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MACROECONOMIC ASPECTS OF ITALIAN PENSION REFORMS OF 1990S

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Macroeconomic Aspects of Italian Pension Reforms of 1990s*

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Abstract

In 1990s, several pension reforms had been adopted to insure financial sustainability of Italian Social Security system. This paper studies two main features of Amato and Dini reforms: (i) adoption of notional defined contributions formula; (ii) price indexation of benefits as compared to wage indexation prior to 1992. As the reforms envision a long phase-in period, I consider the effect of the reforms on different generations. This paper studies household decisions and welfare consequences of the reforms using general equilibrium overlapping generations framework. The major focus is on time allocation and human capital accumulation decisions of transition generations. The economic and demographic structure of the economy is calibrated to (i) Italian macroeconomic variables in 1992, (ii) observed earnings profiles in Survey of Household Income and Wealth by Banca d'Italia (SHIW). The reforms decrease financial obligations of the pension system. The paper quantifies the effect of the reforms on transition generations.

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1 Introduction

The Italian pension system has undergone a number of reforms in 1990s. The system still maintains pay-as-you-go nature and is moving from a defined benefit (DB) to a defined contribution (DC) system. The reforms envision a very long transition and the new system will be fully phased in after 2030. The reforms also provide for a different treatment of generations based on the labor market seniority at the end of 1995. Many scholars argue that the reforms violate an intergenerational equity by placing most of the burden of transition on younger generations, see for example Franco (2002). This paper quantitatively evaluates the effect of the reforms on transition generations.

Following the quantitative tradition of evaluating tax and social security policies, see for example Auerbach and Kotlikoff (1987), DeNardi, Imrohoroglu and Sargent (1999), and Kotlikoff, Smetters and Walliser (1999), this paper develops a macroeconomic model with overlapping generations (OG). The model is calibrated to match the main macroeconomic variables of the Italian economy before the introduction of the reforms. I model the institutional features of the Italian pension system before and after the reform. The pension reform introduced in 1992 changed the indexation of pensions to price inflation from wage growth, while the reform passed in 1995 introduced a DC system and provided rules for calculating the retirement benefits for transition generations. The workers who have entered the labor market before 1995 will have their benefits calculated based on two formulas: (1) *pro-rata* system for young workers with less than 18 years of seniority in 1995, and (2) *modified defined benefit* system for workers with more than 18 years of seniority (the details for these formulas are given in Sections 2 and 4.1).

Many economists have studied the impact of these reforms on individual decisions. Borella, Belloni and Fornero (2005) evaluate the changes in labor supply induced by the reforms, wealth accumulation and saving behavior are investigated by Attanasio and Brugiavini (2003) and Jappelli, Padula and Bottazzi (2003). To evaluate the effects of the Italian reforms on individual as well as aggregate macroeconomic variables, the agents in the model economy make consumption versus saving and leisure versus production activities decisions within the general equilibrium set-up. The time endowment is allocated between leisure, market production and human capital investment activities. The human capital investment technology is the one introduced by Ben-Porath (1967).

The results of this paper show that the Italian reforms will reduce the pension expenditures and restore the financial sustainability of the system in the long-run. The change in the indexation rule alone reduces the pension expenditures only during the initial fifteen years after the introduction of the reforms, while the long-term reduction is achieved through transition to a DC retirement system. During the transition, the older workers with more than 18 years of seniority in 1995 are protected by the reforms, while young and future generations bear the cost of transition to a new system. The reforms induce the agents to increase investment into physical and human capital. In the new stationary equilibrium with a DC retirement system, the aggregate capital stock and labor supply are by 13% and 6.3% higher, respectively, as compared to pre-1992 levels. These increase in the factors of production results in the higher aggregate output and consumption. The future generations who will be born after year 2050 are only slightly worse off as compared to pre-1992 level, the welfare of these generations is only lower by 0.16% in terms of lifetime consumption.

The closest papers to my analysis are Borella and Coda-Moscarola (2006) and D'Amato and Galasso (2002). The distributive properties of the Italian reforms are studied in Borella and Coda-Moscarola (2006). This paper uses microsimulation approach and incorporates rich heterogeneity within cohorts to study the redistribution and fairness properties of the retirement system within and across generations. Since Borella and Coda-Moscarola (2006) model the change in retirement rules for different cohorts, they can analyze the change in the redistribution of the retirement system during the transition to a defined contribution system. At the same time, their paper abstracts from consumption, savings and labor supply decisons. Hence, Borella and Coda-Moscarola (2006) can not make predictions regarding macroeconomic characteristics of the Italian economy and pension system during the transition. D'Amato and Galasso (2002) use political economy model with overlapping generations to study political sustainability of the new retirement system. They limit the scope of their analysis to a steady state and consider the features of the DC retirement system that will be fully operational in Italy in 2050. In contrast to D'Amato and Galasso (2002), I model the transition process as well as convergence to a new stationary equilibrium. Therefore, this paper can analyze welfare of all generations affected by the reforms.

The paper is organized as follows. In section 2 , I describe the Italian pension system and the legislative basis for the reforms that took place in 1990s. Section 3 provides details of the economic environment to model the transition to a new retirement system. The calibration of the model is documented in section 4 . The results for simulating the transition to a new system are discussed in section 5 . Section 6 concludes the paper.

2 Italian Pension Reforms of 1990s

The Italian pension system is characterized by pay-as-you-go nature. The system is highly fragmented and consists of over fifty different schemes. More than two thirds of public pension system is administered by *Istituto Nazionale Previdenza Sociale* (INPS) which covers the major part of private sector employees and self-employed workers. As for decomposition of pension expenditures by sectors in 2000, 62 % of expenditures were directed at the private sector employees, 24 % at public sector workers and 14 % at self-employed workers. Before 1992, the pension system was very generous and on average pension benefits constituted 80 % of wage income, according to OECD (2005). Prior to the reforms, retirement benefits were computed using a defined benefits (DB) formula. The DB formula depended on pensionable earnings computed over the last years' earnings, the number of working years and the annual accrual rate. The number of years over which the pensionable earnings have been averaged differed among the sectors: it was the last five years for private sector employees, the last one month for public sector workers, and the last ten years of taxable income for self-employed. The fragmentation of the system led to the excessive generosity of benefits. At the beginning of 1990s, Italy had one of the highest pension expenditures levels measured as fraction of GDP among OECD countries. There was a further concern to financial sustainability of the system due to aging population.

The Italian pension system has been heavily reformed through a number of legislative acts in 1990s. In particular, I consider three main reforms: Legislative Decree 503 of 1992, the Amato reform; Law 335 of 1995, the Dini reform; and Law 449 of 1997, the Prodi reform. Here, I discuss the elements of the reforms that are most relevant to my analysis. The Amato reform has introduced indexation of benefits to inflation as compared to wage growth before. Secondly, the Amato reform has harmonized the rules for computing pension benefits across workers of different sectors.

The Dini reform has introduced the retirement system based on defined contributions (DC) principle while still preserving the pay-as-you-go nature of the funding. All people who have entered the labor market after December 31, 1995 will have their retirement benefits computed based on the amount of payroll taxes contributed to the system. The contributions to the system will be accrued at the rate of GDP growth and converted into an annuity at the time of retirement. This conversion coefficient is a function of retirement age and life expectancy. The Dini reform established the rules for transition generations. The people who have entered the labor market before December 31, 1995 are divided into two groups. The first group consists of people who had less than 18 years of experience at the end of 1995. The pension benefits of these workers is calculated on *pro-rata* basis and is composed of two parts. Labor income earned prior to 1995 constitutes the basis for the first part of benefits computed based on defined benefits formula. The contributions made to the retirement system after 1995 will be accounted for using Defined Contributions formula.

People with more than 18 years of experience in 1995 constitute the second group. Their retirement benefits are completely based on defined benefit formula but now the labor income is averaged over the longer period of time. These regime is called modified defined benefits (MDB).

The Prodi reform of 1997 have sped up the transition to a new system. In this paper, I explicitly model a transition from a system with defined benefits to the one with defined contributions. The details for different generations and the benefit formulas are given in Section 4.1 The rules for computing the retirement benefits are specified on the website of INPS.

3 Economic Environment

Households. The economy is populated by overlapping generations. Time is discrete, indexed by $t = 0, 1, ...,$ and continues forever. The economy is populated by a continuum of individuals. At each date t, a new cohort is born that is η percent larger than the previous cohort. The agents live for J adult periods, with ages denoted by $j \in \Im \equiv \{0, ..., J-1\}$. The agents' life-spans are certain. The size of a generation born at a time period t and of age j is denoted by n_{t+j}^{t}. An individual's consumption allocation, c_{t+j}^{t}, is indexed by a superscript which denotes the date of birth t and by one subscript $t+j$ which denotes the time period at which allocation takes place.

Preferences of an agent born at period t are ordered by

$$\sum_{j=0}^{J-1} \beta^{j} u(c_{t+j}^{t}, 1 - l_{m,t+j}^{t} - l_{h,t+j}^{t}), \tag{1}$$

where β is a time preference parameter. Each agent chooses sequences of consumption, market hours, and investment hours, $\left\{c_{t+j}^{t}, l_{m,t+j}^{t}, l_{h,t+j}^{t}\right\}$, to maximize the discounted value of life-time utility subject to its budget constraint,

$$\begin{aligned}(1+\tau_{c,t})\, c_{t+j}^{t} + s_{t+1+j}^{t} \leq (1-\tau_{l,t})\,(1-\tau_{p,t})\, w_{t+j} h_{t+j}^{t} l_{m,t+j}^{t} \\ + (1 + (1-\tau_{k,t})\, r_{t+j}) s_{t+j}^{t} + d_{t+j}^{t}.\end{aligned} \tag{2}$$

This constraint must be balanced at each age of the agent's life, i.e., for any $j \in \Im$.

The market-clearing wage and the rate of return on physical capital at date $t+j$ are given by r_{t+j} and w_{t+j}, respectively. An agent's labor income depends on efficiency units of labor, $h_{t+j}^{t} l_{m,t+j}^{t}$. The agent's stock of human capital h_{t+j}^{t} is determined by the undepreciated human capital from the last period and the new human capital accumulation during the last period:

$$h_{t+j}^{t} = (1-\delta_h) h_{t+j-1}^{t} + Q(h_{t+j-1}^{t}, l_{h,t+j-1}^{t}). \tag{3}$$

The creation of new human capital depends on its existing level and investment hours and is determined by the function $Q(h, l_h)$. The Q function is increasing in both arguments and has decreasing returns to scale. The agent's savings earn capital income at the real rate of return r_{t+j}. Agents are restricted to have strictly positive amount of savings at all ages

$$s^t_{t+j} \geq 0. \tag{4}$$

Agents pay taxes on consumption at rate $\tau_{c,t}$ and capital income net of depreciation at rate $\tau_{k,t}$. Labor income is subject to ordinary labor income tax, $\tau_{l,t}$, and to payroll tax, $\tau_{p,t}$.

The government transfers to the agent born at t and of age j are denoted by d^t_{t+j}. These transfers consist of two components: a lump-sum transfer for agents of all ages, f^t_{t+j}, and social security benefits to retirees, b^t_{t+j},

$$d^t_{t+j} = \begin{cases} f^t_{t+j}, & j = 0, \overline{J} - 1, \\ f^t_{t+j} + b^t_{t+j}, & j = \overline{J}, J - 1. \end{cases}$$

The agents of the same cohort receive equal lump-sum transfers, f^t_{t+j}, independent of earnings' group. Agents are entitled to retirement benefits starting with age $\overline{J}$. The formula for calculation of Social Security benefits depends on the date when an agent entered the labor market. The detailed description of benefit formula is given in Section 4.1

Production technology. At period t, firms hire capital, K_t, and labor, L_t, to produce output with a constant returns-to-scale production technology,

$$Y_t = A_t K_t^{\theta} L_t^{1-\theta},$$

where A_t is total factor productivity which is assumed to grow at a constant exogenously given rate γ. Factor markets are assumed to be competitive and factor inputs are paid the marginal products:

$$w_t = (1-\theta) A_t K_t^{\theta} L_t^{-\theta},$$
$$r_t = \theta A_t K_t^{\theta-1} L_t^{1-\theta} - \delta_k,$$

where δ_k is the depreciation rate of capital.

Government. The government operates through two different budgets, the social security and general budgets. Both budgets are balanced every period t. The retirement benefits, $b_{t+j}^{t,i}$, are financed through payroll taxes, $\tau_{p,t}$. The exogenously given stream of government consumption, G_t, and lump-sum transfers to households, f_{t+j}^{t}, are financed through consumption taxes, $\tau_{c,t}$, capital income taxes $\tau_{k,t}$, and labor income taxes, $\tau_{l,t}$.

$$
\begin{aligned}
G_t + \sum_{j=0}^{J-1} n_t^{t-j} f_t^{t-j} = & \sum_{j=0}^{J-1} n_t^{t-j} \left(\tau_{c,t} c_t^{t-j} + \tau_{k,t} r_t s_t^{t-j} \right) \\
& + \sum_{j=0}^{\overline{J}-1} n_t^{t-j} \left(\tau_{l,t} (1-\tau_{p,t}) w_t h_t^{t-j} l_{m,t}^{t-j} \right), \qquad (5)
\end{aligned}
$$

$$
\sum_{j=\overline{J}}^{J-1} n_t^{t-j} b_t^{t-j} = \sum_{j=0}^{J-1} n_t^{t-j} \tau_{p,t} w_t h_t^{t-j} l_{m,t}^{t-j}. \qquad (6)
$$

Market arrangements. All markets are competitive. The aggregate inputs are determined as

$$
\begin{aligned}
K_t &= \sum_{j=0}^{J-1} n_t^{t-j} s_t^{t-j}, \\
L_t &= \sum_{j=0}^{\overline{J}-1} n_t^{t-j} h_t^{t-j} l_{m,t}^{t-j}.
\end{aligned}
$$

The aggregate feasibility constraint at period t is

$$
\sum_{j=0}^{J-1} n_t^{t-j} c_t^{t-j,i} + K_{t+1} + G_t = A_t K_t^{\theta} L_t^{1-\theta} + (1-\delta_k) K_t. \qquad (7)
$$

Definition 1. *A competitive equilibrium is a sequence of prices and allocations such that: (i) given equilibrium prices and government policies, consumers maximize a discounted stream of utilities (1) subject to their constraints (2)-(4); (ii) firms maximize profits given prices; (iii) the social security and the general government budgets are balanced; (iv) the market clearing and feasibility conditions hold.*

4 Parameterization of the model

Since I model the transition from Defined Benefits to Defined Contributions retirement system in Italy, the calibration and computation strategies are as follows. The initial stationary equilibrium is calibrated to macroeconomic characteristics, tax and retirement system in Italy in 1992. Then I model the change in the rules for retirement benefits as prescribed by Italian laws. The parameter values are summarized in Table 4.

4.1 Demographics and timing of the reforms.

Agents enter the economy at age 20, retire at age 65, and die at age 80. Each model period corresponds to 5 years. Hence, the agents are working during the first nine model periods, $\overline{J} = 9$, are retired during the last three model periods and the life length is $J = 12$. The population grows at a constant rate which is set to 0.7 % annually. Population structure during transition is summarized in Table 1. The period from 1990 to 1994 is the initial stationary equilibrium with defined benefits (DB) retirement system, this period is labeled by 1992 in Table 1 and in all other results presented in tables and graphs. The first period in which reforms are being implemented is the one from 1995 to 1999, this period is labeled as 1997. The generation born in 1915 completes their lives under the initial stationary equilibrium with DB retirement system. The generation of 1915 is representative of the generations born from 1913 to 1917. To simplify notation, I relabel the time periods and generations as specified in Table 2. Hence, the flow of generations during transition using the model notation is described in Table 3.

The generations born from 1920 to 1930 have completed their working lives under the DB system. The retirement benefits of these generations are computed using DB formula but their benefits are indexed to prices as prescribed by Amato reform of 1992. Using the model notation, the retirement benefits for generations $t = -11, ..., -8$ are computed based on the average wage income during the last N_b periods of working life:

$$b^t = \frac{\overline{J}\phi^{1t}}{N_b} \sum_{j=\overline{J}-N_b}^{\overline{J}-1} w_{t+j} h_{t+j}^t l_{mt+j}^t, \tag{8}$$

where $\overline{J}$ accounts for number of periods an agent have been working,[1] ϕ^{1t} is the annual accrual rate.[2] To match the replacement rate for retirement benefits, I set ϕ^{1t} equal to 0.015. At the initial system, the benefits are calculated based on 5 calendar years, hence, N_b is set to one model period. The Social Security benefits are indexed during the retirement. At the pre-1992 system, the indexation is based on the wage growth rate, $\xi_t = \lambda_{wt}$. Starting with model period 1, the benefits are indexed to inflation, hence, $\xi_t = 1$ for $t = 1, 2, ...$

The retirement benefits for generations from 1935 to 1955 are computed using the Modified Defined Benefits (MDB) system. The benefits are based on the wage income received from 1997 up to retirement and are also indexed to inflation. The generations in this group had at least 20 years of seniority under the old system.[3,4] This formula is the same as the one for DB system but the pensionable earnings are computed based on the wage income from the period $t = 1$ onwards. These are generations that were born at $t = (i - J), i = 5, ..., 9$. From a time period of reform announcement, a generation t will work for the number of periods $\tilde{J} = \overline{J} - (1 - t)$ and live for the number of periods $\hat{J} = J - (1 - t) = i - 1$. The Social Security benefits are calculated according to the formula

$$b^{1,(i-J)} = \frac{\overline{J}\phi^{1,(i-J)}}{\tilde{J}} \sum_{t=1}^{\tilde{J}} w_t h_t^{(i-J)} l_{mt}^{(i-J)}.$$

The generations born from 1960 to 1970 receive retirement benefits on pro-rata basis. These generations had less than 20 years of seniority at the time $t = 1$. The first part of benefits is based on wage income prior to the period $t = 1$ and is computed based on the MDB formula. The second part is computed based on contributions from $t = 1$ and later using the Defined Contributions formula. Using model notation, these are generations that were born at $t = (i - J), i = 10, 11, 12$. From a time period of reform announcement, a

[1]Since there is no labor market exit/entrance in my model, the number of years for Social Security contributions is equal to the length of working life.

[2]Annual accrual rate was equal to 2 percent for earnings up to a given threshold. For the earnings above the threshold, the annual accrual rate was gradually decreased. The non-linearity of the annual accrual rate represented the distributive feather of the system.

[3]The seniority is determined based on the number of years worked. Since the agents don't make decision of labor market entrance/exit, the seniority is determined by the number of working years.

[4]The provisions of Italian reform put the threshold at 18 years of seniority at the end of 1995. Since my model period corresponds to five calendar years, my threshold is at least 20 calendar years or 4 model periods of working prior to the time period $t = 1$.

generation t will work for the number of periods $\tilde{J} = \overline{J} - (1-t)$ and live for the number of periods $\hat{J} = J - (1-t) = i - 1$. The first part of retirement benefits is calculated according to the MDB formula

$$b^{1,(i-J)} = \frac{\overline{J}\phi^{1,(i-J)}}{\overline{J} - \tilde{J}} \sum_{t=(i-J)}^{0} w_t h_t^{(i-J)} l_{mt}^{(i-J)}$$

and the second part is given by

$$b^{2,(i-J)} = \phi^{2,(i-J)} \sum_{t=1}^{\tilde{J}} \tau_{p,t} w_t h_t^{(i-J)} l_{mt}^{(i-J)} \prod_{z=t+1}^{\tilde{J}} (1 + \lambda_{Y,z}),$$

where λ_Y is the growth rate of output, ϕ^{2t} is the annuity rate. The annuity rate depends on the age of retirement, for the ages between 57 and 65. The annuity rates are published by *Istituto Nazionale Previdenza Sociale* (INPS) and is available at www.inps.it. In the calibration, I set $\phi^{2t} = 6.1\%$ as for 65 year-olds.

For all generations who enter the labor market at the time of reform announcement and later, the retirement benefits are calculated based on the Defined Contributions (DC) system. These are the generations that were born in 1975 and later. In the model, these generations are labeled by $t = 1, 2, ...$ Under the new system, the retirement age is equal to 65 calendar years or 9 period years. The Social Security benefits, $b^{2,t}$, are calculated based on Social Security contributions during the working life:

$$b^{2,t} = \left[\sum_{j=0}^{\overline{J}-1} \tau_{p,t+j} w_{t+j} h_{t+j}^{t} l_{mt+j}^{t} \prod_{z=j+1}^{\overline{J}-1} (1 + \lambda_{Y,t+z}) \right] \phi^{2t}, \tag{9}$$

where λ_Y is the growth rate of output, ϕ^{2t} is the annuity rate. The Social Security benefits are indexed to inflation at the new system. The Social Security benefits are calculated based on wage income during the whole working period, $N_b = \overline{J}$. The contributions to Social Security system is determined by payroll taxes, τ_p, and are compounded by the growth rate of output.

4.2 Parameters of utility and production functions

The time preference parameter β is calibrated to match the capital-to-output ratio at the level of 3. I assume that the agents' flow utility functions are

$$u(c, 1 - l_m - l_h) = \log c + \alpha \log(1 - l_m - l_h),$$

where α is chosen to match average weekly hours of the population of ages between 20 and 64.

The calibration of production technology is standard. Capital income share, θ, is set to 0.333. Depreciation of physical capital, δ_k, is calibrated to match the investment share in GDP. The resulting depreciation rate is 5.4%. This estimate of the depreciation rate is in line with the one commonly used in the literature. Stokey and Rebelo (1995) estimate the depreciation rate to be 6%. Rios-Rull (1996) calibration results in the rate of 5.4%.

Average effective tax rates are calibrated using the methodology of Mendoza, Razin and Tesar (1994) and are reported in Table 4. The share of government expenditures in output, g, is set to match the corresponding value in NIPA. The replacement rate for pension benefits, ϕ^1, is calibrated to match the replacement rate for pensions.

4.3 Parameters of human capital production technology

I assume the following law of motion for human capital:

$$h_{j+1} = (1 - \delta_h)h_j + Bh_j^{\psi_1} l_{h,j}^{\psi_2},$$

where the conditions $B, \psi_1, \psi_2 \geq 0$ and $\psi_1 + \psi_2 \leq 1$ guarantee the decreasing returns to scale. Hence, the life-cycle profile of time investment into human capital is time-independent.

I have to choose five parameters for the human capital production technology: initial stock of human capital, h_0; the depreciation rate of human capital, δ_h; productivity of human capital accumulation, B; weight of human capital stock in new accumulation, ψ_1; and weight of time investment, ψ_2. I calibrate these parameters to match the life-cycle earnings profile, which is constructed using data from Survey of Household Income and Wealth (SHIW) collected by the Bank of Italy. I divide the population of ages between 20 and 64 into nine age groups, $j \in \{0, ..., 8\}$. The size of the working age population is denoted by N_t. The measure of earnings is the hourly wage rate, denoted by e_j, $j \in \{0, ..., 8\}$. The average wage rate for the working population is denoted by $\overline{e}$. This average rate for the working population is calculated using the size of each age group, $n_j(t)$:

$$\overline{e} = \frac{\sum_{j=0}^{8} n_j(t) e_j}{N_t}.$$

To express the wage earnings profile in units comparable to the model, I report the average hourly wage for an age group j as the ratio to the average hourly wage of the working population: $\varepsilon_j = e_j / \overline{e}$, $j = 0, ..., 8$.

Equivalently, the wage rate in the model is $w_t h_j$ and the average wage for the working population is

$$\overline{wh} = \frac{\sum_{j=0}^{8} w_t h_j}{\overline{J}}.$$

I choose parameters of the human capital production function to minimize the distance between the model and data wage hour profiles:

$$\min_{(h_0, \delta_h, B, \psi_1, \psi_2)} \sum_{j=0}^{8} \left(\frac{wh_j}{\overline{wh}} - \frac{e_j}{\overline{e}} \right)^2.$$

The chosen parameters are reported in Table 4. The resulting life-cycle efficiency profile at the initial stationary equilibrium with the defined benefits system is plotted in Figure 1.

5 Results

People who entered the labor market after 1995 will have their retirement benefits computed using the DC formula. By 2040, the stock of all retirees will receive their benefits under the new system. This paper shows that the Italian economy will reach a new stationary equilibrium by 2100, see evolution of wage and interest rates reported in Figure 4.

The simulations consider two reforms that took place during the 1990s. In the first reform, the indexation of retirement benefits is switched from wage growth to inflation. This reform affects all generations alive in 1995 including people who have already retired. The second reform is cumulative to the first one and considers the transition to a system with a defined contributions benefits. In this simulation, I model the change in the benefit formula depending on the labor market seniority in 1995 as prescribed by legislative acts of Dini reform. The details on the method for calculating the pension benefits for transition generations are given in section 4.1 In all graphs, these two reforms are labeled as 'Reform 1' and 'Reform 2', respectively.

Figure 2 shows the evolution of the government budget during the transition. The payroll tax used to finance the retirement benefits is fixed during the transition. The general government budget is balanced through adjustments in the labor income tax. Although the government maintains two budgets, one for the retirement system and one for the general government expenditures, the pension system can be subsidized from the general revenue. The switch to the indexation of the retirement benefits to inflation reduces the government expenditures by 10% in the first 10 years after the introduction of the reforms. Figure 2 confirms that the change in the indexation method is only effective in the short run. Since the Dini reform preserves the pension rights of the generations with more than 18 years of seniority at 1995, the government pension expenditures exceed the pre-reform level for the period from 2010 to 2024 when these generations enter the retirement. From year 2025, the pension expenditures are bellow the pre-reform level and eventually decrease by 24% in the new stationary equilibrium. Due to the labor supply decision responses, the revenues to the pension fund fluctuate around the pre-reform level until year 2024 and increase by 8.5% by year 2070. Therefore, the reforms are effective in restoring the financial balance of the pension system in the long-run.

Reduction in the pension benefits induces the agents to increase their savings. Hence, the aggregate capital stock will increase by 13% by year 2070 as shown in Figure 3. Before year 2025, the capital stock increases only by 2% which is due to the behavior of the cohorts that have already participated in the labor market at the time of the reforms implementation. Within the DC retirement system, the aggregate labor supply will be 6.3% higher than the one before 1992. These changes in the factors of production will lead to adjustments in the wage and interest rates. As reported in Figure 4, the wage rate will increase at the new stationary equilibrium, while the interest rate will decline by 28 percentage points.

Figure 5 reports household welfare as measured by compensating variations. The cohorts are shown by their year of birth. The cohort born in 1915 have completed their lives under the retirement system with the defined benefits. The welfare of all generations is compared to the life-time utility of the cohort born in 1915. The compensating variations measures in percentages by how much in terms of life-time consumption an agent has to be compensated in order to make him indifferent between the reforms and the initial stationary equilibrium with the DB system. Formally, let $c_{t+j}^{t,z}$, $l_{m,t+j}^{t,z}$, and $l_{h,t+j}^{t,z}$ be the consumption and labor market choices of cohort born at the time period t, of age j and under a retirement system z. The retirement systems considered are the pre-1992 system with defined benefits (DB), the Amato reform with the change in the indexation of benefits (Reform 1), and the Dini reform that have introduced the defined contributions system (Reform 2). The compensating variation associated with a switch from DB to system z, for cohort t, is calculated as the $CV^{t,z}$ such that the lifetime utility under system z and system DB are equal:

$$\sum_{j=0}^{J-1} \beta^j u(c_{t+j}^{t,DB} \frac{(100 + CV^{t,z})}{100}, 1 - l_{m,t+j}^{t,DB} - l_{h,t+j}^{t,DB}) = \sum_{j=0}^{J-1} \beta^j u(c_{t+j}^{t,z}, 1 - l_{m,t+j}^{t,z} - l_{h,t+j}^{t,z}).$$

In terms of welfare consequences, the cohorts can be divided into five groups. Firstly, the cohorts born from 1920 to 1935 have completed their working lives under the old system and are affected by the change in the indexation rules. Since these agents can't change their stock of savings, their welfare decreases by 1.1% on average. The second group consists of the cohorts who had more than 20 years of labor market experience in 1995. The pension benefits of these generation is computed using the MDB formula. The welfare of the generations born between 1940 and 1955 will increase by 0.7% on average. The generations whose pension benefits are calculated with the pro-rata system are in the third group. The welfare of these generations will decrease by 2.1%. The cohorts that have entered the labor market immediately after the implementation of the reforms are in the fourth group. The generations born from 1975 to 2000 are adversely affected by the macroeconomic adjustments that are taking place during the transition and the welfare of these cohorts is bellow negative 2%. The fifth group consists of the generations that are alive in the new stationary equilibrium, their welfare have decrease by only 0.16% as compared to the DB retirement system.

The explanation for the welfare experience of the different cohorts can also be provided through the present value ratio (PVR) which is the ratio between the present value of future pension benefits and the present value of contributions paid, both valued at the beginning of life. The agents' welfare and the PVR are both plotted in Figure 7. The PVR for the cohort born in 1915 is normalized to one. As we can see from the figure, the retirees at the time of the reform introduction, the cohorts from 1920 to 1935, have the drop in their PVR by as low as 11%. The generations born from 1940 to 1955 had their pension rights protected and their PVR increases to as high as 7.8%. Finally, the PVR for the generations born in 1960 and onwards drops by 24%. Clearly, the generations which had more than 18 years of seniority at the end of 1995 have been protected and have benefitted from the reforms. While the younger and future generations incur the cost of moving to a new retirement system.

Agents allocate their time endowment between leisure, market production and human capital investment activities. Figure 6 plots average weekly hours for working age population in a given year. Initially, there are a lot of changes in the hours of work as transition generations adjust their labor supply in response to the reform introduction. The average market hours decline by 1 hour per week by year 2022 and return back to a pre-reform level by year 2050. At the same time, the investment hours display an increasing trend during the transition and are on average 2 hours per week higher in the new stationary equilibrium with the DC retirement system as compared to the pre-reform level. Therefore, investment into human capital is an important channel for adjustments during the transition to the DC retirement system and leads to higher levels of aggregate labor supply and output at the new stationary equilibrium, see Figure 3.

Individual allocations are recorded in Tables 5 to 10. These tables show how different generations are affected by the rules of implementing a new retirement system. The generations who have already retired in 1995, for example, the generation born in 1930 in Table 5, are affected by the change in the indexation rule. These agents can not adjust their labor supply and experience the decrease in consumption due to the reduction in their pension benefits. The generations with more than 18 years of labor market experience in 1995 have been the most protected by the reforms. As can be seen from Table 6, the generation born in 1950 will increase their consumption with negligible adjustments in the labor supply behavior.

The generations who have already entered the labor market at the time of reform announcement but had very little experience have to change their labor market decisions. The generation born in 1970 has almost the same lifetime consumption profile as the generation which have completed their lives under the DB system. But this generation have to increase their savings to compensate for the reduction in the present value of their pension benefits. To achieve the higher stock of savings, these agents increase the investment into the human capital early in life and work more hours during the later stages of their career to take advantage of the higher labor productivity. The change in hours of work for this generation is documented in Table 7.

The generation born in 1985 will have their retirement benefits calculated under the new DC system. The consumption of this generation goes down early in life because they increase their human capital investment. These agents also postpone the savings to the later stages of life when they have the highest level of labor market earnings, see Table 8.

For generations born in the new stationary equilibrium with a DC pension system, such as the generation born in 2090 and reported in Table 10, the increase in the lifetime consumption is achieved through higher investment into the human capital early in life and through higher market hours during middle ages.

6 Conclusion

This paper have used a general equilibrium overlapping generations model with endogeneous labor supply and human capital accumulation decisions to analyze the impact of the 1990s reforms in Italy on welfare of transition and future generations. The general equilibrium set-up also allows to predict the evolution of macroeconomic variables during the transition to a new retirement system with defined contributions benefits.

The analysis have shown that the introduced pension reforms will be effective in the long-run in reducing the pension expenditures and restoring the balance to the public retirement system. However, the implementation of the reforms has unequal treatment of transition generations. The agents with more than 18 years of labor market experience in 1995 have been protected by the reforms and experience welfare gains due to the changes in the retirement system. While younger and future generations bare the cost of moving to the DC retirement system.

This paper have analyzed two major reforms that took place during the 1990s. The first reform implemented the indexation of pension benefits to prices as compared to wages before and the second reform introduced the defined contributions system. The simulations show that the change in the indexation rule decreases the pension expenditures only in the short-run while the introduction of the DC system leads to more sizeable reduction by year 2050.

The results of this paper raise more general questions about government transfer programs. The introduction of the DC retirement system induces the agents to increase their human capital. This leads to higher time investment into human capital and lower consumption early in life. Hence, some form of transfers to young and borrowing-constrained agents will help to smooth their lifetime consumption and increase welfare.

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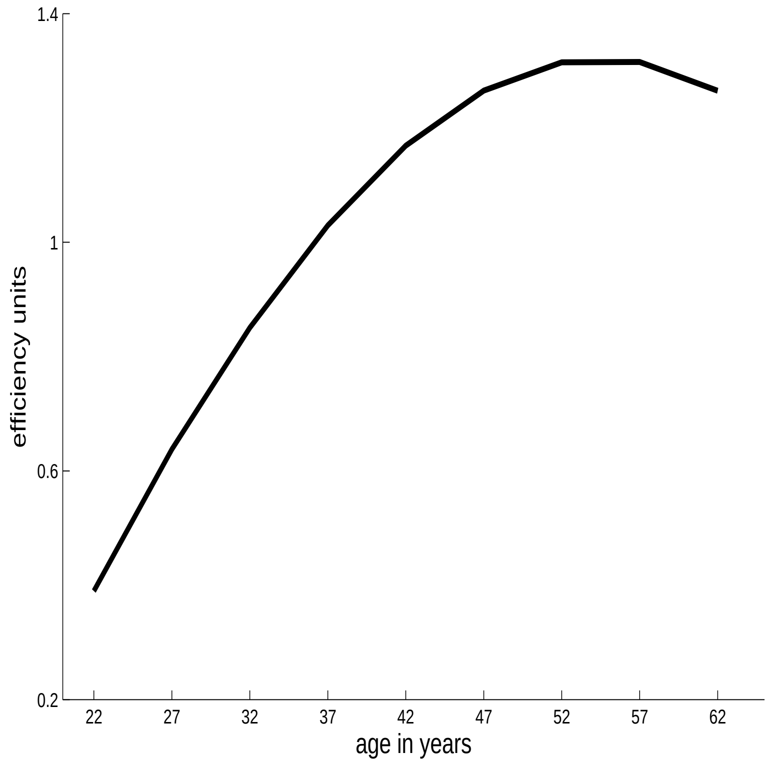
Figure 1: Profile of efficiency units by age.



Profile of efficiency units is given for the initial stationary equilibrium with Defined Benefits retirement system. The profile represents the wage income during the working life scaled to the average wage income.

Table 1: Population Structure during Transition.

Generations	Time Periods													
year born	1992	1997	2002	2007	2012	2017	2022	2027	2032	2037	2042	2047	2052	2057
	Defined benefits, Pensione retributiva													
1915	$\mathbf{c_{92}^{15}}$													
1920	$\mathbf{c_{92}^{20}}$	$\mathbf{c_{97}^{20}}$												
1925	$\mathbf{c_{92}^{25}}$	$\mathbf{c_{97}^{25}}$	$\mathbf{c_{02}^{25}}$											
1930	c_{92}^{30}	$\mathbf{c_{97}^{30}}$	$\mathbf{c_{02}^{30}}$	$\mathbf{c_{07}^{30}}$										
	Modified defined benefits													
1935	c_{92}^{35}	c_{97}^{35}	$\mathbf{c_{02}^{35}}$	$\mathbf{c_{07}^{35}}$	$\mathbf{c_{12}^{35}}$									
1940	c_{92}^{40}	c_{97}^{40}	c_{02}^{40}	$\mathbf{c_{07}^{40}}$	$\mathbf{c_{12}^{40}}$	$\mathbf{c_{17}^{40}}$								
1945	c_{92}^{45}	c_{97}^{45}	c_{02}^{45}	c_{07}^{45}	$\mathbf{c_{12}^{45}}$	$\mathbf{c_{17}^{45}}$	$\mathbf{c_{22}^{45}}$							
1950	c_{92}^{50}	c_{97}^{50}	c_{02}^{50}	c_{07}^{50}	c_{12}^{50}	$\mathbf{c_{17}^{50}}$	$\mathbf{c_{22}^{50}}$	$\mathbf{c_{27}^{50}}$						
1955	c_{92}^{55}	c_{97}^{55}	c_{02}^{55}	c_{07}^{55}	c_{12}^{55}	c_{17}^{55}	$\mathbf{c_{22}^{55}}$	$\mathbf{c_{27}^{55}}$	$\mathbf{c_{32}^{55}}$					
	Combined system DB-DC, Pensione pro rata													
1960	c_{92}^{60}	c_{97}^{60}	c_{02}^{60}	c_{07}^{60}	c_{12}^{60}	c_{17}^{60}	c_{22}^{60}	$\mathbf{c_{27}^{60}}$	$\mathbf{c_{32}^{60}}$	$\mathbf{c_{37}^{60}}$				
1965	c_{92}^{65}	c_{97}^{65}	c_{02}^{65}	c_{07}^{65}	c_{12}^{65}	c_{17}^{65}	c_{22}^{65}	c_{27}^{65}	$\mathbf{c_{32}^{65}}$	$\mathbf{c_{37}^{65}}$	$\mathbf{c_{42}^{65}}$			
1970	c_{92}^{70}	c_{97}^{70}	c_{02}^{70}	c_{07}^{70}	c_{12}^{70}	c_{17}^{70}	c_{22}^{70}	c_{27}^{70}	c_{32}^{70}	$\mathbf{c_{37}^{70}}$	$\mathbf{c_{42}^{70}}$	$\mathbf{c_{47}^{70}}$		
	Defined contributions, Pensione contributiva													
1975		c_{97}^{75}	c_{02}^{75}	c_{07}^{75}	c_{12}^{75}	c_{17}^{75}	c_{22}^{75}	c_{27}^{75}	c_{32}^{75}	c_{37}^{75}	$\mathbf{c_{42}^{75}}$	$\mathbf{c_{47}^{75}}$	$\mathbf{c_{52}^{75}}$	
1980			c_{02}^{80}	c_{07}^{80}	c_{12}^{80}	c_{17}^{80}	c_{22}^{80}	c_{27}^{80}	c_{32}^{80}	c_{37}^{80}	c_{42}^{80}	$\mathbf{c_{47}^{80}}$	$\mathbf{c_{52}^{80}}$	$\mathbf{c_{57}^{80}}$

Table represents consumption of transition cohorts during the retirement reforms. Superscript for consumption allocation denotes the cohort and subscript stands for the time period when allocation takes place. 1992 is the year of initial stationary equilibrium with defined benefits retirement system. The reforms are implemented starting with 1997.

Table 2: Timing convention in the model.

Time Periods			Generations		
Time period	Year	Model period	Year born	Year model entrance	Model generation
1990-94	1992	0	1915	1935	-11
1995-99	1997	1	1920	1940	-10
2000-04	2002	2	1925	1945	-9
2005-09	2007	3	1930	1950	-8
2010-14	2012	4	1935	1955	-7
2015-19	2017	5	1940	1960	-6
2020-24	2022	6	1945	1965	-5
2025-29	2027	7	1950	1970	-4
2030-34	2032	8	1955	1975	-3
2035-39	2037	9	1960	1980	-2
2040-44	2042	10	1965	1985	-1
2045-49	2047	11	1970	1990	0
2050-54	2052	12	1975	1995	1
2055-59	2057	13	1980	2000	2
2060-64	2062	14	1985	2005	3

To simplify notation in the chapter, I relabel the periods as specified in the table. Timing for periods and generations continues to incorporate transition to a new stationary equilibrium.

Table 3: Model Structure of Generations during Transition.

GENERATIONS	TIME PERIODS													
period born	0	1	2	3	4	5	6	7	8	9	10	11	12	13
	Defined benefits, Pensione retributiva													
$t=-11$	$\mathbf{c_0^{-11}}$													
$t=-10$	$\mathbf{c_0^{-10}}$	$\mathbf{c_1^{-10}}$												
$t=-9$	$\mathbf{c_0^{-9}}$	$\mathbf{c_1^{-9}}$	$\mathbf{c_2^{-9}}$											
$t=-8$	c_0^{-8}	$\mathbf{c_1^{-8}}$	$\mathbf{c_2^{-8}}$	$\mathbf{c_3^{-8}}$										
	Modified defined benefits													
$t=-7$	c_0^{-7}	c_1^{-7}	$\mathbf{c_2^{-7}}$	$\mathbf{c_3^{-7}}$	$\mathbf{c_4^{-7}}$									
$t=-6$	c_0^{-6}	c_1^{-6}	c_2^{-6}	$\mathbf{c_3^{-6}}$	$\mathbf{c_4^{-6}}$	$\mathbf{c_5^{-6}}$								
$t=-5$	c_0^{-5}	c_1^{-5}	c_2^{-5}	c_3^{-5}	$\mathbf{c_4^{-5}}$	$\mathbf{c_5^{-5}}$	$\mathbf{c_6^{-5}}$							
$t=-4$	c_0^{-4}	c_1^{-4}	c_2^{-4}	c_3^{-4}	c_4^{-4}	$\mathbf{c_5^{-4}}$	$\mathbf{c_6^{-4}}$	$\mathbf{c_7^{-4}}$						
$t=-3$	c_0^{-3}	c_1^{-3}	c_2^{-3}	c_3^{-3}	c_4^{-3}	c_5^{-3}	$\mathbf{c_6^{-3}}$	$\mathbf{c_7^{-3}}$	$\mathbf{c_8^{-3}}$					
	Combined system DB-DC, Pensione pro rata													
$t=-2$	c_0^{-2}	c_1^{-2}	c_2^{-2}	c_3^{-2}	c_4^{-2}	c_5^{-2}	c_6^{-2}	$\mathbf{c_7^{-2}}$	$\mathbf{c_8^{-2}}$	$\mathbf{c_9^{-2}}$				
$t=-1$	c_0^{-1}	c_1^{-1}	c_2^{-1}	c_3^{-1}	c_4^{-1}	c_5^{-1}	c_6^{-1}	c_7^{-1}	$\mathbf{c_8^{-1}}$	$\mathbf{c_9^{-1}}$	$\mathbf{c_{10}^{-1}}$			
$t=0$	c_0^{0}	c_1^{0}	c_2^{0}	c_3^{0}	c_4^{0}	c_5^{0}	c_6^{0}	c_7^{0}	c_8^{0}	$\mathbf{c_9^{0}}$	$\mathbf{c_{10}^{0}}$	$\mathbf{c_{11}^{0}}$		
	Defined contributions, Pensione contributiva													
$t=1$		c_1^{1}	c_2^{1}	c_3^{1}	c_4^{1}	c_5^{1}	c_6^{1}	c_7^{1}	c_8^{1}	c_9^{1}	$\mathbf{c_{10}^{1}}$	$\mathbf{c_{11}^{1}}$	$\mathbf{c_{12}^{1}}$	
$t=2$			c_2^{2}	c_3^{2}	c_4^{2}	c_5^{2}	c_6^{2}	c_7^{2}	c_8^{2}	c_9^{2}	c_{10}^{2}	$\mathbf{c_{11}^{2}}$	$\mathbf{c_{12}^{2}}$	$\mathbf{c_{13}^{2}}$

This table presents model structure of generations during transition. I have relabeled the generations and time periods in accordance with convention specified in the previous table. Allocations in bold represent consumption during retirement.

Table 4: Model Parameters.

Parameter	Expression	Value
Preferences and Technology		
Discount factor	β	1.010
Leisure preference parameter	α	1.85
Capital share	θ	0.333
Depreciation rate of physical capital	δ_k	0.054
Rate of technological progress	γ	0.018
Rate of population growth	η	0.007
Government Sector		
Tax rate on consumption	τ_c	0.11
Tax rate on labor income	τ_l	0.15
Social Security tax rate	τ_{ss}	0.16
Tax rate on capital income	τ_k	0.25
Share of government expenditures	g	0.1438
Replacement rate for Social Security benefits	ϕ^1	0.015
Human Capital Technology		
Initial stock of human capital	h_0	0.45
Depreciation rate of human capital	δ_h	0.019
Productivity of HC accumulation	B	0.56
Weight of HC stock	ψ_1	0.43
Weight of time investment	ψ_2	0.40

All parameter values are given in annual terms. Since one model period corresponds to five years, the parameters are adjusted in computations accordingly. All parameters are given for initial stationary equilibrium.

Table 5: Allocations for generation born in 1930.

					Change from generation 1915			
Age	c	l_m	l_h	s'	c	l_m	l_h	s'
22	0.51	7.91	61.76	0.00	0.00	0.00	0.00	0.00
27	1.47	20.37	32.35	0.00	0.00	0.00	0.00	0.00
32	2.52	26.14	20.81	0.13	0.00	0.00	0.00	0.00
37	3.26	37.05	13.39	1.98	0.00	0.00	0.00	0.00
42	4.21	42.42	8.21	5.69	0.00	0.00	0.00	0.00
47	5.45	43.90	4.51	11.03	0.00	0.00	0.00	0.00
52	7.04	41.87	1.98	17.19	0.00	0.00	0.00	0.00
57	9.10	36.03	0.50	22.39	0.00	0.00	0.00	0.00
62	11.77	25.34	0.00	23.53	0.00	0.00	0.00	0.00
67	14.52	0.00	0.00	21.53	-0.70	0.00	0.00	0.76
72	18.75	0.00	0.00	14.51	-0.92	0.00	0.00	0.82
77	24.15	0.00	0.00	0.00	-1.28	0.00	0.00	0.00

Consumption and savings variables are detrended towards the initial stationary equilibrium. Market production and human capital investment hours are weekly ones.

Table 6: Allocations for generation born in 1950.

					Change from generation 1915			
Age	c	l_m	l_h	s'	c	l_m	l_h	s'
22	0.51	7.91	61.76	0.00	0.00	0.00	0.00	0.00
27	1.47	20.37	32.35	0.00	0.00	0.00	0.00	0.00
32	2.52	26.14	20.81	0.13	0.00	0.00	0.00	0.00
37	3.26	37.05	13.39	1.98	0.00	0.00	0.00	0.00
42	4.21	42.42	8.21	5.69	0.00	0.00	0.00	0.00
47	5.56	43.62	4.50	10.99	0.12	-0.27	-0.01	-0.04
52	7.19	41.91	1.94	17.20	0.15	0.04	-0.05	0.01
57	9.25	35.89	0.48	22.26	0.15	-0.14	-0.02	-0.13
62	11.90	24.78	0.00	22.92	0.13	-0.56	0.00	-0.61
67	15.30	0.00	0.00	21.24	0.09	0.00	0.00	0.47
72	19.72	0.00	0.00	14.49	0.05	0.00	0.00	0.80
77	25.55	0.00	0.00	0.00	0.12	0.00	0.00	0.00

Consumption and savings variables are detrended towards the initial stationary equilibrium. Market production and human capital investment hours are weekly ones.

Table 7: Allocations for generation born in 1970.

					Change from generation 1915			
Age	c	l_m	l_h	s'	c	l_m	l_h	s'
22	0.51	7.91	61.76	0.00	0.00	0.00	0.00	0.00
27	1.47	19.93	33.78	0.00	-0.01	-0.44	1.43	0.00
32	2.57	25.80	21.54	0.11	0.05	-0.34	0.73	-0.02
37	3.31	36.85	14.01	2.00	0.05	-0.20	0.62	0.02
42	4.25	42.17	8.82	5.74	0.04	-0.25	0.60	0.05
47	5.47	43.79	5.05	11.13	0.02	-0.10	0.54	0.09
52	7.05	42.36	2.37	17.57	0.01	0.49	0.39	0.38
57	9.13	38.22	0.64	24.00	0.02	2.19	0.15	1.61
62	11.83	29.52	0.00	27.53	0.07	4.19	0.00	4.00
67	15.32	0.00	0.00	24.71	0.10	0.00	0.00	3.94
72	19.74	0.00	0.00	16.36	0.06	0.00	0.00	2.67
77	25.34	0.00	0.00	0.00	-0.09	0.00	0.00	0.00

Consumption and savings variables are detrended towards the initial stationary equilibrium. Market production and human capital investment hours are weekly ones.

Table 8: Allocations for generation born in 1985.

					Change from generation 1915			
Age	c	l_m	l_h	s'	c	l_m	l_h	s'
22	0.47	6.57	65.70	0.00	-0.04	-1.34	3.94	0.00
27	1.45	19.65	34.51	0.00	-0.02	-0.72	2.16	0.00
32	2.54	24.67	22.59	0.00	0.02	-1.47	1.78	-0.13
37	3.41	34.15	15.08	1.36	0.15	-2.89	1.69	-0.62
42	4.41	41.18	9.42	4.84	0.20	-1.25	1.21	-0.85
47	5.72	44.12	5.33	10.46	0.27	0.22	0.82	-0.57
52	7.40	43.68	2.45	17.68	0.36	1.81	0.47	0.49
57	9.54	39.49	0.68	24.81	0.44	3.46	0.18	2.42
62	12.25	30.93	0.00	28.88	0.48	5.60	0.00	5.35
67	15.68	0.00	0.00	25.55	0.47	0.00	0.00	4.78
72	20.05	0.00	0.00	16.74	0.38	0.00	0.00	3.05
77	25.62	0.00	0.00	0.00	0.19	0.00	0.00	0.00

Consumption and savings variables are detrended towards the initial stationary equilibrium. Market production and human capital investment hours are weekly ones.

Table 9: Allocations for generation born in 2030.

					Change from generation 1915			
Age	c	l_m	l_h	s'	c	l_m	l_h	s'
22	0.44	4.94	70.13	0.00	-0.06	-2.97	8.37	0.00
27	1.55	19.32	35.52	0.00	0.07	-1.06	3.17	0.00
32	2.77	24.67	22.67	0.00	0.25	-1.47	1.86	-0.13
37	3.69	34.85	14.81	1.62	0.43	-2.19	1.42	-0.36
42	4.71	41.47	9.27	5.42	0.50	-0.95	1.06	-0.27
47	6.01	44.17	5.26	11.31	0.56	0.28	0.75	0.27
52	7.67	43.54	2.43	18.60	0.63	1.67	0.45	1.41
57	9.78	39.39	0.67	25.72	0.68	3.36	0.17	3.33
62	12.47	30.79	0.00	29.68	0.71	5.46	0.00	6.16
67	15.91	0.00	0.00	26.10	0.70	0.00	0.00	5.33
72	20.29	0.00	0.00	17.03	0.62	0.00	0.00	3.35
77	25.88	0.00	0.00	0.00	0.45	0.00	0.00	0.00

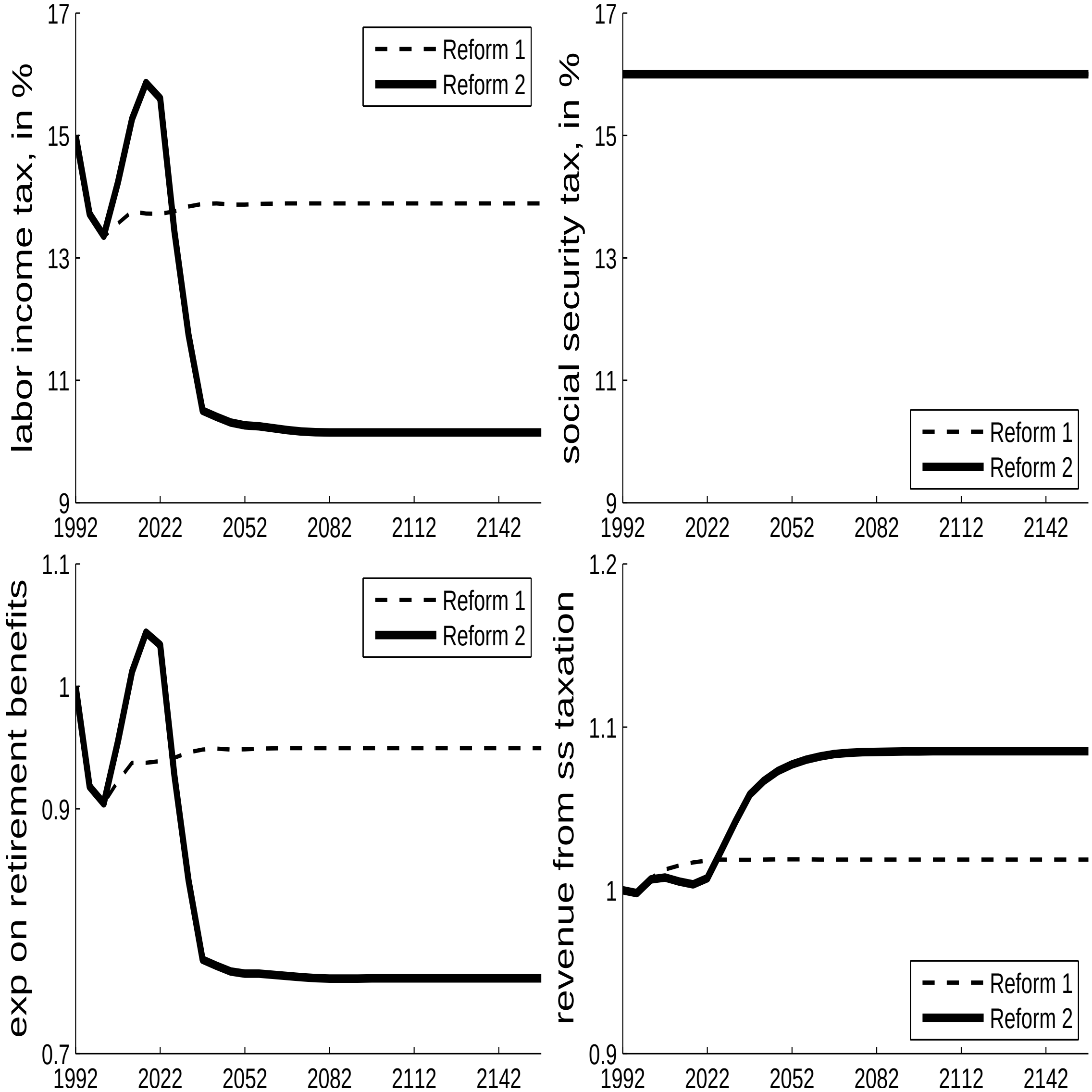
Consumption and savings variables are detrended towards the initial stationary equilibrium. Market production and human capital investment hours are weekly ones.

Table 10: Allocations for generation born in 2090.

					Change from generation 1915			
Age	c	l_m	l_h	s'	c	l_m	l_h	s'
22	0.45	4.95	70.09	0.00	-0.06	-2.96	8.33	0.00
27	1.55	19.32	35.50	0.00	0.08	-1.05	3.16	0.00
32	2.78	24.67	22.67	0.00	0.26	-1.46	1.85	-0.13
37	3.70	34.86	14.80	1.62	0.44	-2.18	1.41	-0.35
42	4.71	41.47	9.27	5.43	0.50	-0.95	1.06	-0.26
47	6.01	44.17	5.26	11.32	0.57	0.28	0.75	0.28
52	7.67	43.54	2.43	18.61	0.63	1.66	0.45	1.42
57	9.78	39.38	0.67	25.73	0.68	3.35	0.17	3.34
62	12.48	30.79	0.00	29.69	0.71	5.45	0.00	6.16
67	15.91	0.00	0.00	26.10	0.70	0.00	0.00	5.33
72	20.29	0.00	0.00	17.03	0.62	0.00	0.00	3.35
77	25.88	0.00	0.00	0.00	0.45	0.00	0.00	0.00

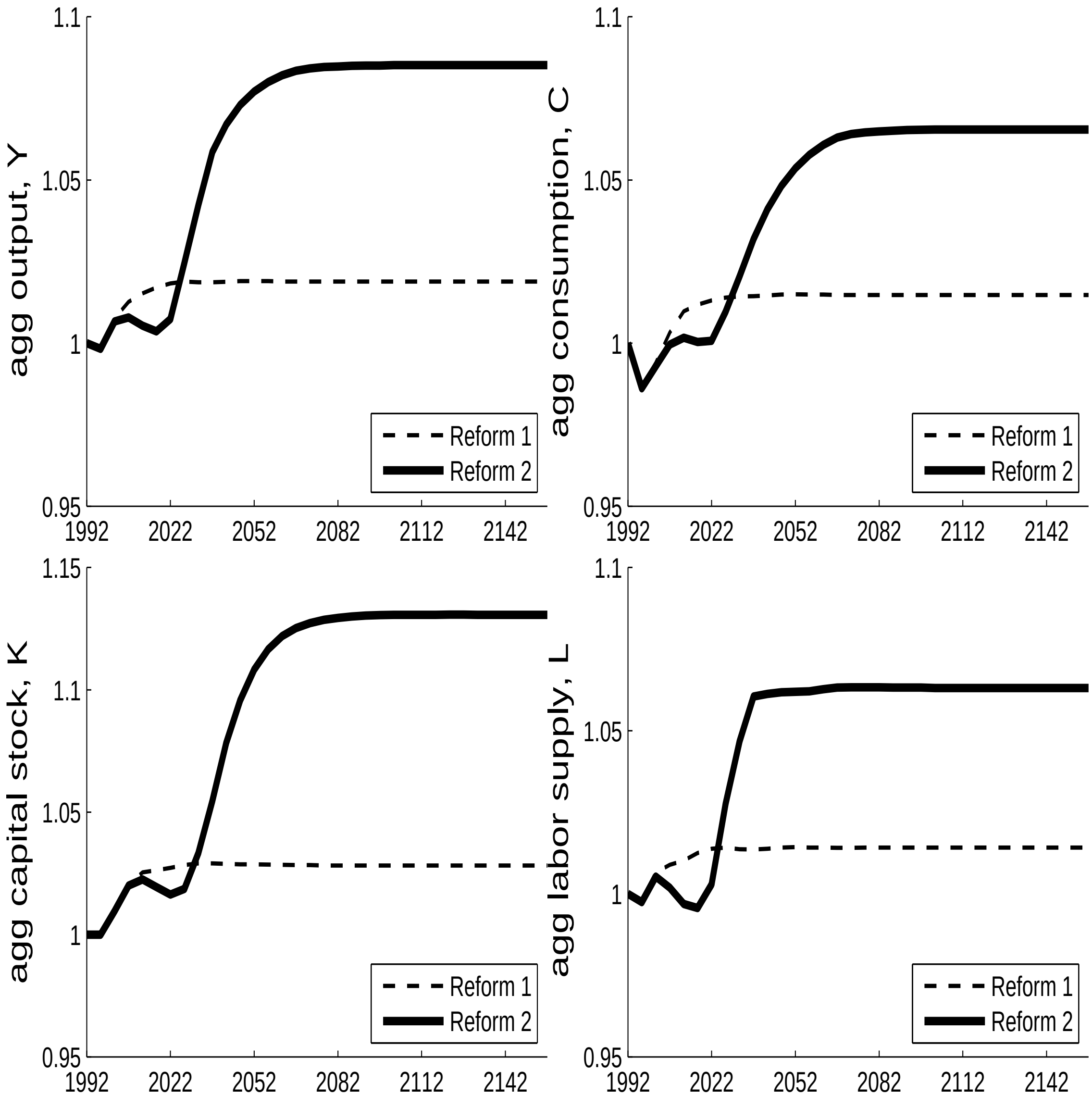
Consumption and savings variables are detrended towards the initial stationary equilibrium. Market production and human capital investment hours are weekly ones.

Figure 2: Budget for public pension system.



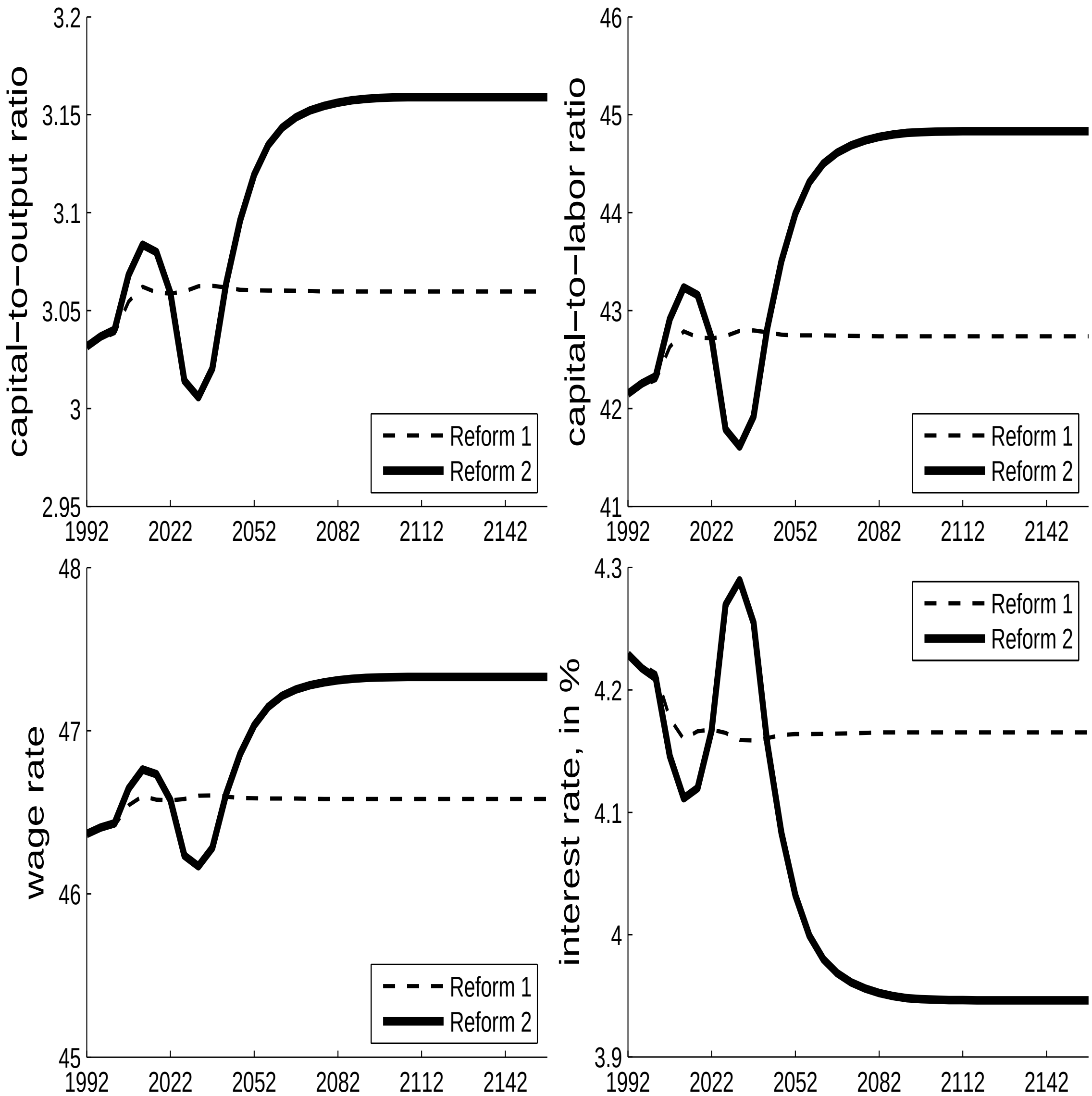
Tax on labor income is adjusted to keep the general government budget balanced during the transition while the social security tax is held fixed. Pension expenditures and revenue are detrended towards the stationary equilibrium and are expressed as ratios of the initial stationary equilibrium values. Year 1992 represents the initial stationary equilibrium with Defined Benefits retirement system. In Reform 1, indexation of retirement benefits is moved from real wages to prices, while Reform 2 also includes the shift towards Defined Contribution system.

Figure 3: Macroeconomic variables.



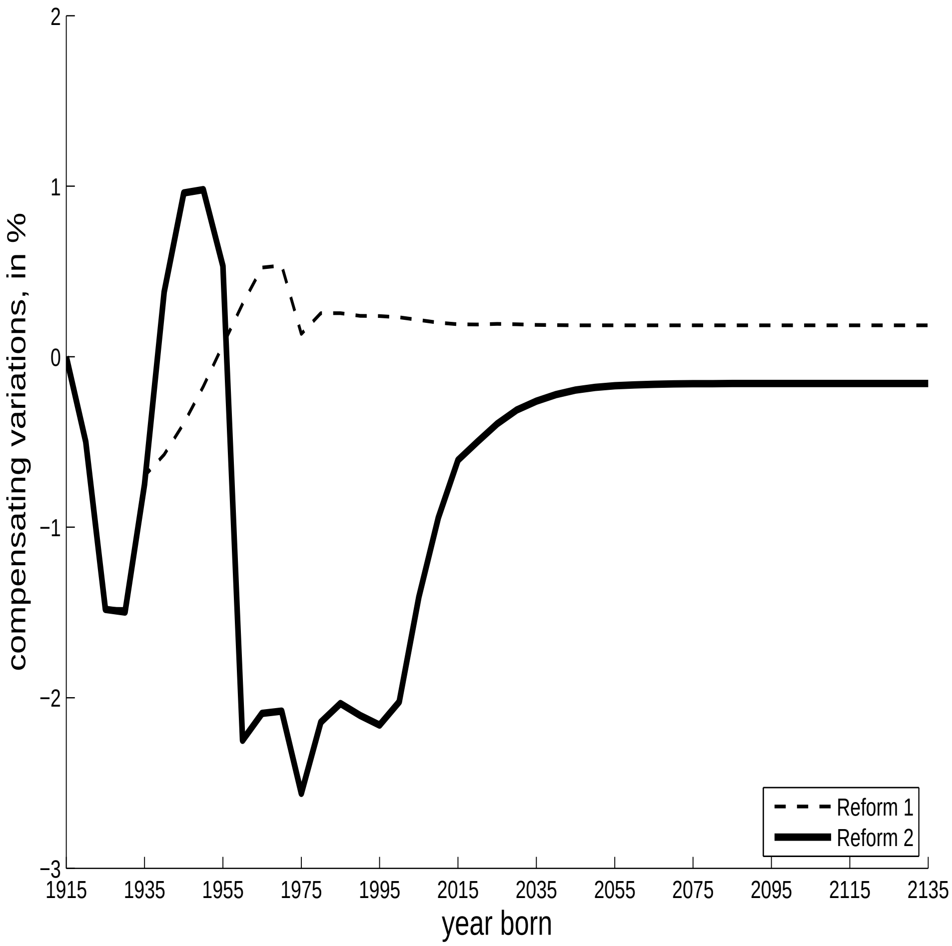
All macroeconomic variables are detrended towards the stationary equilibrium and are expressed as ratios of the initial stationary equilibrium values. Year 1992 represents the initial stationary equilibrium with Defined Benefits retirement system. In Reform 1, indexation of retirement benefits is moved from real wages to prices, while Reform 2 also includes the shift towards the Defined Contribution retirement system.

Figure 4: Macroeconomic variables and factor prices.



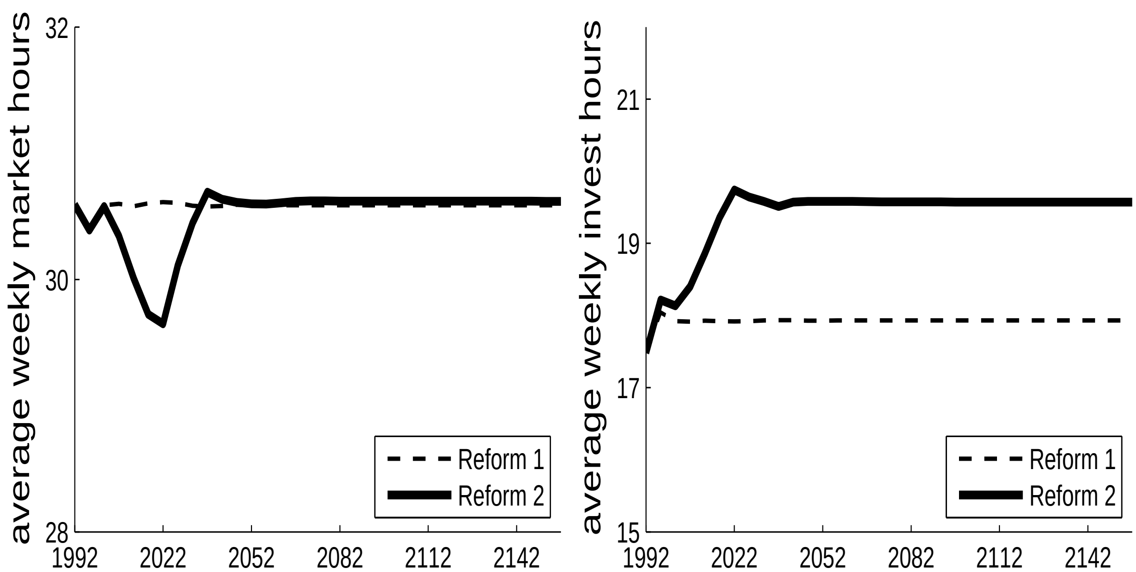
All macroeconomic variables are detrended towards the stationary equilibrium. Capital-to-labor ratio and wage rate are given in model units. Interest rate is expressed in annual terms. Year 1992 represents the initial stationary equilibrium with Defined Benefits retirement system. In Reform 1, indexation of retirement benefits is moved from real wages to prices, while Reform 2 also includes the shift towards the Defined Contribution retirement system.

Figure 5: Household welfare.



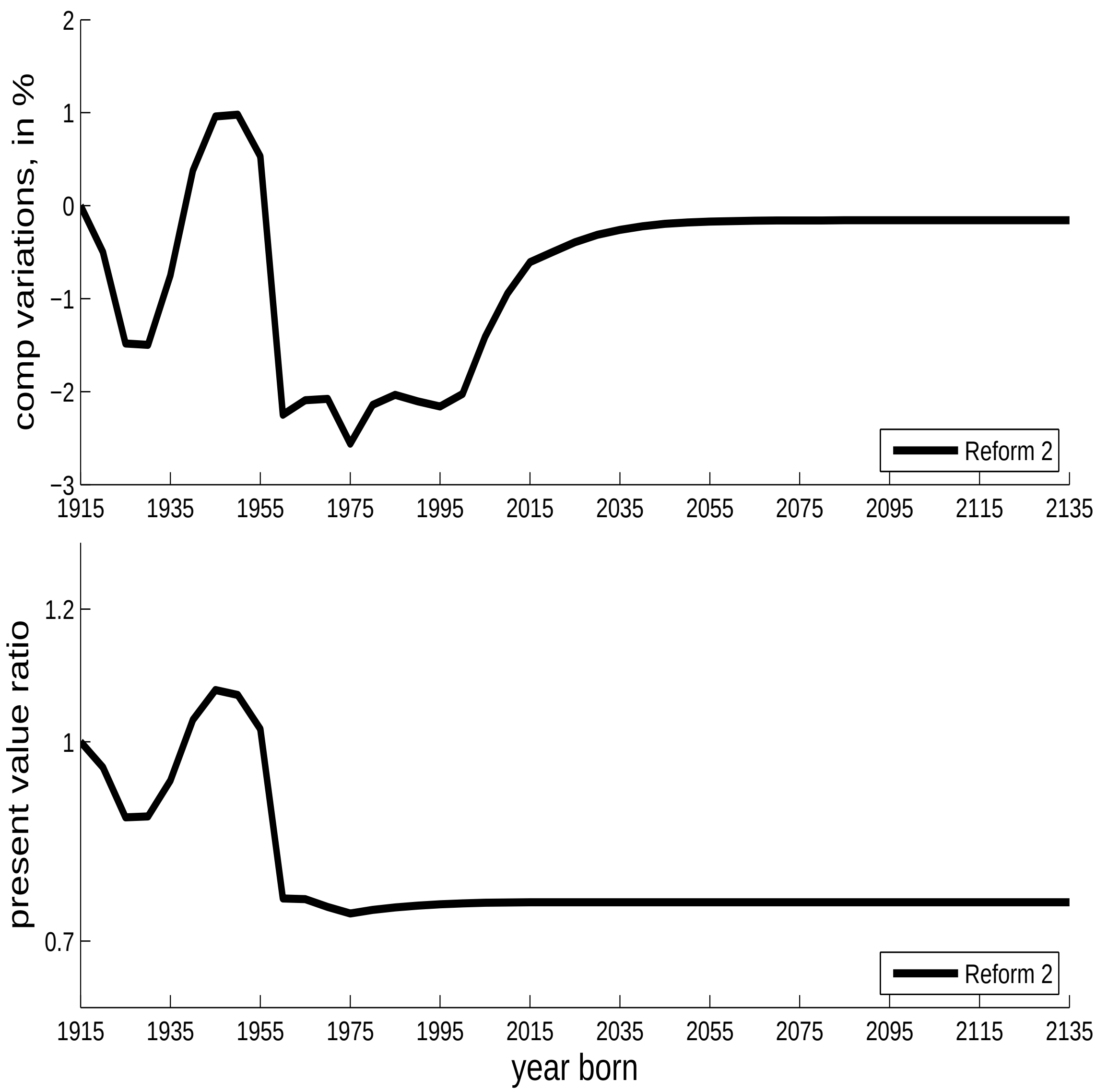
Household welfare is given in terms of compensating variations which measures the amount of life-time consumption that an agent has to be given to be indifferent between a reform and the initial stationary equilibrium. The generation born in 1915 has completed their lives under the initial stationary equilibrium with the Defined Benefits retirement system. The generation born in 1975 enters the labor market under the new rules of Defined Contributions retirement system. In Reform 1, indexation of retirement benefits is moved from real wages to prices, while Reform 2 also includes the shift towards the Defined Contribution retirement system.

Figure 6: Labor supply decisions.



Time endowment is allocated between leisure, market production and human capital investment activities. Average weekly hours are calculated for working age population in a given year. In Reform 1, indexation of retirement benefits is moved from real wages to prices, while Reform 2 also includes the shift towards the Defined Contribution retirement system.

Figure 7: Welfare and Present Value Ratio.



Household welfare is given in terms of compensating variations. Present value ratio (PVR) is the ratio between the present value of future pension benefits and the present value of contributions paid, both valued at the beginning of life. PVR for the generation born in 1915 is normalized to one. In Reform 1, indexation of retirement benefits is moved from real wages to prices, while Reform 2 also includes the shift towards the Defined Contribution retirement system.

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