after 2020.

Second, in the case of a lower economic growth (and higher unemployment rate), the situation is far more pessimistic. The higher unemployment rate prohibits any transfer from the UI towards the pension scheme. The deficit of the basic pension scheme reaches 14.4 B€ in 2050.

Figure 2 summarises the results. In the benchmark scenario, the decrease in the unemployment rate allows a significant transfer from the UI towards the pension scheme (11.5 B€ in 2030 and 18.2 B€ in 2050), which pushes up the balance from the continuous bold line to the dotted one. In the “prudent” scenario, due to a higher unemployment rate, the transfers between the UI scheme towards the first pillar pension scheme are nil and the balance remains highly negative throughout the considered period.

Reading from these forecasts, our simulations provide both receipts and expenditures of the pension regime, to be used in the next section.

### 3 IMPLEMENTING AUTOMATIC BALANCE MECHANISMS

We define hereafter two central concepts to evaluate the long-run insolvency of the pension system: the “unfunded obligations” and the tax gap ratio. These measures are then used to build two examples of ABMs.

#### 3.1 Evaluating long-run solvency

##### 3.1.1 Notations

In this paper, for sake of simplicity, we present a non-stochastic approach to ABMs. All our computations are based upon given forecast values of receipts and expenditures. That means that the estimated adjustment variables must be considered as forecast values for the current period. That also means that these variables will have to be revised as the forecasts will adjust with time.

At the current period ( $t = 0$ ), forecast expenditures at time  $t$  are expressed by  $EXP_t$  with:

<sup>1</sup> Hereafter, B€ will denote billion constant 2013 euros.

$$EXP_t = E_0 \left( \sum_{j \in \Omega_t^R} P_{j,t} \right) \tag{1}$$

with  $\Omega_t^R$  a set of retirees at period  $t$  and  $P_{j,t}$  the pension paid to each individual  $j$ .

Forecast receipts at time  $t$  are expressed by  $REC_t$  with:

$$REC_t = E_0 \left( \tau_t \times \sum_{i \in \Omega_t^E} w_{i,t} \right) \tag{2}$$

with  $\Omega_t^E$  a set of employees at period  $t$ ,  $w_{i,t}$  the annual sum of monthly wages – below the Social Security ceiling – paid to each individual  $i$  and  $\tau_t$  the payroll tax rate.

### 3.1.2 The concept of “unfunded obligations”

The US Social Security administration defines the concept of “unfunded obligations” (denoted  $UO$  hereafter) as:

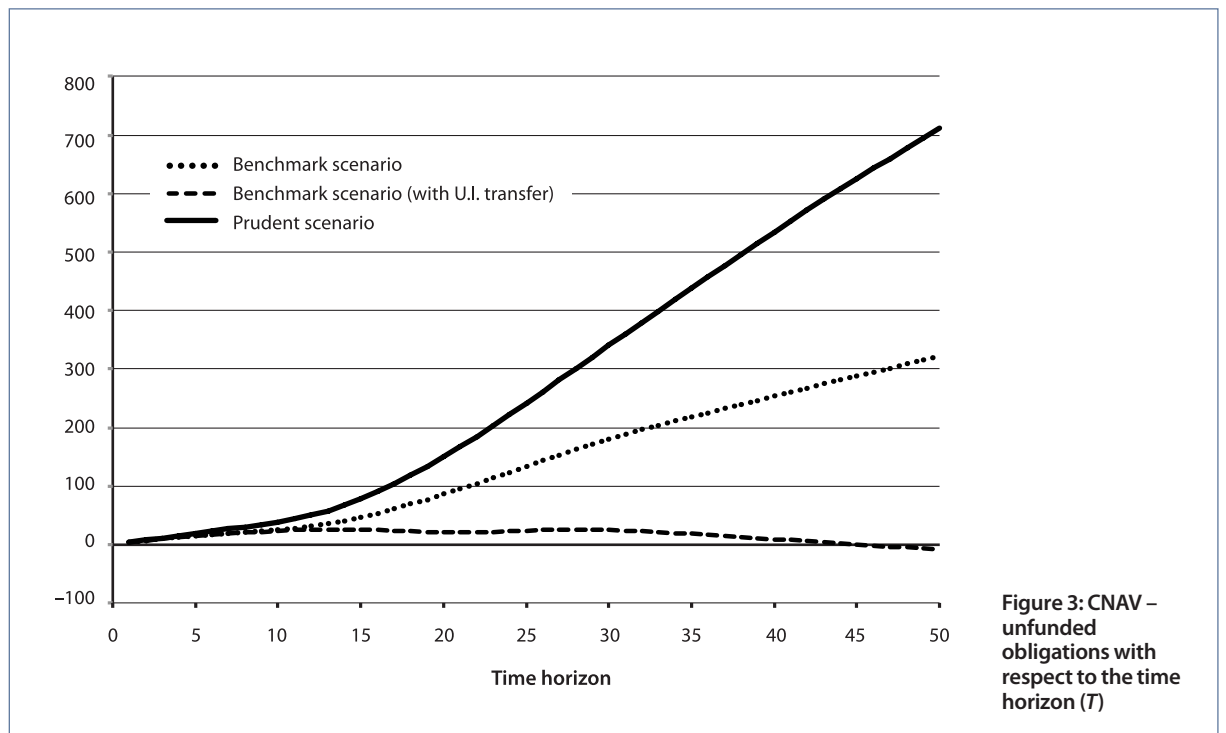
“the excess of the present value of the projected cost of the program through a specified date over the sum of: (1) the value of trust fund reserves at the beginning of the valuation period; and (2) the present value of the projected non-interest income of the program through a specified date, assuming scheduled tax rates and benefit levels.”

At the current period  $t = 0$ , the unfunded obligations compute as follows:

$$UO_0 = \sum_{t=1}^T \frac{EXP_t - REC_t}{\prod_{i=1}^t R_i} - F_0 \tag{3}$$

where  $R_t = 1.02$  is the interest factor at time  $t$  (2% is the value of the real interest rate), with  $F_0 = 0$  (see appendix) the financial amount accumulated in the retirement reserve fund.

The forecast horizon plays a crucial part (Figure 3). With the exception of the scenario including UI transfer, the further the horizon, the more the calculation involves a significant number of deficit periods: the initial capital requirements increase with the length of the solvency guarantee.



### 3.1.3 Tax gap ratio (TGR)

The relative tax gap ratio ( $TGR_0$ ) measures the excess ratio of the present value of expenditures with respect to the present value of receipts. For a given  $T$  time horizon, this ratio is computed as follows:

$$TGR_0 = \frac{\sum_{t=1}^T \frac{EXP_t}{\prod_{i=0}^t R_i}}{\sum_{t=1}^T \frac{REC_t}{\prod_{i=0}^t R_i} + F_0}. \quad (4)$$

## 3.2 Two examples of ABMs

### 3.2.1 Main issues about ABM

The purpose of an ABM is to work out the following problem: how to adjust the expenditures and the receipts to guarantee the solvency of the unfunded pension scheme?

We introduce two adjustment time factors –  $A_t$  and  $B_t$  – applying respectively to payroll tax rate and pension benefits at time  $t$ . Devising an ABM consists in designing a time path:  $A_t \times EXP_t$  and  $B_t \times REC_t$ .

As an illustration, consider Sweden, a pioneer country in adopting an ABM. Its solvency concept is carried by a notional asset-liability approach. The pension amount is the unique adjustment variable: hence,  $A_t$  is constrained to 1 and only  $B_t$  adjusts. In comparison, in France, where official forecasts are based on the optimistic assumption, the transfer from UI can be interpreted as substituting the pension payroll tax by UI payroll tax. If the official assumption proves true, then the sustainability of the CNAV is guaranteed, since the government implicitly adopts a payroll tax adjustment such that  $A_t > 1$  and  $B_t = 1$ .

### 3.2.2 ABMs based on the TGR

Here, we suggest using the  $TGR$  to design a simple ABM (denoted TGR-ABM). When  $F_0 = 0$ , solvency is guaranteed after a permanent adjustment with the following values of parameters:

$$\tau_t^* = \tau_t \times TGR_0, \text{ for a full adjustment by the payroll tax} \quad (5)$$

or

$$p_t^* = p_t \times TGR_0^{-1}, \text{ for a full adjustment by the pension amount.} \quad (6)$$

These changes, based on the tax gap, can be extended to mixed adjustments, by allowing for a possible trade-off between full adjustment by tax or by pension. To this effect, we introduce a tax gap elasticity parameter  $\alpha$  which weights the degree of adjustment by pension. The value  $1 - \alpha$  (respectively  $-\alpha$ ) defines the elasticity of the adjustment factor  $A$  (respectively  $B$ ) to the  $TGR$ . The following permanent solutions are then anticipated:

$$\begin{cases} A_t = TGR_0^{1-\alpha} \\ B_t = TGR_0^{-\alpha} \end{cases} \quad (7)$$

In France, the reserve funds can be considered as nil (see appendix), so these formulae can be directly used to estimate the values of these TGR-ABM.

Figures 4 and 5 respectively depict the sensitivity of the adjustments to time horizon for different values of  $\alpha$  in the benchmark scenario and the prudent scenario. In the two scenarios (benchmark without UI transfers and prudent), the adjustments by receipts  $A$  (respectively by pensions,  $B$ ) describe a decreasing (respectively increasing) relation with respect to time horizon for  $T < 10$ . The relation becomes increasing (respectively decreasing) for a longer horizon. These results illustrate the fact that past reforms cause receipts to grow (on average) faster than expenditures during the first decade.

The graphs also show the sensitivity of the adjustment variables with respect to  $\alpha$ . There are two limit values –  $\alpha = 1$  and  $\alpha = 0$  – meaning a full adjustment through pensions and contributions respectively. Considering a 50-year horizon, a 5.5% permanent decline in pension is required in the first case ( $\alpha = 1$ ), as against a 5.8% permanent increase in contributions in the second case. With the same time horizon and an intermediate value of  $\alpha = 0.5$ , financial solvency requires a 2.8% permanent reduction in pensions coupled with a 2.9% permanent increase in contributions.

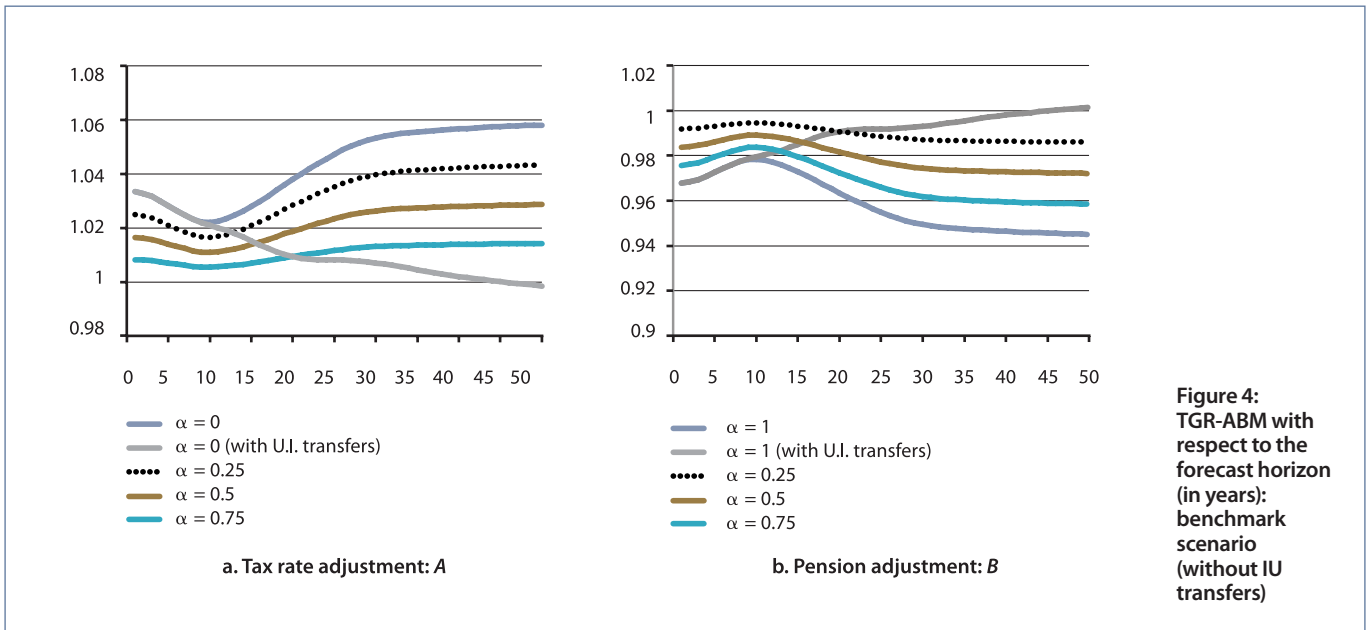


Figure 4: TGR-ABM with respect to the forecast horizon (in years): benchmark scenario (without IU transfers)

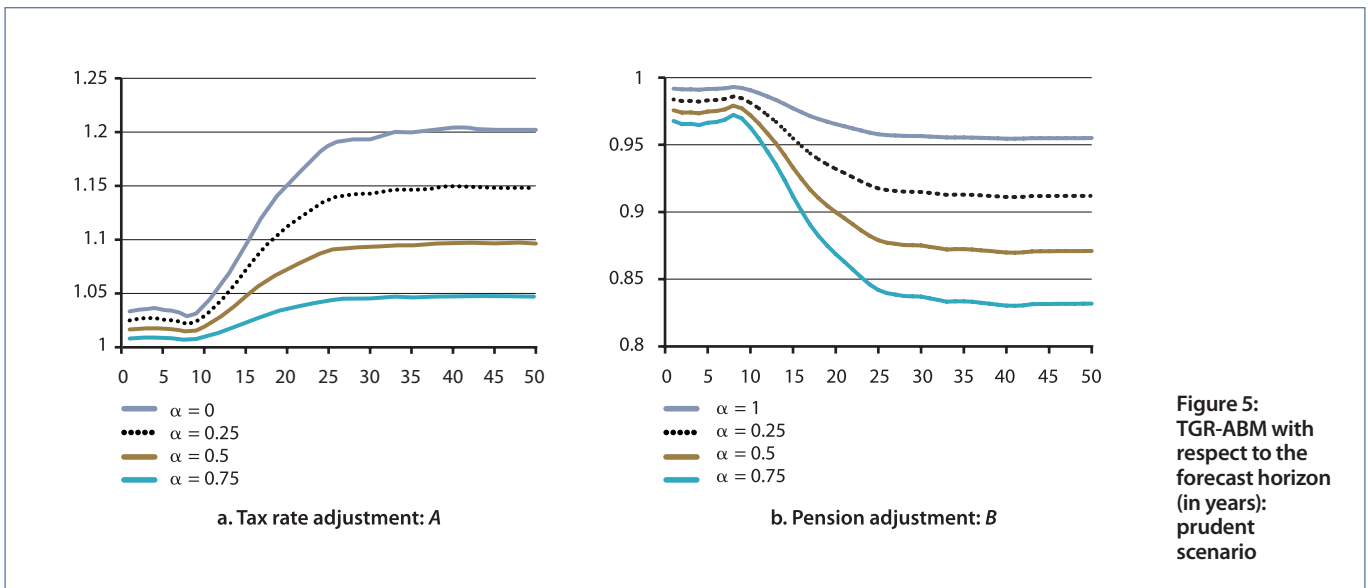


Figure 5: TGR-ABM with respect to the forecast horizon (in years): prudent scenario

### 3.2.3 S-ABM: smooth automatic balance mechanism

Using an ABM derived from a tax gap ratio can be politically and socially difficult to apply, because it induces an immediate and permanent adjustment. To bypass this obstacle, a solution may require devising a smooth, gradual adjustment in contribution rates and pension levels. To this effect, Gannon et al. (2013) build a model based on dynamic programming called “smooth automatic balance mechanism” (S-ABM). The “socio-political” sensitivity to changes in legislation is apprehended by a quadratic loss function. The distortion cost of the receipts (resp. of the expenditures) is given a weighting<sup>2</sup>  $\alpha$  (respectively  $1 - \alpha$ ). At period  $t$  the loss function ( $LF_t$ ) can be written as follows:

$$LF_t = \alpha \cdot (A_t - 1)^2 + (1 - \alpha) \cdot (B_t - 1)^2. \tag{8}$$

2 For the sake of simplicity, we use the same notation as that used for the TGR adjustments because in the presentation of simulation results, the parameter values are the same for the two ABMs: TGR and S-ABM.



For a forecast horizon  $T$ , the S-ABM aims to match the sum of discounted receipts with the sum of discounted expenditures:

$$\sum_{t=1}^T \frac{A_t \cdot REC_t}{\prod_{i=1}^t R_i} + F_0 = \sum_{t=1}^T \frac{B_t \cdot EXP_t}{\prod_{i=1}^t R_i}. \tag{9}$$

The authors assume that the social planner has a time preference. By denoting  $\delta$  the public preference for present rate, the dynamic program to optimise is:

$$\left\{ \begin{array}{l} \min_{\{A_t, B_t\}} \sum_{t=1}^T \left( \frac{1}{1+\delta} \right)^{t-1} \cdot LF_t. \\ s.t. \quad (9) \end{array} \right. \tag{10}$$

The first order conditions lead to the initial optimal values  $A_1$  and  $B_1$ , which are functions of the unfunded obligations:

$$\left\{ \begin{array}{l} A_1 = 1 + UO_0 / \left( \sum_{i=1}^T \frac{R_i}{\left( \frac{1}{1+\delta} \right)^{i-1} \cdot (\prod_{j=1}^i R_j)^2} \cdot \left( \frac{REC_i^2 + \frac{\alpha}{1-\alpha} \cdot EXP_i^2}{REC_1} \right) \right) \\ B_1 = 1 - UO_0 / \left( \sum_{i=1}^T \frac{R_i}{\left( \frac{1}{1+\delta} \right)^{i-1} \cdot (\prod_{j=1}^i R_j)^2} \cdot \left( \frac{\frac{1-\alpha}{\alpha} \cdot REC_i^2 + EXP_i^2}{EXP_1} \right) \right) \end{array} \right. \tag{11}$$

The dynamics of the adjustment factors can be inferred for  $t \geq 2$ :

$$\left\{ \begin{array}{l} A_t = 1 + \frac{REC_t}{REC_1} \cdot \frac{1}{\left( \frac{1}{1+\delta} \right)^{t-1} \cdot \prod_{i=2}^t R_i} \cdot (A_1 - 1) \\ B_t = 1 + \frac{EXP_t}{EXP_1} \cdot \frac{1}{\left( \frac{1}{1+\delta} \right)^{t-1} \cdot \prod_{i=2}^t R_i} \cdot (B_1 - 1) \end{array} \right. \tag{12}$$

We consider two successive scenarios: the benchmark scenario without UI transfer (Figure 6) and the prudent scenario (Figure 7). Figures 6a and 7a provide the simulations for the reference values of parameters:  $\alpha = 0.5, T = 50$  and  $\delta = 2.5\%$ . Assuming the benchmark (respectively prudent) scenario, Figure 6a (respectively Figure 7a) shows that immediate adjustments imply both a 1.5% (respectively 3.6%) reduction in pensions and a 1.4% (respectively 3.5%) increase of tax rate. In the long run, these adjustments reach 4.8% (respectively 9.1%) and 4.5% (respectively 9.1%). In comparison, a TGR-ABM would induce a flat adjustment with a 2.8% (6.3%) pension reduction and 2.9% (6.7%) tax rate increase. This is dramatically illustrated by the dynamics of the reserve fund. For the benchmark scenario, it increases from zero (right vertical axis) to reach in 2026 a maximum of about 18 B€. Over this period, the pension scheme yields a surplus. Then it decreases – deficit period – to reach in 2048 a minimum of –60 B€. It finally grows again – second period of surplus – and cancels out in 2063. A similar dynamic over a larger range prevails in the “prudent” scenario: in 2030 it reaches a maximum of about 93 B€ and a minimum of about –27 B€ in 2057. This difference is due to the fact that, in order to comply with a less optimistic forecast, larger amounts of money must be saved.

We evaluate three parametric variants:

- lower public preference for the present rate, inducing less procrastination (Figure 6b and Figure 7b) with  $\delta = 0\%$
- lower distortion cost through receipts with  $\alpha = 0.25$  (Figures 6c and 7c)
- shorter forecast horizon with  $T = 25$  (Figures 6d and 7d).

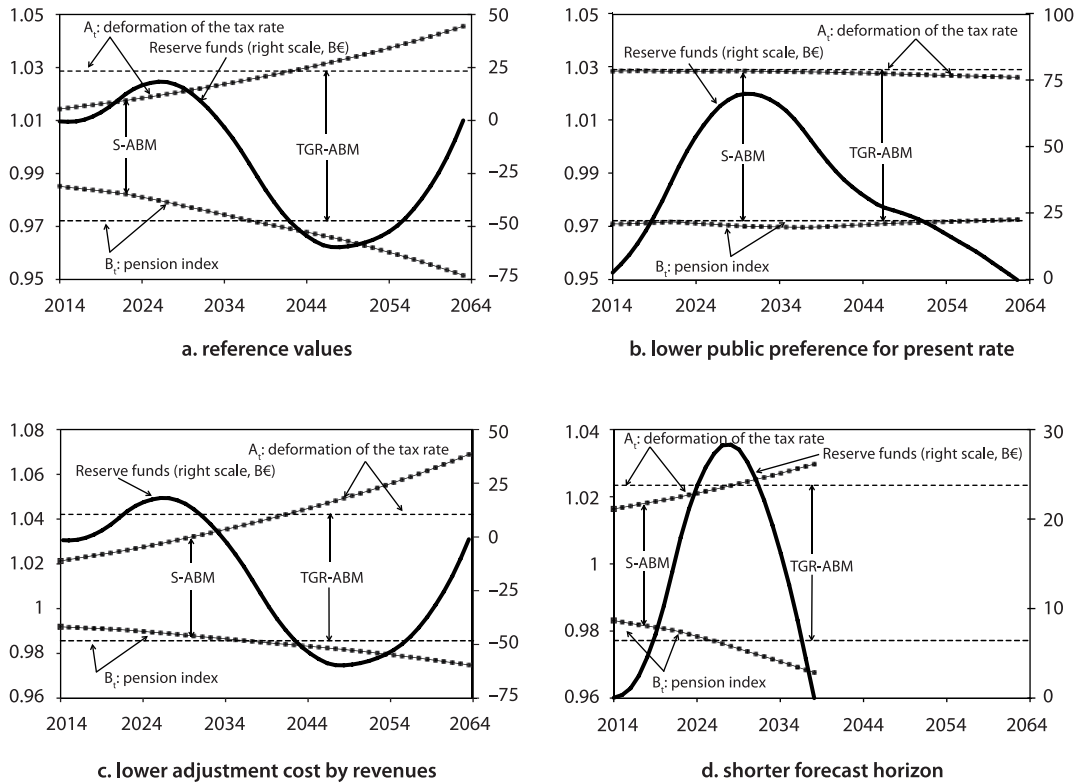


Figure 6: Benchmark scenario (without UI transfer)

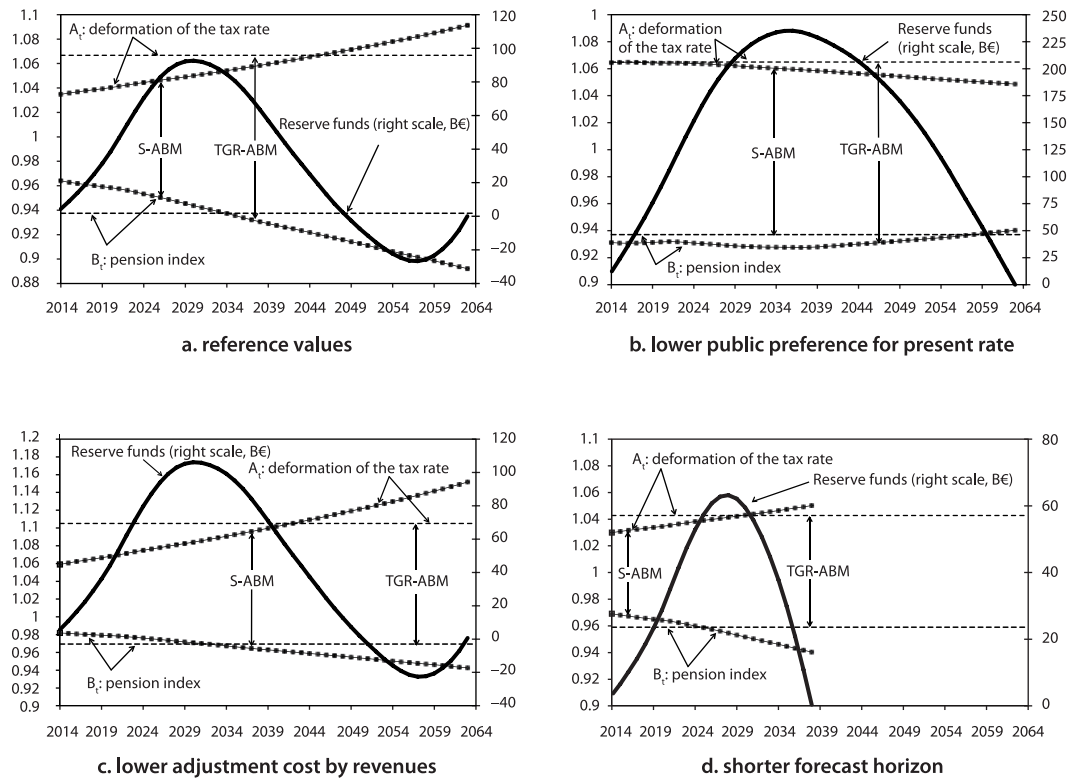


Figure 7: Prudent scenario

A lower public preference for the present rate ( $\delta = 0\%$ ) increases the cost of procrastination. It results in stronger adjustments in the short run and weaker adjustments in the long run. Figures 6b and 7b show a flatter profile of the  $A_t$  and  $B_t$ . In Figure 6b, the path of adjustments is very similar to those obtained under TGR-ABM. Flat profiles are obtained when growth rates of expenditures and receipts are very close to the interest rate, net of the public preference for the present rate (compare with the dynamics of adjustment factors). By contrast, Figure 7b shows a more pronounced decrease in factors. This property results from the fact that the long-run growth rates of expenditures and receipts are lower than the interest rate, net of the public preference for the present rate. Larger immediate adjustments result in more savings being accumulated over a longer period.

Figures 6c and 7c illustrate the fact that a lower distortion cost through receipts ( $\alpha = 0.25$ ) implies a higher adjustment cost through expenditures. Not surprisingly, the adjustment factor of expenditures is reduced, while the adjustment factor of receipts is higher. The profile of the reserve fund is little modified because there is mainly an intratemporal balancing effort from expenditures over receipts.

A shorter forecast horizon ( $T = 25$ ) means lower unfunded obligations. It results in lower levels of adjustment factors (Figures 6d and 7d). It follows that this shrinks the range of the reserve fund.

#### 4 CONCLUSION

In this paper, we have studied how using ABMs could ensure financial stability of the French first pillar pension system for private sector employees (CNAV). Two scenarios are considered, respectively optimistic (benchmark) and pessimistic (or prudent). The use of ABMs can be particularly useful to set the pension scheme on “auto-pilot” (Bosworth & Weaver 2011) so as to avoid systematic and wasteful political debates about adopting reforms to restore solvency.

Unsurprisingly, our results stress that the governance of the CNAV may require significant reductions in pensions and a higher contribution rate.

In the special case of a flat adjustment obtained with TGR-ABM, this requires, for the benchmark (respectively prudent) scenario, a significant 2.8% (respectively 6.3%) reduction in pensions and a 2.9% (respectively 6.7%) rise in the contribution rate.

If the ruling authority (the government) seeks slower and smoother changes, it may set adjustment rules based upon a smooth ABM (S-ABM). For the benchmark (respectively prudent) scenario, such rules imply an immediate 1.5% (respectively 3.6%) reduction in pensions and a 1.4% (respectively 3.5%) increase in the tax rate. In the long run (50 years), such rules imply a 4.8% (respectively 9.1%) reduction in pensions and a 4.5% (respectively 9.1%) increase in the tax rate.

Obviously, the scope of our simulations is limited, since they are based only on two alternative forecasts (pessimistic versus optimistic). A natural extension of our analysis could consist of stochastic simulations, which would capture a larger distribution of possible adjustments.

#### APPENDIX: AN OVERVIEW OF THE CAISSE NATIONALE D'ASSURANCE VIEILLESSE (CNAV)

The pay-as-you-go public pension regimes represent 14.5% of the French GDP and around 97.8% of retirees' revenues. The average direct pension (that is, excluding widows' and orphans' pensions) is close to 1250 euros per month, 1600 for males and 900 for females.

In this paper, we focus on private sector (around 70% of the workers) pensions and on the basic pension scheme, CNAV, which provides an average pension of 641 euros per month (in 2012).

The *Caisse Nationale d'Assurance Vieillesse* (CNAV) was set up in 1945. In 1999, there was an attempt to create a reserve fund in addition to the pay-as-you-go component. It was a failure, because the accumulated funds are not very high and hardly compensate for past deficits. So, CNAV can be considered as a fully pay-as-you-go scheme.

CNAV individual pensions are computed as follows (Gannon & Touzé 2013):

$$P_{cnav} = w \times \lambda \times \min\left(1, \frac{T}{T'}\right) \quad (A1)$$

and:

$$\lambda = 0.50 \times [1 - 0.05 \times \max(\min(T' - T; FRA - ERA); 0)] \quad (A2)$$

where:

- $P_{cnav}$  is the yearly amount of CNAV pension (paid monthly);
- $w$  is the so-called “reference wage”, it is a yearly wage computed as the 25 best wages (under the “social security ceiling”) brought up to date according to the price index;<sup>3</sup>
- $\lambda$  is called the pension ratio, less than a maximum of 50%;<sup>4</sup>
- $T$  is the number of years contributed by a given individual;
- $T'$  is the minimum number of years contributed which is required to draw a full rate pension (Table A1);
- $FRA$  is the full retirement age (Table A1), that is, the age when people must retire if they want to draw a full-rate pension ( $\lambda = 0.5$ ) in case they have not reached the minimum contributive period;
- $ERA$  is the individual’s effective retirement age.

The combination between  $T$  and  $T'$  applies twice: first, to compute the pension ratio  $\lambda$  (A2), if the individual has not contributed during the period set by the scheme’s rules, the pension ratio is lowered whenever the individual has not waited until he has reached the age “ $FRA$ ”. Second, to compute the pension per se (A1) because the pension is paid pro rata temporis. Note that individuals cannot retire before a minimum age (Table A1) even if they have reached  $T'$ , unless they are very early workers (that is, those who have worked before 20 and have completed  $T'$  years of employment, and therefore contributions).

Four cases can be described:

- if the individual retires after the minimum age (see Table A1) while having reached the minimum contributive period (see also Table A1), then  $\lambda = 50\%$  and  $T/T' = 100\%$ , meaning that  $P_{cnav}$  is 50% of the reference wage;
- if the individual retires at the automatic full rate age ( $FRA$ ) and has reached the minimum contributive period, then  $\lambda = 50\%$  and  $T/T' = 100\%$ , meaning that  $P_{cnav}$  is 50% of the reference wage;
- if the individual retires at the automatic full rate age ( $FRA$ ) and has not reached the minimum contributive period, then  $\lambda = 50\%$  and  $T/T' < 100\%$ , meaning that  $P_{cnav}$  is paid pro rata temporis and less than 50% of the reference wage;
- if the individual retires when he or she has not reached these periods/ages, then, a 5% yearly discount is applied to  $\lambda$  and the pro rata temporis is applied to the downgraded value of  $\lambda$  so that the pension is well below 50% of the average wage.

In 2003, a premium was introduced in order to provide some incentives for people to work later. This premium amounts to 3% of the pension the first year, 4% over the following three years and 5% in the fifth year if the individual is aged more than 65.

The last 2012 forecasts (Conseil d’orientation des retraites, 2012) have evidenced the emergency of core adjustments to guarantee sustainability of the French pension system.

Under this constraint, the Ayrault government has taken measures in 2013. A 0.6 point increase in the contribution rate, paid equally by workers and employers, is scheduled between 2014 and 2017, in order to restore the CNAV financial balance. Hence, for each of them, the contribution rate will increase by 0.3 points. If there are no other adjustments, the wage earners’ contribution rate will reach 6.40% of the wage under the ceiling, plus 0.40% of their total wage, and the employers’ contribution will be 8.45% of the bounded wage plus 1.90% of the total wage.

This last 2013 reform also includes a “hardship account”, the purpose of which is to compensate for the tediousness of certain jobs through an early retirement or a training period. Please note that our simulations do not take account of the costs induced by this account.

<sup>3</sup> It is bound to the “social security ceiling” so that the pension is, in fact, proportional to the fraction of the wage lower than or equal to the social security ceiling. In 2014, the “social security ceiling” is valued at 37 548 euros per year or 3129 euros per month.

<sup>4</sup> This means that, if an individual fulfils all the conditions laid down by the scheme’s rules, then his maximum pension provided by CNAV is 50% of the social security ceiling.

Table A1: Minimum ages and contributive periods for PAYGO basic pension scheme after the 2013 reform

Birth year	T': minimum contributive period (years)	Application year	Minimum age	FRA (full retirement age)
before 1944	37.5	Before 2004	60	65
1944	38.0	2004	60	65
1945	38.5	2005	60	65
1946	39.0	2006	60	65
1947	39.5	2007	60	65
1948	40.0	2008	60	65
1949	40 + 1 q.*	2009	60	65
1950	40 + 2 q.	2010	60	65
1951	40 + 3 q.	2011	60	65
1951	40 + 3 q.	2011	60 + 4 m.†	65 + 4 m.
1952	41.0	2012	60 + 9 m.	65 + 9 m.
1953	41 + 1 q.	2014	61 + 2 m.	66 + 2 m.
1954	41 + 1 q.	2015	61 + 7 m.	66 + 7 m.
1955	41 + 1 q.	2017	62	67
1956	41 + 1 q.	2018	62	67
1957	41 + 1 q.	2019	62	67
1958	41 + 3 q.	2020	62	67
1961	42.0	2023	62	67
1964	42 + 1 q.	2026	62	67
1967	42.5	2029	62	67
1970	42 + 3 q.	2032	62	67
1973	43.0	2035	62	67

\* q. = quarter

† m. = month

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