Pension Rules and Implicit Marginal Tax Rate in France

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Abstract

Contributions to Pay-as-you-go pension schemes are included in the tax burden along VAT or income tax. However, the computation rules of pensions rely on contributory principles that tend to make the benefits received conditional on contributions paid. Hence, considering pension contributions as pure taxes is excessive. Following studies done in the United States, we evaluate the fiscal nature of pension contributions for France, by calculating the induced net marginal rate. Explicitly, it consists in using actuarial methods to measure the future amount of additional pension induced by each euro of additional wage. Specific computation rules of pensions for private employees are identified and we compute an analytical expression of the implicit marginal tax rate. We estimate the implicit marginal tax rate for different generations and in various contexts of possible changes in legislation and in parameters. We compare differences by gender (gap in life expectancy, complete vs incomplete career).Our computations show that pension contributions in France induce distortions, expressed by an implicit marginal positive or negative taxation of labor, whose amplitude and profile depend on the pension's rules parameters and individual characteristics. Unsurprisingly, the implicit marginal tax rate depends on the computation rules of pensions. The defined benefit system (CNAV) is affected by a greater distortion than the defined contribution system (Arrco and Agirc), because the former does not take into account all the wages in the computation of the pension. Keywords: pension rule, payroll tax, life insurance, marginal tax rate.

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1 Introduction

Aging population and the massive retirement of the baby boomer generation have led to a major increase in the amounts paid for unfunded pension liabilities in France (about 14% of the GDP), which now represent a significant share of public spending. These payments are financed by contributions on wages that can be considered as a deferred income since they feed the pension rights. However, depending on whether the calculation of pension relies on a definite benefit principle or a definite contribution rule (Devolder, 2005), the link between pension benefits and contributions may vary considerably.

Indeed, contributions differ from a standard remunerated savings, which leads to an implicit taxation of labor as long as entitlement to retire and contributions are not bound by an actuarial rule. In the standard microeconomic analysis, measuring the “tax wedge” is essential to understand the tradeoffs, since individuals are supposed to reason at the margin on a net of tax basis. The tradeoffs with regard to pensions take into account the temporal dimension of costs and benefits. To assess the implicit taxation of pension contributions, it is therefore necessary to estimate the anticipated benefits they generate. Starting from this idea, Burkhauser and Turner (1985) questioned whether social contributions are only taxes ("Is the Social Security Payroll Tax a Tax?"). According to their analysis, considering contributions only in a static framework considerably overestimates their pure tax component. In contrast, considering the life cycle and deferred benefits induced by contributions improves the accuracy of the evaluation of the tax rate. The authors then give a measure of the "true" value of the marginal rate of taxation induced by US social security contributions. It depends, among other things, on the contributor’s age and marital status. The profile of marginal taxation is decreasing with age and becomes negative in the years before retirement. This initial work was completed by more detailed estimates by Feldstein and Samwick (1992) and Cushing (2005).

Implicit taxation of pensions is part of a larger context than simply assessing its potential, since it has an impact on work incentives. There is a trend of microeconomic literature that aims at estimating how the link between contributions and pension retirement affects the lifetime labor supply and the decision to retire. The study by Liebman et al. (2009) on individual U.S data (workers aged over 52) evaluated the effects of marginal tax rates on labor supply under three aspects: the retirement age, hours worked and wage income. Clearcut effects on the retirement choice and mixed effects on two other measures of labor supply are evidenced. In France, the main impact on behavior related to activity focused on the individual’s decision about the date of his retirement (Bozio, 2006 and 2008; Hairault et al., 2010).

In macroeconomic terms, the computable general equilibrium models with overlapping generations (CGE-OLG) often include tradeoffs on individual labor supply, which means, by construction, that the funding of retirement pension "distorts" the behavior of labor supply (Gannon and Touzé, 2012a). This line of research resulted in two categories of analysis of pension reforms: estimating efficiency gains (e.g. Nishiyama and Smetters, 2007) or seeking optimal reforms intended as maximizing the discounted sum of levels of present and future levels of welfare (Conesa and Garriga, 2008).

Compared to this ambitious literature which considers endogenous labor supply, the objective of this paper is far more modest. As in the American studies (Burkhauser and Turner, 1985; Feldstein and Samwick, 1992; Cushing, 2005), we propose to evaluate the fiscal nature of pension contributions for France, by calculating the induced implicit net marginal rate. Explicitly, it consists in using actuarial methods to measure the future amount of additional pension induced by each euro of additional wage.

The paper is organized as follows[1]. The first section outlines the general principles of the estimation method. It is standard and relies on the Likely Present Value (LPV) concept to assess and compare the costs and benefits induced by the financing of pension. Using the expected profiles of lifecycle revenues, we can estimate the likely present value of the added pension benefit induced by a marginal increase in wage and compare it to the additional pension contributions implied by this increase.

In the second section, analytical computations are made out of the specific rules of computation of pensions for France, for private employees. The pension plan relies on two pillars. The first is a mandatory defined benefit plan (Caisse Nationale d'Assurance Vieillesse, CNAV) calculated on the average lifetime wage. The second is a supplementary defined contribution notional scheme (Agirc/Arrco).

In the third and last section, we estimate the implicit marginal tax rates under different assumptions. These computations permit to assess how the marginal rate of taxation evolves according to age. The study is limited to single individuals. Hence, pension benefits do not include survivor's pension. Wages are assumed to be high enough so that retirement pension exceeds the threshold of minimum welfare benefits. For the mandatory defined benefit plan (CNAV), careers are supposed to be complete, but we analyze also some cases of incomplete careers. These computations are made for different generations (prospective approach) and they test the sensitivity of the results to differences for men and women (life expectancy, activity period), and to the values of prospective parameters (activity duration). Finally, the impact

[1]For a preliminary study, see Gannon and Touzé (2012b).

of the tax on pensions –"generalized social contribution" (CSG) and "social debt reimbursment contribution" (CRDS)– is evaluated.

2 General computation principles of the marginal tax rate

Pension P at retirement age R depends on a formula: $P_x(W, I_x)$ for $x \geq R$. W is a vector of wages w_x received at ages x with $x \in [D, R-1]$ where D and R stand for the age at which the worker began his career and the age at which he retires, respectively. I_x is a set of institutional parameters valid at age x (e.g. : contribution rate, duration of insurance, legal age of retirement, ceiling for social security, etc.).

Let τ_x^{emp} and τ_x^{over} denote, respectively, the employer's[2] and the overall (employer's plus worker's) contribution rates which apply to gross wage when the individual has reached age x. In the following computations, we will consider the rates applying to gross wage, hence the overall wage cost for employer. The apparent rate on overall wage then writes:

$$\tau_x = \frac{\tau_x^{over}}{1+\tau_x^{emp}}.$$

We estimate the present value of taxation. To do this, we assess at each age the likely present value (LPV) of wages, pension contributions and benefits. Two key parameters are used: survival probabilities and discount factor. Probability to survive between ages x and y with $x \leq y$ is denoted by $q_{y,x}$ and $q_{x,x} = 1$. Let $R_{y,x} = \prod_{k=x}^{y-1}(1+r_k)$, be the interest factor between ages x and y. It is used to calculate the present value of future revenues and contributions and $R_{x,x} = 1$.

In our estimations, we will rely on historical mortality tables provided by the French national institute of statistics (INSEE) for the retrospective component and on the official TGH/TGF05 tables for the prospective component. The latter, used for the computation of the life annuities, are prudential by construction, which means they tend to underestimate mortality. Figure 1c gives a synthetic estimation of the TGH/TGF05 table as the number of expected years of life for each age from 60 according to gender and generation

[2] The average corporate tax is not constant for wages lower than 1.6 SMIC (due to tax exemptions) – the minimum legal wage for a full-time occupation – or greater than the Social Security ceiling. In our calculations, we use the average rate under ceiling (Insee series). For wages lying slightly above the ceiling, the approximations and errors can be assumed to be of second order. For the sake of clarity of presentation of our results, we assume a fix average rate, whether the wage lies below or beyond the ceiling.

(1952 or 1972). The discount factor is obtained from the OECD's long term interest rate (Fig. 1b). For the prospective component, the rate is assumed to be 4%.

The LPV of wages is the sum of the present values of the future wages under the survival condition:

$$LPV_x\left(wages\right) = \sum_{y=x}^{R-1} \frac{q_{y,x}}{R_{y,x}} \cdot w_y. \tag{1}$$

The LPV of contributions obtains similarly as:

$$LPV_x\left(payroll\ taxes\right) = \sum_{y=x}^{R-1} \frac{q_{y,x}}{R_{y,x}} \cdot \tau_y \cdot w_y. \tag{2}$$

The LPV of pension benefits takes into account the probability to be alive at the age of retirement, R:

$$LPV_x\left(pensions\right) = \sum_{y=R}^{120} \frac{q_{y,x}}{R_{y,x}} \cdot p_y\left(W, I_y\right) = p_R\left(W, I_R\right) \cdot \sum_{y=R}^{120} \frac{q_{y,x}}{R_{y,x}} \cdot I^p_{y,R}. \tag{3}$$

where $I^p_{y,R}$ is the index factor of pension benefits, assumed to be independent of W.

Let $\ddot{a}_R = \sum_{y=R}^{120} \frac{q_{y,x}}{R_{y,x}} \cdot I^p_{y,R}$ be the value of 1 euro pension annuity perceived from age R, indexed by $I^p_{y,R}$. Values of $\ddot{a}_R$ are calculated in table 1 under the following assumptions: 1952 (date of birth), 62 (age of retirement), 4% (discount rate), male (gender), 2% (index rate). We use TGH/TGF05 French prospective mortality tables. Under these assumptions, $\ddot{a}_R = 20,97$. That means that the financial value of a 1,000 euro pension annuity is 20,970 euros.

The implicit marginal tax rate of pension contribution at age x is obtained from calculating the marginal additional contribution induced by a supposedly unique increase of wage at that age, net of the increase in pension benefit, divided by the variation of revenue:

$$\tau_{\text{marg},x} = \frac{\tau_x \cdot \Delta w_x - \Delta LVP_x\left(pensions\right)}{\Delta w_x}. \tag{4}$$

In the case of a permanent increase of wage, the marginal rate of pension contribution at age x is given by the following ratio:

$$\tau_{\text{marg},x} = \frac{\Delta LVP_x\left(payroll\ taxes\right) - \Delta LVP_x\left(pensions\right)}{\Delta LVP_x\left(wages\right)}. \tag{5}$$

Indexation rate of past wages			
1%	1,5%	2%	2,5%
18.52	19.69	20.97	22.37
Actualization rate			
3%	3,5%	4%	4,5%
23.89	22.35	20.97	19.72
Birth year			
1952	1962	1972	1982
Men			
20.97	21.82	22.64	24.41
Women			
23.01	23.83	24.64	25.41
Retirement age			
61	62	63	64
21.48	20.97	20.44	19.91

Table 1. Values of $\ddot{a}_R$ according to different hypotheses

According to the same line of reasoning, the implicit marginal rate of pension contribution at age R derived from an additional quarter of labor supply is given by:

$$\tau^p_{\text{marg},R} = \frac{\tau_R \cdot \Delta w_R - \Delta LVP_R\,(pensions)}{\Delta w_R}. \tag{6}$$

However, we will not evaluate this rate, since it would require, ideally, a model of quarterly frequencies that we have not. Instead, we concentrate on marginal variations of revenues during the activity period. For the French case, Hairault et al. (2005) provide evaluations of the implicit marginal rate of pension contribution at age x derived from an additional quarter of labor supply for different configurations of occupational careers. These evaluations are crucial to analyze the financial incentives for wage-earners to work beyond age 60.

3 Pension rules in France: An analytical estimation of the implicit marginal tax rate

3.1 Defined benefit system (annuity plan): the CNAV

The defined benefit plans are retirement contracts which assure the wage-earner at the time he retires a defined level of pension benefit, that will depend on a replacement rate applied to an average of his yearly wages. CNAV's computation formula is given by (Legros, 2006; Bozio, 2006):

$$\begin{aligned} & p_R(w, I_R) \\ = \quad & \rho(R, d, d_{pro.}, d_{cl.}) \cdot \left(\frac{1}{N} \cdot \sum_{\lambda_{x,R} \cdot w_x \in N \max(\lambda_R \cdot W)} \lambda_{x,R} \cdot \min(w_x, SSC_x) \right) \quad (7) \end{aligned}$$

$$\text{where } \rho(R, d, d_{pro.}, d_{cl.}) = \begin{cases} 0.5 \times \min\left(1, \frac{d}{d_{pro.}}\right) \\ \times \left(1 - \alpha_1 \times \max\left(0, \min\left((65 - R) \times 4, d_{b/m} - d\right)\right)\right. \\ \left. +\alpha_2 \times \max\left(0, \min\left((R - 60) \times 4, d - d_{b/m}\right)\right)\right) \end{cases}$$

with d the number of quarters validated, $N \max(\lambda_R \cdot W)$ denotes the set of the N highest discounted wages, SSC_x the ceiling basis for social security (fig. 1a), $\lambda_{x,R}$ is an updating coefficient of past wages[3] (fig. 1b) and $\lambda_R = (\lambda_{D,R}, ..., \lambda_{R-1,R})$ a vector, $d_{pro.}$ and $d_{b/m}$ are the durations used for *pro rata* computation and bonus/malus rates, respectively (Table 2), $N = 25$ years is the number of best wage-earning years set for the computation of the average wage (Table 2), α_1 is a penalty (malus) discount factor (Table 2), α_2 is a reward (bonus) discount factor (Table 2), equal to 1.25% for each exceeding quarter from January 1st, 2009.

These parameters change over time. Table 2 provides estimations for different dates of birth.

Also, the minimal age to assert one's right to retire gradually increases from 60 to 62. Hence, people born in 1952 must work until 60 years and 8 months. In the future, the activity duration required to benefit the full rate pension is scheduled to adjust to changes in life expectancy[4] (COR, 2011). This may lead to large increases if the shift in the age of entry into activity is not accounted for by the legislative texts (report by Charpin et al., 1999).

[3]Before 1987, the wages taken into account in the calculation of the average yearly wage (SAM) were updated by the index of the national average wage. Since 1987, the wage updating rates for the calculation of pensions are equal to the price growth index, not to the wage growth index any longer (COR, 2009).

[4]The 9 Nov. 2010 law confirms the principle defined by the 21 Aug. 2003 law about the lengthening of the insurance period required to benefit the full rate pension, according to "the evolution of the ratio insurance period or service and bonuses period and the average retirement period".

Birth year	α_1	$d_{pro.}$	$d_{b/m}$	Normal retirement age	Full pension age
1946	2.125%	156	160	60	65
1947	2%	158	160	60	65
1948	1.875%	160	160	60	65
1949	1.75%	161	161	60	65
1950	1.625%	162	162	60	65
1951 1st half	1.5%	163	163	60 + 4 months	65
1951 2nd half	1.5%	163	163	60 + 4 months	65 + 4 months
1952	1.375%	164	164	60 + 9 months	65 + 9 months
1953	1.25%	165	165	61 + 2 months	66 + 2 months
1954	1.25%	165	165	61 + 7 months	66 + 7 months
1955	1.25%	166	166	62 months	67
1956	1.25%	166	166	62	67

Table 2 - Current legislation

In addition to the contributory pensions, there are two minimum welfare benefits for old age:

- the "old age minimum payment" or ASPA: this means-tested pension benefit is paid by the FSV (Old Age Solidarity Fund) which is financed by numerous taxes. It guarantees a monthly minimum income to people aged 65 and older (or, under conditions, to people aged 60 and older). It amounts to 742.27 euros for a single person and 1181.77 euros for a couple. The actual benefit is equal to the difference between the "old age minimum payment" and the household's revenue.

- the "contributory minimum": this benefit guarantees a minimum pension to workers benefiting a full pension but who have contributed on low wages. Under means conditions[5], this minimum benefit can add to other resources such that supplementary pension benefits. It has two components. The first one is a monthly lump sum of 608.15 euros paid if the pensioner's insurance duration (quarters of contribution and quarters taken into account for unemployment spells or long illness sick leaves) reaches its maximum (otherwise, this sum is reduced). The second component is a bonus of 56.39 euros proportional to the ratio of quarters contributed on quarters validated and under constraint of 120 validated quarters, whatever the pension plans. The

[5]Since January 1st, 2012, the pensioner's income (equal to the sum of all the basic and supplementary pension plans, included the contributory minimum) cannot exceed the ceiling of 1005 euros a month.

effective pension benefit is equal to the difference between the contributory minimum and the basic pension paid.

The minimum retirement pension is, in essence, not contributory, in contrast with the contributory minimum, which takes into account the activity duration. However, every increase of the CNAV pension reduces by the same amount the payment of the contributory minimum. The marginal gain in the basis CNAV pension is therefore nil and the implicit marginal rate is equal to the retirement contribution rate of the basic pension regime[6]. With the minimum retirement pension, an increase of the supplementary pension benefit. Hence, the implicit marginal rate includes the contribution rate of supplementary plan.

The implicit marginal rate of the contribution to CNAV is obtained by differentiating and substracting the LPV of contributions and pension benefits with respect to wage w_x:

$$\tau_{\mathrm{marg},x} = \tau_x - \rho\,(.) \cdot \frac{q_{R,x}}{R_{R,x}} \cdot \frac{1_{\text{best years}} \cdot 1_{w_y < SSC_y}}{1 + \tau_y^{emp}} \cdot \frac{\lambda_{x,R}}{N} \cdot \ddot{a}_R \tag{8}$$

with $\tau_x = \tau_x^{SSC} \cdot 1_{w_x < PLF_x} + \tau_x^{totwag}$ and where τ_x^{SSC} and τ_x^{totwag} are the contribution rates applying to the fraction of wage lying below the CNAV ceiling and the whole wage, respectively. Figure 1d summarizes the evolution of these two rates for the 1970-2010 period. $1_{\text{best years}} = 1_{\lambda_{x,R} \cdot w_x \in N \max(\lambda_R \cdot W)}$ and $1_{w_x < SSC_x}$ are two dummy variables taking value 1 (resp. 0) if the condition mentioned in index (wage belonging to the 25 "best wage-earning years" and wage lying below the ceiling, respectively) applies (resp. does not apply). Notice that these two variables depend on random events. Alternatively, the measure of implicit marginal rate could rely on laws of probability on the evolution of wage w_x. That would allow the marginal rate to be estimated by using techniques similar to the option pricing approach (Merton, 1973), following Stock and Wise (1990) who have developed a model of retirement based on the option value of continuing to work. For the sake of simplicity of exposition, we have opted for the conditional dummy variables approach.

If wage w_x lies beyond the CNAV ceiling, its variation has no effect on the average wage and the marginal rate is equal to the rate applying to the overall wage, τ_x^{totwag}. If w_x lies below the CNAV ceiling and does not belong to the set of the 25 best wage-earning years, the marginal rate is exactly equal to the contribution rate, $\tau_x^{SSC} + \tau_x^{totwag}$. Otherwise, the wage increase has an impact of weight $1/N$ on the average lifetime wage, which is then updated by factor

[6] This property holds as long as the income ceiling is not reached. Beyond, each additional euro from the supplementary pension plan decreases the contributory minimum payment.

$\lambda_{x,R}$ that is to be compared with the discount factor $R_{R,x}$. A replacement rate is applied to the variation of the lifetime average wage. In effect, since the pension benefit is paid as an annuity, its financial value at the date of retirement is proportional to $\ddot{a}_R$. The probability to reach the retirement age from age x, denoted $q_{R,x}$, increases with x. Ratio $\lambda_{x,R}/R_{R,x}$ compares the evolution of the updating of wages to the interest rate. If the average interest rate is assumed to be always greater than the average updating rate (Figure 1b), this ratio is also increasing with x. The profile of the marginal contribution rate is then likely to decrease with x if the technical parameters are stationary.

The LPV of a marginal permanent 1 euro increase is denoted $\ddot{a}_{x,R-1}$, equal to:

$$\ddot{a}_{x:R-1} = \sum_{y=x}^{R-1} \frac{q_{y,x}}{R_{y,x}}. \tag{9}$$

The marginal rate is defined by:

$$\begin{aligned} &\tau^p_{\text{marg},x} \\ = \quad &\frac{1}{\ddot{a}_{x:R-1}} \cdot \sum_{y=x}^{R-1} \left(\frac{q_{y,x}}{R_{R,x}} \cdot \tau_y - \rho\left(.\right) \cdot \frac{q_{R,x}}{R_{R,x}} \cdot \frac{1_{\text{best years}} \cdot 1_{w_y < SSC_y}}{1+\tau_y^{emp}} \cdot \frac{\lambda_y}{N} \cdot \ddot{a}_R \right). \end{aligned} \tag{10}$$

After rearranging the terms, it is straightforward to show that this rate is a weighted average of the marginal rates that apply to each future age y:

$$\begin{aligned} &\tau^p_{\text{marg},x} \\ = \quad &\frac{1}{\ddot{a}_{x:R-1}} \cdot \sum_{y=x}^{R-1} \frac{q_{y,x}}{R_{R,x}} \cdot \left(\tau_y - \rho\left(.\right) \cdot \frac{q_{R,y}}{R_{R,y}} \cdot \frac{1_{\text{best years}} \cdot 1_{w_y < SSC_y}}{1+\tau_y^{emp}} \cdot \frac{\lambda_y}{N} \cdot \ddot{a}_R \right) \\ = \quad &\frac{1}{\ddot{a}_{x:R-1}} \cdot \sum_{y=x}^{R-1} \tau_{\text{marg},y}. \end{aligned} \tag{11}$$

3.2 Defined contribution system: the notional plans of the supplementary pension plan (Agirc and Arrco)

In the supplementary pension funds regimes, the contribution allows the individual to buy points at price v_x^{buy}. In turn, each point of supplementary pension benefit confers a right to an annuity of amount v_x^{ann}. The amount of pension depends on the number of points accumulated at the date of the liquidation of the pension plan (Legros, 2006):

$$P_R(W, I) = \rho\,(.) \cdot \sum_{y=D}^{R-1} \frac{\tau_y \cdot w_y}{v_x^{buy}} \cdot v_x^{ann}. \tag{12}$$

Coefficient $\rho(.)$ depends on the number of missing quarters compared either to the legal insurance period defined by the CNAV or to the age for which the length of insurance is not taken into account. The solution chosen is the most favorable for the worker. A 1% penalty applies for each missing quarter if the number of missing quarters is inferior to 12, then 1.25% until 20 missing quarters, then 1.75% for each additional quarter. Figure 1h summarizes the evolution of coefficient $\rho(.)$ according to the number of missing quarters. In the Agirc/Arrco schemes, one can retire before 60.

In practice, the supplementary pension plans apply a repurchase rate. That means the contribution paid does not fully qualify for points. The difference between the contributed rate and the applied rate can be considered as a tax. Figure 1f summarizes the evolution of this repurchase rate. To simplify the notations, we will denote here: $v_x^{buy} = v_x^{buy\_Agirc \text{ or } Arrco} \times$ repurchase rate.

Pensions are updated yearly on April 1st. According to the agreement of March 18, 2011, pensions will be indexed on the evolution of the average wage of the contributors of the Arrco and Agirc plans minus 1.5 points, with the inflation rate as a minimum, which guarantees *a minima* to keep up the purchasing power of the liquidated pension plans.

In addition to the contributions accruing to the worker's future pension, the supplementary pension plans apply an extra social tax to finance the pensions of people who retired before 65 after the 1983 reform. This contribution does not reward points. It is equal to 2% for the fraction A and 2.2% for fraction B.

In case of a transitory marginal increase of wage, the marginal rate writes, formally:

$$\tau_{\text{marg},x} = \tau_x \cdot \left(1 - \frac{q_{R,x}}{R_{R,x}} \cdot \frac{v_R^{ann}}{v_x^{buy}} \cdot \ddot{a}_R\right). \tag{13}$$

At age x, a 1 euro wage increase leads to a τ_x euros increase of the pension tax. This additional tax allows to qualify for euros of additional point for the pension plan. If the individual is still alive at age R (with probability $q_{R,x}$), he will get for each additional point. The present financial value of such an annuity is given by:

$$\frac{\tau_x}{R_{R,x}} \cdot \frac{v_R^{ann}}{v_x^{buy}} \cdot \ddot{a}_R.$$

The marginal rate compares cost τ_x to the LPV of the benefit:

$$\tau_x \cdot \frac{q_{R,x}}{R_{R,x}} \cdot \frac{v_R^{ann}}{v_x^{buy}} \cdot \ddot{a}_R.$$

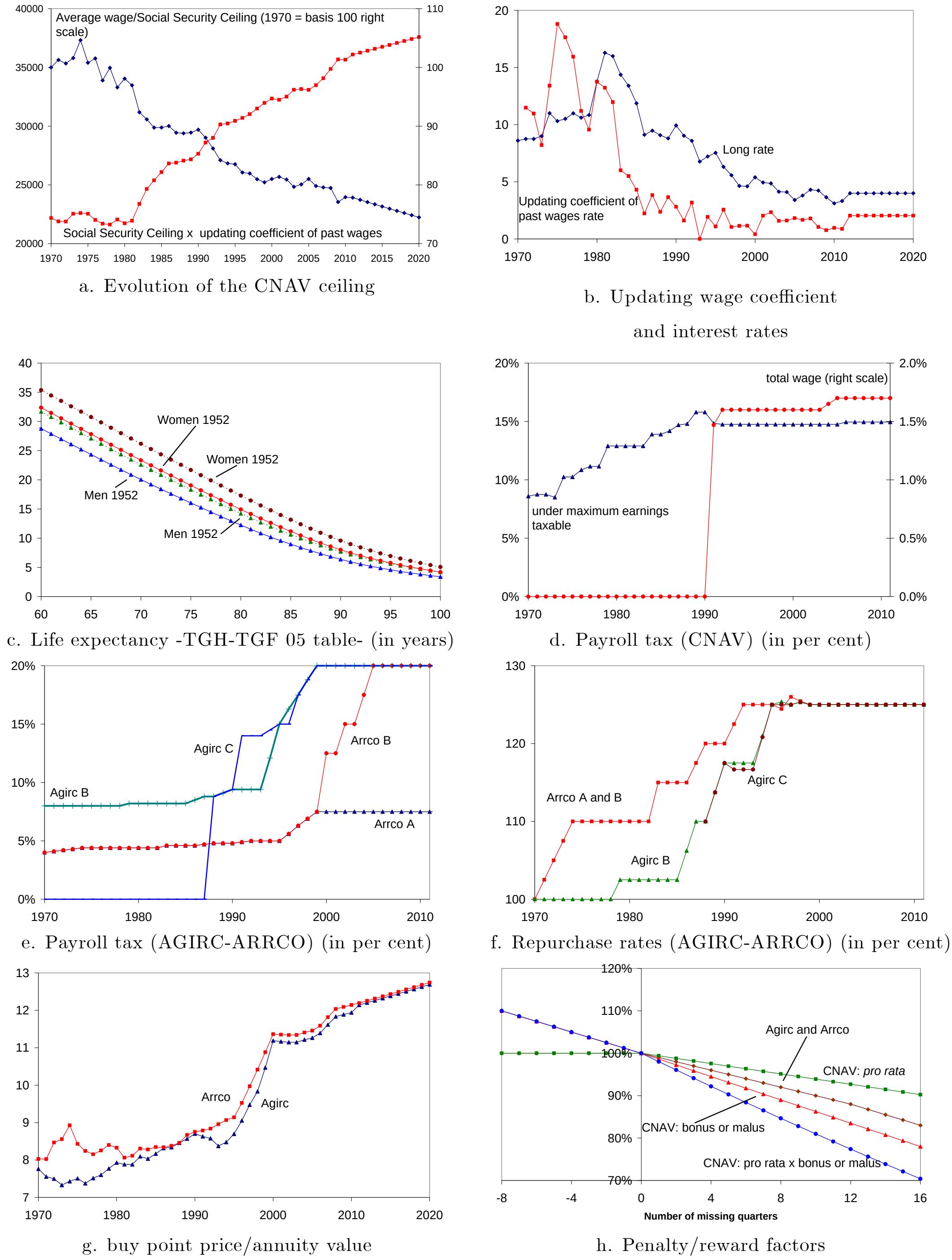
For any given year, it must be noticed that the unitary price of the point of pension benefit is constant at every age. Then, the older generations benefit a better "investment" than younger ones because they are more likely to reach the retirement age (since $q_{R,x}$ increases with x) and the implicit return of the point (measured by $\frac{v_R^{ann}}{v_x^{buy}} \cdot \ddot{a}_R$) is less than the discount rate. Expression $\frac{q_{R,x}}{R_{R,x}} \cdot \frac{v_R^{ann}}{v_x^{buy}} \cdot \ddot{a}_R$ then increases with x. As with the previous computations about the CNAV pension plan, the profile of the marginal rate must decrease with age when parameters are stationary.

If the wage increase is permanent, the marginal rate on the LPV of the overall marginal variations of wage is equal to:

$$\tau^p_{\text{marg},x} = \frac{1}{\ddot{a}_{x:R-1}} \cdot \sum_{y \geq x}^{R-1} \left(\frac{q_{y,x}}{R_{R,x}} \cdot \tau_y - \frac{q_{R,x}}{R_{R,x}} \cdot \tau_y \cdot \frac{v_R^{ann.}}{v_x^{buy}} \cdot \ddot{a}_R \right). \tag{14}$$

Rearranging terms, it is straightforward to show that this marginal rate is an average LPV of the marginal rates computed at each future age y for a transitory wage increase:

$$\begin{aligned} \tau^p_{\text{marg},x} &= \frac{1}{\ddot{a}_{x:R-1}} \cdot \sum_{y \geq x}^{R-1} \left(\frac{q_{y,x}}{R_{R,x}} \cdot \left(\tau_y - \frac{q_{R,y}}{R_{R,y}} \cdot \tau_y \cdot \frac{v_R^{ann.}}{v_x^{buy}} \cdot \ddot{a}_R \right) \right) \\ &= \frac{1}{\ddot{a}_{x:R-1}} \cdot \sum_{y \geq x}^{R-1} \left(\frac{q_{y,x}}{R_{R,x}} \cdot \tau^p_{marg,y} \right). \end{aligned} \tag{15}$$



a. Evolution of the CNAV ceiling

b. Updating wage coefficient and interest rates

c. Life expectancy -TGH-TGF 05 table- (in years)

d. Payroll tax (CNAV) (in per cent)

e. Payroll tax (AGIRC-ARRCO) (in per cent)

f. Repurchase rates (AGIRC-ARRCO) (in per cent)

g. buy point price/annuity value

h. Penalty/reward factors

Fig. 1 - Changes in the pension legislation and mortality data

4 Application

4.1 Benchmark case: single man born in 1952 with a complete career, who started working at 21.

Choosing a typical case in a dynamic framework can be tricky. According to Dupont et al. (2003), “from a static point of view, typical cases are easy to define (minimum wage workers, employees, executives,...)” but “from a dynamic point of view, the concept of benchmark is fuzzy, at least because of wage mobility”. For instance, an employee does not stick to the minimum wage for all his active life. In practice, the chosen typical cases must be “representative of a given reality, but it seems difficult to get a distribution of the ideal types to summarize as truthfully as possible the differences observed in the society as a whole”. To get rid of the arbitrariness of typical cases, one can use retrospective samples of wage-earning careers or build dynamic microsimulation models for a both retrospective and prospective analysis. However, typical cases are efficient tools to characterize the properties of the computation rules and are commonly used (Dupont and Sterdyniak, 2000; Raynaud et Koubi, 2004; COR, 2010).

In our estimations, using typical cases is justified by the fact that they do not need to rely on a precise knowledge of the wage trajectories. The marginal implicit rate is calculated according to the position of the wage with respect to the CNAV ceiling and whether or not it belongs to the 25 best wage-earning years of the individual’s career. Moreover, wages are assumed to be such that, during retirement, the pensioner is not eligible for the old age or contributory minima. However, if he were, the implicit marginal rate would be easy to calculate because the marginal contribution would not trigger any supplementary pension. The marginal tax rate would then be equal to the pension tax rate of the basic CNAV scheme for the contributory minimum and to the sum of pension tax rates (CNAV and supplementary plans) for the old age minimum.

The main hypotheses concern the date of birth, sex, marital status and career duration. In the benchmark case, we consider single men born on January 1st, 1952, whose career is complete, which means they qualify for full retirement pension. Notice that, obviously, no benefits accruing from the reversion pension need be considered here.

People born in 1952 will retire when they are 60 years and 8 months. People born in January 1952 will be allowed to retire from September 2012. Full pension will require 41 years of activity. In our computations, we consider that occupational activity starts at 21 and goes on without interruption for 41 years. Retirement age is then reached on the 62th birthday, which is on

January 1st, 2014.

For our prospective analysis, we assume the contribution rates to be constant. To calculate the future values of the points of the supplementary pension plans, we impose that the ratio buying value / liquidation value keeps its trend value. The updating rate of wages and pensions is supposed to be 2% (i.e. long term inflation rate). The discount rate is 4%.

Actualization	AGIRC/ARRCO		CNAV
	Buy points price	Annuity value	Indexation coefficient
4	2.50	2	2

Table 3 - Hypotheses on the prospective values (in per cent)

For wages that both lie below the CNAV ceiling (fraction A) and belong to the set of the 25 best wage-earning years, the marginal rate induced by the basic pension regime follows an increasing trajectory with age, from age 21 (-1.45%) to 28 (3.3%). The marginal rate is nil about age 38 and rapidly decreases afterwards to reach -17.2% at 61. For wages that lie below the CNAV ceiling without belonging to the 25 best wage-earning years, the marginal rate is exactly equal to the contribution rate. It keeps on increasing until age 39, reaching 11.8%, whereas it is 6.3% at 21. The setting, in 1990, of a CNAV contribution rate on the overall gross wage has a very moderate effect because the contribution rate for the fraction under the CNAV ceiling was lowered. For the basic pension regime, the range of the marginal rate is wide, since the latter can reach 11.8% for the wages of the "bad years" and drop as low as -17.2% for the wages of the "25 best years". As to the wages that are above the CNAV ceiling, the marginal rate is zero until age 38. It is slightly greater than 1% at age 39 and reaches 1.2% about 53.

Regarding the supplementary pension plan Arrco (fraction A of wage), the profile of the marginal rate is slightly modified. The additional marginal rate is stable and positive at the beginning of the career, where it fluctuates around 1.3% until age 31. This stability is due to the increase of the contribution rate. Afterwards, the marginal rate decreases to stabilize again around 0.1% from age 43 on. This new period of stability is a direct effect of the "repurchase rate" on the contributions, which considerably reduces the purchasing power of points through the contribution. From 49 on, the marginal rate decreases to reach -1.8% at age 61.

Beyond the CNAV ceiling[7] (fraction B of the supplementary pension plans

[7] To simplify the presentation of results, the graph does not show the profile for Agirc's fraction C, because it is very similar to that of fraction B.

Arrco and Agirc), the contribution profiles are rather stable until age 31, because of the historical increase of the Arrco and Agirc's contribution rates. Afterwards, the marginal rate decreases until 38. As for the Arrco's fraction A of the wage, the effect of the repurchase rate applies and the marginal rate stabilizes around 1.5% for Arrco and 2.6% for Agirc. This stabilization results in a decrease of the marginal rate with age such that it becomes negative after age 49. The range of fluctuation is less than for the Arrco's fraction A: between -2% and 2% for the Agirc and between -2% and 1.5% for the Arrco. The two plans progressively align with the fraction B with time, which explains why the profiles of the marginal rates are very similar from age 50 on.

The computation rule applying to the supplementary pensions result in a narrower variation interval for the marginal rates: [-1.8%, 1.5%] for Arrco (fraction A), [-4.8%, 1.5%] for Arrco, [-4.8%, 2.9%] for Agirc (fraction B).

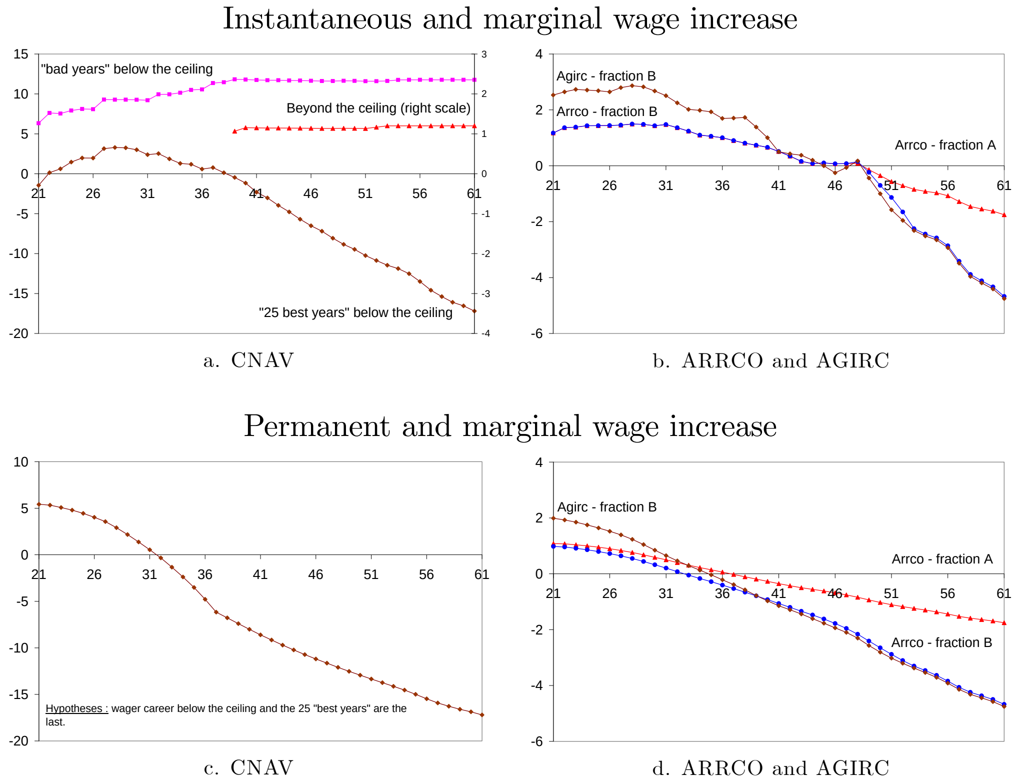
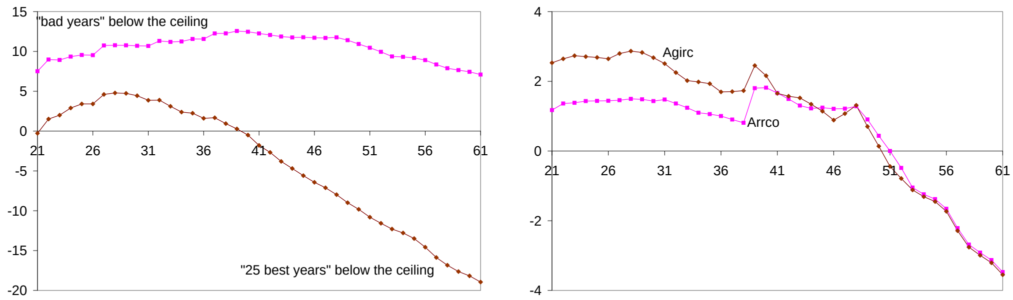


Fig. 2 - Implicit marginal tax rates of pension contributions
(1952 generation, single man, complete career)

In the case of a permanent marginal increase of wage[8], profiles are smoother. For a wage lying in the fraction A (CNAV and Arrco plans), the marginal rate decreases with age. It becomes negative from age 32 for the basic pension regime and from 39 for the Arrco. For higher wages, the profile is also decreasing and the marginal rate turns negative from age 32 for the Arrco and age 35 for Agirc.

To summarize the implicit marginal rates for each fraction of wage, we must add all the marginal rates (Fig. 3): rates for the fractions of wage below and beyond the CNAV ceiling, rates for the Arrco's and Agirc's fractions A and B. For fraction A (Fig. 3a), the ranges are: [-19%, 4.8%] for the 25 best wage-earning years and [7.1%, 12.6%] otherwise. For fraction B (Fig. 3b), the amplitudes are [-3.5%, 1.8%] for the Arrco contributors and [-3.6%, 2.9%] for the Agirc contributors. A significant increase of all the rates of the B fraction occurs at age 39 due to the setting of a CNAV contribution rate (about 1%) applied to the overall wage without any right to retirement attached to it.



Wage below the ceiling (fraction A) Wage beyound the ceiling (fraction B)

Fig. 3 - Implicit marginal tax rates of pension contributions: summary for each wage fraction

4.2 Comparison by generation: some prospective considerations.

The comparison with the profiles for generations born after 1952 must rely on a prospective approach since the legislation applied in the future is totally or partially unknown. Three scenarios are considered:

- Scenario 1 (Figures 4): the contribution period is constant (41 years

[8] Calculations are based on two hypotheses: a). a complete career below the ceiling and b). the wage belongs to the "25 best wage-earning years".

for all the generations) and the global evolution of the annuity ratio is maintained.

- Scenario 2 (Figures 5): the contribution period increases by one year every 10 years, which gives: 42, 43 and 44 years for the generations born, respectively, in 1962, 1972 and 1982.

- Scenario 3 (Figures 6): similar as scenario 2, except that ratio is stabilized at its value observed in 2011 (explicitly, both points increase yearly by 2%).

In scenario 1 (Figures 4), the comparison of the evolution of the marginal rate (except contribution on the overall wage) induced by the CNAV pension plan for the different generations exhibits the following properties:

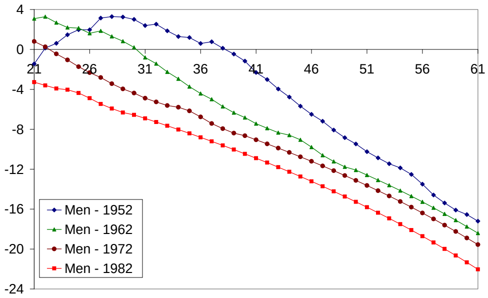
- For the older generations, the rate applying to the "worse" wage-earning wages under the CNAV ceiling is lower at the beginning of the career.

- The differences in the life expectancy benefit the younger generations. For identical contribution periods and retirement ages, an increased life expectancy reduces the marginal rate because the pension benefit is paid on a longer period. Moreover, the gap between the wages updating rate and the interest rate is wider for the older generations, which decreases the LPV of pension gains. As a consequence, the profile of marginal rate is clearly higher for these generations.

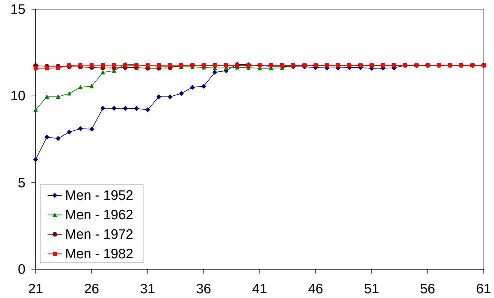
For the supplementary plans, the assumption of an increasing annuity ratio (Fig. 1g) considerably reduces the benefits induced by an increase of life expectancy. According to our computation hypotheses, generations born in 1962, 1972 and 1982 show quite similar profiles as the generation born in 1952.

If the legislation requires an increase of the activity period (scenario 2, Fig. 5), the profiles of the marginal rates for the CNAV pension plan get closer. On the contrary, the gaps widen for the supplementary plans, due to a reduction of the retirement period as compared to the benchmark scenario, which reduces the marginal benefits associated to the contributions. In this scenario, the increases of the annuity ratio and of the contribution period offset the increase of the life expectancy between 1972 and 1982 generations, but overcompensate that assumed for 1952 and 1962.

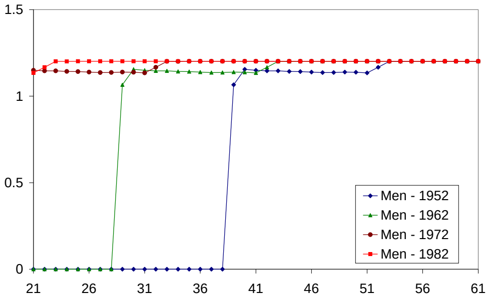
However, a stabilized annuity ratio (scenario 3, Fig. 6) improves the return of the supplementary plans, offsetting the reduction of the LPV of pension benefit. That leads to a dramatic reduction in the differences in the profiles of marginal rates, which clearly converge.



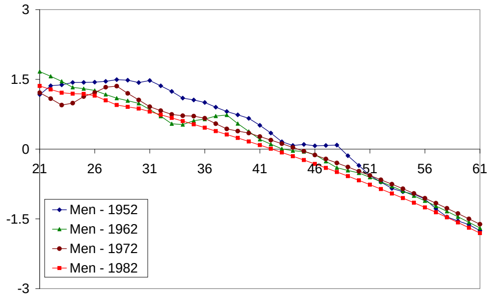
a. CNAV: "25 best years" below the ceiling



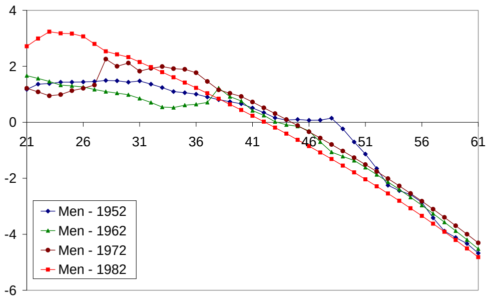
b. CNAV: "bad years" under the ceiling



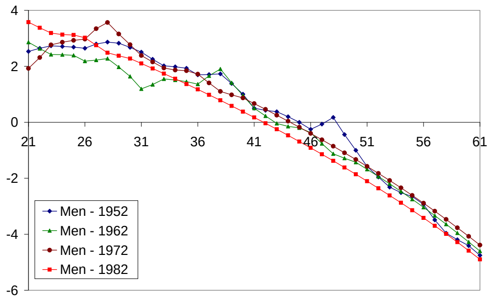
c. CNAV: years beyond the ceiling



d. ARRCO: fraction A

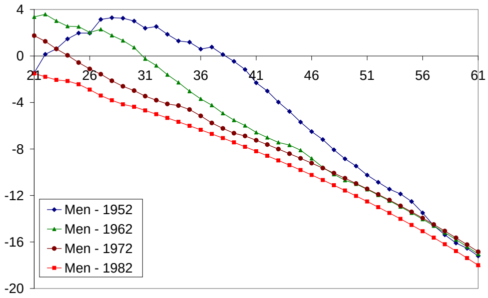


e. ARRCO: fraction B

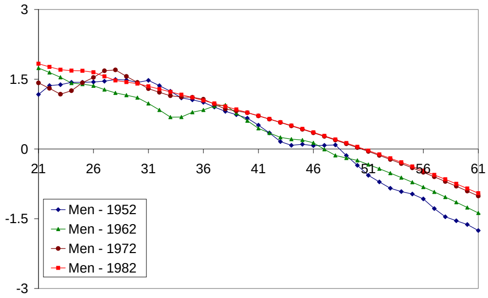


d. AGIRC: fraction B

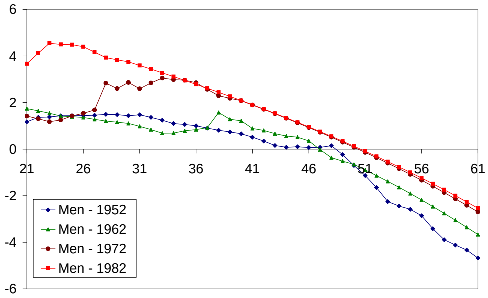
Fig.4 - Scenario 1: Constant contribution period (41 years)



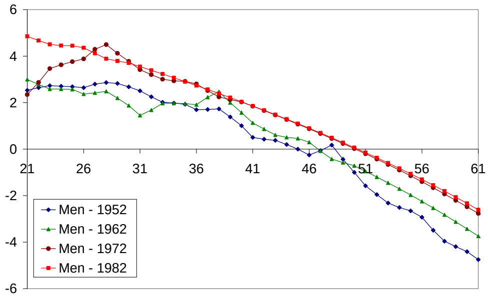
a. "25 best years" below the ceiling



b. ARRCO fraction A

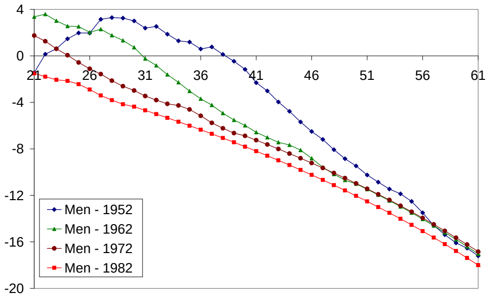


c. ARRCO fraction B

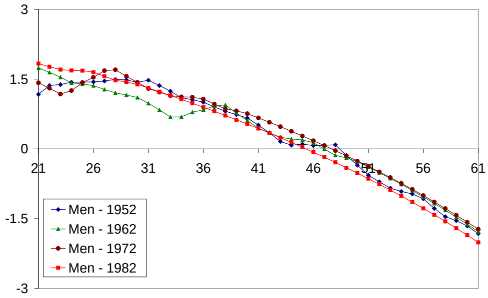


d. AGIRC fraction B

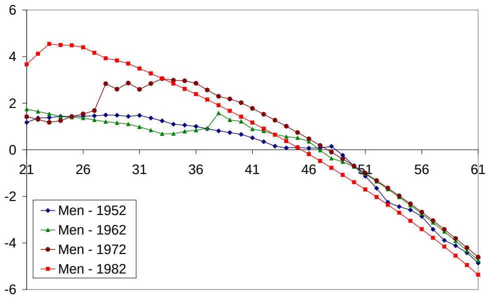
Fig. 5 - Scenario 2: Variable contribution periods



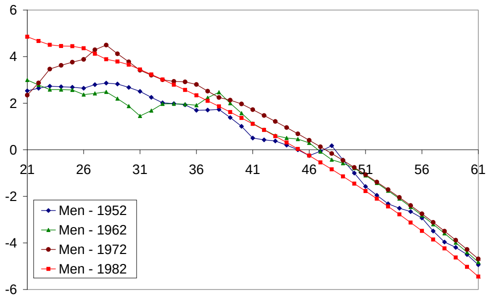
a. CNAV: "25 best years" below the ceiling



b. ARRCO: fraction A



c. ARRCO: fraction B



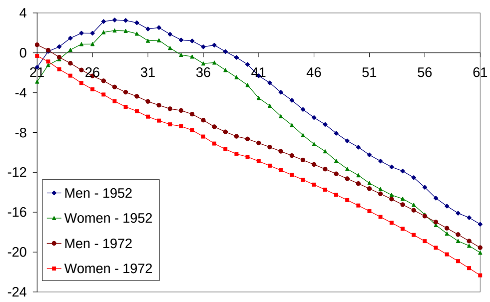
d. AGIRC: fraction B

Fig. 6 - Scenario 3: Variable contribution periods
+ stabilized annuity ratio

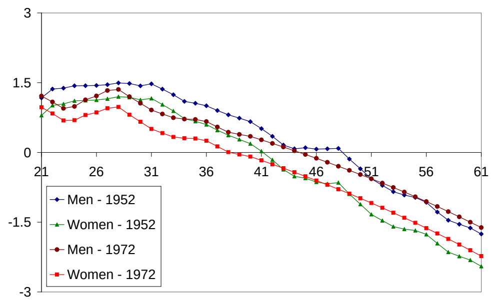
4.3 Comparison of mortality tables: men *vs.* women

For identical careers, the marginal rates paid by women are lower than those paid by men (Fig. 7), because the former benefit a greater life expectancy. As a matter of fact, whether they belong to the generation born in 1952 or in 1972, the gap at the end of the lifecycle is about 2.5 points for the CNAV plan, 0.5 point for Arrco's fraction A and 1.8 points for Arrco's fraction B.

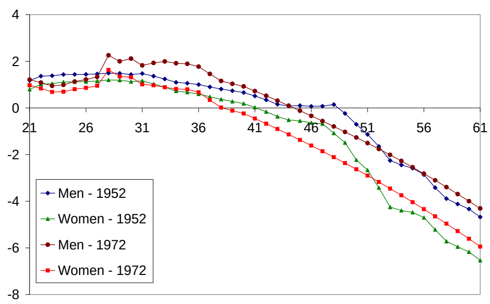
For the supplementary plans, the rise in the price of the point of pension benefit for the future generations offsets their gains in terms of life expectancy. It is then logical to observe rather similar profiles of marginal rates for the 1952 and 1972 generations, except at the beginning of the occupational activity when the contribution rates differ.



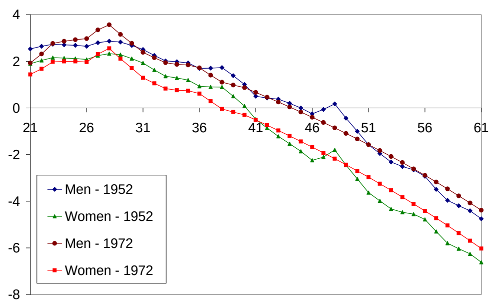
a. CNAV: "25 best years" below the ceiling



b. ARRCO: fraction A



c. ARRCO: fraction B



d. AGIRC: fraction B

Fig. 7 - Comparison men/women for the 1952 and 1972 generations

The comparison of men and women's careers is a rather thorny matter. Here, we estimate only the effects induced by gender differences in life expectancy. For a more realistic assessment of the marginal rates paid by women, it would need to scrutinize the incomplete careers, which generally lead to a later liquidation of pension plans, at the legal age required for a full pension.

4.4 Sensitivity to the contribution length

Regarding the basic pension regime, a mechanism based on penalty, *pro rata* calculation and reward permits to reward (resp. penalize) the careers which are longer (resp. shorter) than the contribution period required to get a full pension. Figures 8 compare three different contribution periods: 4 missing quarters vs. 4 or 8 exceeding quarters, with respect to the required sum of quarters of contribution.

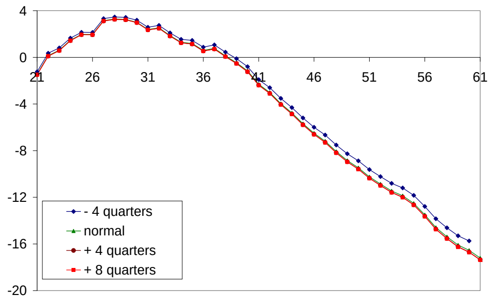
Our computations show that the lengthening of the contribution period (by 4 or 8 quarters) leaves unchanged the time profile of the marginal tax rate for the 25 best wage-earning years under the CNAV ceiling. However, each additional year of contribution increases by one year (only if the corresponding wage earned this very year is also below the ceiling) the period when the marginal rate reaches its maximum, i.e. the contribution rate. A shorter contribution period (minus 4 quarters) induces a penalty combined with a *pro rata* ratio (40/41), which increases the marginal implicit tax rate during the 25 best wage-earning years below the ceiling.

For the supplementary plans, the opposite occurs. The penalty inflicted for too short a contribution period offsets almost all the lengthening of the pension duration. The time profile of the implicit marginal rate is almost unaffected by the penalty. However, the absence of reward implies the marginal rate rises with occupational activity, since the reduction of the pension period is not financially compensated.

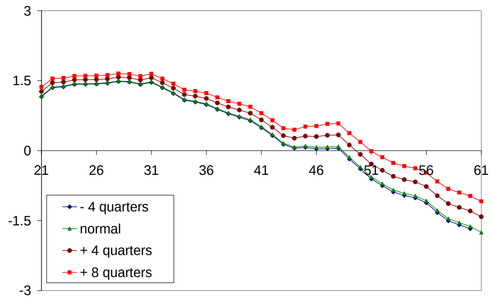
Another scenario for the sensitivity to the insurance period is worth being considered: the case of incomplete careers with a liquidation at the minimum legal age for a full rate pension. Women are more likely to be concerned with this scenario than men. Graph 9a shows the marginal rate induced by the basic pension regime which applies to the 25 best wage-earning years under ceiling for women born in 1952[9]. It compares the rates computed according to four different lengths of contribution periods: 25, 30, 35 and 41 years. See the corresponding profile for men born the same year who have a complete career. We observe that the marginal rates for women are greater the shorter their career. This is due to the fact that, even without penalty at the legal age for a full rate pension, the *pro rata* calculation coefficient is applied, at 25/41 (about 61%) for 25 years of contribution, 30/41 (about 73.2%) for 30 years and 35/41 (about 85.4%) for 35 years. We notice that the marginal rate profile after 41 years of activity (complete career at the legal age for a full rate pension) tends towards the profile for men with a complete career at age 62. But late retirement is penalizing since in that case, marginal rate paid

[9]For the 1952 generation, the eligible age for full rate pension is 65 years and 9 months. The rate calculated for people aged more than 65 then only applies for 9 months.

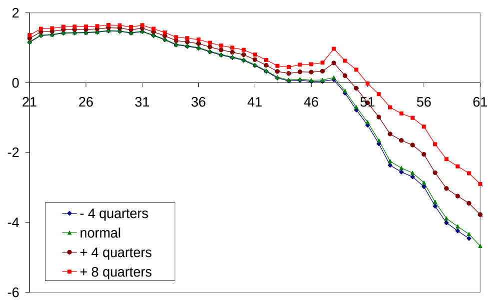
by women is significantly greater than for men in the late years of activity. A retirement delayed three years and 9 months (or 21 quarters) compensates the supplement of life expectancy[10] from which benefit the women with regard to the men and leads to a stronger updating of the future pension.



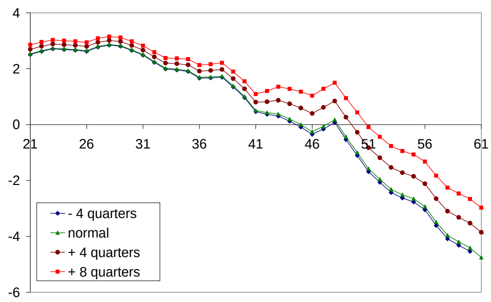
a. CNAV: "25 best years" below the ceiling



b. ARRCO: fraction A



c. ARRCO: fraction B

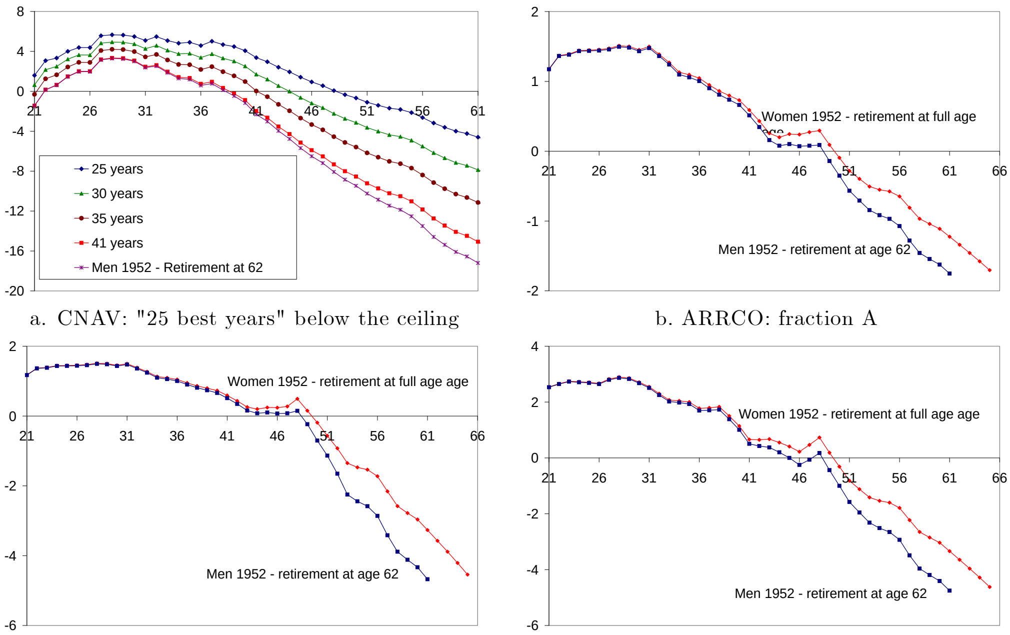


d. AGIRC: fraction B

Fig.8 - Sensitivity to the length of the contribution period
(difference w.r.t. required quarters)

For similar reasons, late retirement leads to a higher marginal tax rate profile for the supplementary plans (Figures 9b, 9c and 9d). We observe a progressive lag of the marginal rates paid by women with respect to those paid by the men. Around age 65, the lag reaches a maximum and the marginal rates paid by the women are roughly identical to those paid by the men aged 61. These results hence moderate those presented previously where a “better” fiscal treatment systematically benefited the women with an identical career as the men.

[10] Using the mortality tables TGH/TGF05, the women’s additional life expectancy with regard to men’s at age 62 is about 3.5 years.



a. CNAV: "25 best years" below the ceiling

b. ARRCO: fraction A

c. ARRCO: fraction B

d. AGIRC: fraction B

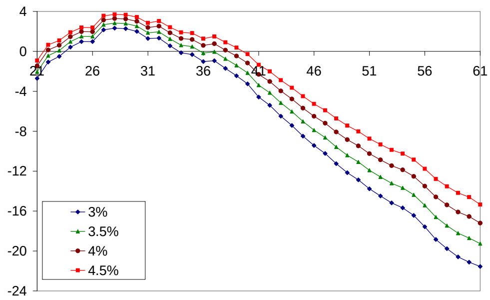
Fig. 9 - Implicit marginal tax rate according to different lengths of the contribution period (women born in 1952 with a pension plan liquidated at 65 years and 9 months)

4.5 Sensitivity to the actualization rate

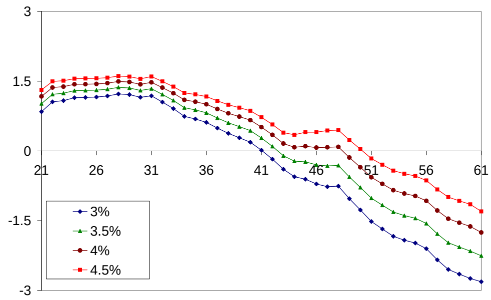
From a prospective point of view, the actualization rate is a crucial hypothesis since it is used to compute the present value of future pensions. The benchmark actualization rate is 4%. We consider three variants: 3%, 3.5% and 4.5%. The following results obtain: (Fig. 10):

- For the basic pension plan, the rate calculated for the 25 best wage-earning years below the ceiling increases with the actualization rate. The range grows with age, to reach about 6 points at the end of the lifecycle.

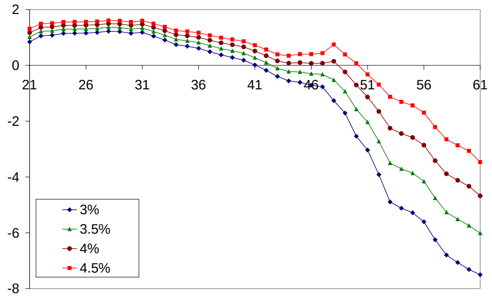
- For the supplementary plans, the marginal rate increases with the actualization rate. The range also grows with age, to reach about 1.5 points for the fraction A of the wage and 4 points for the fraction B.



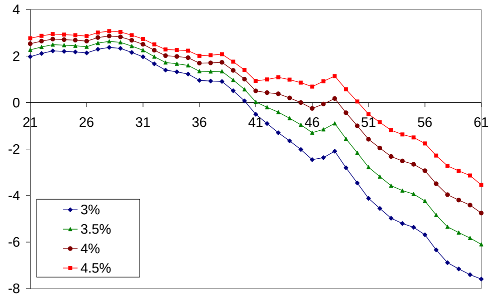
a. CNAV: "25 best years" below the ceiling



b. ARRCO: fraction A

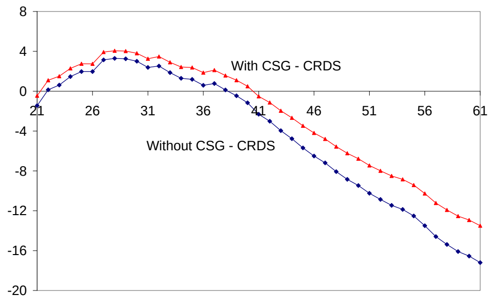


c. ARRCO: fraction B

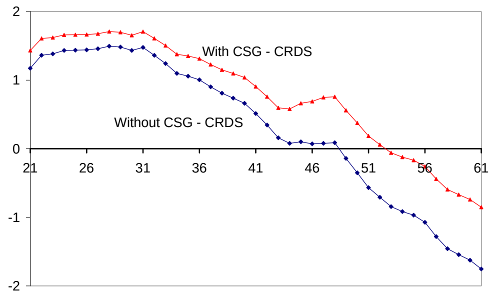


d. AGIRC: fraction B

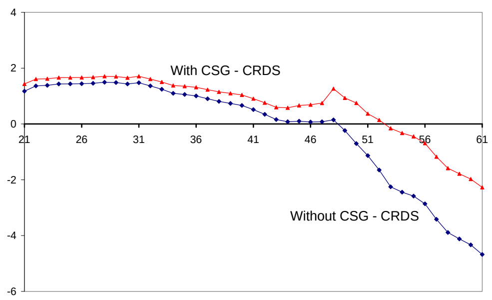
Fig.10 - Sensitivity to the actualization rate



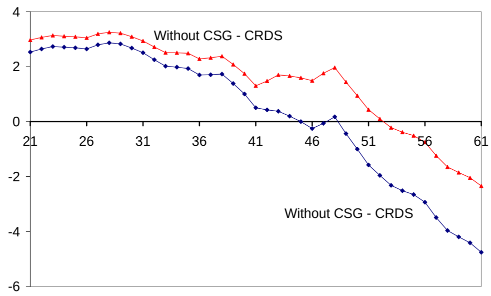
a. CNAV: "25 best years" below the ceiling



b. ARRCO: fraction A



c. ARRCO: fraction B



d. AGIRC: fraction B

Fig.11 - Effect of the tax on pensions

4.6 Measuring the effects of the tax on pensions (CSG-CRDS)

The pension benefit is a gross income. To get a more accurate estimation of the marginal implicit tax rate on wage induced by the pension scheme requires to take into account the CSG-CRDS contributions (6.6%+0.5%) taken from the pension benefit. This has but a little impact on the overall profile of marginal tax rates. (Fig. 11), but the differences in rates increase with age. The rate observed just before retirement is underestimated about 2 points for the basic regime and 1 point for the fraction A of the wage and 1.5 points for the other fractions accounted for by the supplementary plans.

5 Conclusion

This paper estimates the evolution of the marginal implicit pension tax rate with age, from a retrospective and prospective point of view. This marginal rate is estimated for different generations and according to three scenarios about the possible evolution of legislation. Except for one case, the rates computed for the basic regime concern men with a complete career. The gender issue is addressed from the two perspectives of the differences in mortality tables and careers (complete vs incomplete). Although the French pension system share some characteristics with the US one, the marginal rate profiles differ from those presented in the North-American literature. This is due mainly to the computation rule of the US pension benefit, which apply marginal replacement rates that strongly decrease with the average lifecycle wage. This property requires de facto a precise knowledge of the retiree's wage trajectory, which is not the case for the French pension system. The only restriction concerns the basic regime for which the marginal rate expresses conditionally to two conditions about the wage: under/above the CNAV ceiling and in/out of the 25 best wage-earning years.

The defined benefit pension paid by the CNAV induces the strongest fiscal distortion, since it fully taxes – at the margin – the wages under ceiling belonging to the 25 best wage-earning years. The lifecycle profile of the marginal tax rates may then evidence large variations, with edge effects.

The supplementary plans induce a weaker marginal taxation because all the contributions are included in the calculation of pension. However, the fact that the repurchase rate of the point of pension benefit does not depend on age leads to an additional cost for the younger workers and an advantage for the older ones. This property is not fiscally neutral: the range of fluctuations of the marginal tax rates is moderate for the fraction A of the wage and greater for the fraction B, because it is proportional to the contribution rate.

Our calculations clearly evidence that, in France, the pension contributions induce an implicit marginal taxation – less than or equal to the apparent rate – that can be strongly negative or positive. This result forces leads to wonder about (Feldstein and Samwick, 1992) the economic rationales of such variations on the lifecycle. Obviously, a pension system similar to Sweden's, based on the concept of notional account, follows an actuarial rule. The (weaker) fiscal distortion it generates is only due to the gap between the respective returns of pay-as-you go pension scheme (growth rate of the overall payroll) and funded pension scheme (financial rate of return). In France, the study by Bozio and Piketty (2008) supports the adoption of a similar pension system[11], seemingly simpler and clearly contributory, without distortion varying according to age.

However our approach has several limitations. First of all, for the generation born in 1952, the marginal tax rate is partly historical, but our estimation relies on the currently applied legislation, not on that which could prevail and be anticipated/forecast at the time. Workers, much likely, could not have a perfect foresight of the future reforms.

The prospective part relies on numerous assumptions. Our sensitivity analysis would be more accurate if we could use other mortality tables than the TGH/TGF05, which, being too prudential, underestimates future mortality rates. Moreover, differences according to the occupation categories (Blanpain and Chardon, 2011) should be taken into account, by a probabilistic approach of the occupational trajectories.

Our estimations of the marginal rates of the general pension regime depend on random events (wages under ceiling and/or belonging to the 25 wage-earning best years, activity, employment status). Careers could then be studied in a stochastic framework, by simulating many trajectories, to estimate both the expected value of the marginal rate and its distribution according to the simulated individuals' ages and wage histories.

Another way to assess the heterogeneity among individual careers is to rely on samples of historical (Koubi, 2002) or prospective (dynamic microsimulation) career histories. The marginal tax rates could be evaluated according to age and generation, by the way of a distribution. An alternative non stochastic approach of heterogeneity could also be the study of typical-case careers obtained from categorization (Briard, 2007; Koubi, 2004).

Our study focuses on single workers, which restricts the analysis, since

[11] For a rough estimation, see the study by Albert and Oliveau (2009). They develop a dynamic microsimulation model of the transition of the French pension system from an annuity base to a notional account base.

the reversion pensions are not taken into account.

The marginal tax rate of the labor income is a means to assess the contributory nature of a pension contribution. However, for the benefit defined pension schemes, other arguments must be considered, such as the activity duration. It could be useful to estimate the likely present value of the costs and benefits induced by an earlier or later retirement (Hairault et al., 2005).

Finally, we do not consider the interactions of the pension taxes with the other taxes. The impacts of income tax and VAT differ according to age. The marginal rate depends, among other factors, on the average propensity to spend the disposable income, which evolves in the life cycle (Ando and Modigliani, 1957). Also, because incomes decrease at retirement, the marginal income tax rate is weaker. Similarly, during the activity period, the households with children benefit a reduction of their overall income tax, through the family quotients.

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