Allier savoir et décision

2015s-49

Distributional Effects of Social Security Reforms: the Case of France

Raquel Fonseca, Thepthida Sopraseuth

Série Scientifique/Scientific Series

2015s-49

Distributional Effects of Social Security Reforms: the Case of France

Raquel Fonseca, Thepthida Sopraseuth

Série Scientifique
Scientific Series

Montréal
Novembre/November 2015

CIRANO
Allier savoir et décision

Centre interuniversitaire de recherche en analyse des organisations

CIRANO

Le CIRANO est un organisme sans but lucratif constitué en vertu de la Loi des compagnies du Québec. Le financement de son infrastructure et de ses activités de recherche provient des cotisations de ses organisations-membres, d'une subvention d'infrastructure du Ministère de l'Économie, de l'Innovation et des Exportations, de même que des subventions et mandats obtenus par ses équipes de recherche.

CIRANO is a private non-profit organization incorporated under the Québec Companies Act. Its infrastructure and research activities are funded through fees paid by member organizations, an infrastructure grant from the Ministère de l' l'Économie, de l'Innovation et des Exportations, and grants and research mandates obtained by its research teams.

Les partenaires du CIRANO

Partenaires corporatifs
Autorité des marchés financiers
Banque de développement du Canada
Banque du Canada
Banque Laurentienne du Canada
Banque Nationale du Canada
Bell Canada
BMO Groupe financier
Caisse de dépôt et placement du Québec
Fédération des caisses Desjardins du Québec
Financière Sun Life, Québec
Gaz Métro
Hydro-Québec
Industrie Canada
Intact
Investissements PSP
Ministère de l'Économie, de l'Innovation et des Exportations
Ministère des Finances du Québec
Power Corporation du Canada
Rio Tinto
Ville de Montréal

Partenaires universitaires
École Polytechnique de Montréal
École de technologie supérieure (ÉTS)
HEC Montréal
Institut national de la recherche scientifique (INRS)
McGill University
Université Concordia
Université de Montréal
Université de Sherbrooke
Université du Québec
Université du Québec à Montréal
Université Laval

Le CIRANO collabore avec de nombreux centres et chaires de recherche universitaires dont on peut consulter la liste sur son site web.

ISSN 2292-0838 (en ligne)

Distributional Effects of Social Security Reforms: the Case of France*

Raquel Fonseca†, *Thepthida Sopraseuth*‡

Abstract

This paper uses a calibrated dynamic life-cycle model to quantify the long-run distributional impact of two opposite Social Security reforms: modifying the parameters of a defined benefit (DB) plan (such as in France with Ayrault's reform) or switching to a notional defined contribution (NDC) plan (such as in Italy). Both reforms yield an inequal distribution of welfare losses. Low-skilled workers are the main losers of the reforms. This is so for different reasons in each reform. In the case of Ayrault's reform, low-skilled individuals delay retirement by 2 years, up to age 62. In switching to a NDC scheme, low-skilled workers' pensions fall substantially. In NDC schemes, inequalities along the working-life are directly translated into inequalities in pension levels. The switch from a DB plan to the Italian reform yields substantial welfare losses, pensions drastically fall, and individuals save more. Since low-skilled workers do not save as much as middle or high-skilled workers, the switch to NDC schemes leads to a more unequal society in terms of asset distribution.

Résumé

Cet article utilise un modèle de cycle de vie dynamique calibré pour quantifier l'impact distributif à long terme de deux réformes du système de retraite : la première modifie les paramètres d'un système à prestations déterminées (PD) (comme la réforme Ayrault en France). La seconde est fondée que le passage à un système de comptes notionnels à contribution définie (NDC) (comme en Italie). Les deux réformes donnent lieu à une répartition inégale des pertes en bien-être. Les travailleurs peu qualifiés sont les principaux perdants des réforme. Il en est ainsi pour des raisons différentes. Dans le cas de la réforme Ayrault, les individus peu qualifiés retardent la retraite de 2 ans, jusqu'à 62 ans. Dans un système de retraite NDC, les pensions des travailleurs peu qualifiés sont sensiblement réduites. Les inégalités au long de la vie active sont directement traduites en inégalités dans le niveau des pensions. Le passage au régime NDC génère d'importantes pertes de bien-être. Les pensions sont réduites, les individus épargnent davantage. Puisque les travailleurs peu qualifiés n'épargent pas autant que les autres travailleurs, le passage au régime NDC conduit à une société plus inégalitaire en termes de répartition du patrimoine financier.

Mots clés/keywords : Pension reforms, life-cycle heterogeneous-agent model, distributional effects

Codes JEL/JEL Codes : D8, K4, Z13

* We thank David Boisclair, François Langot, Pierre-Carl Michaud, and two anonymous referees for helpful comments. This research was supported by the National Institute on Aging, under grant P01 AG022481. This research is also part of the program of the Industrial Alliance Research Chair on the Economics of Demographic Change. Thepthida Sopraseuth acknowledges the support of the Institut Universitaire de France. Errors are our own.

† Corresponding author. UQAM, CIRANO and RAND. Email : fonseca.raquel@uqam.ca
‡ University of Cergy Pontoise, THEMA and CEPREMAP. Email : thepthida.sopraseuth@u-cergy.fr

1 Introduction

Most OECD countries have adopted reforms over the past two decades to support their *Pay as you go* (PAYG) system which has been jeopardized by population aging. The funding of pension systems is one of the major concerns in view of demographic trends. However, beyond the solvency issue, it is crucial to quantify the distributional effects of Social Security reforms in terms of winners and losers. Some careers are naturally longer than others and some workers expect to live longer after retirement than others. These facts underline that Social Security (hereafter SS) is not only an individual insurance but also a social insurance. By affecting insurance possibilities as well as savings and labor supply, SS reforms redistribute benefits differently within and across generations. Redistributive considerations also help clarify political support for these reforms.

This paper investigates how different pension designs affect redistribution among workers. Faced with aging, some countries, such as France, have manipulated the parameters of their defined benefit (DB) pension plans while others, such as Italy and Sweden, have adopted a drastic approach by switching to a Notional Defined Contribution (NDC) system. France and Italy have thus adopted very different strategies to cope with aging. Our paper aims to assess the redistributive implications of such choices. In order to do so, we choose to focus on the French case and evaluate the consequences of two sets of reforms: first the ones actually implemented in France, and secondly, what would happen if France switched to a more contributive system such as the one implemented in Italy. This switch to an NDC system is indeed the topic of a hot debate in France; for instance, Bozio & Piketty (2008) advocate such a change. In the 2010 pension the law French Senate introduced the mention of a future national debate regarding the adoption of a pension system based on notional accounts. A recent COR (2013) study[1] shows the ways in which French people would report their preferences to preserve the PAYG system. In 2013, their preferences were divided: 30% preferred an increase in the number of years to get the full replacement rate, about 25% would prefer a mandatory delay in retirement age, 25% prefer an increase in the

[1] COR is the acronym for "Conseil d'Orientation des Retraites" that corresponds to a Board of Retirement Guidance.

contribution rate, about 5% prefer a lower replacement rate, and 15% prefer none of these solutions. Another aim of this paper is to understand the insights and the implications of current and potential French pension reforms.

This paper draws on a large literature, focused primarily on the United States, that uses a life cycle framework for the analysis of SS policy reforms (DeNardi et al. (1999),Conesa & Krueger (1999), Huggett & Ventura (1999) among others). The investigation of welfare consequences of the French SS 1990 reforms has been explored by Hénin & Weitzenblum (2005). However, their analysis does not consider the recent French 2013 reforms. Along the lines of Rust & Phelan (1997) , Huggett & Ventura (1999), Fuster et al. (2003) and Hairault et al. (2008), we use a dynamic life-cycle model in which individuals are heterogeneous with respect to age, wealth and labor status. In particular, we build on Hairault et al. (2008)'s model.

Our goal is to analyze the long-run distributional effects of the recent social security reforms in France across different skill groups. Retirement and savings are endogenous decisions made under uncertainty, for example while agents are altruistic (with respect to their offspring) and face financial constraints. The originality of this paper lies in our evaluation of the redistributive effects of policy reforms in steady state after carefully mapping into the model the recent SS reform (Ayrault 2013). Moreover, we evaluate the redistributive effects of the introduction of a *hypothetical* contributive system, such as a notional system similar to the reformed Italian pension system. Both reform sets aim at increasing labor supply by introducing strong incentives to postpone retirement; however, the implications could be different for individuals with a different working life.

Our exercise uses a model with endogenous retirement and wealth that will be able to capture the possible changes in retirement age that French governments are trying to induce through SS reforms. Individuals are heterogeneous with respect to their skill level (low, middle or high), age, employment status and asset holdings. The focus on long-run distributional effects provides a first assessment in order to understand the implications in welfare effects across heterogenous individuals facing different SS reforms, i.e. changing parameters in the defined benefit pension system versus switching to a more contributive one. We analyze

4 scenarios: *i)* The benchmark is a scenario in the economy before the increase in life expectancy and before reforms. The model predictions are then compared to the data for France in the 1990s. The model provides a satisfactory match with the data. *ii)* The benchmark without pension reforms is affected by the increase in life expectancy. The financial sustainability is achieved only through an increase in the contribution rate. We confirm that the model demographic predictions are close to the projections for France in 2040, available in several government reports. The model predicts that, under scenario *ii)*, the economy bears a welfare loss: to cope with the aging of the population, contribution rates increase by a sizable amount. Because of the increased distortionary taxation of labor income, individuals bear a 4% fall in their permanent consumption, relative to scenario *i)*.

In the two subsequent scenarios, we study the impact of a combination of adjustment in the contribution rate and a pension reform, *iii)* being the Ayrault reform and *iv)* a hypothetical NDC system. The welfare consequences of this combination of pension reform and tax rate changes can be ambiguous. Indeed, on the one hand, postponing the retirement eligibility age using *iii)* and reducing retirement benefits using *iv)* results in a significant reduction of the fiscal adjustment required to cope with the aging of the population. We can then expect welfare gains associated with lower adjustment of distortionary taxation of labor income. This supports DeNardi et al. (1999)'s arguement that, as mentioned in Kotlikoff et al. (1999), eliminating the distortion associated with the Social Security payroll tax by linking benefits to contributions raises the welfare of all agents in the economy. Indeed, when a link is established between what an agent contributes to the system and what the agent eventually receives as benefits, much of the labor income tax no longer distorts labor supply decisions. The NDC proposed in the Italian reform can then be welfare improving. On the other hand, *iii)* and *iv)* can also generate welfare losses : *iii)* reduces leisure by postponing the retirement eligibility age, while *iv)* reduces retirement benefits and hence income and consumption at the end of the life-cycle. Our model provides quantitative measures as to which welfare effect dominates. In addition, we provide measures of the distribution of welfare variations across groups in the economy.

Our results are the following: first, both reforms actually yield welfare losses, meaning that the welfare effect of lower adjustment of distortionary taxation of labor income is dominated by the welfare-reducing effects of postponed retirement eligibility age or reduced pensions. Contrary to DeNardi et al. (1999), the switch to NDC (which links benefits to contributions) does not yield substantial welfare gains. The cause of our result lies in the drastic fall in replacement ratios under a NDC system similar to that introduced by the Italian reform in the nineties.[2] The pension system becomes a mandatory savings plan, in which the contributions deliver a low rate of return. Secondly, both reforms yield an inequal distribution of welfare losses in which low-skilled workers are the main losers of the reforms. This is so for different reasons in each reform; in the case of Ayrault's reform, low-skilled workers delay retirement by two years, up to age 62. In the NDC reform, low-skill individuals' pensions fall substantially. In NDC schemes, inequalities along the working-life are directly translated into inequalities in pension reforms. The switch to the Italian reform yields substantial welfare losses: individuals bear a 10% fall in their permanent consumption with respect to scenario *i).* With the switch to NDC, pensions drastically fall and individuals save more. Since low-skilled workers do not save as much as middle or high-skilled workers, the switch to an NDC scheme leads to a more unequal society in terms of asset distribution.

Low-skilled workers are the main losers of all pension reforms. While this qualitative result is quite predictable, our contribution lies in also quantifying the impact of the reforms on asset distribution and retirement choices, as well as the welfare gap between the Ayrault DB's reform and a complete switch to the Italian system. Our results suggest that the switch to a NDC system would actually result in large welfare losses, compared to the current avenue taken by the Ayrault's reform.

The paper is organized as follows: we first present the French pension system and the model in section 2 . We then calibrate the model and check its fit with the data in section 3. We compare the long-run distributional effects of SS reforms across and within skill groups in

[2]Since the fall in replacement ratios plays a major role in the fall of welfare, why not increase the pension? In the Italian pension formula, the pension is directly derived from the amount of contributions during the working life. In order to increase the pension, the policy maker would then need to increase the contribution rate, which could also hurt low skilled workers during their working-life. The contribution rate must also be high enough to bring fiscal revenue, but not too high, as a high contribution rate also means increasing the pension. The notional defined contribution plan makes the choice of the contribution rate a difficult exercise. The model's predictions in section 4 will point to the fact that, under a NDC regime, the financial viability of the PAYG system leads to a moderate contribution rate with low Social security pensions.

section 4. Section 5 concludes.

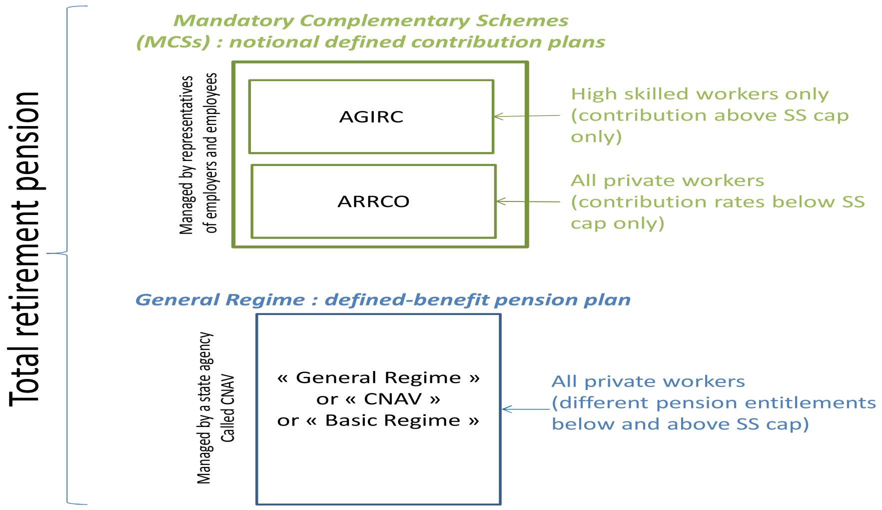
2 Description of the economy

2.1 The French pension system

2.1.1 A 2-pillar system

Our paper focuses on French private-sector workers, where the pension benefit consists of two pillars summarized in Figure 1.

Figure 1: The French private-sector pension system



First, a "General Regime" . This regime is based on defined-benefit pension plans and managed by a State agency (Caisse Nationale d'Assurance Vieillesse, hereafter CNAV). The government can change the pension formula at this level only. Approximately 70 percent of the labor force falls under this so-called "General Regime".[3] The French SS system also

[3]In order to preserve the tractability of the model, we disregard French self-employed individuals and civil servants, who represent 10% and 20% of the labor force respectively. Self-employed and civil servants are characterized by different pension regimes. The earnings process of the self-employed displays more

relies on a second pillar, which consists of the Mandatory Complementary Schemes (MCSs) called AGIRC and ARRCO, organized and managed on an occupational basis. This second pillar is managed by trade unions and representatives of employers. The pension formula is based on notional defined contribution plans.

MCSs provide 40% of retirement pensions for wage earners in the private sector (Blanchet & Pelé (1999)). One might presume that policy reforms such as Ayrault's which alters only the General Regime, affect only 60% of total pension. In order to gauge the empirical relevance of such a claim, we need to carefully map the 2-pillar system into the model.

Both retirement plans are PAYG systems [4], but they rely on different pension formulas and are characterized by separate budgets. We take this point into account in computing the budget balance. We compute three contribution rates separately, one for each scheme of the French pension system (CNAV, ARRCO and AGIRC).

Policy debates focused on how the pattern of CNAV benefits could be modified in order to encourage people to postpone retirement, as in the case of the Ayrault 2013 reform. MCSs would then take into account the changes in normal retirement age in their pension formula, in particular the decrease in pension benefits in cases of retirement before the full pension age (see Appendix A.2).

2.1.2 Pension formulas before reforms (1990s)

Table 1 summarizes the key parameters in the pension formulas. More details are provided in Appendix A.

General Regime (CNAV) Retirees are eligible for a full pension at age 65, or between 60 and 65 if they contributed to the regime for at least 40 years. For people between 60 and 65,

dispersion, and a lower mean than salary/waged workers (Hamilton (2000)) while civil servants do not face any employment risk. In addition, labor market status would have required a more complex modeling, especially for self-employment. Indeed, as suggested by the literature on self-employment (Blau (1987)), self-employed workers actually change occupation to/from wage employment over the life-cycle.

[4] MCSs pay benefits directly out of current contributions. Workers continue to pay for today's pensioners but their contributions are also credited to notional accounts, which have a fixed rate of return. When they retire their pension benefits are based on the notional capital they have accumulated, which is turned into annuities through a formula based on life expectancy at their retirement age.

Table 1: Key parameters in pension formulas

	Balladur (1990s)	Ayrault (2013)	NDC Reform
Age of full pension	65	67	
Early retirement age	60	62	60
Required number of contributive years	40	43	
Downward adjustment	5% per missing year	2.5% per missing year	
Upward adjustment	0	5% per working year	
Social security cap	yes	yes	no

retirement is still possible but with a steep downward adjustment of benefits. In addition, the pension system does not reward any additional year worked beyond the required 40 years of contribution. This yields a strong incentive to work until the age of full pension (whether 65 or earlier if the individual has 40 contributive years) and no incentive to work past that age. Payroll taxes are proportional while Social Security benefits of the General Regime are not tied to contributions. Hence, the Social security system redistributes from agents with high labor earnings to agents with low labor earnings.

MCSs These contributive schemes work with a system of points. During the worker's career, he accumulates points in proportion of his contributions. Each year, a fixed fraction of the wage allows the worker to "purchase" points to MCSs. Upon retirement, the pension equals the total number of points accumulated over the working life. The number of points is converted into euros using a reference value of each point. Contributions on wages below (above) the social security cap are collected by ARRCO (AGIRC). Contribution rates and the value of points during the career and upon retirement are not the same in both schemes. Low-wage workers (below the SS cap) benefit from a lower contribution rate and a higher value of each point upon retirement.

In order to increase their revenue, MCSs can alter several parameters in this formula : make the purchase of points more expensive during the worker's career, lower the reference value of each point when computing the pension, or change the fixed fraction of the wage that allows workers to purchase the points (that is their contribution rates). The latter avenue is explored in this paper. Finally, upon retirement, MCSs apply a downward adjustment on the MCS pension if the worker retires before the required number of contributive years in the General Regime (4% per missing year).

Pension formulas are reported in Appendix A.2. We map these exact pension formulas into the model in order to better capture the effects of pension reforms. In all pension schemes, social security ceiling plays a key role in the computation of the pension computation. First, in the CNAV pension formula, only wages below the social security cap are taken into account in the computation of the average wage (equation (11) in Appendix A.1). Secondly, MCSs apply different contribution rate values of points during the career and upon retirement for wages below and above the social security cap. These elements introduce distributive effects in the computation of the pension formula. This point will be developed in section 4.

2.1.3 Two pension reforms

Ayrault (2013). The pension reform introduced by Jean-Marc Ayrault, the French prime minister, follows a series of pension reforms (by François Fillon 2003 and 2010). In this paper, we evaluate the economic performances of the new pension system as it stands after the latest reform. The CNAV pension formula was altered as follows to induce significant retirement delays: The early retirement age is now 62, rather than 60. Retirees are eligible for a full pension at age 67, or between 62 and 67 if they contributed to the regime for at least 43 years. For people between 62 and 67, retirement is still possible but with a downward adjustment of benefits. The penalty for early retirement is now reduced. The pension system now rewards working years beyond the required 43 years of contribution. Only workers are entitled to this bonus, and individuals who are unemployed or inactive are not enticed to delay retirement. More details in Appendix A.1 and A.2.

NDC reform. What would happen if France were to implement the 1995 Italian reform? We answer this question by considering in the model an early retirement age of 60. In addition, as suggested by Bozio & Piketty (2008), the current two-tier system (General Regime and MCSs) is replaced by a unified system based on notional accounts only, which is reminiscent of the contributive schemes in the MCSs. Under the Italian regime, each year during their working-life, individuals devote a fraction of their earnings to contribute to the pension plan. Each contribution is capitalized at a fixed annual rate of 1.2%. The sum of capitalized contributions is turned into annuities using coefficients of adjustments. These coefficients are taken from the Italian laws (as reported in OECD (2013)). In the model, the contribution rate adjusts to balance the pension budget. The pension formula is reported in Appendix A.3. Again, we map the exact pension formula into the model.

2.2 A life-cycle heterogeneous-agent model with endogenous retirement

Overview of the model This paper uses a life-cycle heterogeneous-agent model with endogenous retirement and endogenous savings. We assume that labor market status consists of employment, non-employment and retirement. Transitions between employment and non employment are stochastic. Agents cannot completely be insured against the idiosyncratic risk of being non-employed.

Beyond the heterogeneity arising from uninsurable shocks to individual employment opportunities, life cycle features are also considered. Each period, some individuals are born and some individuals die. We take into account different age groups and consider stochastic aging along the lines of Castañeda et al. (2003). In addition, individuals face borrowing constraints and cannot hold negative net assets at any time. We introduce wealth accumulation along the same lines as Rust & Phelan (1997) and Hairault et al. (2008). The interest rate will be endogenously determined to equalize demand and supply of financial assets. Moreover, we assume that agents are altruistic with respect to future generations, i.e. they have a bequest motive. Our model does not allow for aggregate uncertainty.

An important feature of the model is the skill structure. We distinguish several ability groups. Mortality risk, employment transitions, life-time earnings, and age at the end of education are specific to each skill category. Hence, the model will be able to predict savings and retirement decisions across and within each skill group by allowing each of these groups to differ substantially in the incentives they face. [5]

[5]We focus on the risks that matter for pensions. In doing so, we follow Fuster (1999) and Fuster et al. (2003) who argue that incorporating altruism, mortality risk and ability shocks is very important in order to obtain differences in induced preferences over the desirability of social security reforms. We take into account these dimensions in our model. In their models, as in ours, an individual receives at birth the realization of

Retirement behavior is endogenous. In order to analyze retirement decisions, we take into account several key features of the retirement process. Pensions depend on life-time earnings which are mechanically linked to non-employment spells during the working life. Transitions on the labor market from employment to non-employment are introduced in order to capture the drastic fall in the employment rate as workers reach older ages. Taking into account the low labor demand for old workers is necessary to measure the implications of any policy aiming at delaying retirement (see Hurd (1996)). Contribution rates will endogenously adjust to balance PAYG pension plans.

A stationary problem In order to define the stationary equilibrium, we divide all variables by the growth rate of technological progress $(1+\gamma)$. We denote stationary consumption, c, and wealth, a, by

$$c = C_t/(1+\gamma)^t \quad \text{and} \quad a = A_t/(1+\gamma)^t$$

whereas the wage, w, and the pension, ω, are denoted in stationary terms by

$$w = W_t/(1+\gamma)^t, \quad \omega = \Omega_t/(1+\gamma)^t$$

2.2.1 Individual risks

We describe in this subsection the three exogenous stochastic shocks that affect individuals in the model: intergenerational skill changes, aging and non-employment risks.

Social mobility : intergenerational skill changes. We distinguish three ability groups (High, Middle and Low, denoted H, M, and L respectively). Skill-level is determined at birth by a random draw. Once born, an individual's skill status is not modified in his lifetime. The ability draw at birth follows a Markov matrix $\Phi(i'|i)$: a newly-born individual's skill status i' is affected by his father's i (see Fuster et al. (2003)). The correlation between the parent's human capital and that of his offspring will be given by an intergenerational ability matrix computed from French data. The risk for an H type agent to have a child

a random ability that determines his lifetime labor ability.

who belongs to a lower ability class will be high. This will provide a strong bequest motive to insure his descendant against this risk.

Life-cycle. Figure 2 summarizes the life-cycle features. An individual's life is divided in two stages. In the first stage, we aim at capturing a typical life-cycle wage profile with three age groups: the young (denoted Y, this period captures the years after first entry on the labor market), the adult (denoted A, the worker accumulates experience) and the older ages (O, to capture the end of the working life). The calibrated wage profile will depend on the age group. As a worker accumulates experience during his life-cycle, we assume that the productivity of the labor input, hence wage, grows with the age of the agent. Following Castañeda et al. (2003) and Ljunqvist & Sargent (2005), agents age stochastically and sequentially during this first stage of life. Individuals face a given probability to move to the next age group. The probability of remaining a young (adult) worker the next period is π_Y (π_A). [6]

In this second stage of the life-cycle, individuals face retirement decisions. With probability equal to $1 - \pi_O$, older individuals reach previous year to the Early Retirement Age (ERA). ERA Is the age at which individuals can start claiming pension benefits.[7] From the ERA onwards, individuals face a probability of dying that is specific to their labor ability.[8] When an individual dies, this agent gives birth to a single child.[9] Individuals belonging to the same dynasty do not overlap. We start the second stage of the life cycle one year prior to the ERA: at age ERA-1, if the agent is alive, the individual chooses to retire next year (at age ERA) or remain in the labor market (whether employed or not). If the agent decides

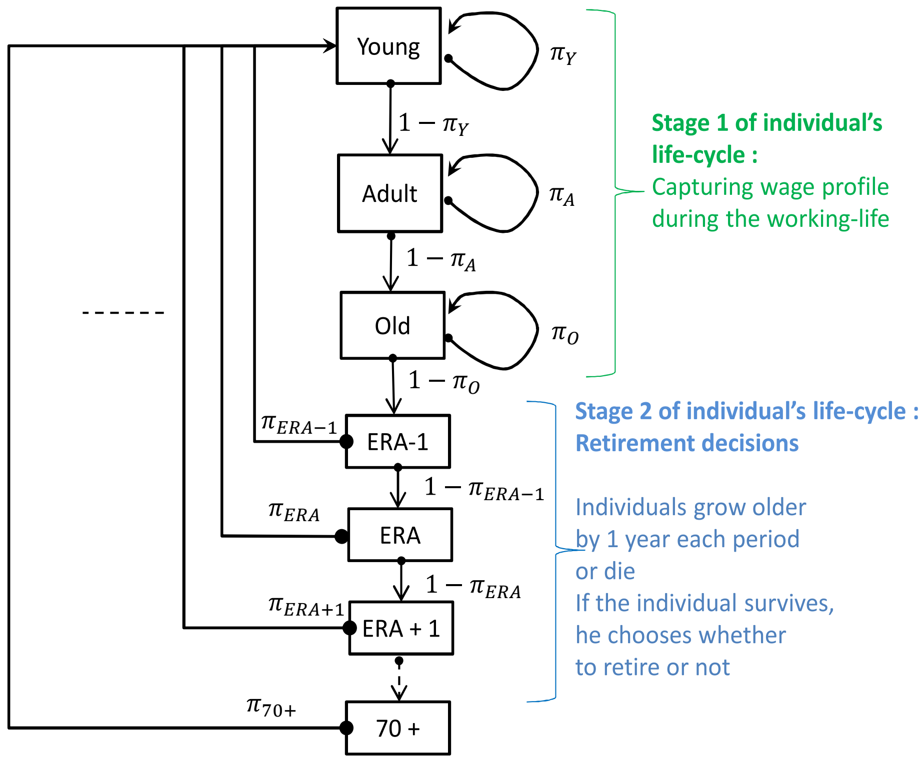
[6] In this first stage of life, we do not assume deterministic aging. Indeed, the stochastic aging reduces the computational burden while allowing to capture the wage-profile along the working-life.

[7] The early retirement age is specific to each reform. In the case of the Ayrault reform, older workers are 55-61 years old, instead of 55-59 in the other scenarios. Also note that workers differ in terms of age at end of education according to their ability. They therefore do not experience the same number of working years before ERA. This translates into different probabilities π_Y across ability. The calibration in Table 9 Appendix C is set accordingly.

[8] In the first stage of life, we ignore death probabilities as in Castañeda et al. (2003)'s model. We want a streamlined model in order to capture the key ingredients for retirement choices. In spite of this simplification, the model fit in terms of retirement choices and financial strain on the PAYG system is satisfactory (section 3).

[9] In all scenarios, the population growth is constant. This assumption is consistent with French data (Aglietta et al. (2002)).

Figure 2: Life-cycle features



ERA: Early Retirement Age (age at which individuals can start claiming pension benefits).

to delay retirement, he remains in the labor force with the same wage as older workers. The agent ages by 1 year with probability $1-\pi_{ERA-1}$, or dies with probability π_{ERA-1} and gives birth to a child. For those who survive, at age ERA, they decide whether or not to retire next year, at age $ERA+1$, and so on, until the age of 70. All agents who have not retired yet at 69 retire at 70. Note that individuals do not necessarily die at age 70; 70+ encompasses individuals 70 years and older. These older individuals simply choose savings and consumption until death. The modeling of the second stage of the life cycle will allow to compute the percentage of individuals who choose retirement for each age, from ERA to 69. This age structure reconciles two requirements: we want a parsimonious modeling of the working-life (in order to reduce the computational burden) while allowing for a detailed analysis of retirement decisions.

Non-employment risk. We want to take into account the non-employment risk that matters for retirement decisions. Thus we take into account non-employment risk for older workers only, ignoring unemployment risk for younger workers.[10] We also discard unemployment risks during the adult stages of working life. This choice is driven by the French data summarized in Blanchet et al. (2007) which shows that the exit rate from employment is very low for prime-age workers in France, for instance much lower than in the United States. Blanchet et al. (2007) point out that the striking feature of the French labor market is the fall in the employment rate of workers aged 55-59. In addition, while the probability of returning to employment from non-employment is still slightly positive at 50, it becomes zero past ages 56 or 57. This very low rate of return to employment sharply contrasts with the US situation where rates of return to employment, though they also decline after 50, remain much larger than in France. Workers aged 55+ have access to specific arrangements of unemployment insurance (including an exemption from seeking employment) until retirement. Introducing this idiosyncratic risk of being unemployed at 55-59 years old is then essential to the understanding of retirement decisions and the implications of any policy aiming at delaying retirement age.

Finally, older non-employed workers also benefit from special programs ("*cessation d'activité anticipée*", also called "pré-retraite", or early withdrawal from the labor market) that allow them to remain non-employed before the ERA (see a description of these programs in Blanchet et al. (2007)). We take into account these specific programs in the model by adding a third labor market status (denoted "P").

We then assume that older individuals face a non-employment shock when aged 55-59, with $\xi = E, U, P$. The individual labor input is set to $l(\xi)$. When non-employed ($\xi = U, P$), the time endowment is devoted to leisure ($l(u) = 0$). Workers receive a non-employment benefit (whether from unemployment or early-withdrawal) until the age of full pension rate. When employed, they inelastically supply l units of labor input ($l(e) = \bar{l}$) at a wage rate w. Consistent with empirical evidence, we will consider that the non-employment states ($\xi = U, P$) are absorbing states until retirement: Once in these programs (unemployment or early-withdrawal), older individuals do not go back to work; they choose to retire as employed or non-employed. As their pension depends on their work history, through the

[10]Even though the unemployment rate is high in France, unemployment risk at younger ages does not after retirement decisions at older ages (see Blanchet et al. (2007)).

average wage, ξ is still a state variable for retirees. As a result, for each retirement age, we will have retired individuals from work $\xi = RE$, unemployment $\xi = RU$ or specific older workers' programs $\xi = RP$.

Employment transitions $P(\xi'|\xi)$ follow a Markov process given by

$$\begin{pmatrix} 1-\pi_U-\pi_P & \pi_U & \pi_P \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{1}$$

where π_U is the probability of an unemployed individual remaining unemployed and π_P is the probability of an early withdrawal from the labor market remaining P and finally, $\pi_E = 1-\pi_U-\pi_P$ is the probability of an employed individual, remaining employed. rows 2 and 3 of matrix (1) are such that labor market status U and P are absorbing states.

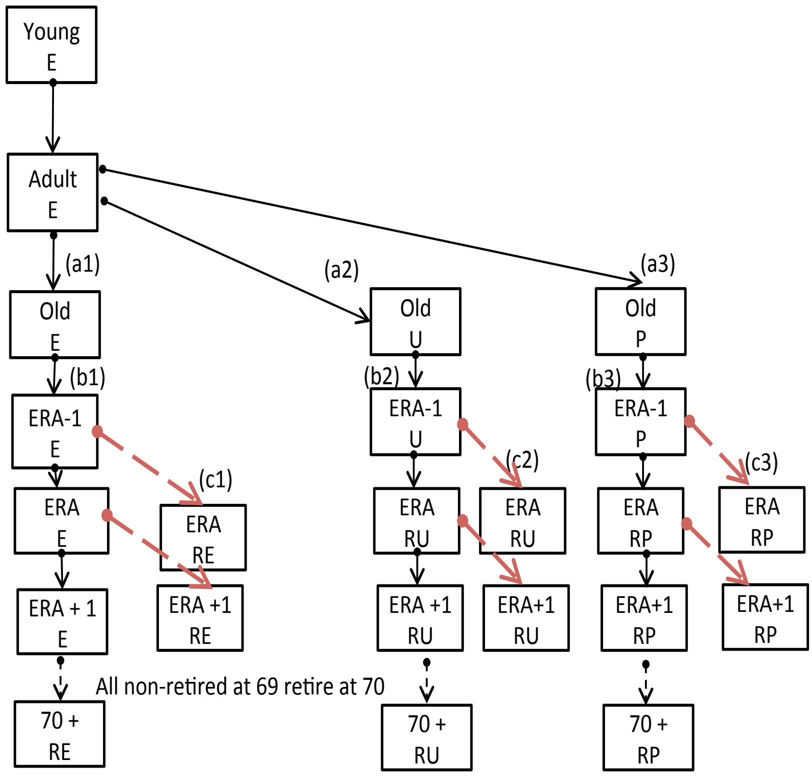
The individual has four state variables: a, the beginning-of-period financial wealth, age ($k = Y, A, O, ERA, ERA-1, ERA+1, ..., 70+$), skill level ($i = L, M, H$) and employment status ($\xi = E, U, P, RE, RU, RP$). Table 2 summarizes the employment status as a function of age and Figure 3 presents the labor market transitions in the model.

Table 2: State variables: for each skill level i

	Labor status ξ	
Age k	not -retired	retired
Y	E	
A	E	
O	E,U,P	
ERA-1	E,U,P	
ERA	E,U,P	RE,RU,RP
ERA+1	E,U,P	RE,RU,RP
⋮	⋮	⋮
69	E,U,P	RE,RU,RP
70+		RE,RU,RP

E: Employed, U: Unemployed, P:Early withdrawal, RE: Retired from work, RU: Retired from unemployment, RP: Retired from early withdrawal programs

Figure 3: Life-cycle and labor market transition



E: employed. U: Unemployed. P: Early withdrawal. RE: Retired from work. RU: Retired from unemployment. RP: Retired from early withdrawal programs. Individuals are born as young employed workers. With probability $1-\pi_Y$, they then become employed adult. (a1) With probability $(1-\pi_A)(1-\pi_U-\pi_R)$, they become older employed individual. (a2) With probability $(1-\pi_A)\pi_U$, they become older unemployed individual. (a3) With probability $(1-\pi_A)\pi_P$, they become older individual in early withdrawal programs. (b1), (b2), (b3) with probability $(1-\pi_O)$, individuals reach the age of $ERA-1$. (c1), (c2) and (c3) with probability $1-\pi_{ERA-1}$, the individual survives and chooses whether or not to retire. With probability π_{ERA-1}, the individual dies and gives birth to a single descendant. Dashed arrows denote the endogenous retirement choice. Notice that once retired, the individual remains a retiree until death. Similarly, once non-employed (whether U or P), individuals do not go back to employment. This is consistent with French data. At age 69, there is no retirement choice. All non-retired individuals at age 69 become retirees at age 70+ if they survive.

2.2.2 Firm and technology

The production technology of the representative firm is given by a constant return to scale Cobb-Douglas function

$$Y = AL^{\alpha}K^{1-\alpha} \tag{2}$$

where $\alpha \in (0,1)$ is the labor's share of output, K and L are aggregate capital and labor inputs, respectively, and $A > 0$ is the total factor productivity. A is assumed to grow at an exogenous and constant rate, and the aggregate capital stock K to depreciate at rate δ.

The profit maximization behavior of the firm gives rise to first-order conditions which determine the net real return to capital,

$$r = (1-\alpha)\, A \left(\frac{L}{K}\right)^{\alpha} - \delta \tag{3}$$

and

$$\overline{w}w(1 + \Theta_f(\overline{w}w)) = \alpha A \left(\frac{L}{K}\right)^{\alpha-1} \tag{4}$$

where $\Theta_f(\overline{w}w))$ is the contribution paid by the firm for the General Regime and MCSs. As can be seen from equation (4), the wage bill is determined by two elements : a wage rate $\overline{w}$ and the workers' wage (w). Workers' wage is calibrated and differs across skill groups and age groups. $\overline{w}$ is the wage rate per efficient labor. This value is endogenously determined because of the endogenous value of the interest rate. After determining the equilibrium r on the financial market, we use equations (3) and (4) to determine $\overline{w}$.

2.2.3 Household

Preference. Individuals derive utility from leisure and consumption, as well as from the consumption of their offspring. As in Huggett & Ventura (1999), we assume that the instantaneous utility function u is a CRRA, where the period utility function u is strictly concave:

$$u(c,l) = \frac{(c^{1-\eta}(1-l)^{\eta})^{1-\tilde{\sigma}}}{1-\tilde{\sigma}}$$

where $\tilde{\sigma}$ is the risk aversion and η the weight of leisure $(1-l)$ in the instantaneous utility. Labor is inelastically supplied by individuals as in Fuster et al. (2003). However, labor participation is endogenous at older ages as individuals choose whether to retire or not. Indeed, we focus on policy reforms aiming at delaying retirement. Retirement age is the core issue in the policy reforms we investigate. Time endowment is normalized to 1.

The utility function is Cobb Douglas, consumption c and leisure l are positive. The reasons for this choice are that this function is compatible with a balanced growth path and the parameters needed for the calibration have been extensively studied in the literature relying on calibration (Auerbach & Kotlikoff (1987), Prescott (1986), Cooley & Prescott (1995), Hansen & Imrogoroglu (1992), Rios Rull (1996), Huggett & Ventura (1999)).

The model has altruistic preferences as in Fuster et al. (2003). Individuals derive utility from their own lifetime consumption and from the *happiness* of their offspring. ϱ is the degree of altruism. The parameter $\varrho > 0$ captures in a simple way the individual's concern for the welfare of his offspring.

Household's budget constraint. Individuals are subject to the budget constraints

$$(1+\gamma)a' = (1+r)a + y(k,i,\xi) - c \tag{5}$$

$$a' \geq 0 \tag{6}$$

where a' is the next period's asset level. $(1+\gamma)$ is the growth rate of technological progress. The individual faces two sources of capital market inefficiency. The first stems from market incompleteness that prevents him from insuring completely against idiosyncratic risks. The second comes from a borrowing constraint: net asset holdings cannot be negative $(a' \geq 0)$. [11]

[11] This assumption precludes the possibility of borrowing. We choose this assumption of tight financial constraint for the sake of simplicity. Indeed, when individuals are allowed to borrow, we need to determine the appropriate borrowing limit. In order to ensure that households are able to reimburse their loan, this

$y(k,i,\xi)$ denotes the labor income net of the contributive tax.

$$y(k,i,\xi) = \begin{cases} \bar{w}w_i^k - \Theta(\bar{w}w_i^k) & \text{if employed } \xi = E \text{ and k=Y,A,...,69} \\ [\bar{w}w_i^k - \Theta(\bar{w}w_i^k)]\theta_i^{k,\xi} & \text{if not employed } \xi = U, P \text{ and } k = O, ERA-1, ...69 \\ \omega_i^{k\xi} & \text{if retired } \xi = RE, RU, RP \text{ and } k = ERA, ..., 70+ \end{cases}$$

Individual wages consist of the endogenous aggregate real wage rate per effective labor $\overline{w}$ times w_i^k the calibrated individual wage profile of age k and ability i. When employed, labor income is $\overline{w}w_i^k$ net of $\Theta(\bar{w}w_i^k)$ contributive taxes. Only the share of contributive taxes paid by employees are introduced in the individual's budget constraint. If non employed, a fraction of wages is paid as non-employment benefits. $\theta_i^{k,\xi}$ denotes the replacement ratio associated with non-employment benefits ($\theta_i^{k,U}$ refers to unemployment benefit, $\theta_i^{k,P}$ refers to benefits for early withdrawals) at age k and skill level i. $\omega_i^{k\xi}$, with $\xi = RE, RU, RP$, denotes the pension of an individual who retires at age k and skill level i after being previously E (employed) or non-employed (whether U or P). In the model, pension benefits $\omega_i^{k\xi}$ are computed with French Social Security formulas and a NDC system as described in section 2.1.

Optimization problem in the first stage of the life-cycle $k = Y, A, O$: optimal asset accumulation in a life-cycle setting The discount rate is set in order to be compatible with the utility choice, that is $\tilde{\beta} = \beta^{(1-\eta)(1-\tilde{\sigma})}$. Individuals maximize their optimal consumption path that solves the following value functions subject to equations (5) and (6). The value function of workers at age $k = Y, A$ is

$$V(a,k,i,E) \quad = \quad \max_{c \geq 0,\ a'} u(c,l) + \tilde{\beta}\left[\pi_k V(a',k,i,E) + (1-\pi_k)V(a',k+1,i,E)\right]$$

maximum amount of borrowed money undoubtedly depends on future income flows and value of current assets. Aiyagari (1994) proposes a borrowing limit set at the worst possible outcomes in terms of income flows. In models of financial accelerator (Bernanke et al. (1999)) or entrepreneurship (Cagetti & De Nardi (2006)), the borrowing limit is an endogenous fraction of assets. The question of the endogeneity of the borrowing limit and how it relates to retirement decisions is left for future research. In addition, this restrictive hypothesis of very tight financial constraint still allows the model to replicate the wealth distribution observed in the data, especially at the bottom of the distribution.

At age $k = O$, individuals face the non-employment risk. For $k = O$ and $\xi = E$

$$V(a, O, i, E) \quad = \quad \max_{c \geq 0,\ a'} u(c, l) + \tilde{\beta} \begin{bmatrix} \pi_O V(a', k, i, E) \\ +(1 - \pi_O) P(\xi'|\xi) V(a', ERA - 1, i, \xi') \end{bmatrix}$$

And for $k = O$ and $\xi = U, P$:

$$V(a, O, i, \xi) \quad = \quad \max_{c \geq 0,\ a'} u(c, l) + \tilde{\beta} \left[\pi_O V(a', ERA - 1, i, \xi) + (1 - \pi_O) V(a', ERA - 1, i, \xi) \right]$$

Optimization problem in the second stage of the life-cycle : mortality risk, intergenerational skill change, retirement and saving decisions From the age of $ERA-1$ onwards, individuals face mortality risk as shown on Figure 2.

For ages $k = \{ERA - 1, ERA, ..., 68\}$: savings and retirement choices.

From the age of $ERA - 1$ onwards, individuals have the legal right to claim a pension the following year. We adjust ERA depending on the reform or scenario (see Table 1). Each individual compares the future value of being retired next year to the future value of remaining on the labor market next year, given the probability of death $(1 - \pi_k^i)$.

When older, individuals observe their employment status $\xi = E$ (employed), U (unemployed) or P (early withdrawal). As current income, pension benefits and labor market shocks depend on the current labor market status prior to retirement, value function is different for individuals with a different labor market status.

We report below the choice faced by employed workers $\xi = E$ of age k and skill i. Value function maximization is subject to equations (5) and (6).

$$V(a, k, i, E) \quad = \quad \max_{c \geq 0,\ a'} u(c, l) + \tilde{\beta} \begin{bmatrix} \pi_k^i \Phi(i'|i) \varrho V(a', Y, i', E) \\ +(1 - \pi_k^i) Max\,(\ V(a', k + 1, i, E), V(a', k + 1, i, RE)\ ) \end{bmatrix}$$

Let us denote $\Psi(a,k,i,\xi)$ the optimal retirement choice for $k = ERA, ..., 68$

$$\Psi(a,k,i,\xi) = \begin{cases} 1 & \text{if} \qquad V(a,k,i,\xi) \geq V(a,k,i,\xi') \text{ delayed retirement} \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

where $\xi = E, U, P$ and $\xi' = RE, RU, RP$. For ages k, without retirement choices, let us define $\Psi(a,k,i,E) = 1$ for employed individuals and $\Psi(a,k,i,U) = 0, \Psi(a,k,i,P) = 0$. $\Psi(a,k,i,\xi)$ will be useful to compute the aggregate labor supply (see section 2.2.4).

Individuals can die with probability π_k^i, in which case a new young individual is born with a skill group which is determined by the mobility matrix $\Phi(i'|i)$. ϱ is the degree of altruism. Following Castañeda et al. (2003), at the beginning of the first period of life, the young individual inherits the estate of his deceased father. Conditional on being alive (with probability $1-\pi_k^i$), workers age by 1 year (hence the $k+1$ in the future state) and choose whether to retire or not. Retirement choice is captured by the max operand in the future values of employed $V(a',k+1,i,E)$ and retired individual $V(a',k+1,i,RE)$. The rest of the value functions maximization are in Appendix B.

In the model, once individuals are retired, they remain retired. This is consistent with French data. There does not appear to be important un-retirement flows as in the U.S. (Gruber & Wise (1999)). Retirees receive a pension that is the sum of the public SS pension and benefits paid by mandatory complementary schemes. The only choice faced by a retiree is his consumption profile and the optimal amount of financial assets he wants to give to his child, according to the stochastic intergenerational expected changes in ability.

For ages $k = \{69, 70+\}$: savings. At age 69, individuals can only retire in the age group 70+. They do not make any retirement choice. Their future value function is only retirement. The future of agents of 70+ is remaining in their current state if they survive or give birth to a single child if they die. Their optimal choice is on a' and c, given their death probability.

2.2.4 Steady State Equilibrium

Given the Social Security system, a stationary equilibrium [12] consists of individuals' choices for consumption, savings and retirement $c(a,k,i,\xi), a'(a,k,i,\xi), \Psi(a,k,i,\xi)$, value functions $V(a,k,i,\xi)$, a stationary distribution of individuals $\lambda(a,k,i,\xi)$, prices of labor and capital $\overline{w}$, r and a set of contributive taxes of retirement schemes $\tau_{cnav}, \tau_{arrco}, \tau_{agirc}$ such that

(a.) Given social security, prices, and contribution taxes, agents' decision rules on consumption, savings and retirement $c(a,k,i,\xi), a'(a,k,i,\xi), \Psi(a,k,i,\xi)$ solve households' decision problem in section 2.2.3.

(b.) Aggregation holds.

$$K = \sum_{a,k,i,\xi} \lambda(a,k,i,\xi) a'(a,k,i,\xi) \tag{8}$$

$$L = \sum_{a,k,i,\xi=E} \lambda(a,k,i,\xi) \Psi(a,k,i,\xi) \bar{l} \tag{9}$$

where $\Psi(a,k,i,\xi)$ is defined in equation (7).

(c.) Factor prices ($\overline{w}$ and r) are competitive, i.e., equations (3) and (4) hold.

(d.) The real interest rate r endogenously always adjusts to equalize supply of (from households' assets, equation (8)) and demand for (from firms, equation (3)) capital.

(e.) Using equations (3) and (4), with r determined in step *(d.)*, $\overline{w}$ is determined.

(f.) The social security contribution rates (τ_{cnav}, τ_{arrco} and τ_{agirc}) are such that the budgets of the social security are balanced separately. Three contribution rates are then determined endogenously. For each pension scheme (CNAV, ARRCO and AGIRC), fiscal revenues are

$$T = \sum_{a,k,i,\xi=E} \lambda(a,k,i,\xi) \Psi(a,k,i,\xi) [\Theta_f(\overline{w} w_i^k) + \Theta(\overline{w} w_i^k)]$$

[12] For computational reasons, we are discarding transitional dynamics as in Huggett & Ventura (1999) and Fuster et al. (2003). We have 213 agent-types with different age, ability levels and labor status and endogenous retirement. We focus on the impact of reforms after the transition is over, which allows to identify long run welfare consequences of the reforms. The investigation of transitional dynamics is interesting but left for future research.

Expenditures are

$$X = \sum_{a,k,i,\xi=RE,RU,RP} \lambda(a,k,i,\xi)(1-\Psi(a,k,i,\xi))\omega_i^{k\xi}$$

For each pension scheme, contributions Θ_f and Θ depend on a contribution rate τ [13] that adjusts endogenously to equalize current revenues T to current expenditures X. When France hypothetically switches to a unique NDC system, we determine only one contribution rate.

(g.) the endogenous probability distribution $\lambda(a,k,i,\xi)$ is the stationary distribution associated with $a'(a,k,i,\xi)$ and $\Lambda(s'|s)$ follows a Markov process (capturing individual shocks on age k, ability i, and employment ξ) where $s = k, i, \xi$, such that:

$$\lambda(a', s') = \sum_{a,s} \Lambda(s'|s)\lambda(a,s)$$

We implement numerical techniques based on a discretization of state variables (Ljungqvist & Sargent (2000)).

3 Calibration and model fit

The model period is a year. In order to check the empirical relevance of our model, we compare its predictions with the French data prior to the increase in retirement ages and prior to pension reforms. As a result, our benchmark calibration relies on data from the 1990s. The calibration focuses on men.[14] Our aim is not to reproduce exact population patterns but simply to adjust to the stylized facts of the French economy. Rather than relying on calibrated replacement rates, we compute pensions based on DB pension formulas

[13] In Appendix A.2 is shown that in the French pension system, Θ_f and Θ are non-linear functions of τ. This non-linearity is taken into account in the model.

[14] Adding women would have required a complex modeling because of several female specific elements in retirement decisions, such as endogenous fertility and the way child rearing should be taken into account in the pension formula. Women are characterized by a lower wage profile over the life-cycle and higher non-employment rates than their male counterparts. The model could thus be interpreted as an optimistic scenario in an economy where everybody behaves like men in terms of labor decisions.

applied by the Social Security rules. Given that retirement and wealth are endogenous in the model, we can better capture the different profiles for heterogenous workers.

3.1 Individual uncertainty

3.1.1 Skills

We use occupations to create "skill" groups. We retain three broad categories: low-skilled workers, middle-skilled workers and high-skilled workers. More details are in Appendix C.

The correlation between the parents' human capital and that of his offspring is given by the social mobility matrix Φ computed from the 1993 Labor Force Survey (see Table 7, Appendix C). The probability for an H-type agent of having a child who belongs to a lower ability class is superior to 50%. This will provide a strong bequest motive to insure his descendant against this risk.

We can compute the stationary distribution of skills from the social transition matrix.[15] 55.9% of individuals in the economy are L-type workers, 25.79% are M-type workers, and 18.31% are H-type workers. This is consistent with the aggregate skill distribution from the French LFS in the 1990s.

3.1.2 Demographics

In the first-stage of the life-cycle We study three stages of the working life (youth, adult and older). We suppose that individuals are born as young workers when they enter the labor market. The age at the beginning of the working life is 22.2, 19.5, and 17.4 years old for H, M and L-type workers respectively (Colin et al. (2000)). As a proxy, we use the age of the end of education. Since the French pension formula depends on the number of contributive years during the working-life, the age at first job affects the amount of pension benefits, and hence retirement choices.

[15] The number of agents born in each skill group in period t only depends on the number of fathers in each skill group in period $t-1$. We can iterate some ten to twenty times over $\Phi(i'|i)$ for any given skill distribution. The skill distribution converges to the invariant distribution of a simple 3-state Markov-chain.

Young workers are individuals who are between the beginning of their working life and age 34. The number of expected years as a young worker is then 34 minus the skill-specific age of entry. The adult group encompasses agents aged 35 to 54. Older workers' age lies between 55 until a year prior to the second life stage,i.e., age $ERA - 2$. During this period, before being eligible for SS benefits, they face a non-employment risk. The life-cycle transition probabilities are reported in Table 8, Appendix C.

In the second stage of the life cycle From ERA onwards, individuals face a death probability. This probability depends on the labor ability of the worker. As shown in Figure 2, we need to calibrate death probability at each age between ERA and 70. It would be possible if we had life expectancy, at each age between ERA and 70 for each skill group, which we could not find. However, we use the information on life expectancy at age 60 and 65, for the three skill groups, and use inter/intrapolation to get values for each age in the model. Life expectancy at 60 years old equals 24.4, 20.7, and 18.6 years for H, M, and L type individuals respectively (Charpin (1999)). Blanchet & Monfort (1996) provide figures for life expectancy at age 65 but only for men. This allows us to compute death probabilities between 60 and 65. Death probabilities (Table 9, Appendix C) display an exponential pattern that is consistent with INSEE (1996). We check that the mortality profiles computed for each skill group is consistent with the aggregate mortality reported in Charpin (1999). Death probabilities increase with age and are lower when individuals have more skills. In the new steady state that we examine, life expectancy increases by 6 years at age 60 (COR (2001)). We assume that all skill levels benefit evenly from the higher life expectancy.[16]

[16] In the calibration, we adopt an optimistic approach by allowing low-skill workers to enjoy the same increase in life expectancy as other workers. We show that, in spite of this favourable scenario for low-skill workers, they are the main losers of the reforms. Their welfare remains far below that of their counterparts. If we had used heterogeneous changes in life expectancy across skill-groups, our results would have been even more detrimental to low skill workers.

3.1.3 Non-employment risks

Let θ^U (θ^P respectively) be the replacement ratio associated with French unemployment benefits (for programs specific to older workers). The replacement ratios are computed from the French LFS as averages within each skill level.

π_U refers to the probability of transition each year from employment to unemployment in matrix (1). π_P denotes the probability of transition each year from employment to old workers' specific programs. The annual transition rate from employment to non-employment is set such that the model replicates the employment and unemployment rates of male individuals aged 55-58 for each ability class (computed from the French Employment Survey in 1993). In particular, blue collars and clerks (L-type workers) face a higher risk of non-employment than white collars (M-type workers) (Table 10, Appendix C).

3.2 Calibrating life time careers and pension system

3.2.1 Wage profile

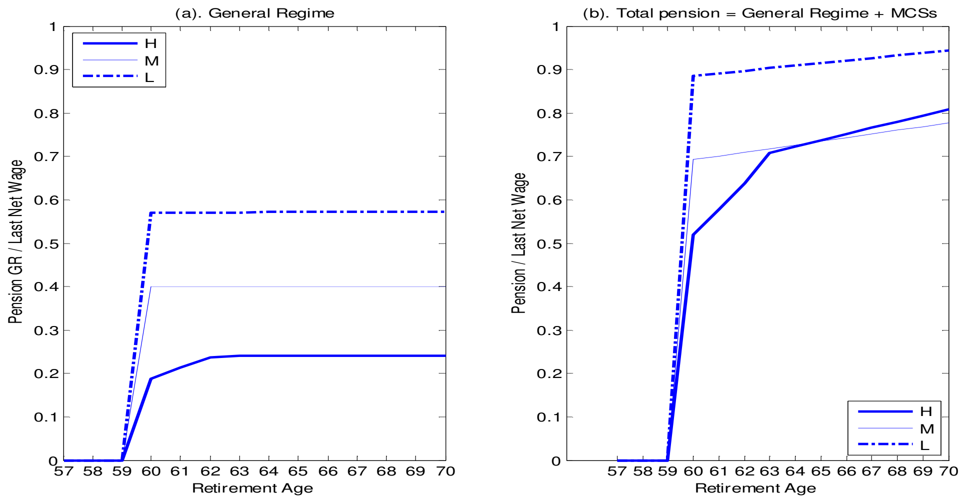
Using INSEE (1999), we calibrate wages across age groups and skill levels. The data from INSEE (1999) is aggregated in order to fit our age structure. Note that, due to experience, wage profiles are upward sloping with age. We calibrate values after taking into account the normalization to one of the young low-skill annual worker's wage[17] (see Table 11 Appendix C). Between the first two periods of life, the wage growth factor is 1.24 for low ability individuals, 1.33 (= 1.86/1.4) for middle ability agents and 1.52(=3.25/2.14) for high ability workers. Between the first and third periods of life, wage growth equals 1.26 for individuals in the low-skilled group, 1.6 for the middle-skilled group and 1.83 for the high-skilled group. In contrast to low-skilled type workers, high and middle ability workers are characterized by a steeper wage profile when older.

[17] All variables in the paper will be then expressed in terms of this wage.

3.2.2 Social Security

Rather than relying on calibrated replacement rates, the computation of pensions is based on real-life formulas. There are three key parameters in the SS system: the reference wage, the pension rate, and the number of contributive years. Three payroll taxes are determined at the general equilibrium to balance the three separate budgets. The share of contribution rate paid by employers is 60% agaist 40% for workers, which pins down $\Theta_f(.)$ in the firm's labor cost (equation (4)) and $\Theta(.)$ in $y(k, i, \xi)$ in households' budget constraint (equation (5)).

Figure 4: Replacement ratios before pension reform for employed workers



H : High-ability. M: Middle-ability. L: Low-ability

Figure 4 illustrates the replacement rates, as they are predicted by the model under the benchmark economy, before the pension reforms, for employed individuals. Panel (a) reports the replacement ratio for the first pillar of the pension system (the General Regime). Consistent with the data (Drees (2012)), L-type workers are characterized by the highest replacement ratios. Indeed, the presence of the SS cap in the CNAV pension formula (equation 11 in Appendix A.1) limits the replacement ratio for H-type workers whose wages are higher than the SS cap.

Let us now have a look at the age at which retirees are eligible for a full pension. H-type workers (M- and L-type workers, respectively) reach the required number of contributive years at age 63 (60 and 58, respectively). However, the early retirement age is fixed at 60 years old in France in the 1990s. This means that it constitutes a binding constraint for low-ability individuals who have to wait until 60 before retiring. As there are no pension adjustments after the full rate age in the General Regime (Figure 4, panel (a)), for L-type but also for M-type workers, the SS pension of the General Regime is completely flat after the full pension age. There is no increase in pension in the case of delayed retirement beyond the full pension age for the General Regime. H-type workers bear a steep decrease in pension if they retire before the full rate reached at age 63, and if they want to postpone retirement beyond 63, they would get no increase in pension.

We display in panel (b) on Figure 4 replacement ratios for the total pension (including MCSs). Since MCSs are based on notional defined contribution plans, delaying retirement increases the pension. In addition, retiring before the full pension leads to a steeper fall in replacement ratios as MCSs add a downward adjustment in case of early retirement. The kinked profile of replacement ratios in Figure 4 suggests that individuals have little choice in terms of retirement age. For instance, H-type workers have no incentive to claim benefits before 63 (for fear of a dramatic fall in pension) and little incentive to retire beyond this age (because the increase in pension is low). The Ayrault reform aims at dampening the kinks in the profile of replacement ratios by lowering the penalty in case of early retirement and increasing the reward in case of delayed retirement. The model will predict whether individuals will be responsive to these new incentives.[18]

3.3 Preferences and technology

Following Charpin's (1999) report and OECD (2000), the technological trend is set to 2% a year in the case of France. Labor's share of output α is set to 0.64 and the depreciation rate δ is 10% as in Hairault et al. (2008). The discount factor is set to 0.96. Such a parameter value makes the model consistent with observed real interest rate and capital-output ratio (see section 3.4.1). We set $\tilde{\sigma} = 2$, which is consistent with Attanasio et al. (1999) and Fuster et al. (2003). Assuming that 8 hours per 24-hour day are devoted to labor, we get $1-l = 2/3$.

[18] For non-employed individuals, whether unemployed or in early withdrawals, the replacement ratio displays the same profile as in Figure 4, except that pension formulas do not reward delayed retirement.

The unemployed and retirees enjoy full time leisure ($l = 1$).

In the benchmark calibration, the altruism parameter is set to $\varrho = 0.9$ in order to replicate the ratio of annual flows of intergenerational transfers (defined as the sum of unintended transfers plus bequests) to aggregate wealth. This ratio amounts to 2.3% (Arrondel & Laferrère (1991); Arrondel & Laferrere (2001); INSEE (1997); INSEE (1998)). With $\varrho = 0$, the ratio of annual flows of intergenerational (unintended) transfers to aggregate financial wealth falls down to 1.1%, which is half its empirical counterpart. The ratio of bequests to aggregate wealth is sensitive enough to the altruism parameter to be confident in the calibrated value. In Appendix D we report the model's predictions in an economy without altruism ($\varrho = 0$).

In order to pin down the value of leisure η, Hairault et al. (2008) estimate the parameter such that the model replicates the fact that 95% of male individuals retire with the full pension rate. Such a calibration also allows to match the elasticity of retirement response to the pension reforms prior to 1993 (Blanchet & Pelé (1999), Dress (2003)). The distribution of retirement age prior to reform captures this feature in the model (Figure 5).

This estimation procedure leads to $\eta = 0.62$ for France, which is close to the value of 0.77 in Huggett & Ventura (1999) on U.S. data with similar preferences. We assume that the leisure parameter is similar across skill groups. Hence, differences in retirement behavior across skill groups will not be generated by differences in preferences. Table 12 in Appendix C summarizes the calibration.

3.4 Model fit

The model's predictions and data are reported in Table 3. In this section, we compare column A (French Data in the 1990s) to column B (Economy in the 1990s). Scenario B will also be referred to as the "benchmark".

Table 3: Data and model's predictions

		Data	**1990s**	**2040**	**Ayrault**	**Italy**
		A	B	C	D	E
Macroeconomic performances						
1.	Interest rate (in %)	5	4.98	4.78	4.75	4.55
2.	K/Y	2.40	2.40	2.44	2.44	2.47
3.	C/Y	0.51	0.51	0.53	0.53	0.51
Pension						
	Increase in life expectancy		no	yes	yes	yes
4.	Dependency ratio 1990	0.44	0.4485			
5.	Dependency ratio 2040	0.64		0.640	0.50	0.58
	Contribution rate (a)					
6.	Contribution rate High		0.16	0.23	0.19	0.12
7.	Contribution rate Middle		0.13	0.18	0.15	0.12
8.	Contribution rate Low		0.11	0.17	0.14	0.12
Inequalities						
9.	Gini assets	0.73	0.75	0.74	0.75	0.81
10.	% of Constrained agents: Total	0.22	0.25 (b)	0.23	0.25	0.37
10.i.	% of Constrained agents: High		0.0577(c)	0.0483	0.0573	0.1885
10.ii.	% of Constrained agents: Middle		0.3454	0.3316	0.3393	0.1312
10.iii.	% of Constrained agents: Low		0.4670	0.4381	0.4363	66.13
11.	Bequest-to-total-asset ratio	0.0234	0.0234	0.0207	0.0210	0.0198
12.	Average bequest High		2.16 (d)	1.37	2.46	5.46
13.	Average bequest Middle		0.52	0.32	1.06	1.76
14.	Average bequest Low		0.21	0.12	0.23	0.10
15.	Gini income	0.28	0.29	0.29	0.30	0.33
16.	Gini consumption	0.25 - 0.30	0.25	0.24	0.25	0.28
Welfare: percentage change in permanent consumption with respect to economy B						
17.	High			-4.55 (e)	-0.42	-4.10
18.	Middle			-3.70	-0.86	-8.35
19.	Low			-3.94	-1.74	-10.38
20.	Total			-3.95	-1.51	-9.64

(a) Contribution rate of prime-age workers defined as sum of employee's contributions (CNAV, ARRCO, AGIRC) divided by gross wage. (b) 25% of agents in the economy with zero assets. (c) Among H-type workers, 5.77% have zero assets. (d) The average bequest of a H-type individual is 2.16 times the annual wage of a young L-type worker.(e) High-skilled individuals in scenario C bear a 4.55% fall of their life-time consumption compared with scenario B.

3.4.1 Macroeconomic performances

The model is able to match the capital to output ratio as well as the consumption to output ratio. The equilibrium interest rate that equalizes asset supply to capital demand is 4.98%, which is very close to the average real French interest rate of 5%.[19]

3.4.2 Pension: Distribution of retirement age, dependency ratio and contribution rates

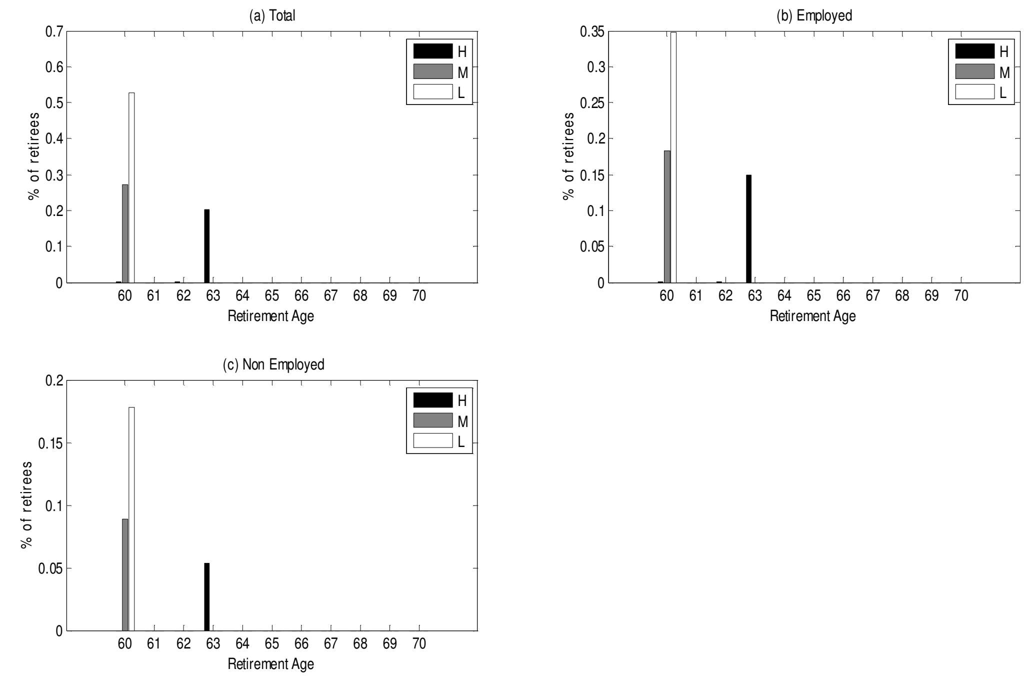
Figure 5 displays the predicted distribution of retirement age. Consistent with our comments on replacement ratios (section 3.2.2), all individuals retire when they reach the age of full pension (63 for H-type workers, 60 for other workers). This model prediction echoes the fact that, in the 1990s, 95% of male retirees had indeed accumulated the required number of contributive years (Dress (2003)). The value of leisure η was calibrated to match this salient feature of retirement choices in France, prior to reforms. Since we disregard heterogeneity in the length of contributing years at the same age within each labor ability class, health status, specific female participation, and incomplete careers, the model cannot capture the complete distribution of retirement ages. However, we replicate the stylized fact that agents mostly retire as soon as the full rate is available.

The dependency ratio (defined as the number of retirees divided by the number of individuals in the labor force (employed and non employed)) equals 44.85% in the model (Table 3, row 4, column B), which is close to the 44% observed in France in the 1990s (Belhaj (2004); Charpin (1999)) .

The model determines three payroll taxes, one for each pension budget (CNAV, ARRCO, AGIRC). We check that the benchmark model (B) yields endogenous contribution rates that are consistent with observed levels. The workers' equilibrium contribution rate to the General Regime equals 8.35% versus 6.55% in the data (as reported in Charpin (1999)). For

[19] The capital-output ratio is 2.6 in Caballaro & Hammour (1999) and 2.2 in Villa (1995). Moreover, 2.4 corresponds to the ratio we found using Vikram & Dhareshwar (1995)'s data on the French physical capital stock in the post-1955 period. The consumption to output ratio is computed from OECD annual National Accounts, for the 1990-2014 period. The average real interest rate is defined as the difference between the long-term interest rate and the CPI (all items) inflation, both time series extracted from OECD Key short term economic indicators database, annual data for the 1990-2014 period.

Figure 5: Retirement age before pension reform



H: H-type, M: M-type, L: L-type Non-employed = Unemployed + Early withdrawal

complementary schemes, the equilibrium rates paid by workers are, respectively, 3.32% (and 8.30% AGIRC) in the model versus 3% (and 8% AGIRC) in the data. Because of the social security cap in the collection of contributions (see Appendix A.1 and A.2), the profile of contribution rates is non-linear in earnings. In all model simulations in Table 3, we actually compute three payroll taxes for the three separate pension plans. For the sake of brevity, we only report in Table 3 (rows 6-8) a contribution rate defined as the sum of employee's contribution divided by the gross wage for prime-age workers.

The model is reasonably close to the data with respect to the dependency ratio and the contribution rates in the benchmark economy, which suggests that the model can be considered a good proxy to capture the age structure, retirement patterns and resulting strains on PAYG budgets.

3.4.3 Wealth and consumption distribution

Data on wealth distribution in France in the 1990s is reported in column A of Table 3, rows 9-15. The Gini coefficient on wealth is based on computation from the 1998 French Wealth Survey (Enquête Patrimoine). The fraction of liquidity-constrained agents (with zero-asset) in the French economy is taken from Arrondel (2002). The Gini coefficient on income in the 1990s is 0.276 from OECD (2015). The altruism parameter η is calibrated to match the ratio of annual flows of intergenerational transfers to aggregate wealth of 2.34% found in Arrondel & Laferrère (1991) and Arrondel & Laferrere (2001), so that there is little surprise that the model fits along this dimension (row 11). The model fits the other dimensions well (column B of Table 3, rows 9-10 and 15).

On row 16, we also report the Gini coefficient on consumption. For want of French data, we report in column A, the Gini coefficients on US and UK data as reported in Castañeda et al. (2003) and Blundell (2011). The model's predicted Gini lies within the range consistent with the data (Column B). When a comparison is made between the distributions of consumption in the data and in the model in column B, it is important to keep in mind that we have not used the distribution of consumption as part of our calibration targets. Therefore, any similarities between the model economy and the data along this dimension can be considered to provide further evidence of the model's fit.

4 Distributional effects of Social Security reform

4.1 The increase in life-expectancy without change in pension formula

In this subsection, we compare columns B and C in Table 3. In economy C, life expectancy at 60 goes up and the PAYG system is balanced only with an endogenous increase in the contribution rate. Since the pension formula is not changed in economy C, the distribution of retirement age is similar to the one found for economy B (Figure 5), and the increased distortionary labor tax makes working less attractive. With agents retiring at the same age and living longer in retirement, the dependency ratio goes up to 64%, which is consistent with the predicted worsening of the dependency ratio by COR (2001). The model can then be considered a good proxy for capturing aging and the resulting strain on PAYG budgets. Pension regimes are balanced only through a significant increase in contribution rates (for the General Regime and MCSs). For prime-age H-type workers, the overall pension contribution rate goes up from 16% to 23% (12.5% to 17.8% for M-type workers, from 11% to 16.6% for L-type workers). The Charpin (1999) report predicted that, without pension reform, the contribution rate had to increase by 50% in order to balance the PAYG system after the foreseeable increase in life expectancy. Our model is consistent with these forecasts since contribution rates in economy C are approximately 50% higher that the contribution rates in economy B. The model's predictions on dependency ratios and contribution rates changes (without pensions reforms) are consistent with the projections in official reports (COR (2001),Charpin (1999)), which suggests that our quantitative exercise can also be considered a good proxy for the French economy after a foreseeable increase in life expectancy and without change in pension formula.

With the increase in the contribution rates, workers cannot save as much as in the benchmark economy B. Average bequest falls for all skill groups (columns B-C, rows 12-14). The available capital in the economy falls, with no increase in labor supply (as individuals do not delay retirement). As a result, aggregate output goes down. The increase in K/Y and C/Y in Table 3 are driven by the fall in output.

The welfare consequences of switching from economy B to C are measured using changes in permanent consumption. Let $\tilde{W}_B$ denote the ex-ante welfare of a young agent computed in economy B as in Imrohoroglu et al. (1999). The welfare measure is based on the value function of young agents. This value function takes into account all possible future outcomes during the life-cycle, including individual risks and intergenerational skill changes.

$$\tilde{W}_B = \int_a \Phi(i'|i)V(a,Y,i,E)\lambda(a,Y,i,E)da$$

We then compute $\bar{c}_B$, the permanent consumption associated with $\tilde{W}_B$ such that

$$\sum_t \tilde{\beta}^t \frac{(\bar{c}_B)^{1-\tilde{\sigma}}}{1-\tilde{\sigma}} = \tilde{W}_B$$

The same computation is done for economy C, yielding $\bar{c}_C$. Table 3 rows 17-20 report the % gap between $\bar{c}_B$ and $\bar{c}_C$: a measure of the percentage change in permanent consumption compared with economy B. Consumption equivalents appear to be negative: in the switch from B to C, all agents suffer from a welfare loss. The overall economy is characterized by a 3.95% fall in permanent consumption with respect to the benchmark economy. The rise in contribution rate is the main driver for the significant welfare loss [20]. We report in Table 3 rows 10i-iii the fraction of liquidity-constrained agents in each skill group. The lower the ability group, the higher the fraction of liquidity-constrained agents. 46.70% of L-type agents rely only on labor earnings as the main source of income. They are also characterized by the lowest consumption levels in the economy, with the highest marginal utility of consumption. The realized loss from increasing the payroll tax is thus substantial.

The results of this section clearly point to the detrimental welfare consequences of relying only on the contribution rate in order to balance the PAYG pension system. Can the policy maker decrease the welfare loss by altering the pension formula, which would reduce the upward adjustment of the contribution rate? In the subsequent sections, two avenues are explored: the Ayrault reform and the switch to a NDC scheme. We can expect the reforms to result in a significant reduction of the fiscal adjustment required to cope with the aging of the population and the rise of the life expectancy. Hence, by reducing the extent of distortionary taxation of labor income, we can expect both reforms to generate welfare gains. However, pension reforms, by postponing the retirement eligibility age or lowering pension benefits, can also generate sizable welfare losses. Our model will indicate which effect dominates.

[20] We checked that a model with a constant contribution rate and only the increase in life expectancy actually yields welfare gains for all workers.

4.2 Ayrault reform

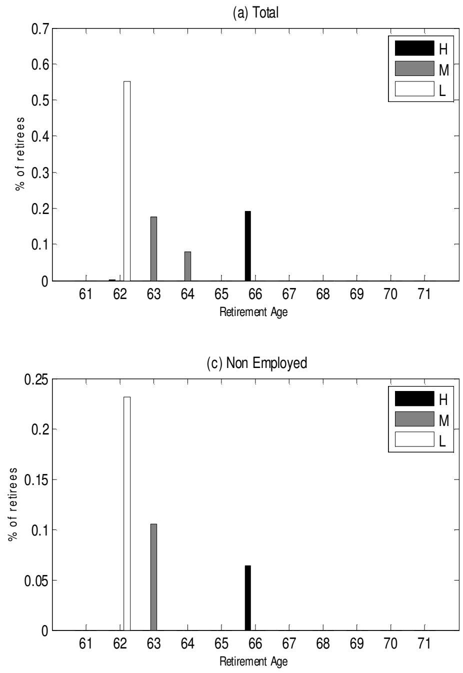
The Ayrault reform (column D of Table 3) increases the early retirement age by two years, from 60 to 62, for all individuals. Postponing the retirement age by two years, and then using payroll taxes to finance the remaining burden reduces the size of the fiscal burden and therefore the size of the additional tax required to finance it compared to economy C(see Table 3, rows 6-8, columns C-D).

The retirement distribution mechanically shifts to the right (Figure 6, panel (a), compared to Figure 5, panel (a)). The reform also alters the profile of replacement ratios. Figure 7 displays the replacement ratio as a function of retirement age for each economy and each skill group. Let us have a look at panel (c). Without reform, the replacement ratio displays a kink at age 60, the age of full pension for low-skilled workers. With the change in the early retirement age, the kink is now at age 62. The increase in the number of contributive years (from 40 to 43) does not shift the age of full pension beyond 62 as L-type workers start their working-life at an early age (see calibration section 3.1.2) and, thus, accumulate the required years prior to age 62. Therefore, it is then not surprising that the model predicts that all low-skilled workers retire at age 62 (Figure 6, whether employed, panel (b), or not, panel (c)).

Let us consider H-type workers. Without reform, the replacement ratio displays a kink at age 63, the age of full pension for high skill workers (Figure 7, panel(a)). The Ayrault reform shifts the full pension age to 66 after the increase in the number of contributive years (from 40 to 43). The kink at full pension age (66) is not as apparent as that in the economy without reform (at 63) because the Ayrault reform lowers the penalty in case of retirement before the full pension age and rewards working years beyond this age. The model predicts that, faced with this new pension formula, all H-type workers retire at 66 (Figure 6, panel (a)): H-type workers are sensitive to the fall in pension before age 66 but are not responsive to the rewards offered in case of work beyond 66.

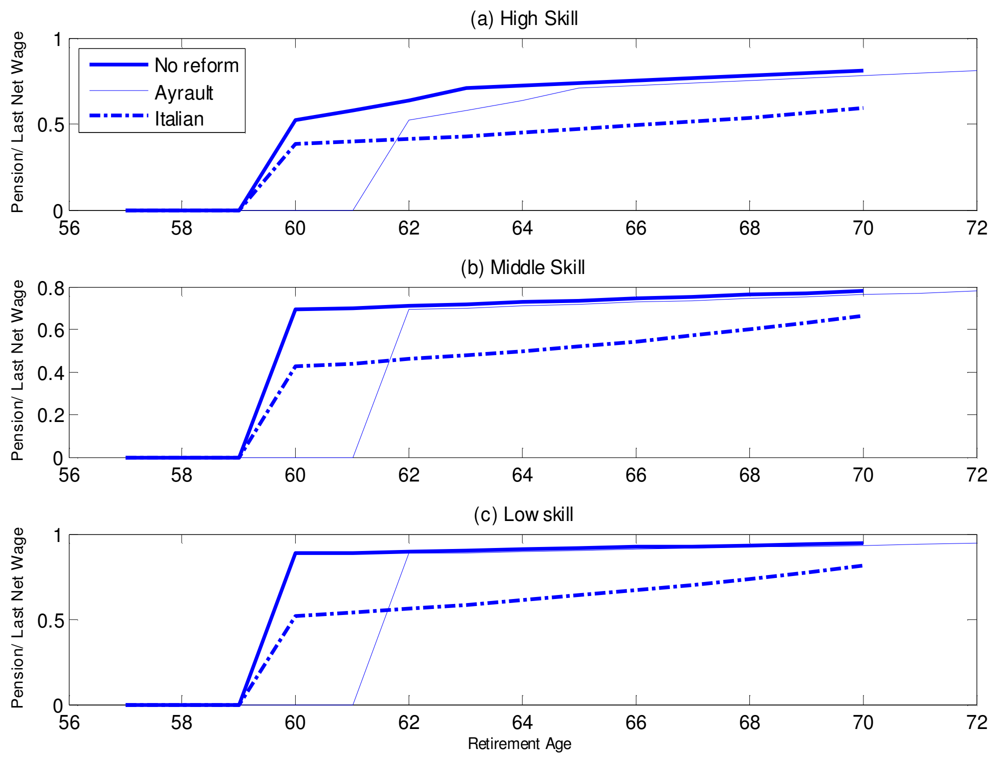
Interestingly, for M-type workers the retirement age is heterogeneous. With the increase in the number of contributive years, the full pension age is now at 63, which is the first peak on Figure 6 panel(a). This first peak is due to retirement of all non-employed M-type individuals

Figure 6: Retirement age after Ayrault reform



H: High-skill, M: Middle-skill, L: Low-skill. Non employed = unemployed + early withdrawal

Figure 7: Replacement ratios after pension reform for employed workers



(Figure 6, panel(c)). These workers are not entitled to the pension bonus in case of delayed retirement. This first peak is also due to some M-type workers who are not willing to delay retirement (Figure 6, panel(b)). The second peak at 64 comes only from employed M-type workers who are willing to work beyond the full pension age (Figure 6, panel(b)) and get the corresponding increase in pension. The model predicts that these individuals represent 13% of retirees. This is consistent with the 14% reported in Drees (2014) and Benallah (2011) [21]. The reason behind the willingness to postpone lies in altruism. M-type workers face the risk of lower productivity for their child (i.e. ability and wages). In order to insure against this risk, they are willing to work an additional year to accumulate savings, and hence bequest. In Table 3, row 13, column D, the bequest of M-type workers significantly increases compared to the benchmark economy.

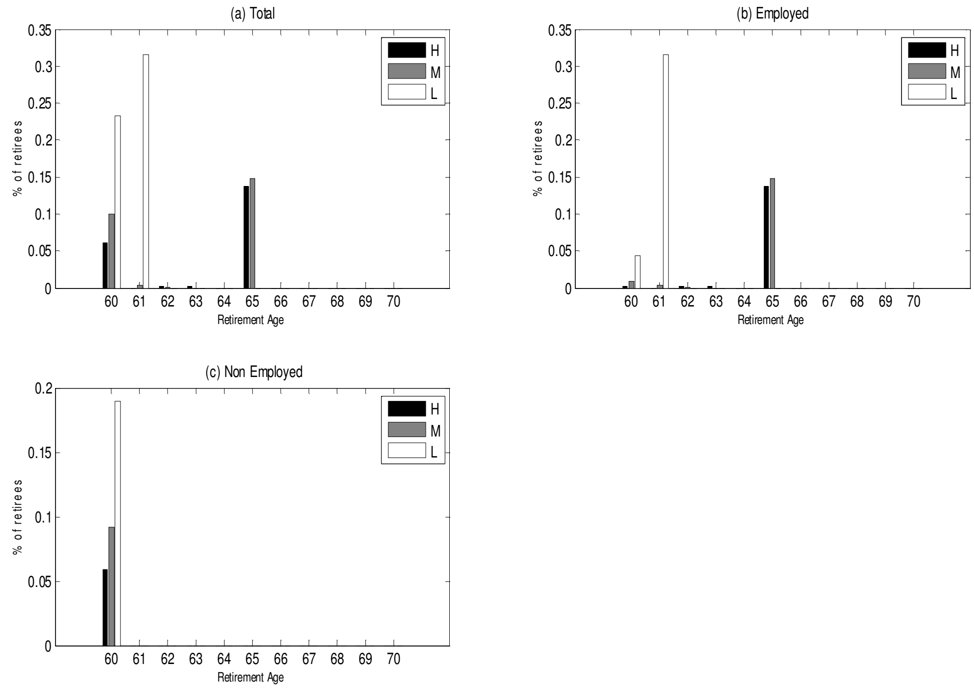
Our analysis shows that all elements of the Ayrault reform contribute to delayed retirement in economy D: the delayed early retirement age at 62 is particularly important for L-type workers, the increase in the number of contributive years shifts the retirement peak for H-type and M-type workers, while the latter are somewhat responsive to the reward in case of work beyond the full pension age. Delayed retirement significantly lowers the dependency ratio compared to economy C (50% versus 64% without pension reforms, row 5 of Table 3). The shift in the early retirement age to 62 greatly contributes to the good performance of the Ayrault reform in terms of dependency ratio as L-type workers constitute more than 50% of retirees (Figure 6, panel(a)). With delayed retirement, the contribution rate does not have to increase as much as in economy C to balance the PAYG system (rows 6-8, columns C-D, of Table 3), which reduces the total welfare loss from 3.95% to 1.51% (row 20, columns C-D, of Table 3). The welfare loss is mainly borne by L-type workers. The increase in contribution rate (row 8, columns B-D, from 11% to 14%), as slight as it may seem, is actually the highest in percentage terms for low skill workers (27% increase in contribution rate versus 15-19% for other worker types). In addition, comparing retirement ages in Figures 5 and 6, L-type workers delay retirement by two years, from 60 to 62, hence suffering from loss in leisure.

[21] The pension reward in case of delayed retirement was actually introduced prior to the Ayrault reform, so that there are first estimates available of the impact of this incentive on retirement decisions.

4.3 Switching to a NDC in France

A more dispersed distribution of retirement age. The model predicts a much more dispersed retirement distribution (Figure 8) if France were to switch to a complete notional defined contribution scheme as in Italy. Let us first have a look at L-type workers. As in the 1990s, whether employed or not, they all retire at the early retirement age of 60 (Figure 8, panel (a)). Compared with economy in column C, L-type workers retire at the same age of 60. Since they represent more than 50% of retirees, we are not surprised that the dependency ratio in economy E (58%, row 5 of Table 3) is not very far from the one in economy C (65%). These workers do not have any incentive to delay retirement to accumulate wealth for their child. L-type workers are already at the bottom of the ability distribution. Their child can only go up in the wage distribution, or stay at the parents' ability level. Without any strong bequest motive, L-type workers are not enticed to delay retirement and they leave little bequest (row 14, column E, Table 3). Their bequest even falls compared to under the Ayrault reform as their pension dramatically falls (Figure 7, panel (c)).

Figure 8: Retirement age after NDC reform



H: High skill, M: Middle - Skill, L: Low skill. Non employed = unemployed + early withdrawal

Interestingly, the retirement age distribution for M-type and H-type workers displays heterogeneity *within* each skill group. The reason behind this dispersion lies in the pension formula. As seen on Figure 7, panels (a) and (b), within the NDC reform the replacement ratios no longer display any kink. This gives agents more freedom in their retirement age. Indeed, retirement at an early age yields a slight decrease in pension. A delayed retirement age equally yields a slight increase in pension. This symmetry between early and delayed retirement in the profile of replacement ratios reveals the interaction between wealth accumulation and retirement decisions. Altruism is an important driver of wealth accumulation in the model: The existence of earnings risks at birth explains that altruistic older individuals want to work longer in order to have more income available to insure their descendants. This is particularly true for M-type and H-type workers, who are higher on the scale of ability levels. They therefore fear a descending ability change for their child. In Table 7, H-type (and M-type respectively) individuals have a 60% (43%) chance of giving birth to a child of lower ability. The bequests of H-type and M-type individuals are therefore higher than L-type individuals', in all columns of Table 3 (rows 12-15). The bequest motive is particularly strong in column E. The dispersion in the wealth distribution translates into dispersion in the distribution of retirement age.[22] Wealthier agents retire earlier. Wealth compensates for the lower pension. We develop this point in the next paragraph.

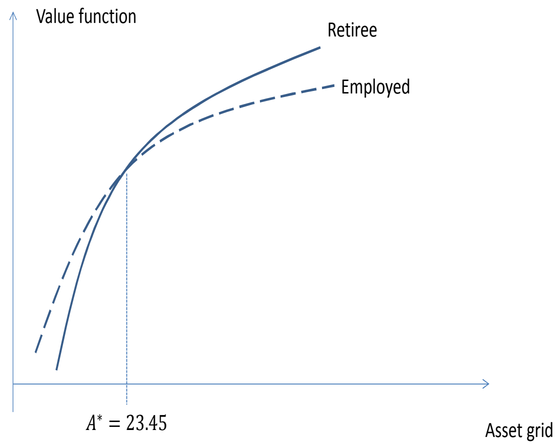
4.4 Additional considerations

Understanding the interaction between wealth decisions and retirement choices
The inspection of the individual decision rules reveals the interaction between wealth accumulation and retirement. Figure 9 illustrates the choice of a 64 years old H-type agent. In order to make his decision, he compares the value of being retired at age 64 to that of remaining active at the same age. The value functions intersect when his financial holdings equal $A^* = 23.45$. If his current wealth is larger than A^*, the high-ability agent will retire. If the high-ability worker is not wealthy enough ($A < A^*$), he chooses to keep on working.

The model actually yields an array of wealth thresholds above which individuals of each

[22]We check this intuition in Appendix D by examining the model's predictions in the absence of altruism.

Figure 9: Understanding the interaction between wealth decisions and retirement choices



ability category decide to retire (Table 4). For instance, a M-type worker who considers retiring at 60 years of age must have current wealth greater than 8.95 in order to cease working. Given the normalization considered in our model, this threshold corresponds to three years of his current net wage. We indicate in Table 4 (columns (2), (4), and (6)) the percentage of employed workers within each ability group who decide to retire at a given age. For instance, 4.20% of H-type employed workers are wealthy enough ($A > A^*$) to retire at age 60.

The interaction between wealth and retirement decisions yields a more inequal distribution of assets. The Gini on assets goes up from 0.75 to 0.81 (row 9 of Table 3, columns B and E).

Figure 10, panel(b) displays the Lorenz curves for economies C, D and E. Under the NDC scheme, the increase in inequalities appears strong at the bottom of the asset distribution. The fraction of agents without assets (row 10, columns B and E of Table 3) goes up from 25% to 37%. This increase in the fraction of liquidity constrained agents is unevenly distributed (rows 10i-iii, column E). Nearly two thirds of L-type workers have zero assets, versus one third in economy B. M-type workers are less liquidity-constrained than in Economy B (33% in economy B versus 13% in economy E). Indeed, M-type workers delay retirement to accumulate assets for bequest motives. The Gini on income (defined as the sum of earnings and capital income) goes up from 0.29 to 0.33. The Gini on consumption goes up as well to 0.28

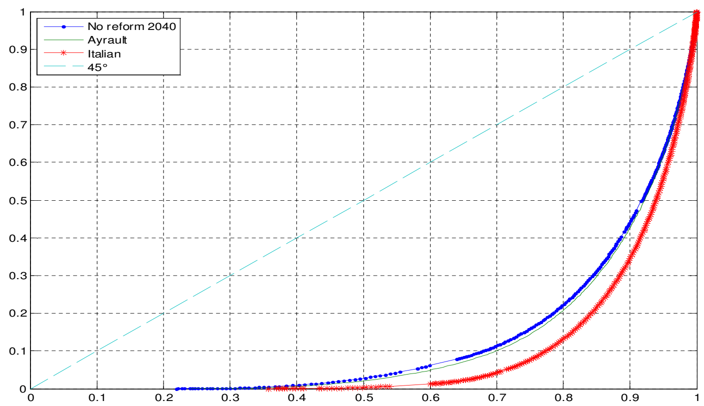
Table 4: Wealth accumulation and retirement decisions: examining the example of employed workers' decisions

	H		M		L	
	1	2	3	4	5	6
Age	A^*	fraction	A^*	fraction	A^*	fraction
60	31.97	0.0420	8.95	0.1309	0	100
61	31.91	0	8.17	0.0105	0	0
62	31.28	0	8.48	0	0	0
63	27.94	0.0103	8.79	0	0	0
64	$23.45^{(a)}$	$0.0309^{(b)}$	6.58	0.0223	0	0
65	21.36	0.0135	4.58	0.0452	0	0
66	21.62	0	2.96	0.0661	0	0
67	20.11	0.0111	1.37	0.3986	0	0
68	16.16	0.0380	0	0.3266	0	0
69	13.64	0.0349	0	0	0	0
70	0	0.8193	0	0	0	0

(a) H-type employed worker's retirement decision: if his current assets are larger than 23.45, he retires. Otherwise, he keeps working. (b) 3.09% of H-type employed workers retire at age 64.

(row 16, column E). Switching to a NDC scheme as in Italy moves the economy towards a more inequal distribution of wealth, and hence of income and consumption.

Figure 10: Lorenz curves on asset



No reform 2040: economy C in Table 3; Ayrault : economy D in Table 3; NDC-Italian : economy E in Table 3.

Choosing the right contribution rate and distributional effects. The NDC system yields significant welfare loss: individuals bear a nearly 10% fall in permanent consumption relative to economy B (row 20, column E, Table 3). The welfare loss is particularly large for L-type workers. The reason behind this uneven distribution of welfare loss does not lie in the difference between contributive rates across skill groups: In rows 6-8, column E, the contribution rate of 12% is actually the lowest of all scenarios. As in the NDC Italian reform, employees' contribution rates are equalized across skill groups. The welfare loss is due to the fall in replacement ratios associated with the Italian reform. On Figure 7, replacement ratios are the lowest within the NDC. The fall in pension is particularly strong for L-type workers at age 60, their retirement age. As the pension is the sum of capitalized contributions on wages, wage inequalities along the working-life directly translate into inequalities in pensions. The inequal income distribution, resulting from an inequal distribution of assets, also plays a role in generating uneven consumption and welfare.

Since the fall in replacement ratios plays a major role in the fall of welfare, why not increase the pension? In the pension formula (Appendix A.3), the pension is directly derived from the amount of contributions during the working life. In order to increase the pension, the policy maker would need to increase the contribution rate, which could also hurt L-type workers during their working-life. This is the case because, as L-type workers are the skill group with the largest fraction of financially constrained agents (row 10.iii. in Table 3), they mostly rely on labor income. They have lower income, lower consumption, hence higher marginal utility. The contribution rate must also be high enough to bring revenue but not too high, because a high contribution rate also means increasing the pension. The notional defined contribution plan makes the choice of the contribution rate a tricky exercise. The model's predictions point to the fact that, under the NDC Italian regime, the financial viability of the PAYG system leads to a moderate contribution rate (12% employees' rate, rows 6-8, column E), with low pensions.

5 Conclusion

Our exercise uses a model with endogenous retirement and wealth that is able to capture the possible changes in retirement age that French governments are trying to induce through SS reforms. Individuals are heterogeneous with respect to their skill level (low, middle or high), age, employment status and asset holdings. Focusing on long-run distributional effects provides a first assessment to understand the implications in welfare effects across heterogeneous individuals facing different SS reforms, i.e., changing parameters in their defined benefit pension plans versus switching to a more contributive one. We analyze four scenarios: *i)* The benchmark is a scenario in the economy before any increase in life expectancy and before reforms. The model predictions are then compared to the data for France in the 1990s. The model provides a satisfactory match with the data. *ii)* This scenario is France after an increase in life expectancy and without pension reforms. Financial sustainability is achieved only through an increase in the contribution rate. We check that the model demographic predictions are close to the projections for France in 2040, available in several government reports. The model predicts that, under scenario *ii)*, the economy bears a welfare loss: because of the significant increase in the contribution rate, individuals bear a 4% fall in their permanent consumption with respect to economy *i)*.

In the two subsequent scenarios, we study the impact of a combination of adjustment in the contribution rate and a pension reform, namely *iii)* the Ayrault reform and *iv)* a hypothetical NDC system. Both reforms yield inequal distributions of welfare losses. Low-skilled workers are the main losers of the reforms. In the case of the Ayrault reform, low-skilled workers delay retirement by two years, up to age 62. In the NDC reform, low-skill individuals' pensions fall substantially after the switch to the Italian pension system. In NDC schemes, inequalities along the working-life are directly translated into inequalities in pension reforms. The switch to a similar Italian reform yields substantial welfare losses: individuals would be willing to give up nearly 10% of their permanent consumption to go back to economy *ii)*. With a switch to NDC, pensions drastically fall and individuals save more. Since low-skilled workers do not save as much as middle or high-skilled workers, the switch to NDC schemes leads to a more unequal society in terms of asset distribution. In that sense, the paper does not support Bozio & Piketty (2008)'s call for implementing a NDC scheme in France.

References

Aglietta, M., Blanchet, D. & Héran, F. (2002), *Démographie et Économie*, Vol. 35 of *Rapport CAE*, Conseil d'Analyse Economique, Paris.

Aiyagari, S. R. (1994), 'Uninsured idiosyncratic risk and aggregate saving', *The Quarterly Journal of Economics* **109**(3), 659–684.

Arrondel, L. (2002), 'Risk management and wealth accumulation behavior in france', *Economics Letters* **74**(2), 187–194.

Arrondel, L. & Laferrère, A. (1991), 'Sucessions et héritiers à travers les données fiscales', *Economie et Prévision* **100-101**(4/5), 137–175.

Arrondel, L. & Laferrere, A. (2001), 'Taxation and wealth transmission in france', *Journal of Public Economics* **79**, 3–33.

Attanasio, O. P., Banks, J., Meghir, C. & Weber, G. (1999), 'Humps and bumps in lifetime consumption', *Journal of Business and Economic Statistics* **17**.

Auerbach, A. & Kotlikoff, L. (1987), *Dynamic Fiscal Policy*, Cambridge Univ. Press.

Belhaj, H. (2004), 'Les indicateurs de suivi des pensions : L'annexe statistique présentée par la france dans le rapport de stratégie nationale sur les pensions', *Solidarité et Santé* **2**, 29–52.

Benallah, S. (2011), 'Comportements de départ en retraite et réforme de 2003: Les effets de la surcote', *Economie et Statistique* **79-99**.

Bernanke, B., Gertler, M. & Gilchrist, S. (1999), The financial accelerator in a quantitative business cycle framework, *in* J. B. Taylor & M. Woodford, eds, 'Handbook of Macroeconomics', Vol. 1, Elservier, pp. 1341–1393.

Blanchet, D., Aubert, P. & Blau, D. (2007), Social contract and age at retirement: some elements of a franco-american comparison, *in* 'Age, Generations and the Social Contract', Springer Publishing.

Blanchet, D. & Monfort, J. A. (1996), 'L'âge et la durée de la retraite depuis 50 ans', *INSEE Première* **448**.

Blanchet, D. & Pelé, G. (1999), Social security and retirement in france, *in* 'Social Security and Retirement around the World', NBER Chapters, National Bureau of Economic Research, Inc, pp. 101–133.

Blau, D. M. (1987), 'A time-series analysis of self-employment in the united state', *Journal of Political Economy* **95**(3), 445–67.

Blundell, R. (2011), From income to consumption: Understanding the transmission of inequality, Mimeo, UCL.

Bozio, A. & Piketty, T. (2008), Pour un nouveau système de retraite : Des comptes individuels de cotisations financés par répartition, Opuscule Cepremap 14, Cepremap.

Buffeteau, S. & Godefroy, P. (2005), Conditions de départ en retraite selon l'âge de fin d'études : Analyse prospective pour les générations 1945 à 1974, Document de travail INSEE G 2005 / 01, INSEE.

Caballaro, R. J. & Hammour, M. (1999), The limits of special interest: What caused three decades of high unemployment in europe?, Mimeo, MIT.

Cagetti, M. & De Nardi, M. (2006), 'Entrepreneurship, frictions, and wealth', *Journal of Political Economy* **114**(5), 835–870.

Castañeda, A., Diaz-Gimenez, J. & Rios-Rull, V. (2003), 'Accounting for the u.s. earnings and wealth inequality', *Journal of Political Economy* **111**(4), 818–857.

Charpin, J. M. (1999), *Rapport Au Premier Ministre : L'avenir de Nos Retraites*, Documentation Française.

Colin, C., Iéhlé, V. & Mahieu, R. (2000), 'Les trajectoires de fin de carrière des salariés du secteur privé', *Solidarité-Santé* (3).

Conesa, J. & Krueger, D. (1999), 'Social security reform with heterogeneous agents', *Review of Economic Dynamics* **2**(4), 757–795.

Cooley, T. & Prescott, E. (1995), Economic growth and business cycles, *in* T. Cooley, ed., 'Frontiers of Business Cycle Research', Princeton University Press, pp. 1–38.

COR (2001), *Retraites : Renouveler Le Contrat Social Entre Les Générations*, Conseil d'Orientation des Retraites.

COR (2013), Les évolutions depuis 2000 des attentes et opinions vis-a-vis de la retraite des francais d'age actif, COR document de travail 6, Conseil d'Orientation des Retraites.

DeNardi, M., Imrohoroglu, S. & Sargent, T. (1999), 'Projected u.s. demographics and social security', *Review of Economic Dynamics* **2**(3), 575–615.

Drees (2012), Montant des pensions de retraite et taux de remplacement, Dossiers Solidarité et Santé 33, La Direction de la recherche, des études, de l'évaluation et des statistiques (Drees).

Drees (2014), Les retraités et les retraites, Collection Etudes et statistiques 33, La Direction de la recherche, des études, de l'évaluation et des statistiques (Drees).

Dress (2003), 'L âge de la liquidation des droits à la retraite de la génération 1934', *Etudes et Résultats* **237**. available at http://www.sante.gouv.fr/drees/etude-resultat/.

Fuster, L. (1999), 'Is altruism important for understanding the long-run effects of social security?', *Review of Economics Dynamics* **2**, 616–637.

Fuster, L., Imrohoroglu, A. & Imrohoroglu, S. (2003), 'A welfare analysis of social security in a dynastic framework', *International Economic Review* **44**(4), 1247–1273.

Gruber, J. & Wise, D. (1999), *Social Security Around the World*, National Bureau of Economic Research Conference Report.

Hairault, J., Langot, F. & Sopraseuth, T. (2008), 'Quantifying the laffer curve on the continued activity tax in a dynastic framework', *International Economic Review* **49**(3), 755–797.

Hamilton, B. H. (2000), 'Does entrepreneurship pay? an empirical analysis of the returns to self-employment', *Journal of Political Economy* **108**(3), 604–631.

Hansen, G. & Imrogoroglu, A. (1992), 'The role of unemplyment insurance in an economy with liquidity constraints and moral hazard', *Journal of Political Economy* **100**, 118–142.

Hénin, P. Y. & Weitzenblum, T. (2005), 'Welfare effects of alternative pension reforms : Assessing the transition costs for french socio-occupational groups.', *Journal of Pension Economics and Finance* **4**(3), 249–271.

Huggett, M. & Ventura, G. (1999), 'On the distributional effects of social security reform', *Review of Economic Dynamics* **2**(3), 498–531.

Hurd, M. (1996), The effects of labour market rigidities on the labour force behavior of older workers, *in* D. Wise, ed., 'Advances in the Economics of Aging', Chicago University Press, pp. 11–58.

Imrohoroglu, A., Imrohoroglu, S. & Joines, D. H. (1999), Computational models of social security: A survey, *in* R. Marimon & A. Scott, eds, 'Computational Methods for the Study of Dynamic Economies', Oxford University Press, pp. 221–237.

INSEE (1996), *La Situation Démographique En 1996*, Vol. 49-50 of *Résultats*.

INSEE (1997), 'Successions et donations en 1994, de plus en plus de successions declarees', *INSEE premiere* (521).

INSEE (1998), 'Le patrimoine national', *INSEE première* (595).

INSEE (1999), *La Structure Des Salaires En 1994*, Vol. 146-147 of *Emploi et Revenu*.

Kotlikoff, L., Smetters, K. & Walliser, J. (1999), 'Privatizing social security in the u.s. – comparing the options', *Review of Economic Dynamics* **2**(3), 532–574.

Ljungqvist, L. & Sargent, T. J. (2000), *Recursive Macroeconomic Theory*, MIT Press.

Ljunqvist, L. & Sargent, T. (2005), Obsolescence, uncertainty and heterogeneity : The european employment experience, Mimeo.

OECD (2000), Economic survey of france., institution = OECD, Technical report.

OECD (2013), Pensions at a glance 2013: country profiles - italy, Technical report, OECD.

OECD (2015), In it together: Why less inequality benefits all, Technical report, OECD.

Prescott, E. (1986), 'Theory ahead of business cycle measurement', *Federal Reserve Bank of Minneapolis Quarterly Review* pp. 9–22.

Rios Rull, V. (1996), 'Life-cycle economies and aggregate fluctuations', *Review of Economic Studies* **63**, 465–490.

Rust, J. & Phelan, C. (1997), 'How social security and medicare affect retirement behavior in a world of incomplete markets', *Econometrica* **65**(4), 781–831.

Vikram, N. & Dhareshwar, A. (1995), A new database on physical capital stock: Sources, methodology and results, Technical report, Wolrd Bank.

Villa, P. (1995), Séries longues macroéconomiques, Technical report, CEPII. available on CEPII website : http://www.cepii.fr/francgraph/bdd/villa/mode.htm.

Appendix

A Pension formulas

All pensions formulas are based on past wages. In the model, wages depend on individual ability i. All pensions are then dependent on ability i. For the sake of brevity, we omit ability i in the formulas below, but the reader shall keep in mind that all pensions depend on ability level i as wages are ability-dependent.

A.1 Pension formula and calibration: General Regime

Total pension is

$$P(k) = P^{CNAV}(k) + P^{ARRCO}(k) + P^{AGIRC}(k)$$

with $P^{AGIRC}(k) = 0$ for workers whose wage is below the SS cap.

Before reform Individuals can start claiming benefits at early retirement age of $ERA = 60$. The pension paid by CNAV ($P^{CNAV}(k)$ for an individual of age k, with d contributive years) is the product of three elements.

$$P^{CNAV}(k,d) = \underbrace{SAM}_{(i)} \times \underbrace{\min\left(1, \frac{d}{40}\right)}_{(ii)} \times \underbrace{[\zeta - 0.05 * \max(0, \min(65-k, 40-d)]}_{(iii)} \tag{10}$$

(i). SAM The average wage computed over the 25 best years of each individual's career. The social security capping (cap_t^{SS}) applies to the computation of the average annual wage for redistributive purposes (SAM).

$$SAM = \frac{1}{25}\sum_{t=1}^{25} \min(w_t, cap_t^{SS}) \tag{11}$$

(ii). The second element is the proratization term, $\min\left(1, \frac{d}{40}\right)$, with d the number of contributive years. In the pre-reform Balladur 1993-2003, individuals can retire with a full pension rate at age 65 or earlier if they contributed 40 years ($d \leq 40$). In case of retirement before 40 contribution years, the proratization term reduces the pension by $\frac{d}{40}$. In case of retirement beyond 40 contribution years ($d \leq 40$), the individual does not gain any additional benefits. (*iii*) The third element is the pension rate (ζ). The full pension rate amounts to 50%. If the individual retires before contributing 40 years, the pension rate is reduced by 5% per missing year. In order to get the full pension rate, the individual has to retire at 65 or later. He can also get the full pension rate before 65 if he contributed 40 years. Finally, in the Balladur regime, the pension rate does not reward additional working years beyond the required 40 years of contribution or beyond age 65.

Ayrault reform After the Ayrault reform, the pension formula becomes

$$P^{CNAV}(k,d) = \underbrace{SAM}_{(i)} \times \underbrace{\min\left(1, \frac{d}{43}\right)}_{(ii)} \times \underbrace{\left[\zeta - \frac{0.05}{2} \times \max(0, \min(67-k, 43-d)\right]}_{(iii)} \times \underbrace{(1.05 \times \max(0, d-43))}_{(iv)} \tag{12}$$

Individuals can start claiming benefits at age $ERA = 62$. The computation of the average wage *(i)* is similar. The number of required contributive years increases to 43. The proratization term (*ii*) takes into account this new reference. In term (*iii*), in order to get the full pension rate, the individual has to retire at 67 or later. He can also get the full pension rate before 67 if he contributed 43 years. In the term (*iv*), the pension formula rewards additional working years beyond the required 43 years of contribution (5% per additional year).

A.2 Pension formula and calibration: MCSs (ARRCO and AGIRC)

Different contribution rates are applied to the part of the wage below and above the SS cap. For executives, ARRCO collects the contribution for the part of the wage below the SS cap. For the remainder, AGIRC collects the contribution for the part of the wage above the SS cap. We present below the pension formula for ARRCO $P^{ARRCO}(k)$, it is the same for the AGIRC pension.

Before reform. Each year, a fixed proportion of the wage τ_{arrco} is devoted to the purchase of points at a price p^{ARRCO}. One euro of earnings yields $1/p^{ARRCO}$ points each year. Upon retirement, points are converted into euros of pension by multiplying the number of points by the price of a point denoted v_{arrco}, the value of each point at the date of retirement. Pension at age k, after d contributive years is then

$$P^{ARRCO}(k,d) = points(k) \times v_{arrco} \times multiplier(k,d)$$

where $points(k) = \sum^k \frac{\tau_{arrco}\bar{w}w(i)}{p^{ARRCO}}$ denotes the total number of points accumulated throughout the working life. $multiplier(k,d)$ captures a downward adjustment in pension in case of retirement prior to the full pension rate in the General Regime ($d \leq 40$). The pension loss is 4% per missing year.

$$multiplier(k,d) = 1 - 0.04 \times max(0, 40 - d)$$

60% of contributions to the complementary schemes are paid by employers ($\Theta_f(.)$ in equation (4)) and 40% by the employee ($\Theta(.)$ in $y(k,i,\xi)$ in equation (5)). This sharing rule is left unchanged throughout the paper. Key parameters for the MCSs are reported in Table 5.

Table 5: Parameters for MCSs (in euros)

Annual social security cap 1993	purchase price of point p		value of point on retirement v	
cap^{SS}	arrco	agirc	arrco	agirc
23893	3.4150	2.9759	0.3743	0.3511

As the number of contributive years is not a state variable in our model, we use a proxy for this variable by considering the current age k minus the age at the end of education for employed individuals. The age of end of education is 22.2 for high-skilled workers, 19.5 for middle-skilled workers and 17.4 for low-skilled workers. Buffeteau & Godefroy (2005) who develop a microsimulation model for France adopt a similar approach. For unemployed agents, the number of contributive years is given by the difference between the current age and the sum of age at the end of education, and the average number of years of non-employment at this age and skill level.

Ayrault reform MCSs adjust the computation of the pension to take into account the increased number of contributive years in the General Regime

$$multiplier(k, d) = 1 - 0.04 \times max(0, 43 - d)$$

A.3 Pension formula and calibration: NDC-Italian reform

In the hypothetical Italian scenario, the 2-pillar pension system (based on CNAV and MCSs) is replaced by a unified framework with only one pillar based on the Italian system. Contributions are paid by employers and employees along the working life. The contributions increase each worker's notional capital at a fixed rate (denoted γ^I) 1.2%, which is the average real French GDP growth in the past 15 years (computed using OECD National Accounts, 2000-2014). It is still a PAYG system as current benefits are paid out of current contributions. Upon retirement, the individual notional capital is converted into annuities using coefficients of adjustments c_k^I based on life expectancy. The conversion coefficient c_k^I is chosen by Italian authorities. We keep the values set by the Italian government (as reported in OECD (2013), Table 6).

Table 6: Coefficients of adjustment c_k^I as a function of age k

Age k	60	61	62	63	64	65	66	67	68	69	70
c_k^I in %	4.661	4.796	4.940	5.094	5.259	5.435	5.624	5.826	6.046	6.283	6.541

The pension formula for an individual of age k is:

$$P(k) = c_k^I * \sum_{t=1}^{d} \tau \times \bar{w}w_t \times (1 + \gamma^I)^{k-t}$$

where d is the number of contributive years, calibrated as for previous reforms, and τ is the equilibrium contribution rate paid by employers and employees to balance the hypothetical NDC reform.

B Value functions

All optimization programs are subject to equations (5) and (6). The value function faced by workers of age $k = O$ when $\xi = U$ of age k and skill i is:.

$$V(a,k,i,U) = \max_{c\geq 0,\ a'} u(c,l) + \tilde{\beta} \begin{bmatrix} \pi_k^i \Phi(i'|i) \varrho V(a',Y,i',U) \\ +(1-\pi_k^i) Max\ (\ V(a',k+1,i,U), V(a',k+1,i,RU)\ ) \end{bmatrix}$$

The value function faced by workers of age $k = O$ when $\xi = P$ of age k and skill i is:

$$V(a,k,i,P) = \max_{c\geq 0,\ a'} u(c,l) + \tilde{\beta} \begin{bmatrix} \pi_k^i \Phi(i'|i) \varrho V(a',Y,i',P) \\ +(1-\pi_k^i) Max\ (\ V(a',k+1,i,P), V(a',k+1,i,RP)\ ) \end{bmatrix}$$

The value functions for ages $k = \{69, 70+\}$, at any ξ of age k and skill i is:

$$V(a,k,i,\xi) = \max_{c\geq 0,\ a'} u(c,l) + \tilde{\beta} \begin{bmatrix} \pi_k^i \Phi(i'|i) \varrho V(a',Y,i',\xi) \\ +(1-\pi_k^i)\ (\ V(a',k+1,i,R\xi)\ ) \end{bmatrix}$$

C Calibration

We use occupations to create "skill" groups. Skill levels are defined by the French Bureau of statistics (INSEE). The low-skilled workers are unskilled workers and clerks dealing with non-specialized office work in administrations or firms; middle-skilled workers are white-collars; and high-skilled refers to highly skilled workers and executives.

Table 7: Social mobility matrix $\Phi(i'|i)$

		Son's Ability $(t+1)$		
		High-skilled	Middle-skilled	Low-skilled
Father's Ability (t)	High-skilled	0.4077 [a]	0.3187	0.2736
	Middle-skiled	0.2191	0.3507	0.4302
	Low-skilled	0.0929	0.1952	0.7119

a: A high-skilled worker faces a 40.77 percent probability of giving birth to a high-skilled type son

Source: Own computations from French LFS 1993.

Table 8: Life-cycle transition probabilities

	π_Y			π_A	π_O	ERA
	High	Middle	Low	(a)	(a)	
Benchmark and NDC	1/(34-22.2)	1/(34-19.5)	1/(34-17.4)	1/(54-35)	1/(58-55)	60
Ayrault	idem	idem	idem	idem	1/(60-55)	62

(a) Same probability for all skill groups

Table 9: French Death probabilities between 59 and 70, before the increase in life expectancy

Age	59	60	61	62	63	64	65	66	67	68	69	70+
H	0.043	0.044	0.046	0.048	0.050	0.052	0.054	0.056	0.059	0.062	0.065	0.068
M	0.049	0.051	0.053	0.056	0.058	0.061	0.064	0.068	0.071	0.075	0.080	0.086
L	0.056	0.059	0.062	0.065	0.068	0.072	0.076	0.081	0.087	0.093	0.100	0.109

Own computations from COR (2001) and Blanchet & Monfort (1996)

Table 10: Non-employment risk

	Unemployment		Early withdrawal	
	π_U	θ_U	π_P	θ_P
H-type worker	0.0467	0.6	0.0167	0.6
M-type worker	0.0433	0.59	0.0400	0.63
L-type worker	0.0400	0.62	0.0467(a)	0.68

(a) Each period, an employed L-ability worker faces a 4.67% probability of entering a specific program of early withdrawal from the labor market.

Table 11: Annual wage by age k and skill i

	Young	Adult	Old
High-skilled	2.14 [b]	3.25	3.91
Middle-skilled	1.40	1.86	2.25
Low-skilled	1 [a]	1.24	1.26

a: The annual wage of low-skilled young workers is normalized to one

b:A young high-skilled agent's annual wage is 2.14 times higher than a young low-skilled agent's annual wage

Source: INSEE (1999)

Table 12: Calibrated parameters

Labor share's of output	α	0.64
Depreciation rate	δ	10%
Growth productivity	γ	2%
Discount rate	$\tilde{\beta}$	0.96
Risk aversion coefficient	$\tilde{\sigma}$	2
Leisure of worker	$1 - l$	2/3
Weight of leisure in utility	η	0.62
Altruism	ϱ	0.9

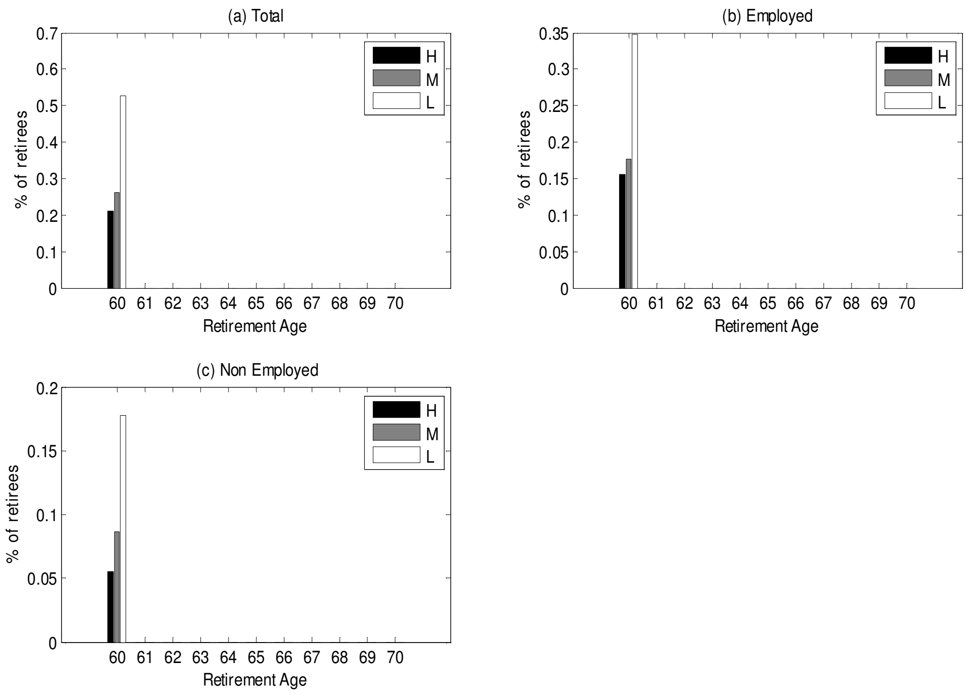
D Altruism

In this section, we report the model's predictions in an economy without altruism ($\varrho = 0$). We choose to look at the steady-state under the Italian regime since it is the pension system that results in the most heterogeneous distribution of retirement age under the benchmark calibration ($\varrho = 0.9$). The contrast between the economy with and without altruism will be more striking. In order to illustrate the difference in economic behavior, we compute the steady-state with non altruistic individuals, with the same interest rate and contribution rates as in the economy with altruism (as reported in Table 3, rows 1, 6-8, column E). Individuals only derive utility from their own lifetime consumption of leisure and goods.

Figure 11 reports the distribution of retirement age in an economy without altruism ($\varrho = 0$). There is no heterogeneity with regards to retirement age. All agents retire at 60, regardless of skill level and labor market status prior to retirement. The replacement ratio is then 66%, which is worse than that prevailing in economy C, since H-type workers retire at 60 here rather than at 63 as in economy C.

When individuals are altruistic, older agents would like to insure their children against the risk of low labor productivity. They delay retirement in order to accumulate savings that they can bequeath to their descendant. When individuals do not care about the well-being of future generations, they have no incentive to work longer to accumulate savings. Since older individuals in this scenario do not leave bequests, they have a lower marginal propensity to save than in the benchmark economy Table 3, column B. This experiment illustrates the leading role of bequest motives in retirement decisions. Our results echoe Fuster (1999)'s stress on altruism as a key element in understanding the effects of Social Security.

Figure 11: Distribution of retirement age in the economy without altruism ($\varrho = 0$)



H: H-type M: M-type. L: L-type

1130, rue Sherbrooke Ouest, bureau 1400, Montréal (Québec) H3A 2M8
Tél. : 514-985-4000 • Téléc. : 514-985-4039
www.cirano.qc.ca • info@cirano.qc.ca