Microsimulations of the retirement decision: a supply-side approach

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Abstract

The economic debate on pensions in France has been increasingly focusing on introducing more flexibility in the retirement decision (up to now sharply constrained by the strength of incentives to claim SS benefits at the so-called « full rate » in the private sector): see Charpin (1999) and Taddei (2000). This paper analyzes methodological issues in implementing a supply-side modelling of the retirement decision in the microsimulation model Destinie. We simulate the retirement decision for cohorts 1943 to 1947 under various assumptions regarding the parameterization of the model. To assess the sensitivity of the model to change in the computation of pensions, we also simulate the possible impact on individual behaviours of reforms that would simultaneously decrease the penalties implied by anticipated retirement and increase the level of benefits in case people would decide to keep on working after being entitled to the full rate.

Keywords: microsimulation, retirement decision, pension schemes

Résumé


Mots-clés: microsimulation, décision de liquidation, barèmes de retraite

JEL classification: C15, H55, J11, J26
**Introduction**

In the French pension system for wage earners in the private sector (Régime Général), people are entitled to SS benefits as soon as they are 60. However they face strong incentives to postpone their retirement until they reach either the age of 65 or 40 years of contributions\(^1\) (‘full rate’). Indeed the penalties associated with anticipated retirement are high and the increase in the pension if the worker stays in employment after 40 years is very low. The distribution of the retirement age has therefore a familiar two peaked shape: wage earners with long work tenure claim SS benefits as soon as they can (i.e. at 60) whereas short careers (mainly women) wait until 65 in order to get the full rate.

Reforms of the pension system allowing more flexibility in the choice of the retirement age are currently under debate in France (Charpin 1999, Taddei 2000). For instance, the Charpin Report published in Spring 1999 suggested to reduce the penalties associated with anticipated retirement. The loss in the level of SS pension per year missing to reach the full rate could be fixed around 7% (instead of 12.4% today) for short careers, a value closer to actuarial neutrality (see appendix 3 for a definition). To alleviate the consequences of demographic trends on the pension system in the years to come, the report also proposed to shift progressively to 42.5 (instead of 40) the number of contribution years necessary to get the full rate.

In order to assess the effects of such reforms on the retirement age, one needs a model of the retirement decision. Up to now the dynamic microsimulation model Destinie developed at Insee used a very simple rule: people were supposed to retire as soon they reached the full rate. This straightforward assumption relied on the fact that individual choices are highly constrained with the current pension scheme and allowed us to roughly replicate the two peaked distribution of the retirement age. However such an assumption is no longer sustainable if schemes closer to actuarial fairness were to be adopted.

A new version of the model relying on an explicit modelling of the individual retirement behavior is therefore under development. The main idea of the model is that people choose their retirement age by comparing over the life cycle the utility of retirement at different dates. This supply side model implicitly assumes that the individual choice is not constrained by the demand on the labour market.

The purpose of this paper is to analyze methodological issues in implementing such a supply-side approach of retirement and simulate several reforms of pensions schemes. We performed simulations on cohorts that will retire in the coming years (cohorts 1943 to 1947) since there now remains little uncertainty about their careers. For those cohorts, the simulations show that the effect to be expected from more flexible pensions schemes should be rather limited given the strong proportion of individuals that reach the 40 years target before the minimum age of 60.

Using results on these cohorts also allows us to assess the validity of the model predictions, which would not have been the case if we had considered more recent cohorts on which there is today little information. Once a new version of the microsimulation model, based on an updated data set drawn from the 1998 Financial Assets Survey, is available, further studies will assess the expected effects of pension reforms on more recent cohorts.

The paper is organized as follows. In a first section, we give a brief overview of the microsimulation model Destinie. A second section details the model of the retirement decision. A third section simulates the retirement decision under current rules and explores the sensitivity of the results to the parameterization. A last section simulates several reforms.

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\(^1\) This target corresponds to the so-called ‘full rate’ (taux plein) and this is the term we will use in the rest of the paper.
reforms of the pension system: enforcement of more actuarially fair schemes; Charpin reform; return to the system prevailing before the 1993 reform.
1. The dynamic microsimulation model Destinie: a brief overview

This section gives a brief overview of the structure and of the main assumptions of the microsimulation model Destinie. A more detailed description can be found in the INSEE working paper presenting the model (Insee 1999).

The main purpose of the model is to simulate the evolution of pensions in the long run accounting for the heterogeneity of careers and the change in the demographic structure. The model is based on individual data derived from the 1991 Financial Assets Survey. The initial sample is composed of 15,000 households i.e. about 37,000 individuals. Each person is characterized by demographic and economic information such as age, income (wages, pensions...), relatives, labour participation. In order to follow this population year by year from 1992 to 2040, different kinds of events are simulated:

- A demographic module simulates events like death, birth, immigration, departure from parents’ home, marriage (this step requires a matching process), divorce.

- A labour market submodule provides information on the age at which people leave school and on transitions on the labour market.

The school leaving age is one of the main variables of the model. It sums up all the heterogeneity in term of social status, socioprofessional group and qualification. The individual school leaving age is related not only to the average one of her cohort but also to her father’s and mother’s. This latter assumption accounts for some kind of ‘social replication’.

To model transitions on the labour market, six states are distinguished: employment, unemployment, school, inactivity (mainly housewives), early retirement and retirement. The labour market module is organized in two stages. The first one simulates the participation in the labour force whereas the second determines if a participating individual is employed or unemployed. Transition probabilities are estimated on the 1991 Employment Survey. The probabilities are treated as a first-order Markovian process and depend on sex, age, school leaving age, and, for women, the number and the age of children. For each person who is no longer in school and not yet retired, the model randomly determines, given her transition probabilities, whether her labour force status changes. The parameters of the transition equations are adjusted to account for the increasing labour force participation of women and to allow for changes in the macroeconomic environment. Two levels of unemployment rate are considered in the long run: 9 % (‘base case’) and 6 % in 2020.

- The income submodule allows us to simulate wages and pensions.

  The annual wage is the sum of a deterministic component and a stochastic one. The first one is econometrically adjusted, for each sex, to the school leaving age and the total tenure on the labour market. The stochastic component includes an individual fixed effect and an autocorrelated residual. In the central scenario, the career mobility is close from the one observed in mid-eighties. Given the regular increase in the school leaving age, the wage equations induce an increase by about 1 % per year in individual wages.

  To allow for productivity gains related to technical progress, we add an additional 1 % increase each year. Hence, individual wages annually grow by 2 % in average with a growth slightly smaller at the end of the period.

In the model, all unemployed (respectively early retired) persons receive unemployment (respectively early retirement) benefits. Once a person retires, her pension benefit is indexed on price inflation. The model also simulates survivor pension benefits and the old age minimum benefit (minimum vieillesse).
The modelling of the retirement decision, which is the main purpose of this paper, is detailed in the next section.
2. The modelling of the retirement decision

2.1. The French pension system for wage earners in the private sector

The French pension system is composed of a wide range of pension schemes that provide quite different benefits. About 65% of working people (most wage earners in private firms) fall under the *Régime Général*, whereas civil servants, farmers or self-employed people have specific schemes (Blanchet-Pelé 1999). In the current version of the model, all working people are assumed to fall under the *Régime Général* for pensions. For these workers, the pension system is a two pillar scheme: the first one provides basic pensions (the so-called *Régime Général*); the second one includes complementary benefits (ARRCO and AGIRC). The rules that determine the level of pensions are detailed below.

**Basic pensions**

The computation of the basic pension is rather complex. It depends on three terms: the reference wage, the pension rate and a so-called ‘proratization’ variable. The formula may be simplified as follows:

\[ B_w = \tau \cdot w_{ref} \cdot \min \left( 1, \frac{d}{150} \right) \quad (1) \]

where \( \tau \) is the pension rate, \( d \) is the number of quarters worked, and \( w_{ref} \) is the reference wage.

- Since the major 1993 reform, for people born after 1948, the reference wage \( w_{ref} \) is computed as the average gross wage of the 25 best years of their career\(^2\) (the wages are truncated to the social security ceiling that prevailed that given year and then reevaluated\(^3\)).

- The pension rate \( \tau \) has a maximum value of 50% ('full rate') that is automatically reached when people retire at 65. Nonetheless, one can retire from 60. In this case, \( \tau \) equals 50% only if the total number of contributing quarters is greater than 160 (for people born after 1942). Otherwise it decreases by 1.25% for each quarter missing to reach either the age of 65 or 160 contributing quarters. If a person retires at age \( a \) (in quarters) after \( d \) contributing quarters \( \tau \) writes:

\[ \tau = 0.5 - 0.0125 \cdot \max \left( 0, \min \left( 260 - a, 160 - d \right) \right) \]

This rule implies strong penalties for people claiming SS benefits before the full rate. Their amount ranges from 10% to 12.4% per year missing depending on the total tenure on the labour market. This level of penalty is one the highest among the SS pension systems around the world (Gruber-Wise 1997). *A contrario* the system provides no increase in basic pensions if retirement is postponed beyond the full rate.

- The last term in (1) states that the amount of pensions is decreased by about 0.7% for each quarter missing to reach the contribution duration of 150 quarters.

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\(^2\) For people born between 1934 and 1948, the number of years on which the reference wage is computed is progressively increased from 10 to 25 (one year per generation).

\(^3\) In 2000, the monthly SS ceiling amounted to FF 14 700 - about 2240 Euros. The 25 best wages entering the computation of the reference wage are reevaluated using a consumption price index.
Complementary pensions

Beside the basic pension benefit, two mandatory complementary systems exist for wage earners in private firms: the ARRCO regime that applies to everybody and the AGIRC regime exclusively for executives. Non executive wage earners pay contributions to the ARRCO on their whole wage. Executives pay contributions to the ARRCO on the part of the wage below the social security ceiling, and to the AGIRC on the part of the wage above the ceiling.

In the microsimulation model, the school leaving age is the only proxy for occupational status. Therefore, one cannot separate executives from non executives. We thus assume in the model that every person that earns more than the ceiling is an executive and pays contributions to the AGIRC on the fraction of the wage above the ceiling.

People receive each year a number of units ('points') proportional to their contributions; the amount of their complementary benefit equals:

\[ B_c = N_p \cdot v_p \]

where \( N_p \) is the total number of units they have accumulated since the beginning of their career and \( v_p \) is the current value of the unit ('valeur du point'). This value roughly follows the consumption price index. Both systems (ARRCO and AGIRC) are financed through pay-as-you-go mechanisms. People may enjoy complementary pensions benefits before being entitled to the full rate of 50% for basic pensions: in that case they get a downward adjustment that makes their pension decrease by 4% for each missing year.

2.2. The retirement decision in the first version of the model

In the first version of the model, the retirement decision rule was very simple. It relied on the assumption that people decide to retire when they are eligible to the 50% full rate. Following the 1993 reform, this full rate can be obtained when the individual has more than 160 quarters of contribution or reaches the age of 65. The former condition does not necessarily mean that people have worked for at least 40 years. For instance, unemployment or pre-retirement spells giving right to benefits are considered as periods of contribution. Moreover 2 years of contribution are granted to mothers for each child. Another assumption of the model was that nobody chooses to enjoy complementary benefits before being entitled to the full rate for the basic pension.

These sets of assumptions did not seem too restrictive as a first approximation with the current pensions rules. The incentives towards anticipated claiming of SS benefits are indeed very low in the private sector since people deciding to retire one year before the full rate face a 10% decrease in their basic annuity (the decrease can even amount to 12.4% for people retiring at 64 with short careers). Under this assumption, the distribution of the age of retirement for the generation born between 1943 and 1947 is highly concentrated at 60 for men and displays another peak at 65 for women (figure 1). This distribution is very similar to the one observed on administrative data for the 1930 cohort (figure 2). The discrepancies between the two distributions reflect partly generations effects. In particular, for older cohorts, women still working have often quite long careers. Moreover, the full rate assumption tends to overestimate the 60 peak. For the 1930 cohort, only 83% claim SS benefits at the full rate and 80% of the remaining 17% retire above the full rate (figure 3).
2.3. The retirement decision in the new version of the model

The full rate assumption has the advantage of simplicity. However it does not allow us to account for any influence of individual preferences such as the valuation of leisure on the retirement decision. Therefore this assumption needs to be relaxed in order to assess the implications of pension schemes closer to actuarial fairness.

The decision to retire: theoretical background

In order to model the retirement decision, an assumption has to be made on the functioning of the labour market. Most existing models rely on the assumption that the retirement is an individual choice involving the comparison over the life cycle of the benefits to retire at different dates. This supply side approach implicitly supposes that the choice is not constrained by the demand on the labour market. In low unemployment countries like the United States, this assumption may not seem too restrictive. It is certainly more in many European countries.

There exists a wide range of models of the retirement decision that mainly differ in the treatment of consumption over time and the specification of individual expectations about mortality risk and wage uncertainty. One first type of models relies on utility-maximizing behaviour under non-linear lifetime budget constraint (Burtless (1986)). It assumes that individuals jointly determine the optimal age of retirement and consumption path. This
approach rests on the restrictive assumption that individuals have a perfect information about their future wages and social security entitlements. It thus makes no allowance for updating of information about future opportunities as the individual ages.

Another line of research relaxes the assumption of perfect foresight on future income flows. It allows an updating of the decision to retire to account for unexpected changes in variables such as annual wage earnings (Stock-Wise 1990; Rust-Phelan 1997). Conversely, given the burdensome computational requirements of such models, consumption and income are identical each period. This no-saving assumption may be more restrictive for high income individuals.

The common limitation of these models is to assume that the individual is the appropriate unit of analysis for modelling retirement behaviour. The retirement decision should be in principle analyzed at the household level. It is likely that the decision to claim SS benefits is strongly related to the spouse’s occupational situation and income. This is particularly true for housewives. However including the spouse as a decision-maker requires the specification of additional information and expectations on the spouse’s wage, income, employment status which increases the computational burden in an exponential way. Hence empirical studies generally restrict to the retirement behaviour of male heads of household.

The retirement decision in Destinie

A supply-side approach may seem restrictive in the French institutional context. It is well known for example that employers are allowed to breach the labour contract as soon as their employee is eligible to the full rate. Given the current employment context -and the relatively large wage gap between elder and younger workers- it is quite likely that firms will quasi-systematically make use of this possibility. This opportunity raises some doubt on the ability of a wage earner to work above the full rate even if she has a low valuation of leisure. As a consequence, the choice to retire at the age when one gets the full rate may be interpreted as a demand side as well as supply side decision. Nonetheless, since the scope of our model is the long run, we decided to focus on a supply side approach in the line of Stock and Wise (1990)4.

As usual in retirement models, the individual level will be privileged. Such an assumption is clearly not sustainable for non-working people (mainly housewives) whose decision to claim SS benefits is a priori highly dependent on the spouse. The scope of our analysis will thus be restricted to people still on the labour market at 59. Moreover, we can assume without loss of generality that people decide simultaneously to quit the labour market and claim SS benefits.

The basic idea of the model is that the decision to retire depends on a trade-off between the utility the individual expects if she retires now and the one she can get if she delays her decision.

When there is no uncertainty on preferences, the decision rule is quite straightforward. Let us consider an individual still in the labour force at age $t$. If she retires at age $r$, she can expect a flow of labour incomes of $(Y_t, Y_{t-1}, ...)$ until retirement and then a flow of pension

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4 Such an assumption is consistent with the fact that participation rates for elder workers should increase in the future as pensions schemes will face growing financial imbalances due to aging.

5 It is clearly not the case for many elder workers in France due to high unemployment rate and generous early retirement provisions. These people are de facto excluded from our sample.

6 However, the complexity of the pension rules for workers in the private sector (particularly the combination of basic and complementary pensions) may raise doubt on the ability of people to have perfect foresight of what they can gain by delaying their retirement decision.
benefits \( (B_r(t), B_{r+1}(t), \ldots, B_s(t), \ldots) \). It is assumed that this individual derives an indirect utility \( U_w \) from her labor income and an indirect utility \( U_r \) from pension benefits. Time discounting occurs at rate \( \beta \). For an age at retirement equal to \( r \), the expected utility at age \( t \) is therefore:

\[
V_r(r) = \sum_{s=t}^{r-1} \beta^{s-t} E_t U_w(Y_s) + \sum_{s=r}^{T} \beta^{s-t} E_t U_r(B_s(r))
\]

with:

\[
U_w(Y_s) = \frac{V_s^{1-\gamma}}{1-\gamma}
\]

\[
U_r(B_s(r)) = \left[ k B_s(r) \right]^{1-\gamma} \frac{1-\gamma}{1-\gamma}
\]

where \( \gamma \) denotes the risk aversion and \( k \) the preference for leisure. Note that this specification does not consider the possibility of smoothing income through private savings.

Since retirement is irreversible and uncertainty affects most variables of the model (mainly mortality and wage prospects), postponing retirement by one year allows the individual to base her decision on a larger set of information. However solving a program that incorporates all sources of uncertainty requires dynamic programming techniques that would be excessively time consuming in our microsimulation context. As a consequence, our modelization does not assume any updating of the individuals expectations. In particular, people expect their wages to remain unchanged in real terms until retirement. These assumptions ignore the value of waiting associated with any irreversible decision and therefore should lead to slightly underestimate the optimal age of retirement.

Hence, we assume that the individual decides to retire at date \( t \) if the resulting expected utility is higher than the maximum value of utilities expected for all other possible choices \( r > t \). If we write

\[
G_r(r) = E_t V_r(r) - E_t V_t(t)
\]

the individual chooses to remain in the labor force if \( \exists r^* \geq t + 1 / G_r(r^*) > 0 \).

At this stage, the only sources of uncertainty are the mortality risk and the wage evolution. We assume that each year people consider retirement, they base their decision on the survival probabilities given by the mortality tables by cohort, sex and school leaving age of the year considered. The survival probabilities in 1991 are extrapolated from the INSEE...
mortality tables by age, sex and socio-professional status for the 1980-1989 period and from the distribution of the school leaving age by socio-professional status derived from the 1991 Financial Assets Survey. For the following years, the mortality tables are extrapolated using the INSEE prospective mortality tables by sex and age as a benchmark. The distributions of the age of death conditional on survival at 55 for the 1943 generation and three values of the school leaving age are depicted in figures 4-5 for men and women.

As for the career prospects, we assume myopic expectations: the individual believes that her wage will follow the deterministic trend given by the wage equation (that depends on the school leaving age and the total tenure on the labour market) for all future years. This expectation can be very different from the wage she will actually receive if she stays on the labour market given the random shocks in our modelling of the wage equation.

Uncertainty on preferences also should be taken into account. We detail in the next section our assumptions regarding the uncertainty on preferences.
3. Simulating the retirement decision under current rules

3.1. Calibrating preferences

The parameters of the utility function need to be calibrated in order to simulate the retirement decision. This is not an easy task since data on risk aversion, time preference or individual valuation of leisure are scarce in France. *A priori*, these parameters are fairly heterogeneous among the population. In lack of any empirical studies on the dispersion of preferences, we decided to use uniform values for risk aversion and time discounting but allowed some heterogeneity in the preference for leisure.

More precisely, one assumes that the preference for leisure \( k \) is heterogeneous in the population but is not affected by shocks over time. Therefore \( k \) is randomly distributed in the population. We also explored the case where the preference for leisure randomly varies over time. This is more complicated to implement and did not yield a more satisfactory adjustment to actual behaviours. The simulation of the retirement decision under this specification is reported in appendix 2.

In almost all simulations, we assume that the age of retirement cannot exceed 65. This assumption is consistent with current behaviours displaying participation rates above 65 close to zero. However this may result from SS incentives (Gruber-Wise, 1997) as well as demand-side effects on the labour market. Fixing 65 as an upper bound for retirement may be less valid if the situation on the labour market improves or if new computation rules for pensions are decided. In appendix 5, this assumption will be relaxed and the upper bound arbitrarily fixed to 70.

3.2. The retirement decision under current rules

The simulations of the retirement decision were performed for people born between 1943 and 1947 and still employed at 59 i.e. 1710 persons in our sample. We focused on these generations because they are the first ones on which the 160 contribution duration to get the full rate fully applies.

In all simulations, we fixed \( \gamma = 0.95 \) and \( \beta = 1 \). This implies a moderate risk aversion and no time discounting. These values are close to the results of the estimation of the structural specification of Stock and Wise on French data (Blanchet-Mahieu 2000).

In the base case, we assume that the mean value of the preference for leisure is equal to 3 and the standard error of the random residual \( \sigma \) to 0.2. These values were chosen to roughly replicate the strong accumulation on the full rate under current rules. However, our purpose was not to perfectly adjust the share of people claiming SS benefits at the full rate to the one observed for the 1930 cohort. As was mentioned earlier, part of this accumulation may reflect demand side effects not considered in the model.

To understand what means such a \( k \) value, let us consider an individual expecting to live \( P \) periods (with probability 1) and whose pension is increased by \( x\% \) if she postpones retirement for one year. Under the assumption of no time discounting, this individual will decide to claim her SS benefits immediately only if her replacement rate is greater than \( \frac{1 + x(P - 1)}{k} \), for small values of \( x \) (see appendix 1). With \( x=10\% \) (which corresponds approximatively to the current penalties in the *Régime Général*) and \( P=20 \), this critical value amounts to 97%.
The simulated proportion of individuals retiring at the full rate is rather high: more than 60% of wage earners claim SS benefits when they reach the full rate (figure 6). Our simulation generates a relatively high number of people retiring just one year after the full rate (19%): most of them already had 40 years of contributions at 60 and choose to retire at 61 following a negative shock on their wage. Hence, the distribution of the retirement age displays a peak at 60 for men but also a relatively high share of people quitting at 61. For women, the distribution has a peak at 65 that corresponds to short careers (figure 7). Appendix 6 investigates the case where there is no mobility in the wage careers after 59 which roughly corresponds to no updating of retirement behaviour between 60 and 65.

Figure 6: Share of individuals retiring below/at/above the full rate

Figure 7: Distribution of the retirement age (mean value of preference for leisure equal to 3)

3.3. Sensitivity of the results to the value of the preference for leisure

To assess the sensitivity of our results to the value of the preference for leisure, we simulated the distribution of the retirement age under the assumption k=2. Such a value corresponds to quite a higher critical replacement rate: 145% instead of 97% in the simple example above.

The lower value of the preference for leisure implies that people stay longer on the labour market. This value clearly does not fit as well the data as before: too many persons decide to claim SS benefits after the full rate (figure 8). Only one man out of 3 claims SS benefits at 60 instead of 60% previously. Besides the 65-peak of the retirement is too high (figure 9).

Figure 8: Share of individuals retiring below/at/above the full rate: k=2/k=3

Figure 9: Distribution of the retirement age 2 values of the preference for leisure k

7 However this share remains 20 points lower than the one observed in administrative data for the 1930 cohort (figure 3).
4. Simulating pension reforms

In this section, we simulate the effect of various reforms of the basic pension scheme. Three types of reforms are investigated: enforcement of more actuarially fair pension schemes; Charpin report proposals; return to the pension system prevailing before 1993.

4.1. Enforcing more actuarially fair pension schemes

The scenario: reforms

In order to give more weight to individual preferences, we assume here that the penalties associated to anticipated retirement are lowered and the amount of pension keeps on increasing above the full rate. More precisely:

- the decrease in the basic pension for each quarter missing to reach the full rate is reduced from 1.25% to 0.6%
- the target length of contributions in the ‘proratization’ term is increased from 150 to 160
- In 2 reforms out of 3, the basic pension is increased if the individual postpones her retirement after the full rate. Two formulas are considered to compute the increase in the basic pension for each quarter of contribution above the full rate. In the first one, the basic pension is increased by 0.3% for each quarter of contribution above 160 quarters (‘0.6% penalty-0.3% bonus’). In the second one, the bonus is applied to the sole terms above 160 worked after the age of 60 (‘0.6% penalty-0.3% truncated bonus’). As will be discussed below, this second scheme aims at partly neutralizing the income effect associated to the bonus for long careers workers.

The new formula that determines the level of pension writes:

\[
B_B = \tau \cdot w_{ref} \cdot \min\left(1 - \frac{d}{160}\right)
\]

where the pension rate is

- in the first case (‘0.6% penalty’):
  \[
  \tau = 0.5 - 0.006 \max\left(0, \min(260 - a, 160 - d)\right)
  \]
- in the second case (‘0.6% penalty-0.3% bonus’):
  \[
  \tau = 0.5 - 0.006 \max\left(0, \min(260 - a, 160 - d)\right) + 0.003 \max(d - 160, 0)
  \]
- in the third case (‘0.6% penalty-0.3% truncated bonus’):
  \[
  \tau = 0.5 - 0.006 \max\left(0, \min(260 - a, 160 - d)\right) + 0.003 \max\left(0, \min(d - 160, a - 240)\right)
  \]

with \(a\) the retirement age (in quarters) and \(d\) the contributing quarters.

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* Complementary schemes ARRCO and AGIRC are assumed not to change over time.
In these simulations, the age of retirement cannot exceed 65. This assumption is relaxed in appendix 5 where the effects of the ‘0.6% penalty-0.3% truncated bonus’ reform are simulated with an age of retirement ranging from 60 to 70.

**Expected effects of more flexible pension schemes on retirement decisions (see appendix 4 for a detailed analysis)**

The lowering of the penalties associated to anticipated retirement reduces the opportunity cost of leisure (the decrease in the replacement rate if the individual claims SS benefits before the full rate is lower). This decrease in the relative price of leisure provides a strong incentive to quit earlier (‘substitution effect’). An ‘income effect’ may strengthen this former effect: wage earners who previously claimed SS benefits below the full rate enjoy a higher level of pension if their behaviour remains unchanged. The combination of these two effects leads to an unambiguous prediction of earlier retirement.

Conversely, allowing pensions to increase above the full rate has more uncertain effects. On the one hand, the substitution effect increases the value of waiting (the opportunity cost of leisure is higher); on the other hand, wage earners who previously claimed SS benefits above the full rate enjoy a higher level of pension if their behaviour remains unchanged which increases the demand for leisure. This latter effect may be rather important for generations with long tenure on the labour market as we shall see later on. On the whole, the sign of the change in the mean age of retirement is ambiguous and depends on the distribution of individual characteristics (total tenure, preference for leisure, mortality risk...) within the sample. Truncating the bonus to the periods worked after 60 may help to partially neutralize the income effect.

**The retirement behaviour under pension schemes closer to actuarial fairness**

The enforcement of pension schemes closer to actuarial fairness has a limited effect on the retirement decision of people still working at 59. When the only reform is the lowering of the anticipated penalties (‘0.6% penalty’), 3% of workers put forward their retirement decision and 6% instead of 3% claim SS benefits below the full rate (figures 8-9). This result is not surprising since we focus on people still working at 59: 69% of them reach the 160 quarters target before 60. Should we consider people out of the labour market at 59 (mainly housewives), the decrease in the penalty would have larger effects.

Introducing incentives to postpone retirement after the full rate does not necessarily increase the average retirement age. With the ‘0.6% penalty-0.3% bonus’ reform, 6% of workers retire earlier following the implementation of the bonus and none of them delay retirement. This counterintuitive result stems from the income effect previously mentioned. Before the reform, 71% of workers claim SS benefits with at least 41 contributing years (figure 12). 65% of them have at least 44 years of contributions at retirement which implies an increase of at least 10% in their pension benefits if they do not change their retirement decision (table 1).
Table 1:
Distribution of $d$ for people retiring with over 40 years of contributions

<table>
<thead>
<tr>
<th>Years of contributions at retirement</th>
<th>Instantaneous increase in the basic pension due to the bonus</th>
<th>Distribution of $d$ (sum=100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>2.4%</td>
<td>9.3%</td>
</tr>
<tr>
<td>42</td>
<td>4.8%</td>
<td>10.2%</td>
</tr>
<tr>
<td>43</td>
<td>7.2%</td>
<td>15.7%</td>
</tr>
<tr>
<td>44</td>
<td>9.6%</td>
<td>15.0%</td>
</tr>
<tr>
<td>45</td>
<td>12.0%</td>
<td>15.0%</td>
</tr>
<tr>
<td>over 45</td>
<td></td>
<td>34.8%</td>
</tr>
</tbody>
</table>

Should this income effect be partly neutralized (as with the ‘0.6% penalty-0.3% truncated bonus’ reform), results more consistent with our expectations would be observed: almost 20% of workers retire later and 45% instead of 34% claim SS benefits after the full rate (figures 10-11). On the whole, this reform would favour a larger dispersion of the retirement age (figure 13).
We also assessed the global impact of the ‘0.6% penalty-0.3% truncated bonus’ reform with another specification of the preference for leisure. Indeed, the longer people have worked or the older they are, the more likely they are to prefer leisure to work. To account for an age-related preference for leisure, we arbitrarily assume the following specification:

\[ k = 0.7 + 2.5 \Phi \left[ \frac{d-33}{5} \right] \]

where \( d \) stands for the total tenure on the labour market and \( \Phi \) for the cumulative distribution function of the normal density. The preference for leisure thus ranges from 0.7 to 3.2 and is equal to 3 for a total tenure of 40 years. As expected, fewer people choose to work above the full rate under this specification. However, the results are very close to those obtained with a preference parameter set to 3 independently of age or tenure: as before, the effect of the ‘0.6% penalty-0.3% truncated bonus’ is an increase by 3 points (resp. 10 points) of the proportion of people retiring below (resp. above) the full rate. This limited effect is partly due to our parameterization but also to the fact that the lower and upper age bounds (60 and 65) constrain individual choices on a narrow range. Should these bounds be relaxed (see appendix 5), the specification of the dependency of the preference for leisure on age and tenure would matter more.

**Financial impact of the reforms**

We simulated the impact of these scenarios on the discounted sum of pensions received by the individuals of the sample (by comparison with the current situation). We did not accounted for the impact of the variation in contributions paid when people change their retirement decision. Decreasing the penalties and increasing the proratization target from 150 to 160 quarters would have a small negative effect on the aggregate pensions bill (see table 2): the positive effect of the decrease in the penalties would be slightly more than offsetted by the cost of the change in the proratization target. Conversely, introducing a bonus without limiting its effects to the sole quarters worked after the age of 60 may strongly increase the pensions bill (by 5%). This increase could be almost entirely offset with the ‘0.6% penalty-0.3% truncated bonus’.

**Table 2: Impact of the reforms on the aggregate pensions bill**

<table>
<thead>
<tr>
<th>Discount rate</th>
<th>‘0.6% penalty’</th>
<th>‘0.8% penalty-0.3% bonus’</th>
<th>‘0.6% penalty-0.3% truncated bonus’</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>-0.5%</td>
<td>+4.8%</td>
<td>+0.1%</td>
</tr>
<tr>
<td>4%</td>
<td>-0.4%</td>
<td>+5.1%</td>
<td>-0.3%</td>
</tr>
</tbody>
</table>

**4.2. Changing the duration of contributions required to get the full rate**

The previous reforms aimed at relaxing the constraints on the age of retirement with no a priori financial macroeconomic costs or benefits. Other reforms may tackle the future expected financial imbalances due to aging by increasing the duration of contributions requested to get the full rate. Two types of reforms are now investigated. The first one simulates the effect of some proposals suggested in the 1999 Charpin report: lengthening of the target duration of contributions to 42.5 years instead of 40 without (‘42.5 reform’) or with a decrease in the penalty associated to anticipated retirement (Charpin proposals). We also simulate the effect of a decrease to 37.5 years in the target in order to come back to the system that prevailed before the 1993 reform (‘pre-1993 reform’).
The Charpin scenario

The proposals made in the Charpin reports explore several scenarios. We simulate below the effects of two steps of reforms:

- the requested contribution duration for reaching the full rate in the General Regime is lengthened to 42.5 years instead to 40 and the target length of contributions in the ‘proratization’ term is increased from 150 to 170 (‘42.5 reform’).

- Beside this reform, the penalty associated with anticipated retirement is reduced from 1.25% to 0.6% for each quarter missing to reach the full rate (‘Charpin proposals’).

The formula that determines the level of pension is:

\[ B_g = \tau \cdot w_{ref} \cdot \min \left( 1, \frac{d}{170} \right) \]

where in the first case:

\[ \tau = 0.5 - 0.0125 \cdot \max \left[ 0, \min (260 - a, 170 - d) \right] \]

in the second case:

\[ \tau = 0.5 - 0.006 \cdot \max \left[ 0, \min (260 - a, 170 - d) \right] \]

where \( a \) is the retirement age (in quarters) and \( d \) the contributing quarters.

These reforms are supposed here to be fully implemented for cohorts born after 1943\(^9\).

The pre-1993 reform

The changes with respect to the current rules are the following:

- the requested contribution duration for reaching the full rate in the General Regime is lowered to 37.5 years instead to 40.

- the reference wage is computed as the mean of the 10 best reevaluated wages instead of the 25 best wages for generations born after 1948.

The formula giving the level of pension writes:

\[ B_g = \tau \cdot w_{ref} \cdot \min \left( 1, \frac{d}{150} \right) \]

with \( \tau = 0.5 - 0.0125 \cdot \max \left[ 0, \min (260 - a, 150 - d) \right] \)

Effect of the reforms on the age of retirement

As could be expected, the lengthening of the duration of contributions required to get the full rate induces a postponement of the retirement decision with the ‘42.5 reform’: 15% of people still working at 59 delay their retirement by 2.5 years on average (figure 14). The effect is not huge since 54% of our sample has already at least 43 years of contributions at

---

\(^9\) The Charpin report suggested a progressive increase in the lengthening of the duration target, the full effect being reached for generations born after 1959.
59. Besides, 45% of the others cannot delay retirement since they already claimed SS benefits at 65 (the 65 full rate condition is thus binding).

After the ‘42.5 reform’, the share of people retiring below the full rate increases from 3% to 10% (figure 15). With the ‘Charpin proposals’, this proportion is larger (13.5%) since the penalty associated to anticipated retirement is lower. On the whole, 12% of our sample delay their retirement by 2.2 years on average. The share of people waiting until 65 to retire grows from 22% to 27% (figure 16).

The ‘pre-1993 reform’ is the mirror image of the ‘42.5 reform’: 18% of people still working at 59 retire earlier and the share of people claiming SS benefits at 60 rises from 41% to 50% (figure 16).

Financial impact of the reforms

Here again, we simulated the impact of these scenarios on the discounted sum of pensions received by the individuals of the sample (by comparison with the current situation). The 42.5 reform has a negative impact on the pension bill by inducing people to postpone retirement without giving them additional rights. The effect is opposite for the Pre-1993 reform and is strengthened by the fact that the reference wage for the basic pension is now
computed on the 10 (instead of 25) best years. The Charpin proposals have roughly the same financial impact as the 42.5 reform since very few people retire below the full rate in the baseline scenario.

<table>
<thead>
<tr>
<th></th>
<th>Pre-1993 reform</th>
<th>42.5 reform</th>
<th>Charpin proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate 2%</td>
<td>+10.5%</td>
<td>-2.2%</td>
<td>-2.2%</td>
</tr>
<tr>
<td>Discount rate 4%</td>
<td>+11.0%</td>
<td>-2.7%</td>
<td>-2.5%</td>
</tr>
</tbody>
</table>
Concluding remarks

According to our simulations, the implementation of more actuarially fair pension schemes should favour a larger dispersion of the age of retirement. However, the expected impact should remain limited for the generations retiring in the years to come as long as the 60-65 age constraint keeps on binding. For the generations born between 1943 and 1947, the tenure on the labour market at 59 is often long, which results in a high proportion of people claiming SS benefits at 60. For them, the lowering of the penalties has no effect since the 60 lower bound is binding. Conversely the pension bonus after the full rate does not affect - under our assumptions - behaviour of people retiring at 65 who represent a significant part of the sample.

A contrario, the behaviour of people retiring before 65 with the full rate should be very sensitive to the implementation of a bonus above the full rate. However, for such a reform to lead to a significant upward shift in the age of retirement, it seems desirable to neutralize income effects by limiting the periods taken into account to compute the bonus to those worked after 60.

Our model suffers from several limitations: no savings assumption, rough modelization of uncertainty, no joint decisions within households. Although relaxing these assumptions may be desirable, it may not be a realistic goal to pursue for this type of model. The main purpose of a model like Destinie is - in our view - to provide some insights on the effects of pension system reforms with relatively short deadlines. This leads us to favour improvements that preserve tractability.

References


Charpin J.M. et alii (1999), L’avenir de nos retraites, La documentation française.


Appendix 1:
Preference for leisure and replacement rate

Let us consider an individual who may retire at $t$ or at any later period. Her wage is assumed not to change over time. Besides, she will enjoy an $x$%-year increase in her SS benefits if she chooses to postpone retirement.

Let $V(s)$ be the intertemporal utility derived from retirement at $s$ ($s \geq t$).

$$V(s) = \sum_{i=t}^{s-1} \beta^{i-t} p_t(i) \frac{w^{1-\gamma}}{1-\gamma} + \sum_{i=s}^{T} \beta^{i-t} p_t(i) \left[ \frac{kB(1+x)^{s-t}}{1-\gamma} \right]$$

where $p_t(i)$ is the survival probability at $i$ conditional to survival at $t$, $B$ the pension benefits if she retires at $t$, $k$ the preference for leisure, $\gamma$ the constant relative risk aversion and $\beta$ the time discounting factor.

The additional utility the individual gets if she retires at $s$ instead of $t$ writes:

$$V(s) - V(t) = \sum_{i=t}^{s-1} \beta^{i-t} p_t(i) \frac{w^{1-\gamma}}{1-\gamma} + \sum_{i=s}^{T} \beta^{i-t} p_t(i) \left[ \frac{kB(1+x)^{s-t}}{1-\gamma} \right] - \sum_{i=t}^{T} \beta^{i-t} p_t(i) \left[ \frac{kB^{1-\gamma}}{1-\gamma} \right]$$

For small values of $x$, we may write:

$$V(s) - V(t) = \frac{w^{1-\gamma}}{1-\gamma} \left[ \sum_{i=t}^{s-1} \beta^{i-t} p_t(i) \right] + \left[ \frac{kB^{1-\gamma}}{1-\gamma} \right] \left[ \sum_{i=s}^{T} \beta^{i-t} p_t(i)(1+(1-\gamma)(s-t)x) - \sum_{i=t}^{T} \beta^{i-t} p_t(i) \right]$$

The individual does not retire immediately if there exists at least one period $s$ such that she can expect a greater utility by delaying her departure until $s$ ($s \geq t$). This writes:

$$V(s) - V(t) \geq 0 \Leftrightarrow \frac{kB^{1-\gamma}}{1-\gamma} \left[ \sum_{i=t}^{s-1} \beta^{i-t} p_t(i) \right] - (1-\gamma)(s-t)x \sum_{i=s}^{T} \beta^{i-t} p_t(i) \leq \frac{w^{1-\gamma}}{1-\gamma} \left[ \sum_{i=t}^{s-1} \beta^{i-t} p_t(i) \right],$$

which yields with 2 first-order developments in $x$:

$$V(s) - V(t) \geq 0 \Leftrightarrow \frac{B}{w} \leq \frac{1}{k} \left[ 1 + (s-t)x \sum_{i=s}^{T} \beta^{i-t} p_t(i) \right]$$
This yields a critical value for the replacement rate

\[
\hat{B} = \frac{w}{\tilde{w}} \max_{s \geq t+1} \left\{ \frac{1}{k} \left[ 1 \left( 1 + (s - t)x \right) \right] \left( \sum_{i=t}^{T} \beta^{i-t} \rho_{i} \right) \right\}.
\]

If the replacement rate (in case of immediate retirement) exceeds this critical value, the individual retires immediately; otherwise she keeps on working.

If the individual dies at \( T \) with probability 1 and if she does not discount time, the formula is straightforward:

\[
\hat{B} = \frac{w}{\tilde{w}} \max_{s \geq t+1} \left( \frac{1}{k} \left[ 1 + (T - s - 1)x \right] \right) = \frac{1}{k} \left[ 1 + (T - t)x \right] \quad \text{(1)}
\]

The tables below provide some estimates of the critical replacement rate for different values of \( k, x \) and \( T \) (we assume \( t=60 \)) using formula (1). The results are rather intuitive:

- The critical value for the replacement rate rises with \( x \), that corresponds to the increase in pension the individual may expect if he postpones retirement. The value of waiting is higher if \( x \) is large.

- The value of waiting is lower if the individual has a shorter life expectancy: the increase in pension will benefit for a shorter time. She will thus be less willing to delay her retirement for a given \( x \) (the critical replacement rate is lower).

- The individual will request a lower replacement rate to quit the labour market if her preference for leisure is high.

<table>
<thead>
<tr>
<th>( T=79 )</th>
<th>( x=0% )</th>
<th>( x=5% )</th>
<th>( x=10% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k=2 )</td>
<td>50%</td>
<td>98%</td>
<td>145%</td>
</tr>
<tr>
<td>( k=3 )</td>
<td>33%</td>
<td>65%</td>
<td>97%</td>
</tr>
<tr>
<td>( k=4 )</td>
<td>25%</td>
<td>49%</td>
<td>73%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( T=74 )</th>
<th>( x=0% )</th>
<th>( x=5% )</th>
<th>( x=10% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k=2 )</td>
<td>50%</td>
<td>85%</td>
<td>120%</td>
</tr>
<tr>
<td>( k=3 )</td>
<td>33%</td>
<td>57%</td>
<td>80%</td>
</tr>
<tr>
<td>( k=4 )</td>
<td>25%</td>
<td>43%</td>
<td>60%</td>
</tr>
</tbody>
</table>
Appendix 2:

Time uncertainty on the preference for leisure

An alternative model would consist in allowing preference for leisure to change randomly over time. This would account for unexpected shocks (like health troubles, changes in the family composition...) that affect the relative valuation of work versus leisure. Each period, additive shocks occur on both $U_w$ and $U_r$:

$$U_w(Y_s) = \frac{Y_s^{\gamma-1}}{1-\gamma} + w_s$$
$$U_r(B_s) = \frac{[kB_s(r)]^{\gamma-1}}{1-\gamma} + \xi_s$$

Unlike Stock and Wise (1990), we do not assume here an autoregressive process for disturbances: $w_s$ and $\xi_s$ are i.i.d.

If we note:

$$g_t(r) = \sum_{s=t}^{t-1} \beta^{s-t-1} \pi(s/t) E_t(Y_s^\gamma) + \sum_{s=t}^{T} \beta^{s-t} \pi(s/t) [E_t(kB_s(r))]^\gamma - \sum_{s=t}^{T} \beta^{s-t} \pi(s/t) [E_t(kB_s(r))]^\gamma \right]$$

and $\nu_t = w_t - \xi_t$.

we can write: $G_t(r) = g_t(r) + \nu_t$

The probability that an individual leaves at $t$ can therefore be written:

$$Pr[R = t] = Pr[g_t(r_t^*) \leq -\nu_t] \text{ where } r_t^* = \text{ArgMax}_{r > t} g_t(r)$$

The simulations are performed under the following parametrization: $\gamma = 0.95$, $\beta = 1$, $k=1.5$ and $\sigma_\nu = 10.7$. These values are close to the estimation of the structural model of Stock and Wise (1990) on French data (Blanchet-Mahieu 2000).

The distribution of the retirement age is smoother than with the other specification. More persons claim SS benefits between 61 and 64 (figure 17). Besides, most people decide to stay on the labour market after they are eligible to the full rate (figure 18).

Figure 17: Share of people retiring below/at/above the full rate under Stock-Wise specification

Figure 18: Distribution of the retirement age under Stock-Wise specification
Appendix 3: Computing an actuarially fair pension scheme

A pension scheme displays actuarially fair provisions if the cost induced by retiring one year earlier (i.e. the loss of one year of contributions plus the cost of an additional year of pension benefits) is exactly offset by the implied decrease in the annual benefit (computed on the entire retirement period). This does not mean that individuals are indifferent between retiring now or one year earlier (which requires analyzing the tradeoff between retirement and lower earnings on one side, and continued work, higher earnings and enduring the disutility of work on the other side).

If there is no uncertainty on the age at death, the actuarially fair penalty \( d \) in case retirement is anticipated by one year is therefore determined by the formula:

\[
\sum_{t=q-1}^{N} \frac{(1-d)}{(1+r)^t} B_t + \frac{t W}{(1+r)^{q-1}} = \sum_{t=q}^{N} \frac{B_t}{(1+r)^t}
\]

where \( q \) is the current age of retirement (in most cases the age at which an individual reaches the full rate), \( N \) the age at death, \( W \) the pre-tax wage if the individual works at age \( q-1 \), \( t \) the payroll tax for old-age pensions and \( B \) the level of annual pension benefits if retirement occurs at age \( q \). Let \( \pi \) be the ratio annual benefits/last wage if retirement occurs at age \( q \):

\[
d = \left(1 + \frac{t}{\pi}\right) \frac{1 - \left(\frac{1}{1+r}\right)}{1 - \left(\frac{1}{1+r}\right)^{N-q+2}}
\]

The level of the actuarially fair penalty thus depends on the discount rate \( r \), the age at death \( N \), the age \( q \) at which the individual initially chooses to retire, and the replacement rate at that age \( \pi \). The larger the life expectancy, the lower the penalty since the financial cost of anticipated retirement is spread over a larger period. Conversely, the penalty should be larger for an individual having begun to work late (since he has to retire later to get the full rate, the retirement period is shorter). The larger \( r \), the larger the penalty (see table).

| Fair penalty for the Régime Général if the individual claims her benefit one year before the full rate |
|---------------------------------|------|------|---|
| actuarial penalty* | age at death | age at full rate | discount rate |
| 7.2% | 82 | 61 | 2% |
| 8.4% | 82 | 65 | 2% |
| 9.1% | 82 | 65 | 3% |
| 6.5% | 85 | 61 | 2% |
| 7.4% | 85 | 65 | 2% |
| 8.2% | 85 | 65 | 3% |

In order to make the anticipation of retirement by one year neutral for the pension scheme, the level of annual benefits should be cut by 8.4% if the individual reaches the full rate at 65 (with a 2% discount rate). This penalty is only 7.4% if the individual is expected to live until the age of 85.

---

10 The steady-state (i.e. when the demographic growth rate, the productivity growth rate and the lengths of work and retirement are constant) rate of return of a pay-as-you-go pension scheme is given by the growth rate of the aggregate wage bill, i.e. approximately the growth rate of GDP in the long run. We thus chose a discount rate close to the expected long-run growth rate of GDP.
Appendix 4: Impact of a change in incentives on the retirement decision

We adopt here a simplified framework without uncertainty on income or survival; the discount rate is set to 0% and the wage income is assumed to remain constant until retirement. We intend to assess how the retirement decision marginally changes if new pension provisions are decided, depending on the various situations of individuals when they choose to retire: they may claim SS benefits below, at or above the full rate and their choice may be constrained by the lower bound (age 60) or the upper bound (we set it to 65, although there is no mandatory age of retirement in principle; but in fact, aggregate participation rates are close to zero above 65).

Let $B(r)$ be the level of annual benefits if retirement occurs at age $r$. Let $r$ be the age at which the individual reaches the full rate. To account for the possible existence of penalties (resp. bonuses) if retirement occurs below (resp. above) the full rate, we introduce two pension formulae:

$$B_1(r)$$ for $r < r$.
$$B_2(r)$$ for $r > r$.

If the individual is below (resp. above) the full rate. These formulae are differentiable in $r$ and $B_1(r) = B_2(r)$.

The retirement decisions with current rules

Let $t$ be the age at which the individual considers retiring. The optimal age of retirement solves the program:

$$\max_r \left( (r - t)Y + k(T - r + 1)(B_1(r)1_{r < r} + B_2(r)1_{r > r}) \right)$$

with $B_1'(r) > B_2'(r) \geq 0$.

With the current rules, the penalty $B_1'(r)$ is about 10% for an individual retiring with between 150 and 160 quarters of contributions. Conversely, the slope above the full rate $B_2'(r)$ is 0% (if we do not consider complementary pensions). Besides $60 \leq r \leq 65$.

Let $r^*$ be the age at retirement; 5 situations may be observed (superscript 0 stands for the formulae under current rules):

The individual retires below the full rate but is constrained by the age lower bound

This is the case if:

$$Y + k(T - r^* + 1)B_1^0(r^*) - kB_1^0(r^*) < 0 \text{ et } r^* = 60 < r$$

---

1 The convexity of these formulae makes the existence of an interior solution in principle dubious. But, given our choice of parameters (especially the fact that the length of retirement is below 40 years); the utility function is here concave.
The individual retires below the full rate but is not constrained by the age lower bound

\[ Y + k(T - r^* + 1)B_1^0(r^*) - kB_0^0(r^*) = 0 \quad \text{et} \quad r^* < \bar{r} \]

The individual retires at the full rate

\[ Y + k(T - r^* + 1)B_1^0(r^*) - kB_0^0(r^*) > 0 \]

and

\[ \begin{cases} Y + k(T - r^* + 1)B_2^0(r^*) - kB_0^0(r^*) < 0 \\ r^* = \bar{r} < 65 \text{ or } r^* = 65 = \bar{r} \end{cases} \]

The individual retires above the full rate but is not constrained by the age upper bound

\[ Y + k(T - r^* + 1)B_2^0(r^*) - kB_0^0(r^*) = 0 \quad \text{and} \quad r^* > \bar{r} \]

The individual retires above the full rate but is constrained by the age upper bound

\[ Y + k(T - r^* + 1)B_2^0(r^*) - kB_0^0(r^*) > 0 \quad \text{and} \quad r^* = 65 > \bar{r} \]

The retirement decision after the reform

We consider here a reform that lowers the penalty in case of retirement below the full rate (« lower penalty ») and increases pension rights if retirement is postponed after the full rate (« bonus »)\(^\text{12}\). The slope of formulae thus decreases below the full rate but increases above:

\[ \forall r \leq \bar{r}, B_1^1(r) < B_1^0(r) \]

\[ \forall r > \bar{r}, B_2^1(r) > B_2^0(r) \]

where superscript 0 stands for the current rules and superscript 1 for the rules after the reform. We analyze the impact of the reform in the 5 mentioned cases. Let \( \hat{r} \) be the age of retirement after the reform.

The individual retires below the full rate but is constrained by the age lower bound

In this case \( B_1^1(r^*) < B_1^0(r^*) \) and \( B_2^1(r^*) > B_2^0(r^*) \), therefore:

\(^{12}\) We assume here that the « proratization » rule remains unchanged.
\[ Y + k(T - r^* + 1)B_2^1(r^*) - kB_2^1(r^*) < Y + k(T - r^* + 1)B_2^0(r^*) - kB_2^0(r^*) < 0 \]

As in the baseline scenario the individual would optimally anticipate retirement but she is constrained by the age lower bound \(60 \leq \hat{r} = r^*\). Her decision is unchanged.

The individual retires below the full rate but is not constrained by the age lower bound

\[ B_1^1(r^*) < B_1^0(r^*) \text{ and } B_1^1(r^*) > B_1^0(r^*) \], therefore:

\[ Y + k(T - r^* + 1)B_1^1(r^*) - kB_1^1(r^*) < Y + k(T - r^* + 1)B_1^0(r^*) - kB_1^0(r^*) = 0 \]

The individual anticipates his retirement to get closer to the optimal retirement age (and to reach it if the age 60 lower bound does not bind): \( \hat{r} < r^* \).

The individual retires at the full rate

The decision may be influenced by both the decrease in penalties and the introduction of bonuses.

For this individual, \( B_1^1(r^*) < B_1^0(r^*) \), \( B_2^1(r^*) > B_2^0(r^*) \), \( B_1^1(r^*) = B_2^1(r^*) \) \text{ and } \( B_2^1(r^*) = B_2^0(r^*) \)

If
\[ Y + k(T - r^* + 1)B_1^1(r^*) - kB_1^1(r^*) < 0 < Y + k(T - r^* + 1)B_1^0(r^*) - kB_1^0(r^*) \]

the individual retires earlier: \( \hat{r} < r^* \)

If
\[ 0 < Y + k(T - r^* + 1)B_2^1(r^*) - kB_2^1(r^*) < Y + k(T - r^* + 1)B_2^0(r^*) - kB_2^0(r^*) \]

and
\[ Y + k(T - r^* + 1)B_2^0(r^*) - kB_2^0(r^*) < Y + k(T - r^* + 1)B_2^1(r^*) - kB_2^1(r^*) < 0 \]

the individual does not change his decision: \( \hat{r} = r^* \)

If
\[ 0 < Y + k(T - r^* + 1)B_2^1(r^*) - kB_2^1(r^*) < Y + k(T - r^* + 1)B_2^0(r^*) - kB_2^0(r^*) \]

and
\[ Y + k(T - r^* + 1)B_2^0(r^*) - kB_2^0(r^*) < 0 < Y + k(T - r^* + 1)B_2^1(r^*) - kB_2^1(r^*) \]

the individual postpones retirement: \( \hat{r} > r^* \)

The individual retires above the full rate but is not constrained by the age 65 upper bound

For this individual, \( B_2^1(r^*) > B_2^0(r^*) \) \text{ and } \( B_2^1(r^*) > B_2^0(r^*) \).

The sign of
\[ Y + k(T - r^* + 1)B_2^1(r^*) - kB_2^1(r^*) \]
is a priori undetermined.

On the one side, if the individual does not change her behaviour, the increase in her replacement rate - and thus in her income - allows her to reconsider the work/leisure trade-off in favour of leisure (« income effect »). On the other side, the increase in the annual benefit implied by postponing retirement by one year or more increases the value of waiting (« substitution effect »). If the income effect is the larger, the individual anticipates her retirement. If not, she postpones retirement.

The individual retires above the full rate but is constrained by the age 65 upper bound

The situation is the same as in the last case. If the income effect is the larger, the individual anticipates her retirement. If not, the age 65 upper bound binds and she does not change her decision.
Appendix 5:
Relaxing the 65 upper bound for the age of retirement

We allow here individuals to retire between 60 and 70. The 65 upper bound assumption made in all previous simulations was consistent with current behaviours displaying participation rates above 65 close to zero. However it may be less valid if the situation on the labour market improves or if new computation rules for pensions are decided.

This new assumption makes it necessary to slightly modify the formula that yields the level of the basic pension. Indeed, for people retiring after the age of 65, the pension may be increased in a significant way through the proratization term: the number of years of contribution is increased by 2.5% for each quarter worked after the 65th anniversary.

If \(a\) is the retirement age (in quarters) and \(d\) the contributing quarters, the proratization term writes now: \(\min\left(1, \frac{D}{150}\right)\) where \(D = d^* (1 + 0.025 (a - 260))\). For instance, let us consider an individual totalizing 120 quarters at 65 and retiring at 66, \(D = 124^* (1 + 0.025 (264 - 260)) = 136.4 / 136\). This individual enjoy an increase of 13.3% in her pension benefit by delaying from one year her retirement.

The simulation of the retirement decision in the \([60,70]\) interval is simulated under current rules and with the ‘0.6% penalty-0.3% bonus’ reform. The distribution of the age of retirement is more widespread than before and the 65-peak almost disappears under current rules (figure 19). This outcome is explained by the significant increase in pension that results from delaying retirement after 65.

The ‘0.6% penalty-0.3% bonus’ reform has a stronger effect on the postponement of the age of retirement under the \([60,70]\) assumption: 27.1% of wage-earners retire later instead of 18.5% under the \([60,65]\) assumption (figure 20). The mean age of retirement is increased by more than 6 months instead of 3 previously.

Figure 19: Distribution of the retirement age within the \([60-70]\) interval

Figure 20: Changes in the retirement decision with the ‘0.6% penalty-0.3% truncated bonus’: a comparison of \([60-65]\) and \([60-70]\) intervals
Appendix 6:
The retirement decision under the assumption of no mobility in the wage careers after 59

We assume here that, for people remaining on the labour market, the evolution of wage is purely deterministic after the age of 59. This implies no updating of the wage expectations (recall that people expect their wage to follow the deterministic trend given by the wage equation which depends on the school leaving age and the total tenure on the labour market).

The main effect of the no career mobility assumption is to dramatically decrease the share of people claiming SS benefits between 61 and 64 (figure 21). The significant shift to 65 mainly concerns people totaling at least 40 years of contributions at 60 but whose replacement at 60 would have been low. Given their preference for leisure they decide to postpone retirement and do not update this decision until 65 since wages follow a pure deterministic process.

Figure 21: Distribution of the retirement age under different assumptions on the modelling of wages