# Reducing growth-dependence of the French pension system: options for reforms

Didier Blanchet, Antoine Bozio and Simon Rabaté*

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**Abstract**

Past reforms of the French pension system have generated a strong growth-dependency of pension expenditure, bringing uncertainty on the financial balance of the system. We present different paths of reforms to tackle this problem: parametric reforms but also more structural ones, with a transition toward a notional defined contribution or a generalized points system. We simulate these reforms using the microsimulation model PENSipp. All of the proposed reforms reduce significantly the sensitivity of the system to macroeconomic conditions, compared to the current system: pension expenditures and the relative standards of living of retirees are more stable from one growth hypothesis to the other. Importantly, the precise choices for the systems' parameter (indexation rule for NDC systems, purchase value and conversion coefficient for points systems, and liquidation rate for annuities) are crucial determinants of systems' responses to growth shocks.

*Mots clés:* Micro-simulation; retraites
*JEL:* H2; H3 ; J2

*Blanchet: Institut des politiques publiques (IPP), Insee, Crest and Chaire Transition Démographique-Transitions économiques. Bozio: IPP and Paris School of Economics. Rabaté: IPP, Ecole normale supérieure and Paris School of Economics. This work is based on the microsimulation model PENSIPP, currently developed at the IPP. It is largely inspired from the Destinie model from INSEE. The authors would like to thank the *Redistribution et Politiques Sociales* unit at INSEE, and more particularly Marion Bachelet, Yves Dubois, Malik Koubi, Aude Leduc and Anthony Marino. A part of this work have benefited from a co-funding from the Union Mutualiste Retraite, through the scientific Chair "Transition démographique/Transitions économiques" of Fondation du Risque. The authors bear sole responsibility for the results and opinions expressed in the text.

# 1 Introduction

The French pension system has been reformed a number of times since the early 1990s and, perhaps contrary to some common beliefs, these reforms have had large impacts on the long-term sustainability of the system. Without reforms, the French pension body (*Conseil d'orientation des retraites, COR*) estimates, public pension spending would have reached 19% of GDP by 2040, that is 50% more that their level in the early 2000 (i.e. 12% of GDP). With only the 1993 reform and the other changes in complementary schemes, the COR estimates in its reference macroeconomic scenario, that by 2040 public pension spending would have reached 16.3%. Further reforms in 2003 and 2010 have again reduced pension liabilities, and the latest estimates from COR give in their median scenario a share of pension spending in GDP of 12.8% by 2060, that is below the current level of 14% (COR, 2014). These results are in line with previous simulations (COR, 2012) and those established by Marino (2014) using the dynamic microsimulation model Destinie of Insee.

This short overview could lead to the false conclusion that the reform process of the French pension system has reached an end, and that the seemingly impossible reform in France has been achieved through an albeit complex but decisive set of measures. But at least two main reasons should maintain pension reforms on top of the reform agenda in France.

First, these previous reforms have not achieved any improvement in the transparency of the system, far from it. The French pension systems remains plagued by complexity (more than 35 different mandatory schemes, with different rule for each of them); it is accused to treat various sub-population unequally, with treatment of favour for public sector workers or unfair rules for low income workers with flat career path. The 2003 reform has been a step towards a certain convergence of rules between public and private sector schemes, but these remain significantly different across regimes. In the public sector, pension is computed from the last earnings excluding bonuses, while in the private sector it is the average of the last 25 years of earnings which make the reference wage. In the private sector, the main Social Security pension scheme, an annuity scheme, is completed by two mandatory complementary schemes which are point-based. Details of the rules in all these schemes remain very complex, hard to understand for both policymakers and wage earners. Some rules lead to incoherent situations, sometimes even in contradiction with stated objectives.

Second, the ratio of pension spending to GDP is highly variable from one macroeconomic scenario to the other. Pension spending as a share of GDP is thus estimated to vary from 11.3% to 14.9% by 2060, depending on the assumption of long-term productivity growth (COR, 2014). The direct consequence is that the long-term financial sustainability of the French pension system is highly dependent on the growth rate of the economy: if long-term growth is below 1.5%, the system will exhibit large deficit and if growth is significantly above this level, the past reforms will lead to significant surpluses (and low pension levels). This growth-dependency is the main subject of analysis of this paper. It comes from reforms introduced in the early 1990s which have moved from wage indexation to price indexation, both for the computation of past earnings or contributions, and for the evolution of pension once they have been claimed (Marino, 2014). This move was motivated by the desire of policymakers to reduce pension liabilities which were due to increase with increasing life expectancy and the retirement of baby-boomers. However, the indexation on prices fail to bring savings when the rate of growth decreases. At the limit savings are nil when growth is zero.

This situation is problematic for a number of reasons: first, the balance of a pension system has no reason to depend on the long-term growth rate; if one recall the objectives to offer a certain level of replacement rate to wage earners, the long-term growth does not alter the fundamental issue of consumption smoothing that a pension system is meant to provide. Second, if one would want some linkage between the level of pension spending and long-term growth, one would expect the opposite of the current mechanism (i.e. higher pension spending when growth is high). The fact that the balance of the pension system will not be achieved under lower productivity growth, under scenarios when other resources will be hard to find, is problematic per se. Third, demographic uncertainty is not resolved by price indexation. The French pension system has currently no formal link between the demographic changes and pension rules. The 2003 reform had incorporated a mechanism linking increase in the duration length for full-rate pension to changes in life expectancy, but this link was somehow abandoned in 2014 in favour of deterministic increases of this parameter. Nevertheless, this linkage with life expectancy was only partial as the other determinants of the pension formula were not linked to demographic changes.

To sum-up, while major reforms have indeed taken place in France, one can say that there are at least two structural issues in the French pension system waiting for solution: i) simplification of a particularly complex set of rules ; and ii) resolving long-term sustainability of the system by removing its dependence to demographic and economic uncertainties. This paper is a contribution on these two fronts. It uses the microsimulation model PENSipp to analyse three scenarios of pension reforms which offer solutions to these problems. The first two options suggest structural reforms of the pension system, by simplifying the current variety of rules into one single set of rules. The first scenario consist in a switch to notional defined contribution (NDC) system (Bozio and Piketty, 2008) while the second option aims at converging towards a point-based system (Bichot, 2009). The third option does not address the issue of simplification as it suggests changes to indexation rules within the current pension system, aiming for solving growth-dependance but not for a more transparent pension system.

This paper does not pretend to present fully fledged reform scenarios as it concentrates on the properties of the different options on long-term sustainability. For instance, the analyses do not include redistribution impact or changes to non-contributory pension benefits. These aspect of a potential structural reform are left for further research.

The first section of the article explain in details the underlying reasons behind growth-dependence in the current French pension system. Options for reforms are then presented, with NDC scenario in section 2, point-based system in section 3 and an option for maintaining the current system with new indexation rules in section 4. Section 5 concludes.

## 2 A growth-dependent pension system

What is the magnitude of growth dependence in the French pension system and how can it be explained by the changes in indexation rules that have been implemented in the late 1980s?

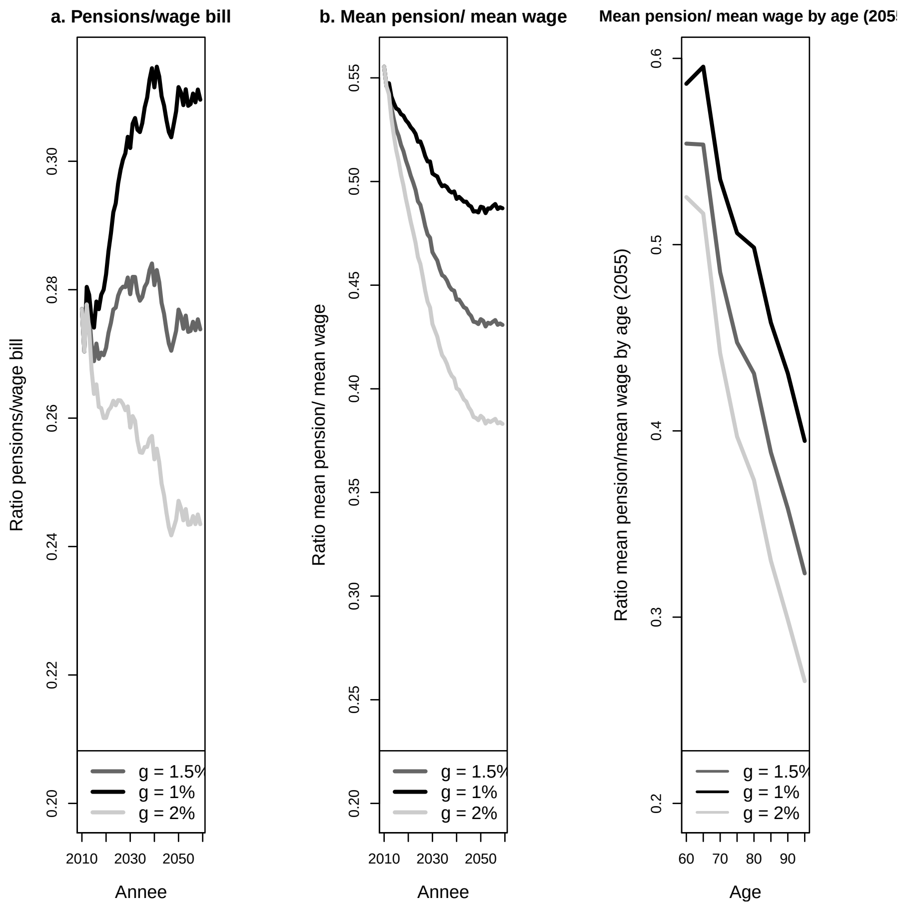
In figure 1.a we use the PENSipp model (see box 1) to project the evolution of the ratio between the mass of pension benefits and the wage bill between 2010 and 2060. This profile is generated under three different hypotheses for long-term productivity growth[1], with growth rate of 1%, 1.5% and 2%. These projections include the effects of all the reforms that have been implemented until 2013 and a large share of the French pension system. We model retirement behavior with a simplifying assumption that individuals retire at the age they get a full rate pension (no minus nor bonus). Under this set of hypotheses, we find that the ratio pensions/wages is roughly stabilized in the long run in the median growth scenario. This result is in accordance with the official projections for the French pension system's financial equilibrium (COR, 2014). However we also find important differences in the projections depending on the assumed growth rate: in 2060, there is a 6 points gap in the ratio between the high-growth and the low-growth scenarios. Compared to the 27.5% baseline of the median scenario, the ratio reaches 24.5% and 31% in the high-growth and low-growth scenario respectively.

This spread in the profile of the ratio between pensions' mass and wage bill corresponds to a similar spread in the ratio between the mean benefit and the mean wage, as shown in figure 1.b. In the median scenario, the ratio decreases by about 20% between 2010 and 2060. The combination of this decline in benefits' average level and the parallel strong increase in retirement age explains the previously described stabilization of the ratio between the mass of pensions and the wage bill. However, this decrease in pensions' (relative) level is milder under the low-growth rate hypothesis, and much more severe under the high-growth hypothesis.

What are the mechanisms behind this decrease in the relative pensions' level and its growth-dependent magnitude? As a general principle, the evolution of the ratio between the average pension and the average wage depends on two factors: the relative level of pension at retirement and the relative evolution of pension and wage after retirement. Since the late 1980s, the French pension system's reforms have plaid on both levers, to a variable extent depending on the considered regime.

[1] defined as the growth rate of the wage bill

Figure 1: Main outputs for the evolution of pension rights, under three growth rates hypotheses




Reading: In 2030, pension expenses amount to 13% of the wage bill with a 1.5% growth rate (dark grey line), 14% with a 1% growth rate (black line) and 12% with a 1% (light grey line).
Source: PENSipp 0.0.

We first consider the biggest one, the basic general scheme for wage earners of the private sector (SS, for social security). It is a classic annuity system amounting to about 40% of the total pension expenditure. Since the late 1980s, pensions after retirement are indexed on inflation only. Compared to the previous indexation on wage growth, price-indexation implies a relative drop in the clamied pensions, compared to current wages. As an illustration, consider an individual retiring at time $t$ with a pension equals to 70% of of the current average wage. With a wage-indexation rule, her pension will always equal 70% of the current average wage, for any year following retirement and growth level. On the contrary, a price-indexation rule implies that the level of pension relative to average wage will depend on the latter's growth rate. With a 1.5% yearly wage growth rate, ten years after retirement the individual's pension only amounts to $(1 - 0.015 \times 10) \times 70 = 60\%$ of the current average wage.

If wage grows at a lower rate, say 1%, the same calculation gives a relative level of pension amounting $(1-0,01\times10)\times70\% = 63\%$ of he current average wage after 10 years of retirement. Symmetrically, with an annual growth rate of 2% the same initial pension will amount only to 56% of the current average wage.

The divergence between the pension perceived after some time in retirement and current average wages is amplified by the fact that pension benefits at the time of retirement amount to a lower proportion of current wages as growth is higher. This second source of growth-dependence channels through the re-evaluation of the wages taken into account for the calculation of the reference wage. The initial pension is the product of the annuity rate by a reference wage, that is supposed to be a summary of the career. The reference wage is calculated as the mean of the $D$ best years of the pensioner's career, with a yearly re-evaluation of the nominal wage between from the date the wage is earned to the date of retirement. A wage-based re-evaluation would neutralized the effect of the growth of the wage, but this in not the case under a price-based reevaluation. This is all the more true when the number of years $D$ used for the calculation of the reference wage increases, as it is the case in France with an increase of $D$ from 10 to 25. In a nutshell, a pension based on the 25 best years reevaluated on inflation leads to replacement rates that are both lower and more growth-sensitive than a pension based on the 10 best years reevaluated on the growth rate of the average wage.

Figure 1.c shows the relative level of pension by age (as a percentage of the current average wage) in 2060. It illustrates the joint effect of the reevaluation of career earnings and the indexation of pension after retirement: growth assumption affects the relative level of pension at claiming, and the gap is progressively increasing as we consider older retires that have been retired a longer time. We can quantify to global effect of both mechanisms in the following way. Suppose a 25 years retirement span. At a given date the average retiree has been retired for about 12.5 years. And her pension is based an average wage over her 25 last years of careers, so on average 12.5 years before retirement. Hence with price-indexation, pension benefits are not anchored on the current wage, but on the wage level of 12.5+12.5 = 25 years before. And this generate growth dependence: a 0.5 point faster growth implies a 0.5x25=12.5% drop relative level of pension, therefore an equivalent drop of 12.5% in the ratio between pension expenditure and wage bill. This is the order of magnitude of growth-dependence that we find in figure 1.a.

This calculation is only indicative since it focuses on one component on the French pension system, the basic general scheme. The consistency between this calculation and the aggregate results of figure 1 comes from the fact that mechanisms of that kind can be found in other schemes.

For civil servants' pension scheme, wage reevaluation does not play since the reference wage is calculated on the last six month of the career. However the effects of the price indexation of pension benefits after retirement are similar to what we described for the general scheme.

In points regimes (e.g the complementary schemes for wage earners of the private sector), the divergence of pension from salaries comes from the hypotheses we made on the evolution of the purchase value and the conversion rate. In points system[2], the amount of pension perceived at each date $t$ is given by the product of the conversion coefficient in $t$ and the number of points accumulated at retirement. Points are yearly accumulated during the career on the basis of paid contribution and the value of those contribution given by the purchase value. As we will demonstrate in section 4, anchoring both the purchase value and the conversion coefficient on the growth rate of average wage (a "wage/wage" indexation). Since the 1980s, we observed oscillations between "wage/price" and "price/price" indexation for the purchase and service values: the latter is more often indexed on prices and the former is indexed sometimes on wages and sometimes on prices. Among those two rules, the "wage/price" one is the more detrimental to pension benefits relative level. Indeed, a purchase value evolving like wages implies that the number of points obtained out of contributions on wages is constant from one generation to the other: if those points are then valued according to current prices, pension benefits do not change, whatever the speed of growth. The "price/price" rule that we have assumed in our projections is less detrimental to retirees since the number of points purchased increased with general growth. Nevertheless the valuation of those points is based on prices so that relative benefits (compared to average wages) decreases when growth is faster. Points bought at the beginning of the career are not reevaluated, and benefits after retirements are only indexed on prices: the mechanisms above described for the general scheme directly apply.

This kind of growth-dependency is an undesirable property for any pension system. Having a size of the pension system that can vary with growth is is not problematic *per se*. It can make sense to have a pension system that is more or less generous according to growth and standard of living. Historically, growth have made it possible to increase the size of the system, as in a classic trade-off between leisure and consumption: strong productivity gains in the post-war boom years have been use to increase consumption on one hand, and to "buy" increasing years of leisure on the other hand. On this historical basis, nothing should impose a constant size of the pension system in 2060, whatever the growth trajectory from now on.

The problem is that past reforms have generated a link between pension expenditure and growth that goes in the opposite direction from that historic evolution, and that is not based on an explicit choice. A high growth scenario leads to a decrease in the relative generosity of the system, and it is relatively more costly in period of slower growth, when public finance is more constrained. This growth-dependence of pension expenditure is also problematic for budget balancing: it is not optimal to have financial balance that is conditional on a good macroeconomic environment, all the more so in a context of uncertain growth level.

[2]See Legros (2006) for a detailed presentation the French points system

In the next three sections, we will consider alternative ways of solving this issue, outlining the properties of three pension systems that stabilize the size and the relative generosity of the system, regardless of growth level.

### Box 1. The PENSipp model and the use of microsimulation.

The PENSipp model is a microsimulation model used to provide projections of the French pension system on the long run. The model is currently developed as a product of a scientific collaboration between the IPP and INSEE, which develops the Destinie model. Destinie has been used since 1990 for projections of the French pension system, and PENSipp is directly inspired by it.

PENSipp has the same overall architecture as Destinie (see Blanchet et al., 2011), with an organization in two blocks. The first one simulates familial (unions, births, deaths) and professional (employment, unemployment, inactivity, wages) trajectories. Starting from a representative sample of the French population, those individual trajectories are projected until 2050, using microsimulation techniques. In the current version of the model, the biographic bloc is exactly the same as Destinie's one. The second block is dedicated to the modelisation of retirement behaviors of individual of the biographic block. Different hypotheses for retirement behavior can be made: retirement when full rate is reached, retirement with a targeted replacement rate or pension level, or retirement according to a "Stock and Wise" model. From individual retirement decisions, the model computes pension benefits applying the relevant legislation of the pension system. A large scope of the French pension system is modeled: the main general scheme (with wage earners of the private sector and workers of the public administration without tenure), the complementary schemes Agric and Arrco (for wage earners of the private sector), the civil servants' scheme and the self-employed workers' one. To this day, it still excludes some important features of the system: the complementary scheme for self-employed workers, military pensions, widowers' pensions, and the minimum old-age income.

The choice of microsimulation for the purpose of an article based on the aggregated effect of pension reform is not straightforward. This tool is more directly relevant for analyzing the redistributive effects of reforms. The kind of results we present could be obtained using a meso-economic model of general equlibrium (as in Chojnicki et Magnani, 2010), or even more simplistic ones using case-studies with one individual by cohorts. Nevertheless, microsimulation methods have already been used in previous works of that kind (Blanchet, 2009 ; Albert and Oliveau, 2009*a* and 2009*b*). The advantages of this approach is twofold, even for aggregate results. First of all, given the complexity of the current system, only a precise model can provide suitable simulations for the *statu-quo* scenario, to which reforms are confronted. Secondly, reform scenarios are overall simpler in microsimulation models than in more synthetic ones. Indeed, a microsimulation model always has a module computing pension rights as a function of the whole career of an individual. Simulate a structural reform only requires to change this module by the new one (which is simpler in general is the reform comes along with a simplification of the system). It is then easy to control the timing of the switch from one module to the other, depending on the transition type we choose (see box 2 in section 3). The only drawback is the computation time, that may prevent from simulating an infinite number of scenarios. On the other hand, microsimulation makes it possible to study reforms at precise level, by comparing pension rights at the individual level, before and after a reform. This potentiality is not exploited in the article but can be more easily implemented.

# 3 Transition toward a Notional Defined Contributions system

We first consider the Notional Defined Contribution (NDC) system option. A detailed presentation of the functioning of pension system of this kind is out of the scope of this article. A thorough review of the different issues at stakes can be found in the different volumes by Holzmann and Palmer (2006, 2012*a* and 2012*b*). In this section, we only present the main feature of NDC systems. A more technical and complete presentation can be found in Appendix A.

## 3.1 NDC: main principles and automatic balancing properties

A NDC system shares with annuity or points regimes the idea of an individual count of pension rights. The difference with annuities – for both NDC and point systems – is the unit of account for accumulated pension rights. With NDC systems, individual pension rights are expressed directly is a monetary unit (in euros for France). During the career, euros contributed out of yearly wage are added to the accumulated past contributions. Accumulated rights are yearly reevaluated, with a return corresponding to the internal return of a pay-as-you go system, approximately equal to the growth rate of the wage bill.[3] Note that this reevaluation of past contributions with a rate of return is conceptually similar to the reevaluation of past wages in the calculation of the reference wage that we described in section 2.

At retirement, accumulated pension rights are converted to annuities, through the conversion rate. This conversion rate is based on the principle of actuarial fairness: the expected flow of pension benefits received during retirement must be equal to the accumulated rights at retirements.[4] As a results, its calculation takes into account the expected time spent in retirement, but also the chosen rule of indexation of pensions after retirement. If pensions are strongly indexed (e.g on the growth rate of average wage), this must be compensated for by a lower conversion rate. Conversely, with a lower indexation of pensions (e.g following inflation) a higher initial pension can be offered though a bigger conversion rate. In the Swedish case, the latter option has been adopted: the replacement rate at retirement is based on a on an expected growth of 1.6% and pension after indexed on the basis of the growth rate of average real wage minus 1.6%. This corresponds to an indexation over prices when the growth rate equals the projected one.[5]

This leads to a quite complex formula for the conversion rate, that can be simplified under specific assumptions on the rate of return and the rate of indexation of pensions (see appendix

[3]Neglecting turnover duration, a component of the internal return as shown by Settergren and Mikula (2005).

[4]The equality does not hold for each individual but at the level of one generation

[5]See Settergren (2001) for a discussion of this choice of *frontloading* and the alternative options.

A). The formula is straightforward when both parameters are aligned on the growth rate of the wage bill and when we neglect pre-retirement mortality. The conversion rate is then simply equal to the inverse of life expectancy at retirement. This is the most pedagogical presentation of the system: pension at retirement is calculated as the ratio between accumulated rights and the expected retirement duration.

On the basis of those main features of the system, how does it react to various types of shocks, demographic or economic?

Regarding the response to a first type of demographic shock namely the increase in life expectancy, adjustment is direct through the conversion rate. Individuals must adapt to its decrease (automatically generated by the increase in life expectancy) by either a drop in replacement rate and a constant retirement age or an increase in work duration to maintain a constant the replacement rate. This follows the actuarial fairness principle, that establishes a direct mechanical link between individual retirement age and level of benefits.

Secondly, a NDC system adapts to growth shocks through changes in the rate of return, that plays on pension rights accumulation on one hand, and conversion rate or indexation of pensions on the other hand, depending on the choice of indexation rule. A decrease in the return will decrease accumulated contributions, so that individuals reach retirement with fewer rights, hence a lower pension. Then, if we have chosen price-indexation for pensions, replacement rates face an additional drop through the decrease in projected growth. Otherwise, with an indexation on growth of pension after liquidation, a decrease in growth will directly impact pension expenditure.

Timing of adjustment associated to these different balancing mechanisms can be variable, explaining why the system may not adjust instantaneously (Valdes-Prieto, 2000). In the Swedish system, a substantial buffer fund is used to smooth transitory unbalances, along with the implementation of an "Automatic Adjustment Mechanism" (Gannon *et al.*, 2014): an additional decrease in pensions until the moment the buffer fund goes back to its equilibrium trajectory.

This type of transitory adjustment is not a feasible solution in the French case, in the absence of a significant buffer found. Responses to transitory unbalances could have a more common form: increase in taxes – rather than social security contribution to remain true to the NDC system's philosophy – that would be used to financed inherited unbalances of the system. Another solution could be a temporary reduction in pension benefits, to a greater extent than what would impose the demographic constraint. This suggests a possible combination of a parametric reform to deal with the old-system deficits, with a reform implementing NDC for the new retirees (see section 5).

### 3.2 Simulation results

In this section we present the results of simulations of a reform from the current French system to a NDC one.

Cross-cutting questions related to the implementation of a structural pension reform and its simulation are described in box 2. In this article, we tried to maintain consistent choices of simulations between the NDC and generalized points (section 4) reforms. Importantly, we have chosen simple hypotheses over more realist ones, as a first approach for these complicated issues.

In order to simulate a transition toward a NDC system, we need to determine three main policy parameters, determining pension rights accumulation and their conversion into pension annuity: (i) the contribution rate of the new system, (ii) the rate of return applied to accumulated contribution and (iii) the indexation rule for ongoing pensions.

In theory, a natural rule is to use the internal rate of return of a PAYG system as the rate of return for accumulated rights.[6] As an imperfect approximation (Settergren and Mikula, 2005), we use the growth rate of the wage bill as rate of return. We choose a fix contribution rate of 27% over the simulation period. That does not preclude from considering possible increase in the contribution rate, generating additional pension rights, as a way to increase the global generosity of the system in steady state. For simplicity purpose, we maintain a constant contribution rate over time and between the different scenarios. A last and important point must be mentioned: the equilibrium formula for the conversion rate includes a term accounting for accumulated contributions of individuals dying before retirement (see appendix A). In the simulations, we neglected this term in order to have a smoother transition with a stable mass of pension expenditure.

As an illustration of the trade-off between the replacement rate at retirement and the dynamic of pension indexation, we simulate two alternative scenarios: a first one with a rule of price-indexation for pensions (scenario NDC1), another one with an indexation on growth, *i.e* equals to the rate of return on contributions (scenario NDC2). As previously explained, the second one implies a lower initial replacement rate but a stable relative standard of living during retirement.

[6]Note that in the Swedish system, the rate of return is equal to the growth rate of the average wage, which is different as the equilibrium return in the general cases

## Box 2. Simulation choices for transition

Simulating a structural reform of any kind requires to define the main features of the transition: the scope of the reform, the type of transition, the valuation of past rights acquired in the previous system, and the transposition of existing non-contributory pension rights.[a] Those issues can be tackled in a similar way for the NDC and generalized points reforms.

The *scope of the reform* defines the choices of the pension scheme concerned by the reform. The chosen option is to consider the whole system, as it is modeled in PENSipp (see box 1).

The *type of transition* is another key element of any simulation of a structural reform. The first dimension to decide upon is the rhythm of transition. We have chosen the fastest possibility: starting from the transition date (2015), all the new retirees fall under the new regime, with a retrospective calculation of their acquired rights in the system. Other possible choices (implementation of the new rules for new contributors only, or for periods worked after the transition only) have a twofold drawback: a much longer transition, which delay the effect of the reform; and a long-lasting coexistence of two different regimes, which reduces the transparency of the whole system. A last crucial aspect of the chosen form of transition is that we do not modify pensions that are already claimed at the moment of the transition. This constraint will not be applied in the parametric reform.

The chosen transition type requires to set the rules for *the valuation of past rights acquired in the previous system*. Once again we choose the option that is both easier to program and faster to mature. We initiate individual accounts as if the system had always been in place. More precisely, since we simulate a system with a rate of return equals to the current growth rate and a fix contribution rate, we just reconstitute each individual's sequence of fictive past contribution on the bases of their past wages and this unique contribution rate. We apply the actual sequence of growth rates as the rates of return to these contributions. After valuation of past rights, rights are accumulated after the transition following the new rules, applied prospectively.[b]

An exhaustive description of a structural reform requires the definition of the *non-contributory devices*, which are an important part of the current system. This article sets aside this aspect and focus exclusively on the transition toward a totally contributive system. The transcription of non-contributory rights and the redistributive consequences of the reform will be dealt with in further research.

[a]See Palmer (2006) for a complete overview of these issues in the case of NDC systems.

[b]The two other possibilities are the following:

- Convert the pensions rights acquired in the old system as an initial capital in the new regime. This is in line with what is done for calculation of accrued-to-date pension liabilities (Blanchet and Le Minez, 2012).
- Initiate individual accounts on the basis of actual past contribution rates.

We choose a unique contribution rate for valuation of past acquired rights, and for the accumulation of new rights in the NDC system. We use the equilibrium contribution rate in 2015, defined as the ratio between the mass of pension benefits and the wage bill (equals to 27%). Applying this unique rate to past wages to value the acquired rights has different consequences on the balance of the system. Firstly, as contribution rates have increased regularly in the past, it implies an overestimation of the rights acquired in 2015 compared to contributions actually paid. However this is compensated by the fact that the rate of return we apply to these contributions (the growth rate) is lower than the implicit returns offered by the current system for older generations. Secondly, since we choose a unique rate for different pension regimes with different contribution rates and bases, we generate *ad hoc* transfers between regimes and level of wages.[7] Then, new pension rights are accumulated on the same basis, with a 27% contribution rate on gross wages. We stay in line with the Swedish model, in which the NDC system evolves with a constant rate of contribution. As previously mentioned, it is possible to consider changes in contribution. However, increase in contribution cannot be used to balance the system, as it necessarily generate new pension rights. It can only be used to increase the size of the system.

As described in box 2, we simulate an immediate transition for new retirees starting in 2015. The main outcomes of the reforms are presented in figures 2 to 4. The first one presents the evolution of the ratio between the mass of pension and the wage bill between 2010 and 2060. The ratio between the average current pension and the average current wage is shown in the figure 3. Figure 4 presents, for a given year (2055) the ratio between the average pension by age and the average wage. For each figure, three graphs are provided, corresponding respectively to the projection of the current system and the projection of NDC reforms (NDC1 and NDC2). Like in figure 1, results are presented under three different growth assumption: we use growth rate of the wage bill of 2%, 1.5% and 2%. This is a way to test how the new regime reduces the spread of the pension system's outcomes from one macroeconomic scenario to the other.

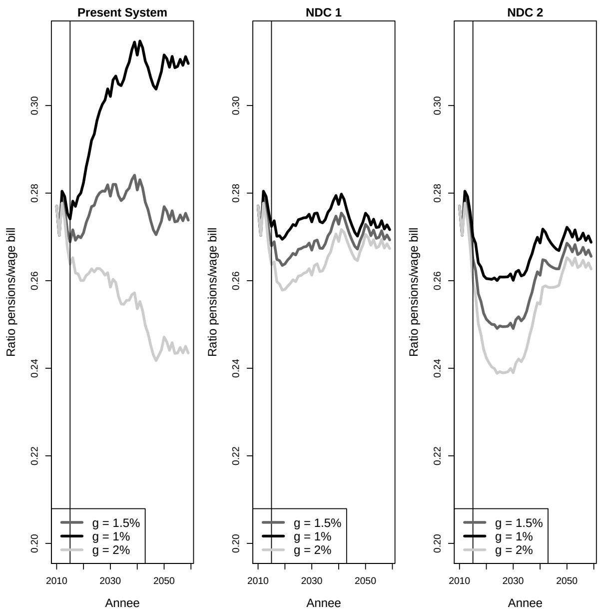
The two graphs on the right of figure 2 confirm the reduction of growth-dependence with the implementation of a NDC system. The gaps between the different macroeconomic scenarios is considerably curtailed compared to what we observe for the current system on the left graph (reproducing figure 1.a).

In both NDC systems, a certain amount of growth dependency remains in the short run. This can be explained by the fact that pension benefits of the old system are not concerned by the reform, which generates a transitory phase during which new pensions replace the old ones. Around ten years are necessary for the former to become the larger part of the stock of pensions. As a result, a part of the spread of the left graph is found at the right ones for the first years after following the transition.

Growth dependency reduces more slowly in the NDC2 scenario, with indexation of pensions on growth. This somehow counter-intuitive result can be explained as follows. In the case of price-indexation, adjustment of pension benefits levels goes by two distinct channels playing at the retirement date. Firstly, a faster growth increases accumulated rights at retirement (higher wages and higher rates of return on contributions). Secondly, it will increase the

[7] As mentioned in box 2, it is possible to value acquired right in the old regime in way that is more consistent with the historical contributions. This will be implemented in future research

Figure 2: Transition towars two forms of NDC systems : Impact on the pensions/wage bill ratio.



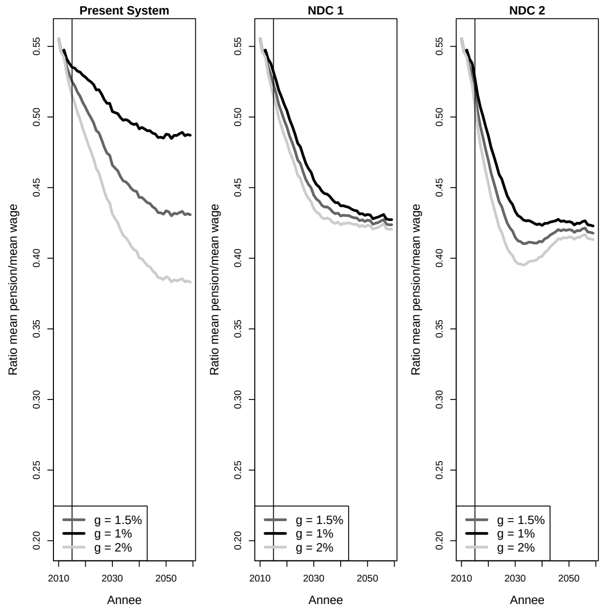

READING: from left to right : (a) status quo, (b) NDC system with price-indexation of ongoing pensions, and (c) NDC system with growth-indexation for ongoing pensions. On each graph, the dark grey line corresponds to the median economic scenario (wage growth of 1,5% per year) and lines in black and light grey respectively correspond to unfavorable (1% per year) and favorable (2% per year) assumptions.
SOURCE: PENSipp 0.0 model.

conversion rate through the projected return on contribution, based on growth rate as well. A symmetric reasoning can be made in case of a slower growth rate. In the scenario with a dynamic indexation of ongoing pensions (NDC2), the first channel is the only one playing. Conversion rates depends only on life expectancy (see appendix A) and do not change from one macro-scenario to the other. A big part of the adjustment plays on the indexation of ongoing pension, which takes a longer time. This explains the longer transition observed for the NDC2 scenario.

In both scenarios, growth-dependence almost disappears on the long run (after 2050), when productivity growth has been stabilized for 30 years.

We find the same kind of results in the analysis of the evolution of the relative level of pensions, compared to the current average wage (figure 3). From 2040 on, when a large majority of the stock of pensions has been claimed in the new system, the relative standard of living of retirees does not depend at all on growth level. As in the previous graph, we can note that scenario NDC2 takes more time to eliminate growth-dependence.

Figure 3: Transition towars two forms of NDC systems : impact on the mean pension/mean wage ratio.




READING: see figure 2.
SOURCE: PENSipp 0.0 model.

As a last interesting outcome of the reforms, we analyze in more details their effect on the relative level of pensions by age, as presented in figure 4.

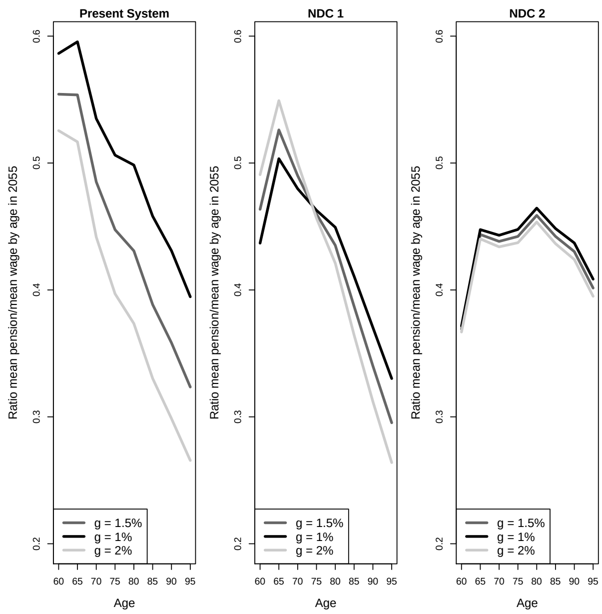
The graph on the left is the same as the figure 1.c of section 2. It illustrates the growth-dependence of the ratio between the mean pension by age and the average wage, with stems from the price-indexation of ongoing pensions and past nominal wages in the calculation of the reference wage. What happens in the NDC systems we simulate?

In the NDC1 scenario, the first effect is maintained since pensions are still price-indexed. Hence between 65 and 100 years old the decrease in the relative level of pensions is bigger with a faster growth (-25%) than in a slower one (-12%). However, the link between growth and the initial level of pensions is inverted: relative pensions at retirement are positively correlated with growth level. This is a consequence of the balance mechanism: a strong growth coupled with a price-indexation for pensions after retirements makes it possible to increase conversion rates, for a given targeted total expenditure. This mechanism explains the positive link between initial replacement rate and growth rate.

The picture is totally different for scenario 2. Indexation of pensions over the growth rate makes the progressive decline of relative pensions disappear. Additionally, since the conversion rate is the same (for a given retirement age) from one growth scenario to the other[8], replacement rate at retirement is exactly the same. Growth-indexation of pension eliminates growth dependency of the profile of relative pensions by age, but it comes at the cost of lower initial replacement rates.

Finally, we can underline that figure 4 reveals each regime specificity regarding the link between pension level and liquidation age. In the current system, this link is quite weak (some individuals can reach their full rate with an important pension at a young age), which translates in a flat profile of replacement rates between 60 and 67 years. On the contrary, NDC systems generate a strong positive relation between liquidation age and pension level. The property directly comes from the conversion rate and the actuarial fairness "at the margin" it embeds.

Figure 4: Transition toward two forms NDC systems : impact on the mean pension/mean wage ratio by age of the pensioner, in 2055.




Reading: see figure 2.
Source: PENSipp 0.0 model.

# 4 Transition toward a generalized point system

Simulations proposed in the previous section have confirmed that a system of notional accounts offers restoring forces that warrant correspondence between pensions and contributions, whatever the path followed by the economic growth rate. Can the same property hold in a point system ?

[8] And equal to the inverse of the expected retirement duration, see appendix A.

## 4.1 Choosing indexation rules for a generalized point system

A feature of notional accounts that is shared by point systems is the principle of letting entitlements accumulate over the active life-cycle in proportion to contributions paid to the system. However, important differences exist between points and a system of notional accounts. The first one is the fact that accumulated contributions are valued as points rather than in Euros. This introduces one first new parameter that does not exist in notional accounts : the purchasing price for these points that gives the relationship between contributions paid and the number of points accumulated at a given period. This parameter is one of the instruments that are available for monitoring the system : by modulating the purchasing price of points for a given contribution rate, one can change the number of points ultimately accumulated by each cohort and hence its future pensions entitlements.

Second difference, the system let points accumulate themselves in the contribution phase without applying any explicit return on their stock. An implicit return rate is ultimately applied to past contributions but it results from the combination between the evolution of the purchasing price of points and the evolution of another parameter : their conversion value. This conversion value is the ratio between the pension delivered by the system and the total amount of points accumulated until retirement. Once the person is retired, this total number of points does not change anymore, and the pension level changes from year to year according to the indexation formula retained for this conversion value, which is therefore the second main instrument available for monitoring the system. Let us note that, under the normal functioning of a point system, this conversion value determines both the replacement rate at retirement, and the ulterior evolution of one's pension while, under notional accounts, these two characteristics are determined separately.

To monitor this system in a way that ensures a stable pensions/GDP ratio, there is one first radical solution. One just has to compute at each time period the conversion coefficient as the ratio between the mass of contributions that are collected by the system and the mass of accumulated points held by people currently retired. In fact, this form of adjustment can work both in cases of a stable contribution rate and in the case where one would choose to increase these contributions rates, if adjustments only supported by retirees are considered as excessively penalizing for them. Yet, this way of managing conversion coefficients is problematic : lacking any rule governing the evolution of purchasing prices for these points, we open the way to an inflation of the number of these points, to the relative benefit of current contributors or youngest retirees and at the expense of older retirees. At the end of the day, this offers no guarantee to future retirees concerning the final value of their entitlements.

Rather than such a go-with-the-flow management of the conversion value, it is preferable to fix oneself *a priori* evolution rules for both the purchasing prices and conversion values of points. Even if mechanisms will differ, this set of explicit rules will share the spirit of notional accounts, aiming at making transparent and explicit the mechanisms used to balance the system. These rules must simultaneously make the dynamics of the system independent from economic growth and provide answers to the demographic constraint.

Let's consider the first problem. Currently, French complementary schemes fluctuate between two rules, either the simultaneous indexation of both parameters on inflation, or the indexation on wages for purchasing prices and on prices for the conversion value. Both rules generate growth dependency according to the mechanisms described earlier 2.

The only way to fully escape this negative link between growth and the relative level of pensions is to opt for a double indexation on wages both for purchasing prices and conversion values of points. The consequences of such a rule are formally described in Appendix B and they are easy to grasp intuitively. Under such rules, as under the wage/prices rule, each cohort reaches retirement with roughly the same number of points but, these points being now valued in proportion to current wages, they offer a relative standard of living at benefit claiming that is completely independent from growth assumptions and that is afterwards fully preserved until the end of the retirement period.

As a consequence, this rule solves the problem of growth dependence. But it does not offer any adjustment to demographic constraints. One can choose to accommodate this demographic constraint through increasing contributions. In that case, one needs the additional precaution of avoiding these additional contributions to generate later additional benefits. This is done in French complementary schemes with the so-called *taux d'appel* (calling rate) that offers the possibility to levy contributions above the benefit-generating contractual rate–. It could be done as well by indexing the purchasing price of points not on the average wage, but on wage growth augmented with the rate of growth of the contributions. Changes in the demographic structure can also be accommodated by raising the age at which a given replacement level can be offered or, equivalently, by subindexing the conversion value of points, leading to lowering the replacement rate offered at unchanged retirement ages. The correction that is needed directly stems from the equilibrium condition relating pensions, contributions and the ratio between pensioners and contributors. The demographic factor that needs to be substracted from wage growth in the indexation formula is the growth rate of the pensioner/worker ratio i.e. $d(R/A)/(R/A)$ if we note $R$ the retired population and $A$ the active population of contributors[9].

If we sum up this discussion, an indexation rule that will make the relative equilibrium of the system independent of changes in the economic growth rates while coping with changes in demographic structures consists in indexing the purchasing price of points on current

[9]See appendix B for the details of the demonstration.

wage growth ($dw/w$, eventually augmented with the current growth rate of contributions $d\tau/\tau$) and in indexing their conversion value on wage growth minus the demographic factor ($dw/w - \frac{dR/A}{R/A}$). One can observe the parallelism with notional accounts: the demographic factor plays a role similar to the conversion coefficient in notional accounts in case of a rising life expectancy, and, under unchanged demography, the implicit revalorisation of past contributions that goes through increases in the conversion value of points follows the growth rate of the total wage bill. The main difference between the two systems is due to the fact that differences in cohorts size are more immediately managed in this point system, with effects shared by new, current and future pensioners, while, under notional accounts, size effects are only managed on the long run, through changes in pension levels offered to successive generations of new retirees.

It is this point system that is simulated in the next sub-section, completed with a stylized rule of marginal actuarial neutrality for the link between pension and individual retirement age. This mechanism consists in a 5% majoration or a minoration, in addition to the mechanical effect of changes in the number of individual number of points due to anticipation or postponement. This majoration/minoration takes place arount a constant pivotal age which is also the age around which is evaluated the $R/A$ ratio.

We simulate however two variants of this general system. Both scenarios are constant contribution scenarios which apply full wage indexation to the purchasing price of points, hence neutralizing all impact of changes in wage growth before retirement. They differ concerning the degree to which they implement the corrective demographic factor. The first one (POINTS 1) consisting only in a partial implementation, limited to the computation of people's first pensions. More precisely, for the first generation of beneficiaries, we apply a conversion value of reconstituted points offering a replacement rate of 55%, to preserve continuity with replacement rates from the status quo scenario. Then, this conversion value at time of retirement changes from one cohort to the next according to wage growth modulated by the demographic corrector. But, each of these cohorts then sees its pension level stay constant in real terms until death, as it is the case under the current system. We therefore remove only one of the elements that create the current negative link between the pensions/GDP ratio and economic growth, the one that goes through the ratio between one's first pension and one's first wage. The second scenario (POINTS 2) applies the same rule as POINTS 1 to new retirees, and then indexes their pensions on wages minus the demographic correction factor.

### 4.2 Simulation results

Other choices made for the simulation are more or less in line with the ones retained for notional accounts, presented in box 2, with a few additional elements. As it was the case with notional accounts, the fixed contribution rate chosen for the new system is equal to 27% of gross wages and we simulate a complete transition for new cohorts of retirees as soon as the new system is set in, in 2015, with an artificial reconstitution of points accumulated by these cohorts based on the retrospective application of rules chosen for this new system. Converting imputed past contribution in current points raises no problem, since we index past purchasing prices of these points on past wage growth. The only parameter that is undetermined for these purchasing prices is a scale factor but this choice can be arbitrary: choosing a high value will imply a lower number of points that will be compensated by adopting a high initial value for the conversion coefficient, and conversely. An elegant convention is to equalize the purchasing price of points with the level of contributions paid by a worker whose wage is just equal to the social security ceiling, since this ceiling, historically, has more or less followed the same path as mean wages, and is projected to do exactly so in the future. This means that one contributor paid at $x$ times the mean wage at time $t$ exactly accumulates $x$ points[10]. This, incidentally, makes the system quasi equivalent to an annuity system for workers always paid at this mean wage.

Main results are provided on figures 5 to **??**, following the same presentation rules as for notional accounts, with the same variants of economic growth roughly equivalent to COR scenarios A', B and C'. Results are as expected, except for a few points calling for additional expertise.

Scenario POINTS 1 reduces sensitivity to growth, but this sensitivity remains significant, since this scenario still imply a growth-dependent divergence between wages and pensions after benefit claiming. Sensitivity to growth is reduced by about one half : the gap between the two extreme scenarios in terms of the pensions/wage bill ratio is reduced to about 3 points, against more than six points under status quo. Under the same scenario, pensions by age in 2055 display the expected narrowing of the ratio between pensions and current wages for new pensioners (figure 6), compared to the growth-dependent gap observed without any new reform. But, from this common point of departure, age profiles remain fan-shaped according the rate of economic growth, without the compensation by the opposite movement of initial replacement rates that one had under notional accounts.

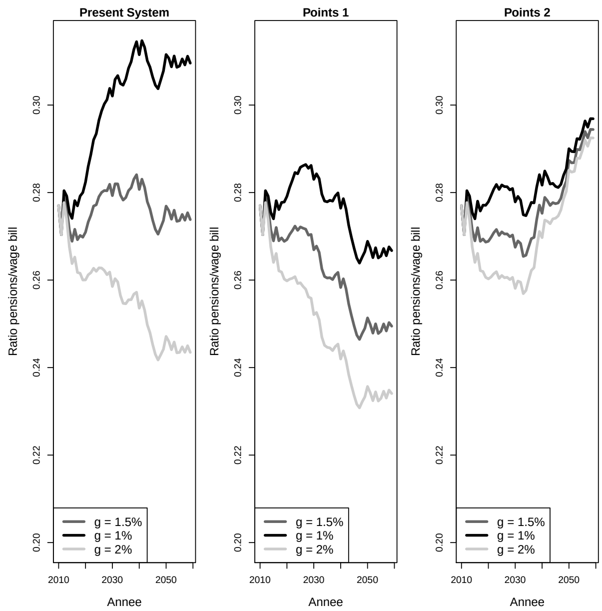
All these phenomena disappear in the POINTS 2 scenario, with a full convergence of trajectories, and an almost completely horizontal profile for relative pensions by age in 2055. The price to be paid for that is however a relatively more costly system in the long run. The reason necessarily comes from the rule of indexation after retirement. This rule achieves an almost complete insulation of the pensions/GDP or pensions/wage bill ratio from changes in the economic growth rate. In the short and median run, the $dw/w - d(R/A)/(R/A)$ also generates a path for ongoing pensions that is relatively similar to what results from price indexation under the median economic growth scenario, given that the rate of growth of $R/A$

[10]This convention is the one used in the German system but it also brings us back to the initial functioning of French complementary schemes, where the purchasing price of points was initially labeled "reference wage", this reference wage being the one for which the current contribution rate allowed purchasing one point. Such a terminology made sense only as long as this reference wage followed the same path as mean wages, and has been progressively abandoned along with this initial indexation principle.

until the mid-2030s is roughly equal ro 1.5% per year. But, afterwards, the $-d(R/A)/(R/A)$ factor looses most of its strength, after closure of the baby-boom parenthesis and the rule comes progressively closer to full reindexation of ongoing pensions on wages, i.e. a more protective but more expensive system. Using prices rather than $dw/w - d(R/A)/(R/A)$ after liquidation avoided this extra cost but with the consequence of solving only one half of the growth dependency problem.

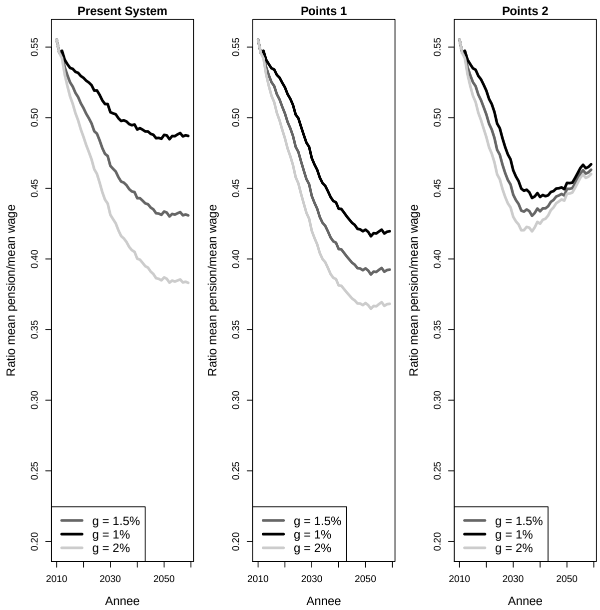
If we want to restore complete protection against those risks with a long run pensions/GDP ratio not higher than its current value, we would need to amend the proposed system in another way. Basically, the problem stems from the trade-off that exists between initial replacement rates and indexation during the retirement period. For a given target in terms of pensions/GDP ratio, a more generous indexation rule has to be compensated by lower initial replacement rates. Here, the problem stems from the fact that we apply this more generous indexation rule to a replacement rates whose level at the onset of the new system has been fixed in continuity with the currently existing system, where part of the long run equilibrium is obtained with the less generous price indexation formula –at least under median or favorable economic scenarios. One solution to this could be to initiate the new system with a replacement rate of gross wages significantly lower than the 55% chosen to ensure continuity with the present system. But this would result in a strong break in replacement ratios for the initial transition cohorts. An alternative can be a more progressive path of adjustment of this initial replacement rate. A last possibility, if we want to keep replacement rates unchanged, is to adopt still other forms of indexation after retirement, that would keep the link with $dw/w$ and demographics, but moderated further by an additional factor, i.e. a $dw/w - d(R/A)(R/A) - x$ rule where the level of $x$ and eventually the rythm of its gradual implementation would require further explorations, that have been left for future research.

Figure 5: Transition toward two forms of a generalized point system : impact on the pensions/wage bill ratio.



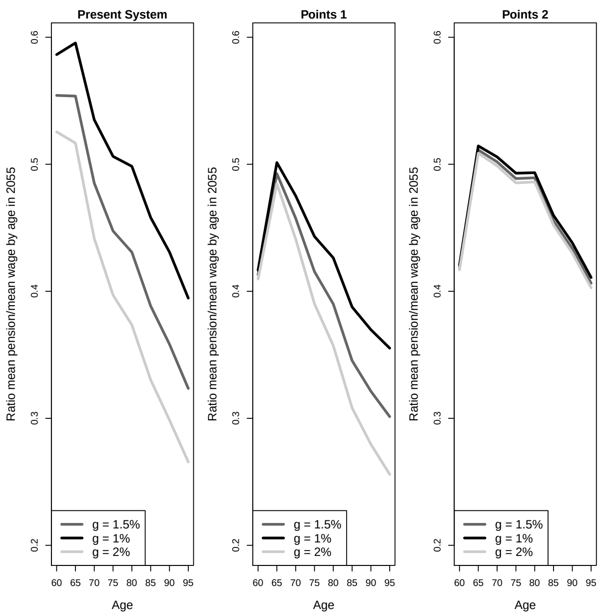

Reading: from left to right : (a) status quo, (b) transition to a point system maintaining indexation on prices after benefit claiming, and (c) complete indexation of purchasing prices and conversion values of points on wages, with demographic correction. On each graph, the dark grey line corresponds to the median economic scenario (wage growth of 1,5% per year) and lines in black and light grey respectively correspond to unfavourable (1% per year) and favorable (2% per year) assumptions.
Source: PENSipp 0.0 model.

Figure 6: Transition toward two forms of a generalized point system : impact on the mean pension/mean wage ratio.




Reading: see figure 5.
Source: PENSipp 0.0 model.

Figure 7: Transition toward two forms of a generalized point system : impact on the mean pension/mean wage ratio by age of the pensioner, in 2055.




Reading: see figure 5.
Source: PENSipp 0.0 model.

## 5 A parametric alternative ?

Notional accounts and a generalized point system applying adequate indexation rules offer two answers to the basic question raised in this paper, i.e. finding modes of adaptation to demographic change whose efficiency does not depend upon economic growth assumptions. Such structural reforms would have another potential interest : they could help restore readability and consistency of pension rules that, reform after reform, have progressively been altered in the present system. But, if it is only the growth dependency problem that is at stake, one can also consider less ambitious reforms limited to changing indexation rules that prevail in the current system without trying to make it simpler and without changing any of its other characteristics. if we adopt this second best strategy, we must consider separately the two pillars that currently exist for workers belonging to the private sector –the basic general regime and complementary schemes– and the one-pillar system that applies to people working in the public sector.

### 5.1 Designing new rules for an unchanged system

As far as complementary schemes are concerned, the policy that has to be implemented is direct. One just has to apply to these schemes the indexation rules tested for the generalized point system discussed in the previous section : wage indexation ($dw/w$) for the purchasing prices of points in the Arrco and Agirc regimes, and wage minus the demographic factor for their conversion value ($dw/w - \frac{dR/A}{R/A}$)[11].

What about annuity schemes ? There is once again an element of the generalized point system that can be easily transposed. It concerns the choice of the indexation rule after benefit claiming, where one just has to move from indexation on prices to indexation on wages minus the demographic corrector, modulo, as discussed earlier, eventual corrections necessary to avoid the extra-cost of this more generous rule in steady state. The question therefore reduces to adapt rules for computing the first pension.

In the general regime, what creates the current dependency to growth is the fact of using prices to actualize the series of the 25 best past wages which is used to compute the reference wage. To get rid of this dependence, we have to restore the revalorization of these past wages on past average wage growth, i.e. the rule that has prevailed until the second half of the eighties. Let's assume an individual $i$ whose 25 last years in employment run from $u = t-25$ to $u = t$ with wages $w(i,u) = k(i,u).\bar{w}(u)$ where $\bar{w}(u)$ is the mean wage at time $u$ and $k(i,u)$ the relative position of this individual $i$ relative to this average wage at each time period. Let's

[11] This entails no rescaling of these parameters. In the previous section, we had considered more satisfactory to align the purchasing price on contributions paid by people earning the mean wage, with one year of full-time labour force participation at $x$ times the mean wage buying exactly $x$ points. But such a choice remains conventional and is not necessary if we prefer to maximize continuity wit the current system.

assume for simplicity that this relative position remains unchanged across macroeconomic scenarios, the impact of productivity changes being only -at first order-, to homothetically displace wages of the whole population. With the revalorization of past individual wages according to $\bar{w}(u)$, the reference wage that will serve as the basis for computing the first pension of individual $i$ retiring in $t$ will be:

$$\frac{w_{ref}(i,t)}{k(i,t)\bar{w}(t)} = \frac{1}{k(i,t)\bar{w}(t)} \sum_{u=t-25}^{t} k(i,u).\bar{w}(u).\frac{\bar{w}(t)}{\bar{w}(u)} = \frac{1}{k(i,t)} \sum_{u=t-25}^{t} k(i,u)$$

which is indeed fully independent of the path followed by the mean wage. One can observe how close this formula is from the one prevailing in the generalized point system, and even the one prevailing under notional accounts. The sum of the $k(i,u)$ is completely akin to a sum of points bought by contributions proportional to wages, at a price indexed on mean wages, or to a sum of past contributions reevaluated every year according to wage growth: the only difference lies in the fact of computing this sum on the 25 best or last years of one's career that favor –up to the social security ceiling– ascending or irregular careers.

To this reference wage now re-anchored to current wages, what remains to do is to apply a replacement rate that won't be fixed but modulated according to the demographic context. The rule to follow applies the same demographic corrector as we do in the point system, but now *in levels*. If $t_0$ is the date when the new rule starts being implemented, the annuity factor to be applied to people retiring at time $t$ is the initial one multiplied by $(R(t_0)/A(t_0))/(R(t)/A(t))$. With this rule and the indexation of current pensions on $dw/w - dR/R$, one gets homogeneous co-movements for pensions paid to the stock of current retirees and to the flow of new retirees, as soon as the new system is implemented: starting from this date, the average pension paid at each period to new retirees is equal to the average first pension of people who have left the year before, augmented according to the rate of growth of average wages between the two periods, and reduced by the growth rate of the pensioner/worker ratio between the same periods.

This system transposes itself directly to the case of public sector employees. Here, the rule retained to reevaluate past wages becomes indifferent, since the first pension is connected to the last wage. All what remains is the adjustment to demographic change, based on the same demographic correction of the annuity factor and this mode of adjustment asks the same effort to private and public sector employees in front of a given change in the global pensioner/worker ratio. The only difference that remain is their different way to manage people with different relative career profiles but the two systems now react in the same way to demographic constraints and to fluctuations in global economic growth.

Now, one major difference with our structural scenarios needs to be emphasized here : it is the fact that, in this structural scenario, the change is not limited to new pensions.

New indexation rules also apply to the current stock and change the expected trajectories for people who have already left activity.

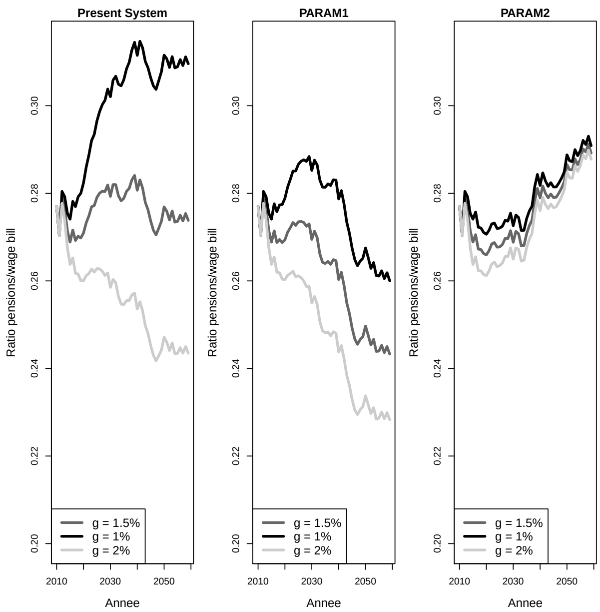
### 5.2 Simulation results

According to these principles, we simulate again two subscenarios, that replicate the POINTS1 and POINTS2 scenarios from the previous section. In a first scenario (PARAM1), one implements the reform above but only for the computation of first benefits, maintaining afterwards the indexation on prices. The second scenario (PARAM2) also applies the new indexation rule to ongoing pensions.

Figures 8 and 10 present results that have been obtained that are indeed very close to the ones ones of scenarios POINTS1 and POINTS2 that they try to reproduce. As it was the case with the POINTS1 scenario, scenario PARAM1 only partially reduces sensitivity to growth, since it leaves uncorrected the share of this growth-dependency that stems from price indexation after benefit claiming.

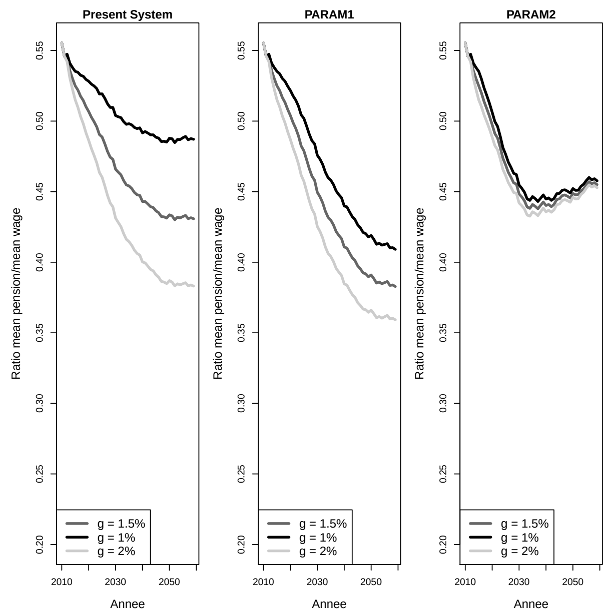
On the other hand, the resorption of this dependency is almost total in the PARAM2 scenario. The fundamental reason for this strong effect compared to what was observed with structural reforms has been underlined above : it is the fact that the new rules immediately apply also to the initial stock of pensioners, while we had conventionally decided to limit the change to new retirees under structural reform. By modifying prospective paths for members of this stock, one is able to efficiently reduce sensitivity to growth without waiting for 2035. Remains the fact that, in the long run, such a system is a little more costly than the current one because, once the demographic structure stabilized, it fully restores full indexation of ongoing pensions on wages : if we want to avoid that, we would need here also to explore the scenarios of additional adjustment mentioned in the discussion of scenario POINTS 2, either a permanent coefficient of additional subindexation for these ongoing pensions, i.e. a $dw/w - d(R/A)/(R/A) - x$ rule, or a stronger initial decline of the initial replacement rate to compensate the more favourable dynamics of pensions after retirement, i.e. a decline stronger than the one implied by the $(R(t_0)/A(t_0))/(R(t)/A(t))$ correction applied to the annuity coefficient. Here again, the calibration of such additional corrections has been left for future explorations.

Figure 8: Two parametric reforms : impact on the pensions/wage bill ratio..



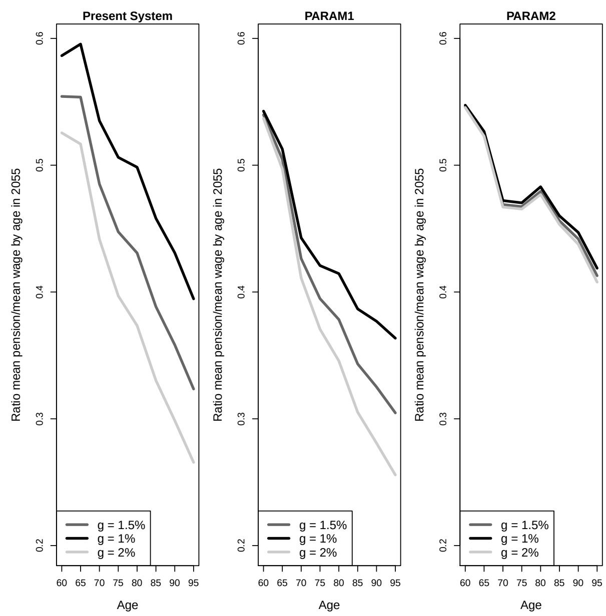

READING: from left to right : (a) status quo, (b) indexation of past wages and purchasing prices of points on the mean wage, demographic corrections at benefit claiming and price indexation afterwards, and (c) as (b) but with demographic correction after benefit claiming. On each graph, the dark grey line corresponds to the median economic scenario (wage growth of 1,5% per year) and lines in black and light grey respectively correspond to unfavourable (1% per year) and favorable (2% per year) assumptions.
SOURCE: PENSipp 0.0 model.

Figure 9: Two parametric reforms : impact on the mean pension/mean wage ratio.




READING: see figure 8.
SOURCE: PENSipp 0.0 model.

Figure 10: Two parametric reforms : impact on the mean pension/mean wage ratio by age of the pensioner, in 2055.




READING: see figure 8.
SOURCE: PENSipp 0.0 model.

# 6 Conclusion

Pension reforms implemented in France since the early 1990s have greatly contributed to reduce the pension liabilities and thus make the financial balance of the system possible. But two major problems remain unaddressed. First the system is plagued by complexity and lack of transparency of the rules that define pensions throughout different occupations. Second, the financial balance of the system is highly uncertain, only dependent of significant long-term productivity growth.

This paper has concentrated on this second issue, examining various policy responses. Two scenarios of structural reforms (NDC and point-based system) have been analyzed, as well as changes to the indexation rules within the current rules of the pension system. All options discussed in this paper allow to remove financial balance uncertainty, making pension spending less dependent on long-term growth.

If all three scenarios answer the initial problem, one might wonder how to choose between these various options.

A first argument could be to choose the option with the most practical administrative feasibility. With this in mind, it is obviously the third option that looks the most attractive, as there is no need to change dramatically current rules and schemes. But one should not underestimate the changes described: the introduction of a direct demographic coefficient will change radically the pension rules, making the reduction in the replacement rate more explicit than it is currently. One should also not that instead of making progress towards a more simple and transparent system, this options has the clear disadvantage of making rules even more complex. This is why the structural reforms analyzed in this paper should also not be put aside too quickly. They offer the only responses likely to simplify radically the current system and bring about a much needed transparency to the pension rules. One could also suggest a two-step reform process, with first some changes to the current rules to solve the issue of growth-dependence and then, at a later stage, a more radical reform to simplify the system.

The comparison between the options in NDC and in points is also interesting in itself. The logic of the two systems are in effect very similar and it is possible to combine their different aspects. For instance, the demographic parameter suggested in the point-system can take into account both life expectancy and the size of the cohorts, unlike the traditional conversion coefficient in NDC. This has the advantage to deal with a papy-boom in a system without reserves. At the opposite, an NDC system has the advantage, being expressed in euros, to offer very strict rules for determining the internal rate of return, and thus avoid the pitfalls of indexation in point-based systems. But again, it is possible to set strict rules in a point-based system, following the example of NDC systems – what has been done in this article. The great strength of NDC system is indeed to take directly into account the long-term parameter to define the level of pensions. It is possible to do likewise in a point-based system, for instance by indexing the purchasing price of the point with earnings growth in a way very similar to the internal rate of return applied to NDC contributions.

If the scenarios presented in this paper give a good picture of the options available to address these issues within the French pension system, there remains a number of points which need further research.

First, the macroeconomic shocks tested in this paper are only of the form of variants of long-term productivity growth, but do not incorporate temporary shocks to macroeconomic conditions. These should be incorporated if one would like to assess the ability of a pension system to smooth consumption within macroeconomic uncertainty while keeping a balance mechanism that remain counter-cyclical.

Second, the exact nature of the parameters on which indexation is based needs to be refined. For instance the definition of the demographic correction term is a simple concept but could be better analyzed in order to take into account both changes to cohort size and life expectancy. Similarly the earnings growth could be also discussed in more depth, whether to use average earnings or index of total earnings growth in the economy, or even weighted average depending on demographic changes.

Third, all scenarios have highlighted the general issue of indexation after the pension is claimed. NDC systems have in that respect a clear advantage, being able to incorporate directly a reduction in replacement rate if indexation rules are more generous after pension claim. The issue is less clear cut with a point-based system where compensation of indexation on earnings growth is not straightforward. More generally this indexation issue, should weigh the desire for a more dynamic pension indexation than price indexation in order to keep pension in line with current earnings, with considerations suggesting higher replacement rate early on in the retirement period.

Finally, any research on the optimal design of pension systems should address the redistribution embedded into the system, a point completely left outside the current paper. In order to do so, we would have to simulate non-contributory benefits within NDC and point systems, and also taking into account – a more difficult task – the heterogeneity in the current French system between different schemes, both in terms of contributions and benefits. This is the plan for forthcoming research.

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# Appendices

## Appendix A: Equilibrating notional accounts with the rate of return and the conversion coefficient

Providing an exact formula for the conversion coefficient in a system of notional accounts is not straightforward but it helps understanding how the system works. Computations are provided here under a continuous time representation, which is more synthetic than the discrete time representation.

Under steady state, wages at age $a$ and time $t$, $w(a,t)$ are decomposed into a fixed age effect and a period effect growing exponentially at rate $g$, which will also be the rate of growth for mean wages, i.e. $w(a,t) = w(a)e^{gt}$.

Pension at age $a$ in $t$ ($p(a,t)$) is the product of three factors: the mass of contributions paid between the age at entry into the labour force, $\alpha$ and the age at retirement $\beta$, reevaluated each year at rate $r$, i.e. $\int_\alpha^\beta \tau w(u,t-a+u)du$), with $\tau$ the contribution rate ; the conversion factor $c(\beta)$ which is applied to this notional capital when the person retires; and at last the cumulative impact of revalorizations applied between $\beta$ and the current age, supposed to take place at rate $r'$.

On the whole, this pension writes down :

$$\begin{aligned} p(a,t) &= \tau c(\beta)\left[\int_\alpha^\beta w(u,t-a+u)e^{r(\beta-u)}du\right]e^{r'(a-\beta)} \\ &= \tau c(\beta)\left[\int_\alpha^\beta w(u)e^{g(t-a+u)}e^{r(\beta-u)}du\right]e^{r'(a-\beta)} \\ &= \tau c(\beta)e^{gt}e^{(r'-g)a}e^{(r-r')\beta}\left[\int_\alpha^\beta w(u)e^{(g-r)u}du\right] \end{aligned}$$

whence :

$$p(a) = \tau c(\beta)e^{(r'-g)a}e^{(r-r')\beta}\left[\int_\alpha^\beta w(u)e^{(g-r)u}du\right] = \tau c(\beta)F(a)$$

The value for c($\beta$) can be obtained by writing the equilibrium condition between contributions and the sum of pensions. With $n$ the population growth rate, $s(a)$ the survival function and $\omega$ the maximum length of life, this condition writes down :

$$\tau\int_\alpha^\beta w(a)e^{-na}s(a)da = \int_\beta^\omega p(a)e^{-na}s(a)da = \tau c(\beta)\int_\beta^\omega F(a)e^{-na}s(a)da$$

It leads to :

$$\begin{aligned} c(\beta) &= \frac{\int_\alpha^\beta w(a)e^{-na}s(a)da}{e^{(r-r')\beta}\int_\beta^\omega\left[\int_\alpha^\beta w(u)e^{(g-r)u}du\right]e^{(r'-g-n)a}s(a)da} \\ &= \frac{\int_\alpha^\beta w(a)e^{-na}s(a)da}{\int_\alpha^\beta w(a)e^{(g-r)a)}da}\frac{e^{(r-r')\beta}}{\int_\beta^\omega e^{(r'-g-n)a}s(a)da} \end{aligned}$$

The formula is therefore particularly complex in this first case when all the burden of adjustment is borne by this conversion coefficient. In particular, it is variations in this coefficient that will compensate for changes in the rate of productivity growth $g$, since the rate of return $r$ and the indexation rule $r'$ are kept exogenous at this stage.

The formula gets simpler if one constrains $r$ to equate the rate of global economic growth $g+n$, which is the natural rate of return of a mature PAYG system with a fixed contribution rate. Let's note $s(a|a') = s(a)/s(a')$ the survival at age $a$ conditional upon survival in $a'$. One gets :

$$c(\beta) = \frac{\int_\alpha^\beta w(a)e^{-na}s(a)da}{\int_\alpha^\beta w(a)e^{-na}da} \frac{1}{\int_\beta^\omega e^{(r'-g-n)(a-\beta)}s(a)da} \approx \frac{1}{s(\beta|a_m)} \frac{1}{\int_\beta^\omega e^{(r'-g-n)(a-\beta)}s(a|\beta)da}$$

where $a_m$ is the mean age at activity. One sees that, in that case, the conversion coefficient just has one remaining effect of $g$ to correct, the one that stems from the different dynamics of wages and pensions after benefit claiming. For a given indexation rule, the conversion coefficient has to go down when growth slows down, to compensate the fact that resources will grow less.

One can avoid this if pensions are themselves indexed on economic growth. If they are indexed on global growth, i.e. $r' = r = g + n$, the formula boils down to :

$$c(\beta) = \frac{1}{\int_\beta^\omega s(a|\beta)da}$$

which is just the inverse of life expectancy at age $\beta$.

In this latter case, answers to the different kinds of shocks are ultimately shared in the following way :

- All shocks affecting economic growth are completely absorbed by the decline in $r$ during the accumulation phase and the decline in $r'$ during the retirement phase : this is true both for shocks on $g$ and shocks on the demographic growth rate $n$.
- A positive shock on longevity is managed through a drop in the conversion rate

With a system of notional accounts, one therefore gets a system that neutralizes the consequences of changing economic growth rates on the different ratios that characterize the pension system. The main limit is that return to equilibrium is not fully immediate. The forces that reequilibrate the system only have progressive effects, whose rapidity depends of indexation rules that have been chosen. One can give two examples :

- When the shock is a shock on economic growth, and if we have adopted price indexation after retirement, as in the NDC1 scenario, the answer to the shock only goes through the impact of $r$ on the entitlements of new retirees, without any impact on pensions currently paid, hence a relatively slow recuperation. This recuperation will be more rapid if ongoing pensions are themselves related to $g$, as it is the case with the $r' = g + n$ rule.

- When the shock is a longevity shock, the modification of entitlements only concerns new retirees, and conversion coefficients based upon period mortality rates generally underestimate the effective length of retirement since they do not incorporate additional longevity gains that will occur during the retirement period. If there are continuous gains in life expectancy, a system of notional accounts with conversion coefficients based on current life expectancy is, in fact, permanently underfunded. Some additional correction is needed.

## Appendix B : A generalized point system with purchasing prices and conversion values of points both indexed on wages

We analyze the properties of this system in the most general case of an unstable economic environment. On the other hand, we transitory assume a stationary age structure with $A$ workers and $R$ retirees, the objective being to focus first on how the system behaves when facing pure economic shocks. One assumes that the wage of individual $i$ aged $a$ at time $t$ combines multiplicatively a period effect, an age effect, and a fixed individual effect, the two later ones being equal to one on the average. This writes down :

$$w(i,a) = w(t).f(i).g(a)$$

We will now count age $a$ from time at entry in the labour force, $D$ being career length. The contribution rate is fixed and again equal to $\tau$. We choose a purchasing price for points equal to $\tau w(t)$ implying that, at time $t$, contributions paid by an individual paid at the mean wage allow him to buy exactly one point but results are independent from this scale convention.

Under these assumptions, when individual $i$ reaches retirement at time $t$, his global number of points is :

$$K(i) = \tau \int_0^D \frac{(w(i,t-D+a)}{\tau w(t-D+a)} da = \int_0^D \frac{(w(t-D+a)f(i)g(a)}{w(t-D+a)} = f(i) \int_0^D g(a)da = Df(i)$$

i.e. the length of his career multiplied by the relative position he has had all over his career relatively to other members of his cohort. On the average, the number of points of a cohort that reaches retirement is therefore juste equal to $D$ and this amount is the same for all current retirees whatever their age, excepting differences due to differential mortality that will be either neglected or considered as stable.

In that case, if the conversion value of points is of the form $aw(t)$, the average pension level is $aw(t)D$, the replacement rate is $aD/g(D)$, and, in fact, it exactly corresponds to what we usually expect from an annuity system. The ratio between the average pension and the average wage is equal to $aD$ and it applies not only on the average but also for each age group of pensioners.

This also implies the stability of the ratio between total pensions and the total wage bill $DRaw(t)/Aw(t) = DRa/A$, whatever the past chronicle of mean wages. The system therefore automatically adapts itself to growth shocks. Let's assume for instance a severe crisis resulting in a drop of $w(t)$ by $\Delta x\%$ at time $t$. This changes nothing to the totals of points owned by people already retired and by new retirees. For the latter ones, the lower contributions paid because of the drop in $w$ buy an number of points that remains centered on $g(D)$, since the purchasing price of points declines in line with $w(t)$, and the addition of these points remains equal to $D$, as for other cohorts. Given that the number of points owned in the population is valued in proportion to the current net wage, the stability of the pensions/wages ratio and of the relative standard of living of retirees is maintained, despite the shock. Hence we have a system that instantaneously shares the consequences of the shock between all age groups.

When shocks affect the demographic structure, if the objective is once again the stability of contributions, one compensates the variation in $R/A$ by an evolution in the opposite direction of the conversion value of points. Put differently, its rate of growth becomes $dw/w - (dR/A)/(R/A)$ instead of the $dw/w$ rule that applies when demographic structure remains unchanged. One manages the stability of the pensions/wage bill ratio by simply combining indexation on wages and this demographic corrections factor.

Of course, if we have a demographic shock, the stability of the pension/wage ratio does not prevail anymore. One cannot simultaneously stabilize the pension/wage ratio and the pensions/wage bill ratio, except by counteracting the consequences of population aging with an increase in retirement ages high enough to cancel the ex ante growth of $R/A$. This can incidentally derive from spontaneous behavior. If the system offers freedom of choice concerning retirement ages and if individuals have a target replacement rate equal to $aD/d(D)$ they will react to the decline in the conversion value of points by postponing retirement in a way that will fully offsets the decline in the return offered by the system.

Two observations however need to be made here :

- This naturally does not mean that lowering the conversion value of points becomes unnecessary, or more precisely of the conversion value that applies at a given retirement age. It is because we will have such a lowering that this modification of retirement ages will occur. This means that the $R/A$ ratio to consider is no more the effective pensioners/workers ratio but the one referring to the pivotal age where the basic rule of point conversion applies, as done here in scenario POINTS1 and POINTS2. This point must be looked at very carefully when designing detailed rules for the system.
- Changes in retirement behavior can also result in transitory disequilibria that would need further expertise. Indeed, during such a transition, the total amounts of points helds by the different cohorts of retirees stop being identical. Younger cohorts have accumulated larger number of points due to increasing career lengths. This can affect short term equilibrium and call for additional corrections.

More generally, even if it looks relatively powerful, automatic adjustment through the double wage/wage indexation and the additional demograplic corrector is probably not total and may have to be complemented by other forms of adjustment. This need of further adjustement can also result from fluctuations in the structure of wages by age, or of the distribution of individual factors $f(i)$. Additional adjustements can take the from of additional corrections to the indexation rule, or changes in contribution rates, in this latter case under the condition that such increases in contributions will not, in turn, generate additional entitlements. This can be done by indexing the purchasing price not on $w(t)$, but more generally on $\tau(t)/w(t)$ where $\tau(t)$ is the time-varying contribution rate.

It is then easy to show how these rules and properties can be reproduced in an annuity system. With past wages reevaluated according to past wage growth rather than on inflation, the reference wage computed when the individual retires is naturally anchored to the current mean wage in a way that is independent of past wage growth. One can then apply to this reference wage a replacement rate that is explicitely linked to the current ratio between workers and retirees. After that, pensions are indexed on wages minus the rate of growth of this demographic factor. Compared with what has been done in France since 1993, this amounts to completely reestablishing previous indexation rules, compensating this step backward by an explicit management of the demographic constraint, instead of the indirect management through price indexation that solves the pension problem only under specific wage growth assumptions.

Last, both in the generalized point system and with annuities, the proposed rules can be seen as simple transcriptions of the fundamental equilibrium condition that has to be fulfilled by any PAYG scheme. With the same notations and $\bar{\pi}$ the average pension, this equilibrium condition writes down :

$$\tau w A = \bar{\pi} R$$

hence, in variations :

$$\frac{d\bar{\pi}}{\bar{\pi}} = \frac{d\tau}{\tau} + \frac{dw}{w} - \frac{d\frac{R}{A}}{\frac{R}{A}}$$

It leads to the proposed indexation rule if $d\tau/\tau = 0$ and in the absence of any renewal effect, i.e. if pension levels are identical between new pensioners and those who die at the current period. In the proposed formulas, this renewal effect is indeed neutralized through the indexation on wages of the purchasing price of points or of past wages since these two mechanisms eliminate gaps in pension levels between old and new retirees. If we augment contribution rates, it is sufficient to add this increase to the indexation formula.