Intergenerational risk shifting through social security and bailout politics*

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Abstract

This paper adopts a stochastic overlapping generations framework to study the allocation of aggregate financial risks under different social security systems and a majority-voting rule. The main aim is to analyze whether or not this economy would experience a switch between Pay-As-You-Go (PAYG) and Fully Funded (FF) systems and, if so, which transition patterns would be observed if the government takes the role of "bailout agent". Heterogeneous agents in terms of labor income, investment technologies and age choose their saving and portfolio allocations and vote on the social security tax rate to be implemented once the aggregate uncertainty is realized. The financial market risk is incorporated to show that a fraction of the young low-income individuals will be induced to form a political coalition with the elderly to implement a PAYG system in the case of a negative aggregate shock. The persistence of the PAYG scheme after a good aggregate shock is also obtained if the system is redistributive enough within generations. The moral hazard problem under the FF system is also analyzed. The model can be used to explain some central facts in U.S. financial history.

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1 Introduction

The design of old age insurance through social security and in particular through a Pay-As-You-Go (PAYG) system has been widely discussed at least since the so called "Beveridge Report" written in Britain during the Second World War period (Beveridge, 1942) and, in particular, since the 1970s when the social security systems of all the major industrialized countries started to face serious financial problems due to low fertility rates and an unprecedented decrease in mortality rates. The aging of the population in those countries has translated into more and more resources being absorbed by social security expenditures. Consequently, one important issue that has been typically studied and debated in recent years, both at the academic level and in the political arena, is how the benefit payments to the retirees and/or the contributions from the working young should be linked to the outcomes of key economic and demographic indexes in the economy such as mortality rates, real wages, birth rates, unemployment and interest rates. This is the debate on so-called "parametric reform proposals" of the social security system: changing some policy parameters in the economy could lead to an improvement of the long-term projections regarding the actuarial imbalance of the systems. However, the increase in the costs associated with the social security system has boosted the fraction of public opinion, policymakers and economists that view a private alternative to the existing public arrangement not only as feasible but also as desirable.

Currently, almost all of the publicly defined benefit systems follow a PAYG scheme, that is, current benefits paid to the elderly are financed by current contributions from workers (and employers). The private system alternative is based on the simple idea that workers, instead of contributing to the PAYG retirement scheme, should put their retirement savings in individually owned private accounts and withdraw these funds from the account when they reach the retirement age. In the discussion that follows, we will refer to this "individually funded" alternative as Fully Funded (FF) system. Once the worker chooses to retire some of these funds could be converted into an annuity lasting until the worker dies. In many privatization plans, workers would be free to decide how to invest their own savings. The clear economic advantage of such a system is that individual accounts would allow workers to tailor their investment and saving decisions concerning their retirement funds to their degree of risk aversion and their preferences for financial market risk. In a PAYG scheme, instead, workers are forced to accept the "portfolio allocation", so to speak, of the public system. However, the variability of the old age income is obviously reduced under the public pension system.

A classic and recurrent argument backing the introduction of a private social security system is the one according to which the introduction of a private system could enhance the growth rate for an economy through the effect on the saving rate. Namely, a worker could obtain higher rates of return by managing accurately his individual account and investing appropriately in securities. As Krugman (2002) points out, the proponents of a private defined contribution scheme often omit the transition costs of a reform in the computations supporting their argument on higher rates of return of a private system. Even neglecting this fact, higher rates of return would still come at a cost: they would embed a higher risk.

In the debate over social security reforms many of the central issues relate to uncertainty. Aaron (1999) argues that the investment risk implies not only intertemporal variation in yields, but also interpersonal variation in returns if workers were to choose their portfolio composition independently. The former would be mainly due to the timing at which decisions concerning purchase/sale of securities are made and the retirement decision is taken; the latter could be attributed to luck and/or different skill levels across agents regarding investment decisions. A defined contribution system allocates risk in a very different way than a publicly financed defined benefit system: a PAYG system has a fundamental advantage in this sense over a system of individual accounts. Its future benefits are backed by the government's power to tax, which will be exerted if this is what the majority of voters want. Consequently the public system can spread the risk across the different cohorts of the population, including the future (unborn) workers. In an individually funded, instead, each worker's pension depends largely on how successful the individual investment decisions have been, and also on how lucky (or, to some extent, skilled) the worker was in choosing the timing of his retirement. The point is quite simple but not yet addressed in all its aspects by the literature: being this type of financial risk unavoidable for workers, should it be shared? And, if so, how and to what extent? In other words, an important, but less stressed issue in the literature is how the reform proposals involving and creating risks should be evaluated on an ex ante basis.

Recent proposals to privatize social security in the US and to invest a portion of the Social Security Trust Fund in equities have drawn attention to this flaw in the economic literature: most of the theoretical literature on social security is framed in the Diamond (1965) deterministic economy. Under uncertainty, the analysis of social security in the overlapping-generation context becomes more complicated because, even leaving aside the important efficiency considerations, risk sharing issues naturally arise. When evaluating reform proposals of the social security, the economic and policy analysis have to consider the implications of such changes in who bears risks, and what are the extent and the nature of such risks. This paper is related to this issue.

The purpose of this paper is to study how political economy considerations on a social security system affect the outcomes in a stochastic economy confronted with aggregate "generational" risk. The risk considered here, in particular, is a risk associated with the return on a financial asset. It is a burden for all members of a generation but does not affect the other generations. We pose the following simple question: could the possibility that a generation may suffer "the risk of having a bear stock market during the years it saves for retirement"[1] help explain the political persistence of the PAYG system? We answer in a positive way. We find that a PAYG system is a tool that is used to shift financial risk across generations.

The present work defines a FF social security system as a decentralized process for the saving decisions. The government does not play a role in this system. On the contrary, under the PAYG system, individuals are forced to contribute with a payroll tax rate in order to obtain the publicly financed future benefits. Under the current social security system in place, young individuals who are heterogeneous in terms of labor income and investment technologies have to choose how much to save and what fraction of savings to invest in risky assets (e.g. stocks) or in risk free assets (e.g. inflation indexed government bonds). There are two states of the world (bad or good) that affect the return of the risky asset. Once the aggregate uncertainty is resolved, voting on the payroll social security tax rate takes place. As a result, the type of social security system economic agents would like to see implemented

[1] Rangel and Zeckhauser (2001), page 113.

(PAYG or FF) is chosen and consumption follows. If a negative aggregate shock hits the economy, consumption smoothing and political decisions regarding social insurance aspects influence the outcomes of the social security in place. In particular, a PAYG system is always implemented if a negative shock hits the economy. Therefore, government plays the role of a "bailout agent." A PAYG system is also likely to be in place after the positive aggregate shock hits the economy. This latter result depends also on the redistributiveness of the system.

The relevance of the simple model introduced here is threefold. The first one is a partial explanation of an historical pattern. The social insurance program in the United States, known as Social Security, was signed into law by President Franklin D. Roosevelt on August 14, 1935, and was designed primarily to pay eligible individuals aged 65 or older a continuing income after retirement. Means of economic support for the elderly surely existed before that, but they were primarily a private matter. Families and households took care of their elderly members – although through a variety of forms, and, frequently, with limited success. This can be ideally thought as the FF system introduced in this paper: unforced private savings to finance the retirement period. With the industrial revolution, and the urbanization process that ensued, collective systems gradually developed. In the U.S., in particular, three important factors provided impetus for the legislation mentioned above: (1) the Industrial Revolution, (2) increased life expectancies, and (3) the Great Depression. As a result of those social, economic, and demographic changes, political pressure grew for greater government involvement to restore confidence and provide for the economic security of the elderly. In general, while the details of social security programs can vary considerably across countries, they always embed an insurance element. That is, they provide insurance against some defined risk in a manner shaped by broader social objectives, rather than by the participants' self-interests. Furthermore, as witnessed in recent years in several industrialized countries, once a PAYG system is in place, it is hard to dismantle. The model accounts also for this real-world stylized fact.

The second contribution of this model is a caveat for social security designers. In the context of social security reforms, Diamond (2000, p.12) states that "You can not do risk analysis without having a political model as well as an economic model. A political model specifies what changes when a shock comes and relates that legislative choice to the structure of the system." If social security reform proposals have to be taken seriously, they must consider also the financial market risk: agents like to spread the risk and the damages of the bear stock market across and partially within cohorts and they may use their vote for such a purpose. This must be considered when proposals for social security reforms are made.

Finally, this paper provides an analytical treatment of the descriptive statement made in Orszag and Stiglitz (1999) on bailout policies for social security systems. They explain why the often believed assertion that bailout politics will be more severe under public defined benefits plan than under private defined contribution plan is not necessarily true. The intuition behind the falsification of this myth has been made explicit also in a very recent empirical work by Constantinides, Donaldson and Mehra (2002, p.1) who state that: "Proposals that a portion of the Social Security Trust Fund assets be invested in equities entail the possibility that a severe decline in equity prices renders the Fund assets insufficient to provide the currently mandated level of benefits. In this event, existing taxpayers may be compelled to act as insurers of last resort". In this paper, a moral hazard problem could make bailout politics even worse if the system in place is a FF one to begin with: starting with a FF system agents rationally anticipate that a PAYG system will be implemented in case of a bad state . This will lead them to invest more in risky assets than they would otherwise do. The population voting for a PAYG is acting as a lender of last resort, thus young workers "over-risk" when taking their saving and portfolio decisions. If a negative shock hits the economy, the adverse effect on the wealth of the individuals is magnified by this moral hazard problem.

Two classic questions of economic theory in the context of stochastic economies are whether or not market economies allocate the risk efficiently and, if not, what the government can do to improve the allocation of risk. The Arrow-Debreu theory of general equilibrium provides an answer: if contingent-claims markets are complete, society can let the invisible hand allocate risk because the allocation of risk will be Pareto efficient. A well-known deviation from Arrow-Debreu theory arises from the simple fact that not everyone is born at the same time. This aspect is typically explored by the overlapping-generations literature. The classic argument is made by Shell (1977) and Cass and Shell (1983): in the overlapping-generations setting, markets are incomplete (missing), because a person cannot engage in risk-sharing trades with those who are not yet born. The risks associated with holding capital assets, for instance, can be shared with others alive at the same time, but they cannot be shared with future generations. As a result, the allocation of risk need not be efficient, and government policy may be able to make Pareto improvements.

With shocks of the sort analyzed in this paper, the literature on optimal risk sharing (Shiller, 1999; Gordon and Varian, 1988; Hassler and Lindbeck, 1998) has argued that there are potential benefits from intergenerational risk sharing. For example, young generations could insure the retirees against the risk of a poor stock market performance. However, Rangel and Zeckhauser (2001) show that neither market institutions (contingent claims commodities, money or a voluntary PAYG mechanism) nor voting institutions are able to reach an optimal level of risk sharing.[2] A combination of private accounts and a contingent PAYG system (which can transfer income in both directions) dominates the pure private system in their model. However, they conclude that the political economy of intergenerational transfers may prevent a government from intervening successfully.

There is a fundamental asymmetry in the economy I consider here. Abstracting completely from within cohorts labor income differences, due to the demographic and the saving structure of the model, one generation gets all the gains from a stock market boom but also all the losses from a downturn and since the transfer payments are only possible from the young to the old (because the social security payroll tax rate is constrained to be non negative) the economic equilibrium outcome would necessarily be not optimal. It is important to stress, nevertheless, that no formal analysis of the optimality of the system is made here: the economy we are going to introduce is composed of heterogeneous economic actors/voters and, obviously, the result of voting decisions imply the presence of winners and losers, so the concept of Pareto optimality cannot apply.

[2] By optimal, Rangel and Zeckhauser (2001) mean both ex ante and interim efficiency. Both concepts of optimality state that a policy is Pareto improving if and only if it improves the welfare of some agent without hurting anyone else. The sharp difference between the concepts comes with what we mean with "anyone". If "anyone" means any agent born at the same time in a given period then we have ex ante optimality. If we mean instead any agent born at the same time and state of the world in a given period then we are dealing with interim optimality.

This paper is motivated by practical issues of public policy. The government influences the allocation of risk among generations in many ways, most notably, but not only, through the social security system. Bohn (1998), for example, considers also the public debt as a device to reallocate risk in a stochastic economy. He finds that it is an inefficient instrument.

The approach followed here to characterize a FF system as a simple portfolio choice is borrowed from Diamond and Geanakoplos (2001) and Abel (2001). However, in this context we make no distinction between savers and non savers and we introduce a political structure. The framework of this paper draws from Casamatta, Cremer and Pestieau (2000) as well. They show the political sustainability of a redistributive PAYG system in a two period overlapping-generation economy with heterogeneous agents. In their model, a fraction of the workers and the retirees form a majority which votes for a positive level of social security. This happens in the present work as well, although redistributive considerations become relevant and play a key role in determining which coalition succeed only in the case of the positive aggregate shock. In the case of a bad state of the world, the winning coalition is always the one supporting the PAYG system independently of the redistributive characteristics of the benefit rule.

The rest of the paper is organized as follows: in section 2 we introduce the model and in section 3 different economic setups of the FF and PAYG system are studied. Section 4 presents the political-economic solutions and outcomes of the model. In section 5, we explain the moral hazard problem that arises and section 6 concludes. All the proofs are in the appendix.

2 The Model

In order to investigate how political decisions regarding social insurance aspects may influence the outcomes of a social security reform we use the overlapping-generation framework of Samuelson (1958) and Diamond (1965). It is a simple dynamical general equilibrium model with overlapping-generations of heterogeneous, non altruistic voters. Time is discrete and goes from 0 to ∞. The generation born at time t is referred to as "generation t" and we assume that the population is growing at a constant rate n. Therefore, we have that population N_t has the following law of motion:

$$N_t = (1+n)N_{t-1} \tag{1}$$

By definition, a worker born at the beginning of period t belongs to generation t.

Each individual lives for two periods. Agents work and consume when young, during the first period of their life they also make their private saving decisions and once they become old they consume only. Young individuals are endowed with one unit of labor in the first period of life and supply it inelastically. This is, of course, a simplifying assumption because potential negative effects of taxation on labor supply (and on benefits for the retirees) are ruled out. Individuals differ in several ways. Young people born at time t differ in terms of their innate production capabilities reflected in their wages; they could either be skilled or unskilled.[3] The wage w is a continuous variable with mean $\overline{w}$, median w^m and support $[w_{\min}, w_{\max}] \subset R_+$. The wage distribution function $f(w)$ is skewed to the right such that $\overline{w} > w^m$. In the first period, a generic young skilled worker k has a wage w_k^S, while a young unskilled worker has a wage w_k^U. It is assumed, without loss of generality, that all individuals with wage below the median are unskilled and all those with wage above the median are skilled.[4] Also, with an abuse of notation, let us denote from now on the wage of a typical unskilled worker by $w^U \in [w_{\min}, w^m]$, thus suppressing the subscript k. Similarly, by $w^S \in (w^m, w_{\max}]$ we will refer to the wage of a skilled worker.

Workers are heterogeneous also in terms of their investment skills. A young agent can choose to invest her private savings in a risk-free asset (like bonds) which yield a sure rate of return r and/or she can invest in risky assets (like equities) which yield a rate of return that depends on the state of the world. In each period two states of the world are possible: with probability π, a good state of the world is realized reflecting a positive aggregate shock to the economy and thus the rate of return on equities is R_G. With probability $1-\pi$, a bad state of the world is realized which implies a negative aggregate shock to the economy and

[3]Since the production technology is not explicitely modeled, a better terminology would be "rich" and "poor" but it is in principle possible to think about agents with different level of skillfulness that therefore have different wages.

[4]The results of this work would be only reinforced with a more "realistic" income distribution assumption (i.e. if more than fifty percent of the population were to be unskilled).

a rate of return on equities R_B. It is assumed that, irrespectively of the state of the world, the skilled young have always a better investment technology in the market for equities. The idea behind this assumption is that skilled people are better at interpreting the various uncertain conditions of the aggregate economy and accordingly their investment decisions are better than those of the unskilled people. Another possible related interpretation is that their cost of investing in the equity market is lower with respect to the unskilled people (Abel, 2001). This is reflected analytically by the fact that the skilled individuals have always a better rate of return from the risky asset than the unskilled individuals. The following assumptions on the distribution of returns are made:

Assumption 1: $R_G > r > R_B$

Then, letting the parameter $R_{j,i}$ denote simply rate of return from the risky asset in the state of the world $j = B, G$ (either Bad or Good), for the worker of type $i = S, U$ (Skilled or Unskilled) it follows that: $R_{G,S} > R_{G,U} > r > R_{B,S} > R_{B,U}$.

These inequalities are simply stating that investing in the risky asset is ex post always better than investing in bonds if a good state of the world has occurred. However, this is not the case if a negative shock has hit the economy. Due to the heterogeneity in the investment abilities, the situation could be even worse (better) for an unskilled (skilled) young investing in equities if a bad (good) state is realized.

Assumption 2: $\pi R_{G,U} + (1 - \pi) R_{B,U} > r$

This assumption implies that the risk is actuarially favorable for both types of young, and therefore a risk averter will always accept a certain amount of it. In other words, there is a positive average equity premium. It is therefore possible to neglect a corner solution for the share of portfolio allocation in the risky asset (i.e. both young types will always invest a fraction of their wealth in the risky asset).

Assumption 3: $1 + n = r$

This last assumption simply states that the economy considered is neither dynamically inefficient nor efficient. This assumption, although apparently restricting, is made because one of the main aims of this paper is to focus on comparing the outcome of voting decisions on the risk sharing properties of different pension systems; it is therefore desirable not to have an ex ante bias in favor or against one of the systems in terms of investment decisions.

This assumption also makes the social security system a perfect substitute for the safe asset.

A generation t individual maximizes the following intertemporal and additively separable expected utility function:

$$U_t^i = u(c_t^i) + \beta\pi u(c_{t+1}^{i,G}) + \beta(1-\pi)u(c_{t+1}^{i,B}) \qquad\qquad i = S, U \tag{2}$$

where c_t^i represents private consumption when young and of type i and $c_{t+1}^{i,j}$ represents private consumption when old and of type i in state j. $\beta < 1$ is the subjective discount factor and it is not type dependent. The Bernoulli utility function $u(.)$ is continuously differentiable, strictly increasing and strictly concave in its arguments and it satisfies $\lim_{x\longrightarrow 0} u'(x) = \infty$ and $\lim_{x\longrightarrow 0} u(x) = -\infty$. These are standard properties that guarantee interior solutions to the maximization problems described below. The last two assumptions are made to induce a strong desire for consumption smoothing since they imply that any amount of positive consumption in both periods is preferred to an allocation with zero consumption in all the possible states. We also impose the empirically relevant assumption that the Bernoulli utility function is characterized by constant relative risk aversion (CRRA) and therefore the intertemporal elasticity of substitution is smaller than 1.[5]

3 Two Economic Environments

3.1 Fully Funded System

First, we will start with the case in which a FF social security system is in place. There are different ways and meanings according to which a FF system has been introduced in the literature (see for example Geanakoplos, Mitchell and Zeldes (1998) and also Lindbeck (2000)). Let us thus be specific. By FF system, we mean a completely decentralized system of saving decisions. There is basically no role for the government in this system. Individuals set up their own personal accounts for retirement and they manage them by

[5] Under another plausible assumption of decreasing absolute risk aversion as in Diamond and Geanakoplos (2001), assuming all else equal, unskilled agents would be more risk averse and the share of their savings invested in risk free assets would be higher than that of the skilled agents without having to assume first order stochastic dominance in the distribution of returns. However, the wealth effect would still play a role in the portfolio choice and this would complicate the political equilibria.

choosing the amount of saving and their portfolio composition without any public intrusion. The CRRA assumption on the utility function implies that the fraction of wealth invested in the risky assets does not change within individual types, this is because CRRA utility functions eliminate the wealth effect in the portfolio choice.[6] However, since the distribution of returns on the risky asset for the skilled agents first order stochastically dominates the distribution of returns on the risky asset for the unskilled by assumption, we can also conclude that the skilled young invest a higher fraction of their wealth on the risky asset compared to the unskilled young. Budget constraints for the agents in period t are then as follows:

$$c_t^i = w^i - s_t^i \qquad i = S, U \tag{3}$$

$$c_{t+1}^{i,j} = \gamma^i s_t^i r + (1-\gamma^i) s_t^i R_{j,i} \quad i = S, U \qquad j = B, G \tag{4}$$

In the first period of life, labor income is completely allocated to consumption (c_t^i) and to savings (s_t^i). The savings are invested totally in bonds and equities where γ^i is the fraction of savings allocated to the risk free assets by a young of type i and $1-\gamma^i$ is the fraction of savings allocated to the risky asset. In the second period, each old individual is retired and consumes $c_{t+1}^{i,j}$, which reflects the return on savings after the aggregate shock is realized. Individuals are rational, therefore the problem the young agent has to solve is:

$$\underset{0<\gamma^i<1,\ s_t^i>0}{Max} \; u\left(w^i - s_t^i\right) + \beta\pi u\left[\gamma^i s_t^i r + (1-\gamma^i) s_t^i R_{G,i}\right] + \beta(1-\pi) u\left[\gamma^i s_t^i r + (1-\gamma^i) s_t^i R_{B,i}\right] \tag{5}$$

For an interior solution the first order conditions with respect to γ^i and s_t^i are:

$$\frac{\partial U_t^i}{\partial \gamma^i} = \beta\pi u'(c_{t+1}^{i,G})(s_t^i r - s_t^i R_{G,i}) + \beta(1-\pi) u'(c_{t+1}^{i,B})(s_t^i r - s_t^i R_{B,i}) = 0 \tag{6}$$

$$\frac{\partial U_t^i}{\partial s_t^i} = -u'(c_t^i) + \beta\pi u'(c_{t+1}^{i,G})(\gamma^i r + (1-\gamma^i) R_{G,i}) + \beta(1-\pi) u'(c_{t+1}^{i,B})(\gamma^i r + (1-\gamma^i) R_{B,i}) = 0 \tag{7}$$

[6] See Mas-Colell, Whinston, and Green (1995), Chapter 6.

After rearranging terms, (6) becomes:

$$\frac{u'(c_{t+1}^{i,B})}{u'(c_{t+1}^{i,G})} = -\frac{\pi}{1-\pi}\frac{r-R_{G,i}}{r-R_{B,i}} \tag{8}$$

This is a classical intra-temporal condition that says that the marginal rate of substitution between consumption levels in the two possible future states is determined by multiplying the likelihood of the two states by the ratio of the differences between the return on bonds and the return on stocks in the two states. Using both (6) and (7), and after some simplification we obtain:

$$u'(c_t^i) = \beta\left[\pi u'(c_{t+1}^{i,G})R_{G,i} + (1-\pi)u'(c_{t+1}^{i,B})R_{B,i}\right] \tag{9}$$

This condition states that the marginal utility of consumption in the first period must be equal to the discounted average of the marginal utilities across states in the second period. Note also that (8) and (9) define implicitly, under the FF system, the optimal level of private savings ($s_t^{i,FF}$) and the optimal portfolio allocation ($\gamma^{i,FF}$) for a young agent. Let us define the indirect utility function associated with this optimal level of savings and with the above portfolio composition for each agent type i as:

$$\begin{aligned} V_t^{i,j}(\gamma^{i,FF}, s_t^{i,FF}, 0) &= u\left(w^i - s_t^{i,FF}\right) + \beta\pi u\left[\gamma^{i,FF}s_t^{i,FF}r + (1-\gamma^{i,FF})s_t^{i,FF}R_{G,i}\right] \\ &\quad + \beta(1-\pi)u\left[\gamma^{i,FF}s_t^{i,FF}r + (1-\gamma^{i,FF})s_t^{i,FF}R_{B,i}\right] \end{aligned}$$

Notice that the third argument of the indirect utility function is zero. This is simply because the payroll tax rate is zero as we are now considering the FF regime.

3.2 Pay-As-You-Go System

Let us consider now the economic structure once a PAYG social security system is in place. In this case there is a constant payroll tax rate on labor income, denoted by τ_t, that finances the retirement benefits $P_{t+1}$to the old. The budget constraints for the agents in period t become:

$$c_t^i = (1-\tau_t)w^i - s_t^i \qquad i = S, U \tag{10}$$

$$c_{t+1}^i = P_{t+1} + \gamma^i s_t^i r + (1-\gamma^i) s_t^i R_{j,i} \quad i = S, U \qquad j = B, G \tag{11}$$

In the first period of life, an individual allocates her after-tax labor income between current consumption and savings, then, once retired, the individual can consume the return on savings (after the realization of the uncertainty) and the pension that she receives (P_{t+1}).

The government in this economy performs only the limited function of collecting payroll taxes levied on the labor income of the young and redistribute them via the old age pensions according to an exogenously given redistribution formula as in Casamatta, Cremer and Pestieau (2000). As mentioned earlier, any distortion on the labor market is assumed away, which means that labor supply is given and normalized to 1. The tax rate is constrained to be non-negative so that the system implies a transfer from young to old individuals. The (per capita) government budget constraint is balanced every period:

$$P_{t+1}(w^i) = (1+n)\tau_{t+1}(\delta w^i + (1-\delta)\overline{w}) \quad i = S, U \tag{12}$$

Recall that $\overline{w}$ is the mean of the wage distribution and the parameter $0 \leq \delta \leq 1$ represents the fraction of pension benefits that is related to contributions. This is an exogenously given formula for redistribution (i.e. no voting on δ). Note that if $\delta = 1$ the pension scheme is purely Bismarckian or contributory, i.e. the pension an individual receives depends only on the amount he has been paid when working so that there is no redistribution within generations. When $\delta = 0$, pension benefits are uniform and we are in a so-called Beveridgean regime.

With an interior solution the problem, each type of young agent has to choose $0 < \gamma^i < 1$ and $s_t^i > 0$ to maximize (2) subject to (10), (11), and (12).
The First-Order Conditions yield:

$$\frac{\partial U_t^i}{\partial \gamma^i} = \beta\pi u'(c_{t+1}^{i,G})(s_t^i r - s_t^i R_{G,i}) + \beta(1-\pi)u'(c_{t+1}^{i,B})(s_t^i r - s_t^i R_{B,i}) = 0 \tag{13}$$

$$\frac{\partial U_t^i}{\partial s_t^i} = -u'(c_t^i)+\beta\pi u'(c_{t+1}^{i,G})(\gamma^i r+(1-\gamma^i)R_{G,i})+\beta(1-\pi)u'(c_{t+1}^{i,B})(\gamma^i r+(1-\gamma^i)R_{B,i}) = 0 \quad (14)$$

After rearranging terms, we obtain similar intertemporal and intratemporal conditions as in the FF system above:

$$\frac{u'(c_{t+1}^{i,B})}{u'(c_{t+1}^{i,G})} = -\frac{\pi}{1-\pi}\frac{r-R_{G,i}}{r-R_{B,i}} \quad (15)$$

$$u'(c_t^i) = \beta\left[\pi u'(c_{t+1}^{i,G})R_{G,i} + (1-\pi)u'(c_{t+1}^{i,B})R_{B,i}\right] \quad (16)$$

Notice, however, that as the budget constraints (3), (4), (10) and (11) show, the consumption levels in the two periods are quite different across different social security systems. Note also that (15) and (16) define implicitly, under the PAYG system, the optimal level of private savings for a young agent (s_t^i) and the optimal portfolio allocation ($\gamma^{i,PG}$) for a young agent. The corresponding indirect utility function for each agent type i in state j will be labeled as

$$\begin{aligned} V_t^{i,j}(\gamma^{i,PG}, s_t^{i,PG}, \tau_t) \quad &= \quad u\left[(1-\tau_t)w^i - s_t^{i,PG}\right] + \beta\pi u\left[P_{t+1} + \gamma^{i,PG}s_t^{i,PG}r + (1-\gamma^{i,PG})s_t^{i,PG}R_{G,i}\right] \\ &+\beta(1-\pi)u\left[P_{t+1} + \gamma^i s_t^{i,PG}r + (1-\gamma^{i,PG})s_t^{i,PG}R_{B,i}\right] \end{aligned}$$

Before moving on to analyze the political equilibria of this economy, it should be noted that the literature has identified two conceptually different forms of risk sharing. Hassler and Lindbeck (1998) carefully review them and it is worthy to restate them here. One type is the so-called "true risk sharing": consider an individual belonging to generation t in the above economy. This individual knows his wage in the first period since the exogenous wage risk has already materialized. However, his lifetime utility is still uncertain because future levels of consumption depend on the stochastic returns on savings that are not realized until the end of the first period when uncertainty is revealed. Thus, here the only source of uncertainty for living individuals is return risk. Any tool that reduces such uncertainty provides a valuable benefit to a risk averse individual. We will see that a PAYG system is certainly such a tool.

A different type of risk is due to uncertainty about variables that are realized immediately at birth. Will a young worker be skilled or unskilled? A reduction of such type of risk is called "ex-ante risk sharing". As noted by Hassler and Lindbeck (1998) ex ante risk sharing requires compensatory transfers to (from) individuals in their first period life who are born with low (high) levels of skills. True risk sharing instead implies compensatory transfers to (from) individuals in their second period of life who receive low (high) returns on their investment. As it should be clear by now this work deals with "true risk sharing".

4 Political equilibria

The tax rate, and therefore the type of social security system implemented, in this model is the outcome of a voting procedure. The political system that is introduced in this section is based on simple majority voting. Although not immune from some minor theoretical drawbacks in the context of social security, as remarked in Casamatta (2000), majority voting is widely used in the literature and provides a sufficient degree of approximation for several political systems. All economic agents, young and old, are of course involved in the voting process. Sincere voting is assumed, i.e. voters choose their preferred tax rate according to their true preferences, independently of any strategic consideration.

The timing of the economy is as follows: every period young workers, after having observed which type of social security system is in place, decide about how much to save and their portfolio allocation. Then the aggregate shock to the economy is realized and it is revealed which state of the world they are in.[7] After that, population votes over the preferred payroll tax rate, and finally, at the end of each period, consumption takes place.

[INSERT FIGURE 1 HERE]

The assumption here is that there is no "political risk" so far in this model so that $\tau_t = \tau$, $\forall t$. Young individuals, when voting on the preferred tax rate for the PAYG system, believe that their contributions to the system will entitle them to receive a pension later in their life. There are basically three groups of agents that vote in this economy: the old, the young skilled, and the young unskilled. To analyze the resulting tax rate from this

[7] As mentioned earlier, people have to take as given the degree of intra cohort redistribution of the PAYG system represented by the Bismarckian parameter δ.

political process, one needs to determine the preferred tax rates for all these groups and aggregate them through voting. The old, clearly, given the assumptions on preferences and their budget constraint, vote to have τ as high as economically viable irrespective of the state. They are a homogeneous group as far as voting is concerned: there is no distinction between old skilled and old unskilled because this heterogeneity does not affect their voting decision. By setting the tax rate to the maximum possible, old retirees are just maximizing their consumption since we assume away any form of altruism.[8] Furthermore, since they do not work, they do not pay taxes and there is no cost for them in setting a high τ and introducing a PAYG system. In other words, retirees want to have a tax rate as high as possible because this does not have any impact on their (previously paid) contributions but it does affect their current level of pension benefits. This argument reflects a widely known fact in the literature, namely the "single mindedness" of the old people once they have to vote on social security as suggested by Mulligan and Sala-i-Martin (1999).

For the young, the choice is not as straightforward: it depends, in principle, on the state of the world and on the type. Young individuals care about the present and the future. Formally, they will choose the tax rate that maximizes their intertemporal indirect utility function subject to their budget constraint (which, of course, differ according to the different economic environments) and to the government budget constraint when necessary.

Proposition 1 The objective function of the young is single peaked.

The political process can be modeled using a median voter framework because the conditions for the median voter theorem are satisfied. The choice of voters is over a single dimension since the preferred labor income tax rate is the only choice variable, and the voter preferences are single peaked. The property of single peakedness has been demonstrated to ensure existence of a voting equilibrium (Persson and Tabellini, 2000).

[8] There are two contrasting arguments we need to consider: first notice that if the elderly were to mechanicaly maximize their consumption they should set $\tau = 1$. However, they are fully rational and so they understand that if $\tau = 1$ then the young are going to starve and that they will not work, therefore the contributions to the social security system will be zero so the old may decide to choose $\tau < 1$. On the other hand if the old consider the outcome of the voting process they know that $\tau \neq 1$ for sure and so they may decide to choose $\tau = 1$ to influence upward the median tax rate. This, however, is a technical detail since the elderly's preferred tax rate is certainly much above that of the other two groups.

4.1 The Bad State Case

Consider first the case in which a FF system is in place. Once the negative shock has been realized, a young worker with earnings of w^i chooses a tax rate $\tau_B^{i,FF}$ such that:

$$\tau_B^{i,FF} = \begin{cases} \underset{\tau}{Max} V_t^{i,B}(\gamma^{i,FF}, s_t^{i,FF}, \tau) \text{ if } \exists \tau \ni V_t^{i,B}(\gamma^{i,FF}, s_t^{i,FF}, \tau) > V_t^{i,B}(\gamma^{i,FF}, s_t^{i,FF}, 0) \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

In words, this simply means that in order for a positive tax rate to be chosen by a young agent, it must be that in the bad state the indirect utility function associated with a positive tax rate and with the optimal saving and portfolio decision under the FF system is greater than the same indirect utility function with a zero tax rate. It is now possible to state the following.

Proposition 2 If a FF system is in place and a negative shock hits the economy, population always votes to introduce a PAYG system.

In a bad state starting with a FF system in place, all the unskilled young would prefer to switch to a PAYG system. Consequently, they will make a voting coalition with the old and this will lead to the introduction of a PAYG system in the economy.

Let us consider now what happens if the initial social security system is instead PAYG and there is a negative aggregate shock. Now, in order to stay with the PAYG system during a bad state, it must be the case that at least for the unskilled type the following inequality holds: $V_t^{U,B}(\gamma^{U,PG}, s_t^{U,PG}, \tau) > V_t^{U,B}(\gamma^{U,PG}, s_t^{U,PG}, 0)$. In this case, after the bad shock, the young worker of type i chooses the tax rate $\tau_B^{i,PG}$ such that:

$$\tau_B^{i,PG} = \begin{cases} \underset{\tau}{Max} V_t^{i,B}(\gamma^{i,PG}, s_t^{i,PG}, \tau) \text{ if } \exists \tau \ni V_t^{i,B}(\gamma^{i,PG}, s_t^{i,PG}, \tau) > V_t^{i,B}(\gamma^{i,PG}, s_t^{i,PG}, 0) \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

Proposition 3 If a PAYG system is in place and a negative shock hits the economy, population always votes to stay with the PAYG system.

It is important to note that the intragenerational distribution of the PAYG system does not play a role here. The elderly in this case exploit the insurance motive of the young in the lower tail of the income distribution to create a PAYG system.

Remark 1 The above conclusions do not depend on the within groups redistributive characteristics of the PAYG system.

It is easy to check that, the unskilled young would always be willing to have a PAYG system if a bad state occurs and this result is independent of the value of δ and the starting social security system. Only the intergenerational risk sharing characteristics of the PAYG system (and consequently the political decisions on these aspects) play a role here.

4.2 The Good State Case

Next, the case in which the good state of the world is realized and a PAYG system is in place is considered. Will the agents decide to switch to a FF system or stay with the current system? The answer to this question for the workers depends on the parameters of the economy. The young skilled and young unskilled workers will decide to stick to the PAYG system if and only if there is a τ such that $V_t^{i,G}(\gamma^{i,PG}, s_t^{i,PG}, \tau) > V_t^{i,G}(\gamma^{i,PG}, s_t^{i,PG}, 0)$.

Since single peakedness of the preferences was proved, and without a specific functional form for the utility function, the way to see what they will choose is once again to compare the returns from private savings under a PAYG system $\frac{\gamma^{S,PG} s_t^{i,PG} r + (1-\gamma^{S,PG}) s_t^{i,PG} R_{G,i}}{s_t^{i,PG}}$ with the returns from the PAYG system $\frac{(1+n)\tau_t(\delta w^i + (1-\delta)\overline{w}) + \gamma^{S,PG} s_t^{i,PG} r + (1-\gamma^{S,PG}) s_t^{i,PG} R_{G,i}}{\tau_t w^i + s_t^{i,PG}}$. It is thus possible to define a cutoff value for the labor income of the skilled workers:

$$\widehat{w}_{S,PG}^{G} = \frac{(1+n)(1-\delta)\overline{w}}{\gamma^{S,PG} r + (1-\gamma^{S,PG}) R_{G,S} - \delta(1+n)} \tag{17}$$

such that if $w > \widehat{w}_{S,PG}^{G}$, the young skilled prefer to vote for $\tau_G^{U,PG} = 0$ (no PAYG system) while if $w < \widehat{w}_{S,PG}^{G}$ the young skilled prefer to vote for $\tau_G^{U,PG} > 0$ (PAYG system). Analogously, when considering the preferred tax rate for the young unskilled group, it is possible to define another cutoff value for the labor income of the unskilled workers:

$$\widehat{w}_{U,PG}^{G} = \frac{(1+n)(1-\delta)\overline{w}}{\gamma^{U,PG} r + (1-\gamma^{U,PG}) R_{G,U} - \delta(1+n)} \tag{18}$$

above which the young unskilled workers will prefer to vote not to have a PAYG system and below which a PAYG system would get the support of this group.[9]

The following lemma states that, starting with a PAYG system in place, the fraction of unskilled young supporting the PAYG system in a good state is higher than the fraction of skilled young. This intuitive result is true as long as there is some redistribution within the system (i.e. $\delta \neq 1$)

Lemma 1 $\widehat{w}^G_{S,PG} < \widehat{w}^G_{U,PG} < \overline{w}$

It is now possible to state the following:

Proposition 4 *If a PAYG social security system is in place and the good state is realized, then as long as $n \neq -1$, a majority of the population would support the PAYG system at period t if and only if:*

$$\int_{w_{\min}}^{\widehat{w}^G_{U,PG}} f(w)dw > \frac{n}{2(1+n)} \tag{19}$$

This proposition says that, when the number of unskilled workers in favor of a positive tax rate is high enough a PAYG system is introduced. In this case the intragenerational redistribution effect of the PAYG social security dominates the return from private saving. How likely is for condition (19) to hold? Table 1 reports the population growth rates of the thirty OECD countries for the year 2000. For the condition in proposition 4 to hold boils down to having less than 1% of the unskilled workers supporting a PAYG system. Thus, as long as very mild demographic conditions are satisfied, a PAYG social security system will stay in place, independently of the realized state of the world.

[INSERT TABLE 1 HERE]

This is actually a known fact in the literature (see for example Azariadis and Galasso, 2002). The political resilience of the PAYG system along with the so called transition costs are at the heart of the discussion about possible social security reforms.

[9] Notice that the optimal tax rates are obtained as follows:

$$\tau^{i,l}_G = \begin{cases} \underset{\tau}{Max} V^{i,G}_t(\gamma^{i,l}, s^{i,l}_t, \tau) \text{ if } \exists\tau \ni V^{i,G}_t(\gamma^{i,l}, s^{i,l}_t, \tau) > V^{i,G}_t(\gamma^{i,l}, s^{i,l}_t, 0) \\ 0 \text{ otherwise} \end{cases}$$

with $l = PAYG, FF$ and $i = S, U$

Finally, let us consider now what happens if a FF system is in place and there is a positive aggregate shock to the economy. The decision of the voters then depends once again on the parameters of the economy, but we will be able to conclude that a transition to the PAYG is more likely to occur than not. The cutoff values for the wage levels in this case would be defined as:

$$\widehat{w}_{S,FF}^{G} = \frac{(1+n)(1-\delta)\overline{w}}{\gamma^{S,FF} r + (1-\gamma^{S,FF}) R_{G,S} - \delta(1+n)} \tag{20}$$

$$\widehat{w}_{U,FF}^{G} = \frac{(1+n)(1-\delta)\overline{w}}{\gamma^{U,FF} r + (1-\gamma^{U,FF}) R_{G,U} - \delta(1+n)} \tag{21}$$

Clearly both worker types would decide to support the FF if and only if their respective labor incomes were above their respective cutoff values.

Lemma 2 $\widehat{w}_{S,FF}^{G} < \widehat{w}_{U,FF}^{G} < \overline{w}$

As the intuition suggests, the political support for a PAYG system is greater among the unskilled types rather than the skilled ones, if the economy is in a good state and the initial social security system is FF. Once again this result is true as long as there is some redistribution (i.e. $\delta \neq 1$). It is then possible to state a proposition analogous to the one above:

Proposition 5 If a FF social security system is in place and if the good state is realized, then a majority of the population would support the FF system at period t if and only if:

$$\int_{Min\{\widehat{w}_{U,FF}^{G},\, w^m\}}^{w^m} f(w)dw + \int_{Max\{\widehat{w}_{S,FF}^{G},\, w^m\}}^{w^{\max}} f(w)dw > \frac{2+n}{2(1+n)} \tag{22}$$

In this case, not only the across-groups redistributive characteristics of the system are fundamental but also the within-group differences play a key role. This is due to the multiple heterogeneities of the economic agents. Again from Table 1, it is possible to note how hard it would be not to have a PAYG system in place in the end.

4.3 Discussion and Implications

Contrary to the results regarding the political sustainability of the PAYG system in the bad state, the conclusions for the good state case do depend on the redistributive characteristics of the system itself. In equations (20) and (23), δ affects the possible interval(s) of integration and therefore the political support for the PAYG system. An interesting puzzle and comparative static exercise is to try to find out how redistributive the system must be in order for a switch to occur or not. Let us start from the last proposition. It is necessary to analyze three cases to check when the condition in proposition 5 can hold:

A) $w^m < \widehat{w}^G_{U,FF} < \overline{w}$ and $w^m < \widehat{w}^G_{S,FF}$: In this case, all unskilled young would vote to have a PAYG system and also some skilled, therefore such a system would be introduced with certainty.

B) $w^m < \widehat{w}^G_{U,FF} < \overline{w}$ and $w^m > \widehat{w}^G_{S,FF}$: In this case, all unskilled vote for a PAYG system and all skilled against it. Due to the presence of the elderly, the PAYG system would again be introduced.

C) $\widehat{w}^G_{U,FF} < w^m$: In this case, all skilled young and also some unskilled young vote in favor of a FF system. This case deserves a more analytical treatment to consider when this group would offset the alliance of the elderly with the remaining unskilled. In such a case, equation (23) would become $\int_{\widehat{w}^G_{U,FF}}^{w^m} f(w)dw + \int_{w^m}^{w^{\max}} f(w)dw > \frac{n}{2(1+n)}$ or equivalently $\int_{\widehat{w}^G_{U,FF}}^{w^m} f(w)dw > \frac{1}{2(1+n)}$. We need to find the value of δ such that the two above restrictions hold. The restriction $\widehat{w}^G_{U,FF} < w^m$ imposes the condition $\delta > \delta^* = \frac{\overline{w}}{\overline{w}-w^m} - \frac{\gamma^{U,FF}r+(1-\gamma^{U,FF})R_{G,U}}{1+n}\frac{\overline{w}}{\overline{w}-w^m}$.[10] The requirement imposed by the second restriction boils down to $F(\widehat{w}^G_{U,FF}) < \frac{n}{2(1+n)}$ where $F(.)$ is the cumulative function associated with the wage distribution. Using algebra, it can be shown that this implies the following restriction on δ: $\delta > \delta^{**} = \frac{(1+n)\overline{w}-\left[\gamma^{U,FF}r+(1-\gamma^{U,FF})R_{G,U}\right]F^{-1}\left(\frac{n}{2(1+n)}\right)}{(1+n)\overline{w}-(1+n)F^{-1}\left(\frac{n}{2(1+n)}\right)}$. It is possible to conclude that, in order for the people to support the continuation of a FF system once a good aggregate shock hits the economy, the system has to be "little" redistributive, where the term "little" is analytically defined by the interval $[\max\{\delta^*, \delta^{**}\}, 1]$ in which the Bismarckian coefficient has to lie.

[10]Notice that $\delta^* > 0$ as long as $\frac{\overline{w}}{w^m} > \frac{\gamma^{U,FF}r+(1-\gamma^{U,FF})R_{G,U}}{1+n}$.

Finally, it remains to carry out another comparative static exercise where we consider the level of δ for which, holding everything else constant, equation (20) in proposition 4 would hold. It is immediate to see that this also imposes a condition on the redistributiveness of the social security system: we need to find a δ such that $F(\widehat{w}^{G}_{U,PG}) > \frac{n}{2(1+n)}$ which, after some computations, yields $\delta < \delta^{***} = \frac{(1+n)\overline{w} - \left[\gamma^{U,PG} r + (1-\gamma^{U,PG}) R_{G,U}\right] F^{-1}\left(\frac{n}{2(1+n)}\right)}{(1+n)\overline{w} - (1+n) F^{-1}\left(\frac{n}{2(1+n)}\right)}$. For people to support the continuation of a PAYG system also during a good aggregate shock, the system has to be redistributive enough.

5 Political Risk

Young agents' behavior considered so far is "naive" due to the assumption of no political risk, i.e. $\tau_t = \tau$, $\forall t$. In this section, we relax this assumption to extend the model presented above and to check its robustness. First, it is important to distinguish legislation changes which are due to political considerations from changes that result from economic conditions. Only the former represent true political risk. However, the aim is to consider a more rational behavior of the agents and check the robustnness of the model presented above. By political risk, we mean that people are myopic in the sense that, agents are not taking into account the future level of payroll tax rates when they make their saving decisions. Incorporating political risk simply means that agents internalize $E_t\tau_t$ and $E_t\tau_{t+1}$when they make their saving decisions. Notice that here $E_t\tau_t$ represents the expected level of the payroll tax rate at time t before the aggregate uncertainty is realized, while $E_t\tau_{t+1}$ is the time t expected level of the $t+1$ payroll tax rate. The main point is that the conclusions on the persistence of a PAYG system would not be changed by incorporating political risk. It can be checked that the cutoff values for the labor income on which the political decisions are taken would now simply become:

$$\widehat{w}^{j}_{i,l} = \frac{(1+n)(1-\delta)\overline{w}E_t\tau_{t+1}}{\left[\gamma^{i,l} r + (1-\gamma^{i,l})R_{j,i}\right] E_t\tau_t - \delta(1+n)E_t\tau_{t+1}}$$

Therefore, the findings in propositions 2, 3, 4, and 5 would be robust to this extension as long as $E_t\tau_t \leq E_t\tau_{t+1}$. This last condition means that agents adapt either rational expectations or are "optimistic" (when the inequality is binding).

By incorporating political risk in the saving and voting behavior of the young, the bailout interventions of the government could even be exacerbated due to a moral hazard problem. To see this, consider now the case in which a FF system is in place. Agents, being rational, know that if a negative shock hits the economy a PAYG system will be introduced. Therefore, young workers will adjust their savings decisions accordingly. In particular, young workers will decrease their savings and overinvest in risky assets (with respect to the optimal level in a FF system). Recall that with a FF system in place, the formal problem for a myopic young agent of type $i = S, U$ was:

$$\underset{0<\gamma^i<1,\ s_t^i}{Max}\ u(c_t^i) + \beta\pi u(c_{t+1}^{i,G}) + \beta(1-\pi)u(c_{t+1}^{i,B}) \tag{23}$$

$$s.t. \quad c_t^i = w^i - s_t^i \tag{24}$$

$$c_{t+1}^{i,j} = \gamma^i s_t^i r + (1-\gamma^i)s_t^i R_{j,i} \quad j = B, G \tag{25}$$

The solution to this problem was labeled by $\gamma^{i,FF}$ and $s_t^{i,FF}$ in section 4.1. Now, agents know that if a negative shock hits the economy they will certainly benefit from a pension scheme which basically acts as a free insurance. Even in the case of a positive shock they may get a retirement benefit, though with smaller probability. Thus, they will solve the following new problem:

$$\underset{0<\gamma^i<1,\ s_t^i}{Max}\ u(c_t^i) + \beta\pi u(c_{t+1}^{i,G}) + \beta(1-\pi)u(c_{t+1}^{i,B}) \tag{26}$$

$$s.t. \quad c_t^i = (1 - E_t\tau_t)w^i - s_t^i \tag{27}$$

$$c_{t+1}^{i,G} = \gamma^i s_t^i r + (1-\gamma^i)s_t^i R_{G,i} + \Gamma_{t+1}(E_t\tau_{t+1}) \tag{28}$$

$$c_{t+1}^{i,B} = \gamma^i s_t^i r + (1-\gamma^i)s_t^i R_{B,i} + P_{t+1}(E_t\tau_{t+1}) \tag{29}$$

where $\Gamma_{t+1}(E_t\tau_{t+1}) < P_{t+1}(E_t\tau_{t+1})$ represents the expected retirement benefit if a good aggregate shock is realized. This is computed as a weighted average of 0 and $P_{t+1}(E_t\tau_{t+1})$ with weights given respectively by $\Pr\left[\int_{Min\{\widehat{w}_{U,FF}^G,\ w^m\}}^{w^m} f(w)dw + \int_{Max\{\widehat{w}_{S,FF}^G,\ w^m\}}^{w^{\max}} f(w)dw > \frac{2+n}{2(1+n)}\right]$ and one minus this probability. Notice that both Γ_{t+1} and P_{t+1} now depend on $E_t\tau_{t+1}$. Let the optimal portfolio composition and saving decision with the moral hazard problem be denoted by $\gamma^{i,MH}$, and $s_t^{i,MH}$.

Proposition 6 $s_t^{i,MH} < s_t^{i,FF}$ and $1-\gamma^{i,FF} < 1-\gamma^{i,MH}$.

The intuition behind this result is quite simple. Agents being rational anticipate the outcome of the voting decisions. They anticipate that a PAYG system will be implemented in case of a negative aggregate shock. For the current young, who do not contribute to the social security system (since it is FF) the introduction of a PAYG system is like an insurance for free. The pension benefits increase their expected intertemporal budget and consumption smoothing implies an increase in the current level of consumption and also an increase in future consumption. The higher consumption levels are implemented through a revision of their portfolio allocation and a decrease in savings. In particular, the fraction of the portfolio allocated to risky assets will increase and young workers will overinvest in risky assets due to the presence of a free insurance. These agents' behavior introduces a problem: if a negative shock hits the economy, the adverse effect on the wealth of the population could be magnified by the moral hazard. Since agents now hold a riskier portfolio, a bad shock will wipe out their savings in a much harder way than expected otherwise.

6 Conclusions

Reforming the social security system is a very complicated issue. A careful consideration of the subject involves analyzing several factors such as transition costs of a reform, labor market reforms, and labor market policies intertwined with the social security reform itself. From the macroeconomic point of view, other important issues such as demographic and actuarial aspects, the impact of such a reform on national savings, related financial market effects, and overall growth effects have to be taken into account as well. Also budget considerations, and thus the allocation of public resources to different types social expenditures is a source of a growing literature on the welfare state. All these topics have been, to some extent, examined by the existing literature on social security. A much less investigated aspect is the embedded risk created by a social security reform and the political support for it.

This paper is an attempt to fill this gap by investigating the allocation of aggregate risk in a stochastic overlapping-generation model under a majority voting rule. Since markets are incomplete due to the demographic setup and since it is not possible to obtain perfect insurance, young agents use their vote as a device to change ex post their saving decisions in the bad state. The social security system is a safe asset that is a perfect substitute for government bonds and a fraction of young voters choose to use their vote as a tool to insure their retirement period by introducing the PAYG system. In order to protect themselves against the bad state of the world during which they have to save for retirement, they vote to partially shift their realized risk over future generations. Hence, they form a pro-PAYG system coalition with the elderly. This finding is consistent with the result that Gale (1990) obtains on the risk sharing properties of debt. He argues that if markets are incomplete, government could introduce new securities that expand risk sharing opportunities and by introducing these safe short dated securities it would be possible to allow each cohort to transfer some risk across life periods. In his setting, government decides exogenously and government debt is the security, whereas in our setting voters decide endogenously and a PAYG social security system is the safe asset.

In order to establish a PAYG system in the good state of the world, a different political mechanism is exploited by the elderly. The classical intragenerational redistributive aspect of the PAYG system is the leverage old agents use to form a coalition with the unskilled young voters. The redistributive role of social security within generations is important to explain the political sustainability of this intergenerational transfer scheme: since the FF system guarantees higher returns in the good state when compared to the PAYG, young unskilled voters have to be "allured" with a redistributive public system.[11] This argument probably explains the political persistence of the PAYG system during the 90s. In our model, the size of the unfunded pension system is represented by the payroll tax rate $\tau_j^{i,l}$. As in Tabellini (2000) and in Casamatta, Cremer and Pestieau (2000), $\tau_j^{i,l}$ is positively linked with the proportion of the pensioners but the median voter is almost always an unskilled young.[12] The size of the PAYG system is increasing in the labor income inequality, and as we would expect to see in bailout politics, it depends on the realized state of the world and on the initial political status quo of the economy.

[11] See Casamatta, Cremer, and Pestieau (2000).

[12] The only case where it is not possible to state this a priori is in proposition 5.

We showed that the model is robust to the case in which political risk is incorporated. In this model, government budget is always balanced, and as Diamond (2002, p.46) argues "...it is not clear whether the possibility of further legislation should be viewed as a political risk or a political hedge. The possibility of adapting Social Security to changing economic and demographic circumstances makes it more valuable to society, not less valuable." Notwithstanding, a robustness check on how agents take their saving decisions was in order. A moral hazard issue naturally arises in this framework: since in case of a bad state a PAYG system always gets implemented, starting with a FF system agents will eventually invest more in risky assets than they would otherwise do. The population voting for a PAYG is acting as a lender of last resort, consequently young workers "over-risk" when taking their saving and portfolio decisions. If a negative shock hits the economy, the adverse effect on the wealth of the population could be magnified by the moral hazard problem. This outcome is consistent with the informal argument presented in Orszag and Stiglitz (1999) on bailout policies for social security systems. They claim that these policies will be more severe under private defined contribution plan than under public defined benefits plan. The policy implication of this last result is that the social security designers should be cautious when advocating a reform towards a FF scheme.

An important source of risk has not been considered here: labor income instability. For example, a productivity shock may lead to random variations in labor income. The importance of this issue is well known in the literature. For example, in the context of retirement planning, the PAYG scheme implemented may reflect the presence of labor income uncertainty. However, the aim of the present work was to single out the fact that political mechanisms and generational risk together may suggest a more careful consideration of social security reform proposals and thus we focused on financial market risk only. A natural extension would be to embed wage uncertainty in this model. Finally, it is worth mentioning that there is at least one more important policy instrument through which aggregate macroeconomic risk could be spread. Government debt does certainly play an insurance role and this instrument was considered in the context of a stochastic economy by others, e.g. Gale (1990) and Bohn (1998). Here, only the social security system is modeled because of the majority voting rule. Under such a voting system, allowing for multiple voting instruments is very difficult because single peakedness of the preferences cannot usually be assured. Considering an economy where heterogeneous agents can cast their votes both on a social security system and on government debt to smooth their macroeconomic risk in the context of a different voting model, such as probabilistic voting, agenda setting model, or sequentially voting, is certainly among the suggestions for future research.

A Appendix

Proof of proposition 1. This is equivalent to showing that the preferences of the young are strictly concave in τ. By taking the first and second derivative of $V_t(\gamma^{i,j}, s_t^{i,j}, \tau)$ with respect to τ and recalling the assumptions on the Bernoulli utility functions we get: $\frac{\partial V_t^{i,j}(\gamma^{i,j}, s_t^{i,j}, \tau)}{\partial \tau} > 0$ and $\frac{\partial^2 V_t^{i,j}(\gamma^{i,j}, s_t^{i,j}, \tau)}{\partial \tau^2} < 0$ ■

Proof of proposition 2. It suffices to show that the unskilled worker support a transition to the PAYG system once a negative shock hits the economy. If this is true, they will make a coalition with the old and the transition will occur.

Let me now lay out the possible rates of return different systems yield and then make a comparison. The rate of return from the PAYG system to unskilled workers during a bad time is $\frac{(1+n)\tau(\delta w^U + (1-\delta)\overline{w}) + \gamma^{U,FF} s_t^{U,FF} r + (1-\gamma^{U,FF}) s_t^{U,FF} R_{B,U}}{\tau w^U + s_t^{U,FF}}$. It is computed as the ratio of the benefits they would obtain if such a system were in place to the resources they would have to give up in the first period of their life. The return from a FF system are simply the returns from private savings. If the economy is in a bad state then, for an unskilled worker under FF system, they are $\frac{\gamma^{U,FF} s_t^{U,FF} r + (1-\gamma^{U,FF}) s_t^{U,FF} R_{B,U}}{s_t^{U,FF}}$. It follows that, for an unskilled worker to switch from FF to PAYG we must have $\left[\gamma^{U,FF} r + (1-\gamma^{U,FF}) R_{B,U}\right] w^U < (1+n)(\delta w^U + (1-\delta)\overline{w})$. Rearranging we obtain: $w^U < \frac{(1+n)(1-\delta)\overline{w}}{\gamma^{U,FF} r + (1-\gamma^{U,FF}) R_{B,U} - (1+n)\delta}$. Notice that if $\frac{(1+n)(1-\delta)}{\gamma^{U,FF} r + (1-\gamma^{U,FF}) R_{B,U} - (1+n)\delta} > 1$, then by our assumptions on the income distribution (i.e. $\overline{w} > w^m > w^U$) the above inequality is always satisfied. Thus, we need that $1+n > \gamma^{U,FF} r + (1-\gamma^{U,FF}) R_{B,U}$. This is always true by assumption 1 and 3 and since $0 < \gamma^{U,FF} < 1$. ■

Proof of proposition 3. The argument is similar to the proof of proposition 2. We need to check that the unskilled young decide not to switch in such a situation so that they form a coalition with the old to keep implementing the PAYG system. The rates of return that need to be compared are now $\frac{(1+n)\tau_t(\delta w^U + (1-\delta)\overline{w}) + \gamma^{U,PG} s_t^{U,PG} r + (1-\gamma^{U,PG}) s_t^{U,PG} R_{B,U}}{\tau_t w^U + s_t^{U,PG}}$ for the PAYG, and $\frac{\gamma^{U,PG} s_t^{U,PG} r + (1-\gamma^{U,PG}) s_t^{U,PG} R_{B,U}}{s_t^{U,PG}}$ for the FF. Notice, in fact, that due to the timing of the game the individuals have to decide and vote about the tax after having taken their saving decisions under the current system in place. The condition that has to be satisfied in order for a PAYG system to stay in place in the case of a bad shock is then:

$w^U < \frac{(1+n)(1-\delta)\overline{w}}{\gamma^{U,PG}r+(1-\gamma^{U,PG})R_{B,U}-(1+n)\delta}$. Since $1+n > \gamma^{U,PG}r+(1-\gamma^{U,PG})R_{B,U}$ by assumptions 1 and 3 and since $0 < \gamma^{U,FF} < 1$, the above condition is always satisfied. ∎

Proof of lemma 1. Suppose not, then $\widehat{w}^G_{S,PG} > \widehat{w}^G_{U,PG}$, but this is true if and only if

$\gamma^{U,PG}r + (1-\gamma^{U,PG})R_{G,U} - \delta(1+n) > \gamma^{S,PG}r + (1-\gamma^{S,PG})R_{G,S} - \delta(1+n)$. After some arrangements, we get $r(1-\gamma^{S,PG}) - r(1-\gamma^{U,PG}) + (1-\gamma^{U,PG})R_{G,U} - (1-\gamma^{S,PG})R_{G,S} > 0$, which can be rewritten as $(1-\gamma^{S,PG})(r-R_{G,S}) + (1-\gamma^{U,PG})(R_{G,U}-r) > 0$ or $\frac{(1-\gamma^{U,PG})}{(1-\gamma^{S,PG})} > \frac{(R_{G,S}-r)}{(R_{G,U}-r)}$.

Notice that the right hand side of this inequality is greater than one by our assumptions on the rate of returns while the left hand side is smaller than one since $\gamma^{S,PG} < \gamma^{U,PG}$ by our assumptions on the distribution of the rate of returns. This is a contradiction and we can thus conclude that $\widehat{w}^G_{S,PG} < \widehat{w}^G_{U,PG}$. Notice also that $\widehat{w}^G_{U,PG} < \overline{w}$, because $1+n < \gamma^{U,PG}r + (1-\gamma^{U,PG})R_{G,U}$ by assumption. ∎

Proof of proposition 4. In general, for a coalition constituting a majority of the population to support the PAYG system it is required that:

$$N_t + N_t(1+n)\int_{w_{\min}}^{Min\{\widehat{w}^G_{U,PG},\, w^m\}} f(w)dw + N_t(1+n)\int_{w^m}^{Max\{\widehat{w}^G_{S,PG},\, w^m\}} f(w)dw > \frac{(2+n)N_t}{2} \tag{30}$$

The first term of the left hand side represents the number of old people in the economy at period t (who always support the PAYG system), the second term represents the fraction of young unskilled supporting the PAYG system; the third term is the fraction of young skilled that would like to have a PAYG system in the good state. The total must constitute more than the fifty percent of the current population alive in period t. Recall from the lemma 1 above that only two cases are possible:

1) $w^m < \widehat{w}^G_{U,PG} < \overline{w}$

2) $\widehat{w}^G_{U,PG} < w^m$

In the first case, clearly at least all the young unskilled (i.e. half of the young population) would support the PAYG system and thus the coalition supporting the PAYG would be a large majority. In the second case, all the skilled would support the FF system. Thus to introduce a PAYG system it must be that $N_t + N_t(1+n)\int_{w_{\min}}^{\widehat{w}^G_{U,PG}} f(w)dw > \frac{(2+n)N_t}{2}$. Simple algebra shows that this condition is exactly equivalent to (19). The next step of the proof is to show that if $\widehat{w}^G_{U,PG} > w^m$ and (19) is satisfied.

If $\widehat{w}^G_{U,PG} > w^m$, then $N_t(1+n)\int_{w_{\min}}^{\widehat{w}^G_{U,PG}} f(w)dw = \frac{N_t(1+n)}{2}$. All the unskilled young are supporting the PAYG system. Thus it suffices to show that $\frac{1}{2} > \frac{n}{2(1+n)}$, and this is always true as long as $n \neq -1$. ■

Proof of lemma 2. Suppose not, then $\widehat{w}^G_{S,FF} > \widehat{w}^G_{U,FF}$ but this is true if and only if $\gamma^{U,FF}r + (1-\gamma^{U,FF})R_{G,U} - \delta(1+n) > \gamma^{S,FF}r + (1-\gamma^{S,FF})R_{G,S} - \delta(1+n)$, or $r(1-\gamma^{S,FF}) - r(1-\gamma^{U,FF}) + (1-\gamma^{U,FF})R_{G,U} - (1-\gamma^{S,FF})R_{G,S} > 0$, which is equivalent to $(1-\gamma^{S,FF})(r - R_{G,S}) + (1-\gamma^{U,FF})(R_{G,U} - r) > 0$. From this we obtain the following inequality $\frac{(1-\gamma^{U,FF})}{(1-\gamma^{S,FF})} > \frac{(R_{G,S}-r)}{(R_{G,U}-r)}$.

Notice that the right hand side of this inequality is greater than one by our assumptions on the rate of returns while the left hand side is instead smaller than one since $\gamma^{S,FF} < \gamma^{U,FF}$ by our assumptions on the distribution of the rate of returns. This is a contradiction and we can thus conclude that $\widehat{w}^G_{S,PG} < \widehat{w}^G_{U,PG}$. Notice also that $\widehat{w}^G_{U,FF} < \overline{w}$ since $1+n < \gamma^{U,FF}r + (1-\gamma^{U,FF})R_{G,U}$ due to our assumptions. ■

Proof of proposition 5. Straightforward from the proof of proposition 4. ■

Proof of proposition 6. Recall that the optimal solution in the case of a FF system are derived directly from the following first order conditions:

$$\frac{u'(\gamma^{i,FF}s_t^{i,FF}r + (1-\gamma^{i,FF})s_t^{i,FF}R_{B,i})}{u'(\gamma^{i,FF}s_t^{i,FF}r + (1-\gamma^{i,FF})s_t^{i,FF}R_{G,i})} = \frac{\pi}{1-\pi}\frac{R_{G,i}-r}{r-R_{B,i}} \tag{31}$$

$$\begin{aligned} u'(w^i - s_t^{i,FF}) \quad &= \quad \beta[\pi u'(\gamma^{i,FF}s_t^{i,FF}r + (1-\gamma^{i,FF})s_t^{i,FF}R_{G,i})R_{G,i} \\ &\quad +(1-\pi)u'(\gamma^{i,FF}s_t^{i,FF}r + (1-\gamma^{i,FF})s_t^{i,FF}R_{B,i} + P_{t+1})R_{B,i}] \end{aligned} \tag{32}$$

For the moral hazard case, the first order conditions are given as follows:

$$\frac{u'(\gamma^{i,MH}s_t^{i,MH}r+(1-\gamma^{i,MH})s_t^{i,MH}R_{B,i}+P_{t+1}(E_t\tau_{t+1}))}{u'(\gamma^{i,MH}s_t^{i,MH}r+(1-\gamma^{i,MH})s_t^{i,MH}R_{G,i}+\Gamma_{t+1}(E_t\tau_{t+1}))}=\frac{\pi}{1-\pi}\frac{R_{G,i}-r}{r-R_{B,i}} \tag{33}$$

$$\begin{aligned} u'((1-E_t\tau_t)w^i-s_t^{i,MH}) &= \beta[\pi u'(\gamma^{i,MH}s_t^{i,MH}r+(1-\gamma^{i,MH})s_t^{i,MH}R_{G,i}+\Gamma_{t+1}(E_t\tau_{t+1}))R_{G,i} \\ &\quad +(1-\pi)u'(\gamma^{i,MH}s_t^{i,MH}r+(1-\gamma^{i,MH})s_t^{i,MH}R_{B,i}+P_{t+1}(E_t\tau_{t+1}))R_{B,i}] \end{aligned} \tag{34}$$

It is thus obvious that $s_t^{i,MH}\neq s_t^{i,FF}$ and $\gamma^{i,FF}\neq\gamma^{i,MH}$. Furthermore, notice that under the moral hazard case the expected lifetime budget of an individual is increased with respect to the FF case because the positive terms Γ_{t+1} and P_{t+1} more than offset the negative term $E_t\tau_t w^i$ as long as $E_t\tau_t\leq E_t\tau_{t+1}$. Due to strict concavity and intertemporal separability of the preferences, we can conclude that consumption must increase in all the possible states with respect to the purely FF case. This implies that present consumption has to increase, and future consumption both in the bad state and in the good state has to increase as well. Agents will move resources from the future bad state (in which they are completely insured) to the future good state and the first period by adjusting their saving/portfolio decision. If the present consumption has to increase compared to the FF case and the wage is exogenously given, it follows immediately that s_t^i has to decrease. Then, $s_t^{i,MH}<s_t^{i,FF}$. If, as stated above, the future consumption in the good state increases, it follows that γ^i has to decrease because $\frac{\partial u(c_{t+1}^{i,G})}{\partial\gamma}=u'(c_{t+1}^{i,G})s_t^i(r-R_{G,i})<0$.

As we have just seen, there must be a decrease in savings as well and the decrease in γ^i is confirmed because $\frac{\partial^2 u(c_{t+1}^{i,G})}{\partial s_t^i\partial\gamma}=(r-R_{G,i})\left[(\gamma^i s_t^i r+(1-\gamma^i)s_t^iR_{G,i})u''(c_{t+1}^{i,G})+u'(c_{t+1}^{i,G})\right]=(r-R_{G,i})\left[(\gamma^i s_t^i r+(1-\gamma^i)s_t^iR_{G,i})\frac{u''(c_{t+1}^{i,G})}{u'(c_{t+1}^{i,G})}+1\right]<0$. Note that the term inside the square parenthesis above is 1+the coefficient of relative risk aversion. Then, it follows that $\gamma^{i,MH}$ is lower than $\gamma^{i,FF}$ and therefore $1-\gamma^{i,FF}<1-\gamma^{i,MH}$. ■

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Table 1: Population Growth Rates for OECD Countries, 2000

Country	n	$\frac{n}{2+2n}$	$\frac{2+n}{2(1+n)}$
Australia	0.0099	0.0049	0.9951
Austria	0.0024	0.0012	0.9988
Belgium	0.0016	0.0008	0.9992
Canada	0.0099	0.0049	0.9951
Czech Republic	-0.0007	-0.0004	1.0004
Denmark	0.0030	0.0015	0.9985
Finland	0.0016	0.0008	0.9992
France	0.0037	0.0018	0.9982
Germany	0.0027	0.0013	0.9987
Greece	0.0021	0.0010	0.999
Hungary	-0.0032	-0.0016	1.0016
Iceland	0.0054	0.0027	0.9973
Ireland	0.0112	0.0055	0.9945
Italy	0.0007	0.0003	0.9997
Japan	0.0017	0.008	0.9992
Luxembourg	0.0126	0.0062	0.9938
Mexico	0.0150	0.0074	0.9926
Netherlands	0.0055	0.0027	0.9973
New Zealand	0.0114	0.0056	0.9944
Norway	0.0049	0.0024	0.9976
Poland	-0.0003	-0.0002	1.0002
Portugal	0.0018	0.0009	0.9901
Slovakia	0.0013	0.0006	0.9994
South Korea	0.0089	0.0044	0.9956
Spain	0.0010	0.0005	0.9995
Sweden	0.0002	0.0001	0.9999
Switzerland	0.0027	0.0013	0.9987
Turkey	0.0124	0.0061	0.9939
United Kingdom	0.0023	0.0011	0.9989
United States	0.0090	0.0045	0.9955

Source: U.S. Census, http://www.census.gov/ftp/pub/ipc/www/idbsum.

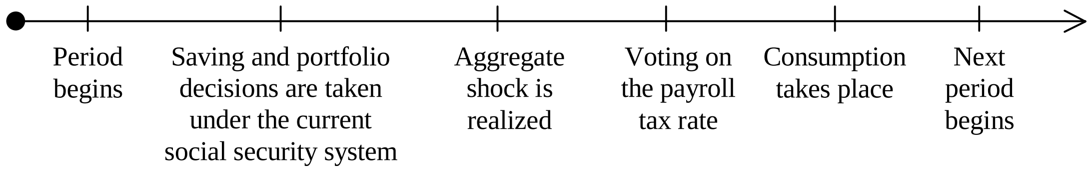

Figure 1: Timing of the model