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Anticipation effects of looming public-pension reforms*

Monika Bütler†
CentER and Department of Economics, Tilburg University, The Netherlands

Abstract

In many countries, current unfunded public pension systems are unsustainable. Though agents recognize that fiscal imbalances will be eliminated sooner or later, the timing of reforms and future policy mixes are typically unknown. The paper proposes a tractable framework to study forthcoming but ill-specified events, such as a crisis in the pension system, within a macroeconomic model based on individual life-cycle optimization. The uncertainty about the timing of a future stabilization is modeled by a subjective hazard function where the state-dependent hazard rate depends on a measure of the public-pension system's expected net liabilities. Using Switzerland as a motivating example, the model is calibrated and simulated under a number of alternative policy options and different perception patterns. Expectations prior to a reform are shown to have large impacts on aggregate variables and on cross-generations profiles of consumption and labor supply. In comparison to well-specified pre-announced stabilization policies, timing uncertainty and misperceptions can lead to welfare losses, in particular for the middle-aged and the elderly.

* *Correspondence to:* Monika Bütler, CentER for Economic Research and Department of Economics, Tilburg University, Postbus 90153, 500 LE Tilburg, The Netherlands; email: monika@kub.nl; Fax + 31 13 466 3042.

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1 Introduction

The early 1990s have witnessed the beginning of a massive crisis of public-pension systems around the world. At the same time recent recessions in countries with high (projected) old-age dependency ratios–notably Japan, Germany, Italy, and Switzerland–were accompanied by reductions in consumption and corresponding increases in savings that were more pronounced than in previous recessions. Could this phenomenon perhaps be explained by anticipation effects of necessary future reforms to social security systems? Some economists even relate the recent stock-market boom to a forthcoming crisis of public-pension systems.[1]

The delicate financial situation of most pension systems will further worsen with the aging of the baby-boomers and last well into the 21st century. Abstracting from insurance aspects, the first generation in the system will probably have been the only one to gain from social security. Although the full impact of the public-pension problem will not be felt for another decade or so, potential reforms will be anticipated long before. Opinions differ about the extent of the problem, but it is generally agreed, that "something has to be changed," and policy amendments are discussed in many countries.[2] The population, learning about worsening pension prospects, suffers from growing uncertainty. In the media, sluggish consumption is often attributed to people's uncertainty as to the future of the pension system.

How does uncertainty about the future of social security affect short-run economic behavior? The answer depends largely on how and when the unsustainability of the system is removed, or expected to be removed, respectively. The problem of uncertainty clearly has two dimensions. On the one hand, it is unclear what measures will be taken to amend the system. It matters a lot to a 60-year-old person whether old-age benefits are reduced or taxes increased. In the former case, he is much worse off, whereas he has no reason to worry about in the latter. On the other hand, there is timing uncertainty about the date of the change. A 20-year-old person for example might not care much whether the retirement age will be raised in 5 years or in 30 years from now, but he or she certainly cares about the timing of an increase in taxes. Consequently, an investigation which neglects the impact of anticipation effects on cross-generations' profiles would not be complete.

Large policy changes are low frequency events. It is therefore difficult to pin down rational expectations of future reforms. A large set of probability distributions (over reform date and type of reform) are consistent with ratio-

[1] I am grateful to Robert Shiller for pointing this out to me.

[2] However, only a few have already reformed their system drastically. An example is Chile, where social security has been privatized. See Diamond (1994) for an appraisal of Chile's scheme.

nal expectations. Consequently, expectations can have a more autonomous role in our context than in standard macroeconomic models.[3] It is also important to know *when* agents have realized the potential unsustainability of the PAYG system. Have they always been aware of its problems, or has there been a shift in perception in recent years? Presumably, the latter is the more realistic case, as reliable information about factors which influence the performance of the system, such as the demographic structure and growth rates, become public knowledge only with a considerable lag. Fears about the future of the pension system seem to be relatively recent phenomena.

The objective of this paper is to provide tentative answers to the following questions: To what extent can expected reforms of an unsustainable social security system in the future explain changes in consumption, savings, and labor supply? How much do different ways to reform the public-pension system in the future affect today's consumption and labor-supply decisions? Which generations suffer most from uncertainty under different regimes? How important are preannounced reform plans in comparison to ill-specified reform expectations in terms of welfare gains? The focus of this paper is clearly on the effects of different expectation schemes in the context of a future reform. We are not primarily interested in long-term forecasting of macroeconomic variables and efficiency gains of different reforms, but in short-run implications of changing expectations.[4] Although the paper focuses primarily on *timing* uncertainty on imminent pension reforms, the framework can also be extended to include uncertainty about the type of the reform.[5]

The paper develops a simple model to answer questions concerning the impact of expectations about future reforms on economic variables. The model is an overlapping generations (OLG) model with endogenous labor supply. The only role of the government is to provide a public-pension sys-

[3] There are also contributions which integrate consumer confidence into general equilibrium (RBC) macroeconomic models. See for example Danthine, Donaldson, and Johnsen (1998) and references cited therein.

[4] Most economists agree on the desirability of reducing the current PAYG systems, as their internal rate of return is much smaller than the real interest rate, and as weak tax-benefit linkages lead to labor-supply distortions. Using the paper's parameterization and the necessary pension parameter adjustments forecasted for Switzerland, a young agent in the new after-reform steady state would gain 8.2% (3.7%) in lifetime consumption if the adjustment is a reduction in benefits rather than an increase in payroll taxes (consumption taxes).

[5] In a companion paper (Bütler (1998)), we develop a method to assess the likelihood of certain reform measures in a similar setting by means of a stylized voting model. The proposed model of voting on the stabilization policy gives a more realistic analysis of policy preferences at all ages than would be possible in the two- or three-period models of classical voting models. The analysis shows that–under prevailing and forecasted demographic structures–the most likely outcome in a vote is clearly an increase in payroll taxes followed by an increase in retirement age, an increase in consumption taxes, and finally a benefit reduction.

tem. The system is in need of reform, as current benefits and taxes lead to a growing pension deficit. Agents incorporate the uncertainty about the timing of a future stabilization by means of a hazard function where the hazard rate is state-dependent. The used hazard-function specification provides a flexible way to model uncertainty in the absence of well-specified distribution assumptions. It is able to map a wide spectrum of possible beliefs, from completely myopic to extremely "pessimistic" (in the sense that a reform is expected very soon). Using Switzerland as a motivating example, the model is calibrated and simulated. The impacts of a number of expected reforms are explored for several expectation patterns, including a preannounced policy change. Some sensitivity results are reported for a potential reduction in the benefit level.

The paper is organized as follows. Section 2 contains a brief review of the related literature. The basic macroeconomic model is presented in Section 3, followed by a description of the public-pension system in Section 4. Section 5 proposes a way to model people's expectations by means of a state-dependent hazard function. The following Section 6 contains computational details including the calibration of the model. The results of our simulation experiments can be found in Section 7. Concluding remarks are given in Section 8.

2 Related literature

Macroeconomic effects of public-pension systems, and of social security in general, have always attracted considerable attention. Since the analysis of Feldstein (1974), publications have mushroomed, covering a wide range of different aspects of social security. The analysis of effects of demographic transitions on the economy and the pension system has become an important topic in this field.[6] In recent publications, the focus is often on ways to privatize social security, which goes hand in hand with a transition from a pay-as-you-go to a fully-funded system.[7]

Early analysis of social security issues has been carried out almost exclusively with overlapping generations models of two-period-lived agents. Though qualitative results about pension systems can be derived, those models are not appropriate for quantitative predictions. Computable multiperiod OLG models have become feasible since the pathbreaking work of Auerbach and Kotlikoff (1987). Auerbach and Kotlikoff study an economy consisting of 55-period-lived individuals in a nonstochastic environment in which they explore the impact of announced or surprise policy changes. Their nonstochastic approach was extended by Ríos-Rull (1994, 1996) to include stochastic production opportunities and changes in fertility patterns. Storesletten (1999) presents an interesting extension of this model by allowing for immigration. İmrohoroğlu, İmrohoroğlu, and Joines (1995) examine welfare effects of an unfunded but sustainable social security system with individual employment uncertainty and borrowing constraints.

Existing work on policy changes in a public-pension security system typically take the type of policy shift as given. Uncertainty about timing is mostly ignored by taking one of the following two shortcuts. In the first, the policy shift is fully anticipated. Agents have perfect foresight about the time and nature of the reform. Questions of consequences of announced policy changes within a public-pension system were successfully addressed by Auerbach and Kotlikoff (1987). Huang et al. (1997) deal with issues concerning the preannounced transformation from an unfunded to a funded social security system, while DeNardi, İmrohoroğlu, and Sargent (1999) perform a number of reform experiments within the unfunded PAYG system. As a second shortcut, it is assumed that the reform is completely unexpected. In view of the wide media coverage which potential reforms of the pension system have enjoyed recently, this second approach is equivalent to assuming partially myopic individuals.

Unfortunately, empirical evidence of anticipation effects of future pension reforms are scarce. Some interesting evidence is given in Rossi and Visco (1995) for the case of Italy which had a major–though by far insufficient–reform in 1992. Cross-section estimates of 1991 data indicate that younger agents discounted implicit pension wealth heavily in their consumption/savings decisions while the elderly did not. Rossi and Visco conclude that (young) agents might have perceived the unsustainability of the Italian social security system. The 1992 reform seems to have confirmed both groups' expectations, as it severely hit the young and left the pension wealth of the elderly basically unaffected.

Timing issues of anticipated future policy changes have been studied in the context of inflationary implications of government deficits. A tight monetary policy cannot avoid inflation if the budget deficit has to be monetized eventually. Rational agents anticipate an expansionary monetary policy in the future and act accordingly. In Drazen and Helpman (1990), for example, the timing of the future policy change is stochastic with an exogenous probability distribution.[8] In recent papers, where government deficits have to be financed by distortionary proportional taxes, Dotsey (1994) and Dotsey and Mao (1996) model expectations of future policy changes endogenously.

[6] See for example Auerbach, Kotlikoff, Hagemann, and Nicoletti (1989), Masson and Tryon (1990), and Shoven, Topper, and Wise (1994).

[7] See for example Diamond (1994), Feldstein (1995), Kotlikoff (1997), and Huang, İmrohoroğlu, and Sargent (1997).

[8] The analysis of Drazen and Helpman (1990) draws on the famous paper of Sargent and Wallace (1981) who assume a deterministic and exogenous timing of stabilization.

The probability of changing a (distortionary) proportional tax to reduce the government debt is assumed to be a function of the debt/GDP-ratio.

In the presence of timing uncertainty, the question naturally arises "Why do most countries not stabilize immediately, once it becomes apparent that the current policy is not sustainable?" Despite potentially high costs of a delay, stabilizations rarely occur before the problem becomes endemic. Alesina and Drazen (1991), for example, argue that heterogeneity in terms of differences of socioeconomic characteristics, which imply conflicting distributional objectives, account for a delay in reforming the system. Although different groups may agree that the system is in need of reform, there may be disagreements about how the burden of the policy change is to be shared. Different subgroups of the population may engage in power struggles until one group concedes to taking a higher burden. Orphanides (1996) offers an alternative explanation of delays in which governments minimize the cost of stabilization, taking into account the cost of failed reforms. In the presence of uncertainty, the government may want to wait until favorable conditions emerge which minimize the possibility of costly failures. Boldrin and Rustichini (1998) model the outcome of majority voting on the PAYG social security system, that is known to be eliminated (by voting) some time in the future. Nevertheless, it is perfectly rational for the median voter to maintain the PAYG system for a certain time period.

3 Description of the economy

We analyze a real overlapping generations economy similar to the one used by Auerbach and Kotlikoff (1987) and Ríos-Rull (1996), but assume the small economy assumption of exogenous factor prices. The model includes a public-pension system which accounts for the only uncertainty of the economy apart from individual lifetime uncertainty.

3.1 *Population and mortality*

The economy consists of overlapping generations of agents who live a maximum of J periods and are indexed by their age $j \in \mathcal{J} = \{1, 2, ..., J\}$. In every period j, individuals face a certain mortality risk $1 - \psi_j$, where ψ_j denotes the probability of being alive in period j, conditional on having been alive in period $j-1$. The unconditional probability of surviving until period j can then be calculated as $\Psi_j = \Pi_{i=1}^{j} \psi_i$. For the presented simulation study, we assume that the probability distribution of an individual's lifetime is time-invariant.[9]

[9]Note that the paper focuses on a relatively short time horizon *prior* to a pension reform. While the projected decrease in mortality rates will be important for the determination of the pension parameters, it will only play a minor role in the short-run. Moreover, starting from an already high level, the forecasted increase in life expectancy for Switzerland is relatively small compared, for example, to the U.S.

The number of age-j-agents at time t is denoted by $\mu_j(t)$. The total population is $\mu(t) \equiv \sum_{j \in \mathcal{J}} \mu_j(t)$. For an economy without immigration and emigration, it would be sufficient to know fertility rates, survival probabilities, and an initial age structure in order to derive the overall demographic structure for the future endogenously. However, this approach is not applicable for most industrialized countries. In the Swiss case with non-negligible population shifts, we would require not only a forecast of fertility rates, but also of net immigration (= immigration - emigration) for each age group. As a shortcut, different population scenarios are utilized as a proxy for the demographic structure and as weights for different age groups.

3.2 *Preferences*

Agents born at the beginning of period t maximize their expected, discounted lifetime utility

$$E_t \left\{ \sum_{j \in \mathcal{J}} \beta^{j-1} \Psi_j U[((1 - \nu(t+j-1))c_j(t+j-1)), l_j(t+j-1)] \right\}, \quad (1)$$

where $c_j(\cdot) \geq 0$ and $l_j \geq 0$ denote consumption expenditures and leisure, respectively, at age j. $\nu(\cdot)$ is the proportional consumption tax, earmarked for social security.[10] Future utility in period j is discounted with both a pure discount factor β^{j-1}, and the survival probability Ψ. The use of the survival probability ψ_j as an additional discount factor implies that agents can estimate their lifetime without a bias. Hamermesh (1985) tests this conjecture by analyzing responses to a questionnaire designed to elicit subjective expectations and probabilities of survival. He finds that individuals are fully aware of their expected lifetime while the subjective distribution has greater variance than its actuarial counterpart.

In every period of their life, agents are endowed with one unit of time which they can allocate to either leisure or labor. However, age-dependent labor productivity e_j is such that agents choose to retire at an age which is in line with the observed retirement age in reality. In order to prevent labor supply from being negative, the following restriction on leisure is imposed

$$l_j(\cdot) \leq 1, \quad \forall j \in \mathcal{J}. \quad (2)$$

[10]In most countries, consumption taxes are not yet used to finance pensions. As they are often discussed as an alternative to payroll taxes in future pension reforms, they are included here.

The instantaneous utility function is assumed to take the CIES-specification

$$U(c_j, l_j) = \frac{\left((c(1-\nu))^{\theta} l^{1-\theta}\right)^{1-\sigma}}{1-\sigma}. \tag{3}$$

Let $w(\cdot)$ denote real wage rate per efficiency unit of labor and $R(\cdot) \equiv 1+r(\cdot)$ the gross real rate of return on asset holdings. The budget constraint of an individual can then be written as

$$a_0(t-1) = 0 \tag{4}$$

$$\begin{aligned} a_j(t+j-1) &= R(t+j-1)a_{t-1}(t+j-2) \\ &+ (1-l_j(t+j-1))e_j(1-\tau(t+j-1))w(t+j-1) \\ &+ I_{[j\geq J^*(t+j-1)]}B(t+j-1) - c_j(t+j-1) \end{aligned} \tag{5}$$

$$a_J(t+J-1) \geq 0 \tag{6}$$

where $a_j(\cdot)$ are end-of-period asset holdings of an age-j individual, $V(\cdot)$ pension benefits paid out after the legal, possibly time-dependent retirement age $J^*(\cdot)$. $I_{[\cdot]}$ is an indicator function: if the condition in brackets is satisfied $I_{[\cdot]} = 1$, if not $I_{[\cdot]} = 0$. Labor productivity e_j varies with age, but is assumed to be time invariant. It is assumed that labor income after retirement is taxed at the same rate as preretirement labor income. With the notation $B(t)$ it is anticipated that the same benefit level is paid out to all retirees, regardless of their age.

Apart from the idiosyncratic uncertainty about their own lifetime, individuals face uncertainty about the parameters of the public-pension system, namely, the proportional payroll tax $\tau(\cdot)$ and consumption tax $\nu(\cdot)$ on the contribution side, as well as the pension level $B(\cdot)$ and retirement age $J^*(\cdot)$ on the benefit side.

3.3 *Market structure*

We consider the case of a small open economy, in which factor prices, the wage rate $w(\cdot)$, and the real interest rate $r(\cdot)$, are exogenous. While this approach would clearly be unsatisfactory for long-run analysis of pension reforms and their macroeconomic consequences, it can be assumed that the omission of a general equilibrium feedback is less important in the relatively short period prior to the reform. Annuity markets do not exist. Agents are not allowed to write debt contracts with payoffs contingent on their survival. Although in reality private annuity markets do exist, they are generally not important. Limited participation is partly due to adverse selection depressing the rate of return which makes the insurance unattractive for many consumers. Friedman and Warshawsky (1990) show, that even if adverse

selection is accounted for, the average expected yield on individual life annuities in the United States is considerably lower than yields on plausible alternative investments.

There are no borrowing constraints on working individuals, but agents are not allowed to borrow against future social security payments. As mortality risk increases with age, the latter assumption is an easy way to preclude insecured borrowing of elderly people with a high mortality risk. There are no bequest or gift motives. Accidental bequest in case of premature death is confiscated by the government.

4 The public-pension system

The only purpose of government in the model is to provide a public-pension system.[11] In order to close the model, a linkage between individual contributions and benefits has to be established. In most countries there is a complex and often highly intransparent linkage between social security payments and future benefits.[12] We therefore assume that future benefits and current payroll taxes are completely unrelated.

$$B_j(t) = \begin{cases} 0, & \text{for } j = 1, 2, ..., J^*-1 \\ B(t), & \text{for } j = J^*, J^*+1, ..., J. \end{cases} \tag{7}$$

The individual believes that marginal social security tax payments provide no marginal benefits. As all quantities of the model, specification (7) is tantamount to a full indexation to price changes.

In this paper, we abstract from the existence of a fully-funded second pillar of the pension system. As long as these compulsory savings yield the same return as private savings and do not exceed the amount agents willingly save for their old age, they do not distort optimal allocations.

A PAYG-system implies that the public-pension budget is balanced on average. The pension system's deficit $d(t)$ in period t is determined as

$$d(t) \equiv \sum_{j\geq J^*} \mu_j(t)B_j(t) - \tau(t)\sum_{j\in\mathcal{J}} \mu_j(t)e_j(1-l_j(t))w(t) - \nu(t)\sum_{j\in\mathcal{J}} \mu_j(t)c_j(t) \tag{8}$$

[11] Social security systems were introduced for various reasons. Pensions should ensure a minimum level of retirement income for everybody and offset myopic behavior. In a period of high growth after World War II, public pensions were thought to redistribute income from the lucky young generations to the not-so-lucky older generations. Although designed as partly funded in most countries, public-pension funds today cover only a small fraction of the aggregate future social security liabilities.

[12] Feldstein and Samwick (1992) give an account of the astonishing variance in marginal tax rates across individuals for the prevailing system in the United States. For Switzerland the benefit scheme is relatively flat. Although the maximum benefit level is twice the minimum level, a majority of people qualify for the upper level or are entitled to "means-tested" supplementary benefits.

Business-cycle fluctuations can lead to a surplus in booms and to a deficit in recessions, but should not lead to a structural deficit. Note, that the demographic structure of most industrialized countries is such that the actual $d(1998)$ is close to zero or even negative, as the number of retirees is still relatively small, while the baby-boomers are in their prime earning age. However, the present value of implicitly accrued net entitlements under the current structure is already large. After the year 2010, moreover, most countries also face the prospect of increasing pension deficits as changes in the demographic structure will lead to an increase in aggregate benefits, a decrease in aggregate contributions, and consequently lead to heavy debt accumulations.

In a small open economy, the country can raise funds on the international capital market at the given world interest rate as long as it is expected to honor its obligations. Financial markets seem to tolerate a substantial debt to GDP ratio provided the public finance perspectives are sound in the long run.

4.1 *Possible reforms*

We focus on a reform within the current PAYG system, and abstract from the possibility of changing the scheme altogether, for example by introducing a fully-funded pension scheme.[13] However, a reduction in the benefit level can also be viewed as a partial (and immediate) transition to a fully-funded system, provided the latter is actuarially fair and does not imply any redistribution. Bohn (1997), moreover, shows that an increase in taxes to fund a retirement trust fund without reducing future benefits is actually equivalent to cutting future benefits.

Within a pay-as-you-go system, a reduction in the pension deficit $D(t)$ can be achieved by one of the following measures–or any combination of them: (1) a reduction of benefits $B(t)$, (2) an increase in retirement age $J^{\star}$, (3) an increase in the payroll tax rate τ, (4) an increase in the consumption tax rate ν. After a policy change, the present value of all future contributions must equal the present value of future entitlements plus the initial stock of debt.

Often, a reform aiming to reduce the level of benefits is accompanied by some sort of grandfathering for the elderly. We abstract from this issue mainly because of the difficulty to specify the way the additional burden is

[13] In their study Chand and Jaeger (1996) conclude that the fiscal costs of undertaking a shift to a fully-funded system may be very high and that it might be preferable to fix the existing PAYG system instead. The political pressure against such a shift is presumably large unless compensating gains to living generations, who by their contributions have acquired an implicit right to future benefits, are sufficiently high.

to be distributed over time and generations.[14] An immediate benefit cut can be viewed as a worst case scenario for the older generations.

The degree of the necessary change depends on the time of the reform as well as on people's expectations prior to the reform. There are basically two strategies to deal with this issue in the model. The first is to adjust the necessary parameter changes for each period in time, taking into account the state of the economy, which in turn depends on people's past expectations. The second strategy is to fix the new parameter values and redistribute interest payments of excess/deficient funds in a lump-sum way. We follow this second route for the following reasons. First, fixing parameter values is a more transparent policy than sophisticated adjustment rules. Second, informed people presumably have some notion about the size of the reform from the media.

5 Modeling expectations on pension reforms

The paper focuses on timing uncertainty and takes the type of reform as given most of the time. Expectations will primarily be modeled along the time dimension. It is important to note that no features of the current state of the economy can help to pin down the probability distribution of the reform date *ex ante*. It is as rational to believe that the pension system will be changed with certainty in the year 2010 as it is to believe it will change with probabilities $\frac{1}{2}, \frac{1}{2}, \frac{2}{3}$, and 1 in the years 1998, 2001, 2005 and 2010, respectively. Moreover, expectations may change over time. Presumably most people did not realize until recently that the public-pension system was unsustainable. The time when people recognize that something has to be changed certainly matters for their optimal allocation of resources.

In order to keep the model tractable, we make a few simplifying assumptions. First, all reforms are final. After the reform, there is no more uncertainty and the system is believed to be sustainable forever. Second, the probability of the country going bankrupt due to its pension-system imbalances is zero. This implies that financial markets are willing to lend money to the government during the transition period at the current (riskfree) world interest rate.

The probability distribution of reform timing can be completely characterized by giving the state-dependent hazard rates (or conditional probabilities) $p(\cdot)$. We will postulate below that these probabilities depend on a

[14] Honoring implicit pension claims of the current retirees, while at the same time having to provide for their own retirement, young agents face a so-called *double burden* during the transition. A transition without grandfathering partially shifts the burden from the current young to the current old. Most policy proposals seem to aim at a compromise between these two polar scenarios.

suitable measure of the pension system's financial situation, and are therefore endogenously determined within the model. The timing of the transformation of the public-pension system can be described conveniently by means of a two-state Markov process. Let S denote the (current) unsustainable system and S^* the set of possible policies after the stabilization date t. The transition matrix is then given by

	S	S^*
S	$1-p(t)$	$p(t)$
S^*	0	1

where $p(\cdot)$ denotes the conditional probability of a policy shift, given there has been no reform before t. S^* is an absorbing state of the process (provided $p(t)$ is bounded away from zero), while S is a transient state with a finite expected duration. The Markov-process specification is flexible enough to capture myopic behavior on the part of the agents (in which case S^* is not an absorbing state) as well as a preannounced reform at date $\tilde{t}$. In the former case, agents act as if the system were sustainable forever with $p(\cdot) \equiv 0$ at all times. In the latter, $p(t) = 0$ for all $t < \tilde{t}$ and $p(\tilde{t}) = 1$ for all $t \geq \tilde{t}$.

The proposed Markov specification for expectations formation can moreover be easily generalized to include uncertainty about the type of the reform. As long as the uncertainty about the type of the reform is independent of the timing uncertainty, the Markov structure is preserved. Consider, for example, a case in which there are two possible policy shifts, a reduction in benefits (with probability $q(t)$) and an increase in payroll taxes (with probability $1-q(t)$). The resulting transition matrix is then given by

	S	s_B^*	s_τ^*
S	$1-p(t)$	$p(t)q(t)$	$p(t)(1-q(t))$
s_B^*	0	1	0
s_τ^*	0	0	1

S is again a transient state with a finite expected duration, while both s_B^* and s_τ^* are absorbing states of the process.

The question is now, what is likely to determine people's expectations about the possible time of the reform. For our analysis, we postulate the following specification of the reform hazard rate $p(t)$:

$$p(t) = f(\tilde{D}(t)) \tag{9}$$

where $\tilde{D}(t)$ is a measure of the pension system's expected financial burden, to be defined below. We further assume that $f(\cdot)$ is increasing in $\tilde{D}(t)(f'(\cdot) \geq 0)$, $f(\tilde{D}(t) < 0) \equiv 0$, and $f(\infty) = 1$. For the simulations, we will use the following parametrization

$$p(t) = (1 - \xi_1 \exp\{-\max[\xi_2 \tilde{D}(t), 0]\}). \tag{10}$$

The parameters ξ_1 and ξ_2 can then be chosen to match the first two moments of the timing distribution, i.e., to yield a certain reform date in expected terms and a corresponding standard deviation.[15] Such a choice facilitates comparisons between preannounced reforms and reforms anticipated with hazard rate (10). Uncertainty about the possibility of a reform in a certain period is resolved at the beginning of the period.

The system's overall financial burden has two important components, which we will use as measures of the public-pension's solvency:

1. The *accumulated pension debt* $D(t)$ is computed as

$$D(t) = d(t) + D(t-1)R \tag{11}$$

where $D(t-1)R$ is last period's debt plus interest payments. $D(t)$ is negative in case a fund has been accumulated to meet future needs. Although $D(t)$ is a backward-looking statistic and does not contain any information about the system's future viability, it has two advantages: first, as it does not depend on future policy actions, it is the least arbitrary measure in a PAYG system; second, reforms clearly become more urgent and more costly, the higher the accumulated debt.[16]

2. The expected *future net liability* D_{exp}^+ of the system depends on expected future policy changes, and is constructed as

$$D_{exp}^+(t+1) \equiv \sum_{s=1}^{\infty} \left\{ d(t+s)R^{-s} \prod_{u=1}^{s} [1 - p(t+u)] \right\}. \tag{12}$$

[15] I am grateful to Chris Phelan for pointing out the desirability of a flexible distribution assumption.

[16] In an analogous way the probability of tax reforms in Dotsey (1994) and Dotsey and Mao (1996) depends on the size of the government debt relative to the GDP.

We compute the present value of the pension system's expected net liability in every future period $s > t$, weighted by the conditional probability of not having reformed the system before the beginning of period s. The expected financial burden exceeds D^+_{exp} if we allow for a transition period, in which implicitly-accrued claims to the system are partially honored.[17]

The expected financial burden of the social security system is proxied by

$$\tilde{D}(t) = D(t) + D^+_{exp}(t+1). \tag{13}$$

Note that expected net liabilities $D^+_{exp}(t)$ and the reform hazards $p(t)$ will have to be jointly determined. If they are, expectations are automatically time consistent.

As an illustrative example consider Figure 1 below. While expected net entitlements define the hazard rate in the near future (the system is still balanced in a "myopic" sense until 2005), a combination of new deficits and expected net liabilities will drive the conditional probability of a reform thereafter. Note that as hazard rates increase (i.e., as the expected time until stabilization decreases), the weight of expected net liabilities becomes small relative to the weight of the already accumulated burden.

6 Calibration and computation of the model

In order to obtain numerical solutions for the model and compare simulations of different scenarios, we have to choose plausible parameter values. The case of Switzerland is analyzed as a representative of a small open economy. The problems of the Swiss public-pension system, moreover, represent an "average" case among industrialized countries. They are more severe than those of pension systems in the United States and Britain, but less extreme than the problems of the Italian and German pension schemes. The parameter choices are also summarized in Table 1.

6.1 *Population structure and mortality*

Individuals are assumed to be born at age 20 and to live for a maximum of 15 five-year periods to age 95. At age 95, death is certain. Pooled survival probabilities were derived from the 1990 census. The demographic structure was taken from population scenarios of the "Schweizerisches Bundesamt für Statistik" (SBfS). As preliminary results were fairly robust to the choice of the scenario, results are only reported for the main scenario. This scenario

[17] See (den Noord and Herd (1994)) for a summary of accounting methods in public-pension systems.

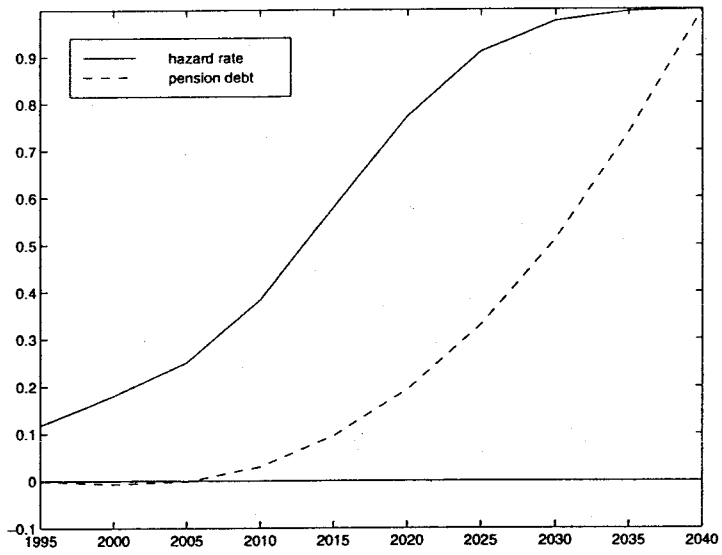

Figure 1:

Figure 1: A typical profile of hazard rates for an expected benefit reduction. The hazard rates imply an expected implementation lag of 15 years. (The accumulated public pension debt is shown as a fraction of the debt in the year 2040).

Table 1:
Parameter Values and Factor Prices
for Calibration of a 15-Period OLG Model

	Parameter	*Benchmark*	*Alternatives*
Ψ_j	survival probability	Swiss census	
β	discount rate (per year)	1.011	
θ	consumption/leisure	0.33	
σ	risk-aversion	4	
e_j	relative productivity	Hansen (1993)	
r	real interest rate (per annum)	3%	1% & 5%

assumes a moderate immigration, a relatively low fertility rate, and a slight decrease in mortality rates. The majority of immigrants are predicted to be between 20 and 40 years old. It is important to note that these demographic assumptions do not lead to a stable population in the long run. This will have consequences on the way parameters of the scheme will have to be adjusted.[18] A graphical representation of the used population structure is provided in Figure 2.

6.2 *Preference parameters and discounting*

We will use the age-independent constant elasticity of substitution specification (3). The coefficient of relative risk-aversion σ (or the inverse of the intertemporal elasticity of substitution) is chosen to be 4, following Auerbach and Kotlikoff (1987) and Ríos-Rull (1996). The coefficient θ, which defines the trade-off between consumption and leisure, is chosen to be 0.33. This value generates an age-profile of hours worked that is very similar to observed profiles. As data on labor-earnings profiles for Switzerland are not as detailed as for the United States, we use the index of relative efficiency for individuals of different ages, computed by Ríos-Rull (1996) with data from Hansen (1993). The pure discount rate β is assumed constant and is taken from Hurd (1989). For yearly intervals, Hurd estimates $\beta = 1.011$.[19]

[18] Chand and Jaeger (1996) assume that fertility rates converge to the level needed to maintain a stable population. In view of the historically low birth rates over a relatively long period in most industrialized countries, this seems a rather optimistic assumption. On the other hand, fertility rates have always exhibited large swings in the past.

[19] Hurd uses data from retired individuals, accounting for mortality in estimating parameters. Estimates for the rate of time preference tend to be upward-biased if mortality risks are not accounted for. The same discount rate is used for example in Ríos-Rull (1994,

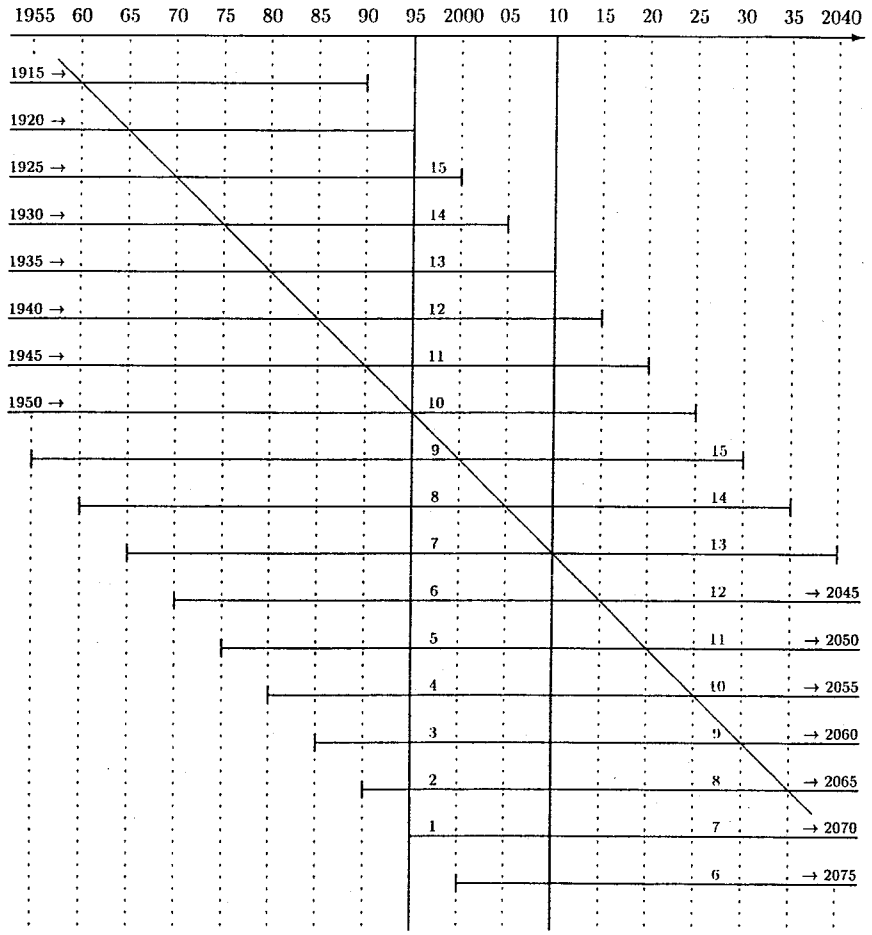

Figure 2: Representation of the used 15–period OLG–model. Horizontal lines show different generations. The numbers on the right and on the left represent dates of birth (at age 20) or death, respectively, for generations which could not be shown in full. The diagonal line marks the (constant) retirement age. The two solid vertical lines define the period of the paper's main focus.

6.3 *Public pensions*

The proportional payroll tax earmarked for public pensions in Switzerland is 8.4% for employed, and 7.4% for self-employed people (1995). In its forecasts, the *SBfS* uses a pooled tax rate of 8.3% for all individuals. It is important to know that 20% of aggregate benefits are financed by general government revenues. As the latter is predominantly (labor) income taxes, the effective tax rate is higher. If federal taxes were proportional payroll taxes, the implied pension tax rate could be calculated as

$$\tau_{\text{impl}} \equiv \tau_{\text{bas}} \left(1 + 0.2 \frac{\text{total benefits}}{\text{total taxes}}\right) \tag{14}$$

The initial payroll tax rate used for the analysis is chosen to be 10.38% which corresponds to the implied tax rate in a balanced pension budget (10.38=8.3/0.8). This value understates the true rate for higher income and overstates it for low income, as federal taxes are progressive. In 1995, no consumption tax revenues are used to finance social security in Switzerland. However, when consumption taxes were introduced in 1994, voters agreed on a clause which allows a certain increase in the consumption tax rate to finance pensions.

The benefit level is only defined relative to the wage rate (which is normalized to 1). It is chosen in a way that the public-pension system in 1995 is balanced, as in the actual economy. Thus $B = .18$ for the benchmark case. The initial retirement age chosen to be 65 years which is the legal retirement age for men. The values for τ and B correspond to a replacement rate—defined as the ratio between the benefit level and average preretirement income—of approximately 45%, as in the Swiss economy.

If people did not expect any changes to the system, and projecting constant fertility and immigration rates for the future, the necessary adjustment would approximately be a doubling of payroll taxes for a reform in the year 2025. Obviously, the assumption on the extent of a necessary reform might seem rather extreme, in particular as the current implicit payroll tax is taken as a base for contributions. Similar estimates for Germany (Börsch-Supan (1991)) and other countries (den Noord and Herd (1994)) forecast an increase in contribution rates of the same magnitude, should the current benefit structure be maintained. The benchmark scenario is therefore a 100% increase in payroll taxes. Equivalent changes in the other parameters are then computed for a population structure consistent with forecasted fertility and immigration rates. As mentioned before, we fix these parameter values for reasons

1996), Storesletten (1995), and İmrohoroğlu et al. (1995). Note that future levels of utility are not only discounted by the pure discount rate β, but also by the probability Ψ_j to live until age j. Early in life, the rate of time preference is negative, while in old age it is positive and monotonically increasing due to increasing mortality rates.

of transparency, regardless of when the reform is carried out. Obviously, an earlier reform would reduce the necessary degree of change to a certain extent, while a later implementation would call for larger adjustments. Interest payments of excess (deficient) funds due to early (late) stabilization are redistributed in a lump-sum way. The resulting tax rates, benefit levels, and retirement ages for the four-corner cases are summarized in Table 2. Any other combination of parameter adjustments can be derived in an analogous way.

Table 2:

		Status quo	$B \Downarrow$	$J^* \Uparrow$	$\tau \Uparrow$	$\nu \Uparrow$
Benefits	B	0.18	$\boxed{0.095}$	0.18	0.18	0.18
Retirement age	J^*	65	65	$\boxed{73\frac{1}{2}}$	65	65
Payroll tax	τ	0.1038	0.1038	0.1038	$\boxed{0.2076}$	0.1038
Consumption tax	ν	–	–	–	–	$\boxed{0.0725}$
Experiments			**1, 5**	**2**	**3**	**4**

Reform scenarios for public-pension systems. Benefit levels are computed for a wage rate 1 per efficiency unit of labor. $B = 0.18$ corresponds to a replacement ratio of approximately 0.45.

6.4 *Interest rate and growth rate*

All results are computed for a nongrowing economy. The growth rate in Switzerland has been low in recent years. For the future, too, most scenarios of the *SBfS* assume zero growth which is partly justified by an aging of the work force. As we deal with a small open economy, the relevant interest rate is the riskfree world interest rate. The main results are computed for a real interest rate of 3%.[20] Results on selected reform options are reported for interest rates of 1% and 5%.

6.5 *Initial asset distribution*

Initial asset distribution is a key issue in determining the model's dynamics. Unfortunately, data on wealth distribution by age groups is often unavailable–

[20]Real interest rates were 1.5% for Switzerland and 4.25% for the United States for 1980-1993. For 1983-1993, the corresponding numbers are 0.45% for Switzerland and 3.65% for the United States. Chand and Jaeger (1996) use a real interest rate of 3.5% and a labor-augmenting technical progress of 1.5% per annum.

as in Switzerland–or is not of a high quality.[21] To solve the problem, we use the following approach: the steady-state distribution of asset holdings is computed for an economy with "myopic" agents, where people act as if the current pension system were sustainable forever. However we also include simulations with agents who had been aware of the pension system's problems (with a probability distribution over possible reform dates) since birth.

For a country with a relatively high immigration, asset holdings of immigrants poses a potential problem. This problem, however, is mitigated by two factors. First, most immigrants are very young. A large majority immigrate before the age of 30, almost everybody before turning 40. Second, asset holdings of young people are generally low also for natives. We conclude that immigrants hold the same amount of asset holdings as the natives when entering the country.

6.6 *Probability distribution of timing*

For the benchmark case we used the specification (10), in which the hazard rates and the expected financial burden of the social security system are jointly determined. In all cases, the year 2010 was chosen as the implementation date. In order to isolate the impact of pure timing uncertainty, the free parameters ξ_1 and ξ_2 were chosen to yield an expected duration until the reform of 15 years (starting from 1995), and a standard deviation of 7.5 years. If the expected duration is longer than 15 years we speak of "optimistic" expectations (in the sense that a postponed reform decreases the burden of current generations at the expense of future generations). If it is shorter, expectations are called "pessimistic." A polar case of the former, myopic expectations with $p(t) \equiv 0$ are computed. Trajectories for agents with a constant hazard rate of $p = 0.9$ after the year 1995 are used as an example of "pessimistic" expectations.

6.7 *Computations*

Computations for an economy with exogenous factor prices are relatively easy, as—in the absence of a public-pension system—individual decisions could simply be aggregated. In the presence of an unbalanced PAYG-system, the size of the expected financial burden $\tilde{D}(t)$ adds an endogenous state variable. To solve the model, the following procedure is adopted: first, decision rules are computed for "myopic" agents who expect the actual benefit and contribution rate to stay at the same level forever. Second, using these decision rules and fixing the expected time until the reform, the expected pension

[21] Moreover, asset holdings are very difficult to measure, as a big fraction of asset consists of housing or is invested in private pension plans.

liabilities $\tilde{D}(t)$, hazard rates $p(t)$, and the parameters ξ_1 and ξ_2 are jointly determined using (10). It also has to be taken into account that interest payments of excess/deficient funds (in case of an early or late reform implementation) are redistributed as lump sums. Third, the model is computed for an economy with individuals taking into account the hazard rates $p(t)$. The second and third steps are repeated until convergence is achieved. Usually, not more than four iterations have to be computed to attain convergence.

7 Simulations

The model is now simulated under a number of different assumptions about possible reforms and different expectation patterns. We conduct ten groups of experiments, which are summarized in Table 3 for reference:

Table 3:
Summary of Simulation Experiments

Experiment	*Expected*	*Implemented*	
1	$B \Downarrow$	$B \Downarrow$	(benchmark cases)
2	$J^* \Uparrow$	$J^* \Uparrow$	
3	$\tau \Uparrow$	$\tau \Uparrow$	
4	$\nu \Uparrow$	$\nu \Uparrow$	
5	$B \Downarrow$	$B \Downarrow$	"pessimistic" agents $p(t) = 0.9, \forall t \geq 1995$
6	$\tau \Uparrow$	$B \Downarrow$	wrong reform
7	$B \Downarrow$	$\tau \Uparrow$	expected
8a	$B \Downarrow \& \tau \Uparrow$	$B \Downarrow$	$q_{\{B\Downarrow\}} = q_{\{\tau\Uparrow\}} = 0.5$
8b		$\tau \Uparrow$	
9	$B \Downarrow$	$B \Downarrow$	$\tau = 1\%$ (sensitivity)
10	$B \Downarrow$	$B \Downarrow$	$\tau = 5\%$

Experiments 1-4 (*pure timing uncertainty*): People expect the correct pension reform (i.e., the reform type which is subsequently implemented), but are uncertain about its implementation date (state-dependent hazard rate). Four pure reform options are investigated.

Experiment 5 (*timing error*): People are correct in expecting a reduction in benefits, but are more "pessimistic" about the time of the reform. A

high probability $p(t) = 9$ (which is moreover assumed to be not state-dependent) is assigned to the likelihood of a reform in every period.

Experiments 6 & 7 (*reform option error*): In these two cases, people do not anticipate the correct reform. Timing uncertainty is again modeled as in experiments 1-4.

Experiment 8 (*reform option uncertainty*): In contrast to all the other experiments, people are assumed to form a probability distribution also over possible reform measures. Here we present the results of a simulation in which a reduction in benefits and an increase in payroll taxes are expected with the same (constant) probability $q(t) = 0.5$.

Experiments 9 & 10 (*interest-rate effect*): The only difference to experiment 1 is the used world interest rate (1% and 5% per annum).

For each experiment, five expectation patterns are explored (as summarized in Table 4). In the first case, which is denoted by **S**, we assume that people will be completely surprised by a reform, i.e., their individual decisions are completely unaffected by the unsustainability of the public-pension system. For the next two cases, it is assumed that there has been a change in perception in the year 1995. This means that agents only start to perceive the pension-system's unsustain ability in 1995.[22] We distinguish between expectation pattern **H**, in which the timing of the reform is uncertain, and pattern **A**, in which the reform time is announced in 1995. To facilitate the isolation of pure timing uncertainty effects, we compare optimal trajectories of a hazard-rate regime **H** with a preannounced policy **A** whose announcement period coincides with the expected duration until the reform of pattern **H**.[23] At the other extreme we assume that all agents have been aware of the pension system's potential unsustainability since they were born (which can be as far back as 1930) in expectation patterns **h** (hazard-rate specification)[24] and **a** (preannounced reform time).

[22]One important reason for this choice is the pattern of changes to social security legislation (and the corresponding public discussion) in Switzerland during the past 25 years. All previous reforms focused almost entirely on redistribution issues within the retired generations and were thought of as "budget-neutral," albeit in a very myopic way. It was not until after the implementation of the last revision of the social security law in 1996 that the focus shifted to the inherent financial problems of the pension system.

[23]Recall from the previous section that the expected duration of the prereform stage is chosen to be 15 years, while the standard deviation of the used hazard-rate parameterization is 7.5 years.

[24]Note that although we maintain the assumption of an expected reform date in the year 2010 (for comparisons), hazard rates for an economy with "long-horizon" agents differ from those derived for an economy with a shift in expectations in 1995. Due to their awareness of the pension-system's problems, long-horizon agents have saved and worked more prior to the critical period.

For all experiments, aggregate and cross-section consumption and labor-supply changes are depicted (in Figures 3-9) as deviations from a scenario without reforms, in which the pension deficit is financed by manna.

Table 4:
Summary of Expectation Patterns

Pattern	*Timing Uncertainty*	*Perception*	*Reform Data*
S	none (surprise reform)	2010	2010
H	hazard rate $p(t)$	1995	2010
A	none (announced reform)	1995	2010
h	hazard rate $p(t)$	at birth	2010
a	none (announced reform)	at birth	2010

To measure welfare differences between any two expectation patterns we compute differences in utility for all living generations in 1995 in terms of remaining lifetime consumption. Utility differences are measured by a fraction ς in remaining lifetime consumption, where ς can be computed as follows. Let $\mathbf{c}^{x,y}$ and $\mathbf{I}^{x,y}$ denote optimal consumption and leisure paths, respectively, for an age-j individual (with asset holdings a_{j-1}) under expectation patterns x and y. Then the same utility level under regime y can be achieved by adjusting consumption for the first pattern x by a fraction ς for every remaining period in life, or formally

$$\mathcal{U}^y[\mathbf{c}^y, \mathbf{I}^y | a_{j-1}] = \mathcal{U}^x[(1-\varsigma)\mathbf{c}^x, \mathbf{I}^x | a_{j-1}]. \tag{15}$$

In other words, an agent optimizing under perception pattern x is as well off as an agent optimizing under pattern y if he or she gives up a fraction ς of the remaining consumption path.

While patterns **H** and **A** only lead to differences in individual decisions after the perception date, consumption and labor supply are different over the whole life-cycle for long-run expectation patterns **h** and **a**. In order to facilitate comparisons, corresponding utility differences are also measured in foregone consumption after the year 1995. Note that we are predominantly interested in short-run welfare losses due to anticipation effects and not in long-run welfare gains from different reform options.[25] Although, for instance, a reduction in benefits might lead to a larger immediate loss in

[25]For a recent computation of welfare comparisons for different generations under different reform regimes within a PAYG pension system, see De Nardi et al. (1998).

comparison to higher taxes, the long-run efficiency gains from the former stabilization measure will overcompensate the initial losses relative to the latter.

7.1 *Pure timing uncertainty: experiments 1-4*

Recall that in experiments 1-4 people correctly anticipate the type of the reform, albeit with timing uncertainty. Pension reforms imply a reduction in lifetime income—and consequently a negative wealth effect—for the majority of the agents. Moreover, there are substitution effects from expected changes in the tax rates. An imminent reform depresses consumption and raises labor supply and savings in all cases, regardless of expectation patterns. Quantitative and qualitative results differ widely for different reform scenarios, as depicted in Figures 3-6 and explained in more detail below. For all policy options expectation patterns **H** and **S** are compared with **A** in terms of remaining lifetime consumption in Table 5. For experiment 1 a comparison between patterns **h** and **a** is also shown. The results of these simulations can be summarized (by reform type) as follows:

- The impact of a possible *benefit reduction* (experiment 1, shown in Figure 3) is large and exceeds the impact of all other reform options, especially if agents perceive the unsustainability of the system relatively late. Reforming the system by reducing benefits entails large wealth effects for the middle-aged and for the elderly despite the fact that efficiency gains may partially offset these losses in the long run. These anticipated efficiency gains lead to a relatively small impact when the likelihood of a reform is anticipated long before (patterns **a** and **h**). The perception date also greatly matters for cross-generations profiles of consumption and labor supply. Fear of a reduction in benefits leads to an increase in labor supply for all ages, but in particular to a much higher (desired) participation rate of the elderly. Similarly, the reduction in consumption expenditure is most pronounced for elderly people, surprised by the prospect of a forthcoming benefit reduction.

- Qualitatively, results for an anticipated *increase in the retirement age* are similar to the results of anticipated benefit reductions (experiment 2, Figure 4). The size of the impact, however, is smaller. In contrast to the benefit reduction scenario (experiment 1), people who are beyond age $73\frac{1}{2}$ at the time of the policy change are not negatively affected by the reform. As in the previous experiment, an early recognition of the system's inherent problems reduces the impact of an anticipated reform considerably.

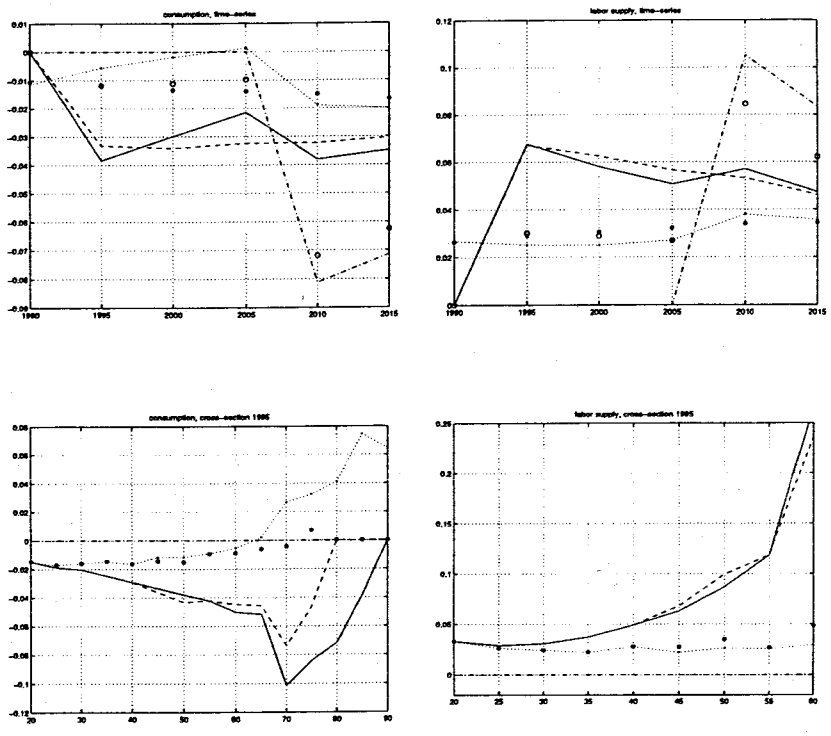

Figure 3:

Figure 3: Simulation results on the impact of an expected pension reform by a *benefit reduction* (experiments 1, 6).

(Solid lines = **H**, dashed lines = **A**, dash-dotted lines = **S**, dotted lines = **h**, * = **a**, o = wrong expected reform (payroll tax increase).)

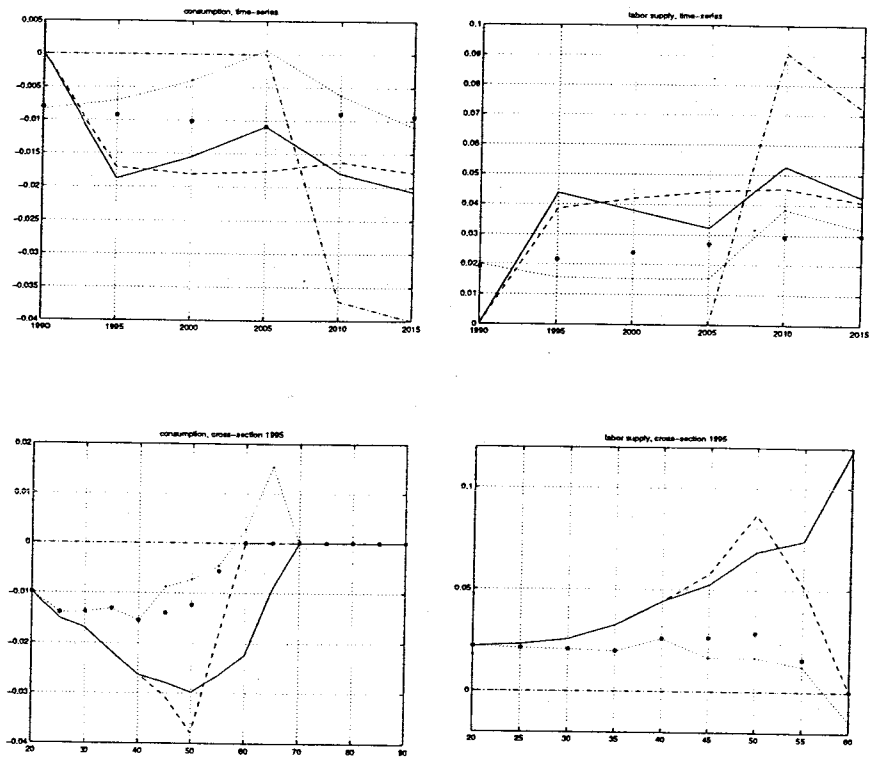

Figure 4:

Figure 4: Simulation results on the impact of an expected pension reform by an *increase in retirement age* (experiment 2).

(Solid lines = **H**, dashed lines = **A**, dash-dotted lines = **S**, dotted lines = h, * = a.)

- Figure 5 shows that the anticipation effect of an *increase in the payroll tax rate* (experiment 3) on consumption is relatively small even if the unsustainability of the system is perceived late. Agents take advantage of the still high after-tax wage rate and substitute expensive leisure today for cheap leisure after the reform by accumulating assets. The additional assets are sufficient to keep consumption relatively high and to support increased leisure after the tax change. The largest reactions both in consumption and labor supply can be observed for the young, as more of their future income will be heavily taxed. Figure 5 reveals that the date people realize the infeasibility of the system is far less important than in the two previous experiments with benefit cuts.

- Effects of an expected *increase in the consumption tax* (experiment 4) are generally small as shown in Figure 6. The necessary prereform adjustments are also small for all generations. Note that a *surprise* reform by an increase in consumption tax does not have any impact on individual decisions.[26] If an increase is expected or announced, however, people will try to smooth after-tax consumption by saving money to cover additional (tax) expenses in the future. Similar to experiment 3, the wealth effect for the young is largest as more of their expected future income is indirectly taxed away. Note that in reality, an anticipated or announced consumption tax increase often leads to an increase (instead of a decrease) in current consumption. However, this effect is due to the inclusion of durable goods which we have not considered in the analysis.

Wealth and substitution effects differ considerably across reform options, both by their size and the relative impact across generations. Aggregate consumption is less volatile in economies with informed agents (expectation patterns **A**, **H**, and especially **a** and **h**) than for economies with an a surprise reform **S**. Aggregate labor supply is also less volatile for an informed economy if the policy changes involve cuts on the benefit side (experiments 1 & 2). The reverse is true for labor supply in case the expected reform involves increases in the tax rates, as people substitute leisure across time when they anticipate the policy change.[27] Timing uncertainty can lead to additional volatility of aggregate consumption and labor supply even if the reform type is known. As long as agents have a correct estimate of the reform date in

[26] This is due to the chosen utility specification (3), as maximizing $\frac{((c_j(1-\nu))^\theta l_j^{1-\theta})^{1-\sigma}}{1-\sigma}$ with respect to c_j and l_j is equivalent to maximizing $\frac{(c_j^\theta l_j^{1-\theta})^{1-\sigma}}{1-\sigma}$ with respect to c_j and l_j.

[27] While the qualitative findings presumably remain unchanged for endogenous factor prices, increased savings would reduce the real interest rate, and changes in labor supply prior and after the reform would influence the wage rate. The consideration of general equilibrium effects would therefore reduce the size of the impact for all reform options.

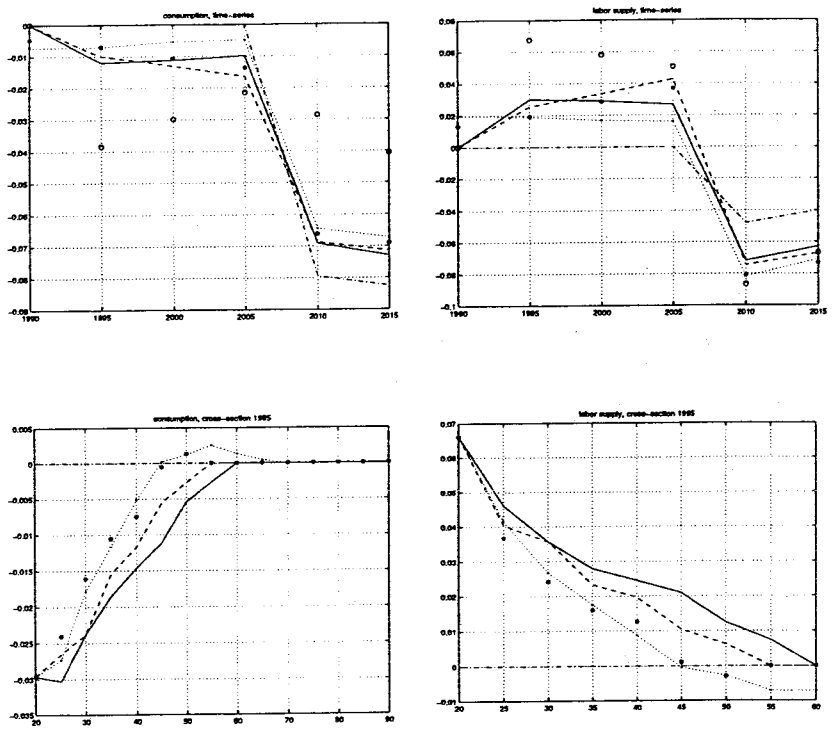

Figure 5:

Figure 5: Simulation results on the impact of an expected pension reform by a *payroll tax increase* (experiments 3, 7).

(Solid lines = **H**, dashed lines = **A**, dash-dotted lines = **S**, dotted lines = h, * = **a**, o = wrong expected reform (benefit reduction).)

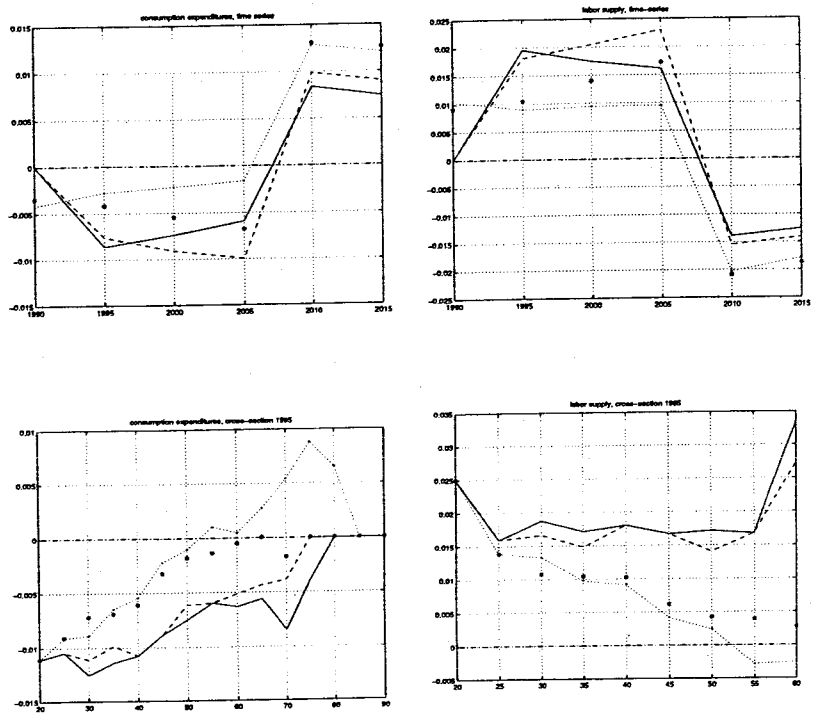

Figure 6:

Figure 6: Simulation results on the impact of an expected pension reform by a *consumption tax increase* (experiment 4).

(Solid lines = **H**, dashed lines = **A**, dash-dotted lines = **S**, dotted lines = h, * = **a**.)

Table 5:

Age	Experiment 1 *Benefit* ⇓ H/A	(h/a)	S/A	Experiment 2 *Retirem. age* ⇑ H/A	S/A	Experiment 3 *Payroll tax* ⇑ H/A	S/A	Experiment 4 *Consum. tax* ⇑ H/A	S/A
20	0		0.07	0	0.05	0.01	0.32	> 0	0.04
25	0		0.13	0	0.09	0.01	0.30	> 0	0.05
30	0		0.19	0	0.13	0.01	0.23	> 0	0.05
35	0		0.30	0	0.20	0.01	0.15	> 0	0.05
40	0		0.50	0	0.34	0.01	0.08	> 0	0.05
45	> 0	(> 0)	0.93	> 0	0.63	0.01	0.02	> 0	0.05
50	0.06	(0.03)	2.00	0.14	1.37	> 0	> 0	> 0	0.04
55	0.05	(0.03)	2.71	0.20	0.40	> 0	0	> 0	0.04
60	0.08	(0.05)	2.84	0.14	0	0	0	> 0	0.03
65	0.12	(0.06)	3.07	0.02	0	0	0	> 0	0.03
70	0.26	(0.10)	3.46	0	0	0	0	> 0	0.02
75	0.56	(0.13)	3.13	0	0	0	0	> 0	0
80	1.02	(0.21)	0	0	0	0	0	> 0	0
85	0.60	(0.11)	0	0	0	0	0	0	0
90	0	(0.04)	0	0	0	0	0	0	0

Welfare comparisons for generations living in 1995 (experiments 1-4, *pure timing uncertainty*): The numbers denote welfare losses in percent of remaining lifetime consumption for a comparison between expectation patterns. Cases in which the simulation results suggest positive but very small welfare losses are denoted by "> 0."

expected terms, the impact of pure timing uncertainty, however, seems to be relatively small.[28] Aggregate consumption and labor-supply trajectories, as well as cross-section profiles, are qualitatively similar for expectation patterns **H** and **A**.

The sooner the likelihood of a reform is perceived, the smaller are the effects on consumption and labor supply, as individuals accumulate asset holdings in order to cushion the impacts of an unfavorable reform. The effect is much larger in experiments 1 & 2, in which long-run perception patterns **a** and **h** lead to smooth consumption and labor-supply profiles over time.[29]

All generations benefit from knowing the likelihood of a reform. In comparison to preannounced reforms **A**, surprise reforms (expectation pattern **S**) lead to much larger welfare losses than anticipation patterns with timing uncertainty **H**. Welfare gains due to correct anticipation are largest for a reduction in benefits (middle-aged and old generations), followed by an increase in the retirement age (middle-aged, prior to retirement). They are much smaller for tax increases, and affect mainly the younger generations. Welfare losses due to pure timing uncertainty tend to decrease for larger anticipation horizons as is shown for the case of a benefit reduction in Table 5 (**h/a**). However, differences in welfare effects due to different horizons are found to be minor for the other three pure reforms.

7.2 *Alternative expectation patterns: experiments 5-8*

It is not often very realistic to assume that agents know the type of the future reform or that they have a good grasp of timing. In this section, we explore some alternative expectation patterns. First, in experiment 5, we consider a situation in which agents assume a high (non-state-dependent) reform hazard in every period of time. This can be viewed as a polar case to the previously encountered surprise reform **S**. The following experiments deal with situations in which the type of reform is not correctly anticipated. While agents are completely mistaken about the reform type in experiments 6 and 7, they attribute a probability of 50% to each reduction in benefits and an increase in payroll taxes in experiment 8.

The results of a simulation with "pessimistic" agents are summarized in

[28] The volatility of aggregate variables increases if the expected reform date does not coincide with the actual implementation date, as shown in Section 7.2.

[29] Increases in labor supply and the savings rate induced by expectations can contribute to the sustainability of the pension system to a limited extent. We have not explicitly focused on this issue in the present analysis. Note that the sign of the effect is unclear in the presence of earmarked consumption taxes, as an increase in the savings rate would lead to a fall in consumption tax revenues which can (partly) offset the increase in payroll tax revenues.

Figure 7 and in Table 6. In comparison to experiment 1, aggregate consumption and labor supply are more volatile. The impact on consumption and labor supply is larger initially, but is reduced later on when "pessimistic" expectations do not materialize. Despite the fact that the expected duration until the reform differs considerably from the one in the previous experiments, consumption and labor-supply trajectories are still fairly close to those of a preannounced policy change. As Table 6 reveals, anticipating the reform with a "pessimistic" timing distribution leads to smaller welfare losses (**H/A**) than being surprised by the reform for almost all age groups (**S/A**, repeated in Table 6 for convenience). The only exceptions are agents over 80 years, who will save too much for fear of having their future pensions cut.

Table 6:

Expected:	Experiment 5 *Benefit* ⇓		Experiment 6 *Payroll tax* ⇑		Experiment 7 *Benefit* ⇓	
Implemented:	*Benefit* ⇓		*Benefit* ⇓		*Payroll tax* ⇑	
Age	**H/A**	**S/A**	**H/A**	**S/H**	**H/A**	**S/H**
20	0	0.07	0.06	0.01	0.07	0.25
25	0	0.13	0.02	0.11	0.04	0.26
30	0	0.19	> 0	0.19	> 0	0.23
35	0	0.30	0.06	0.23	0.03	0.12
40	0	0.50	0.25	0.26	0.20	-0.11
45	0	0.93	0.70	0.23	0.56	-0.53
50	> 0	2.00	1.79	0.21	1.12	-1.10
55	0.11	2.71	2.60	0.10	1.51	-1.49
60	0.37	2.84	2.84	0	1.65	-1.62
65	0.68	3.07	3.07	0	1.73	-1.70
70	0.87	3.46	3.63	0	1.54	-1.52
75	1.99	3.3	3.13	0	1.34	-1.32
80	4.92	0	0	0	1.02	-1.01
85	4.38	0	0	0	0.60	-0.60
90	0	0	0	0	0	0

Welfare comparisons for experiments 5, 6, and 7. The numbers denote welfare losses in percent of remaining lifetime consumption for a comparison between different expectation patterns. Cases in which the simulation results suggest positive, but very small, welfare losses are denoted by "> 0".

What can happen if people expect a reform of the current system, but do

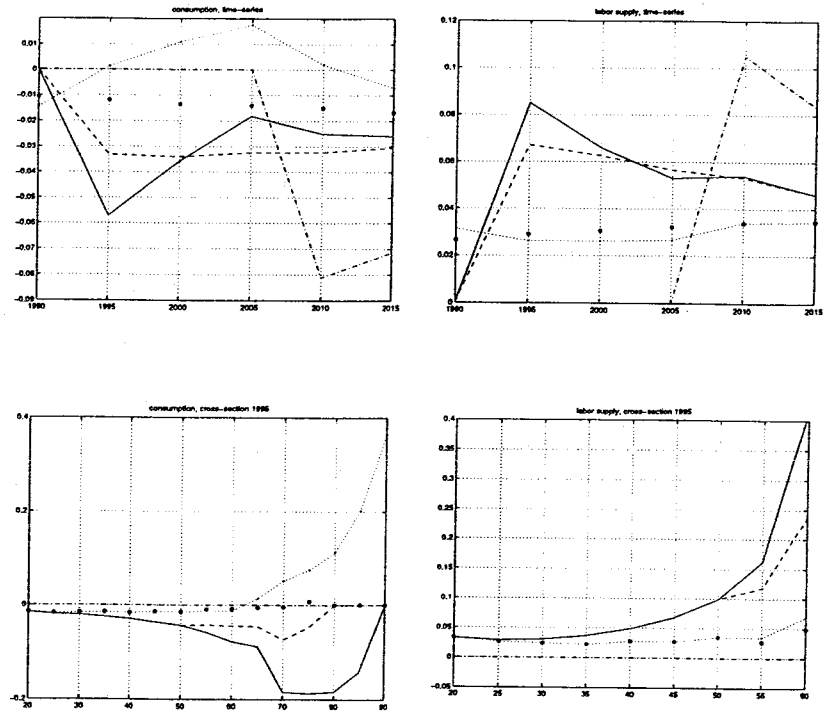

Figure 7:

Figure 7: Simulation results for *"pessimistic" agents* (expecting a benefit reduction, experiment 5).

(Solid lines = **H**, dashed lines = **A**, dash-dotted lines = **S**, dotted lines = **h**, * = **a**.)

not anticipate the correct type is shown in Table 6 as well as superimposed in Figures 3 (experiment 6) and 5 (experiment 7)? Clearly the main impact on welfare does not stem from timing uncertainty but from anticipating the wrong reform. Welfare losses due to false expectations are not symmetric: Expecting a payroll tax increase, even if finally a benefit reduction is implemented, is still slightly more favorable than a surprise reform, but the opposite is not true.[30]

Experiment 8 deals with a situation in which agents form a probability distribution over possible reform options. As a special case, a time independent probability of $q(t) = 0.5$ is assigned to both a reduction in benefits and an increase in payroll taxes. One of the two expected reforms is subsequently implemented in the year 2010. Not surprisingly, the resulting trajectories (as depicted in Figure 8) are approximately in-between the trajectories for the two pure reforms prior to the reform. At the time of the reform implementation, aggregate consumption and labor-supply depend on which policy is finally chosen.

7.3 *Alternative interest rates: experiments 9 & 10*

Factor prices obviously play a substantial role in optimally allocation resources. We therefore include simulations for two alternative values of a constant world interest rate (1% and 5%), shown in Figure 9. Qualitatively, the results look very similar to experiment 1 for both values of r. The size of the impact at both the perception date and the implementation date is, however, smaller for a value of 5% and larger for 1%. Due to a stronger (weaker) incentive to save at a higher (lower) interest rate, asset holdings are larger (smaller), and as a consequence people are better (less) insured even in case they are surprised by a pension reform. There is no structural difference in cross-generation consumption and labor supply between the different interest rates.

8 Conclusions

We have investigated the implications of looming—but ill-specified—reforms of the current PAYG pension system, by carrying out a number of simulations of an artificial economy calibrated to match the Swiss case. In contrast to most other contributions dealing with social security reforms, we have focused on the short-run impact of expectations prior to the reform. In the context of infrequent policy changes, expectations play a much more independent role

[30]Note that in contrast to welfare comparisons in previous experiments, Table 6 compares patterns **S** and **H** directly. Comparisons between **S** and **A** can be found in Table 5 under experiments 1 and 3.

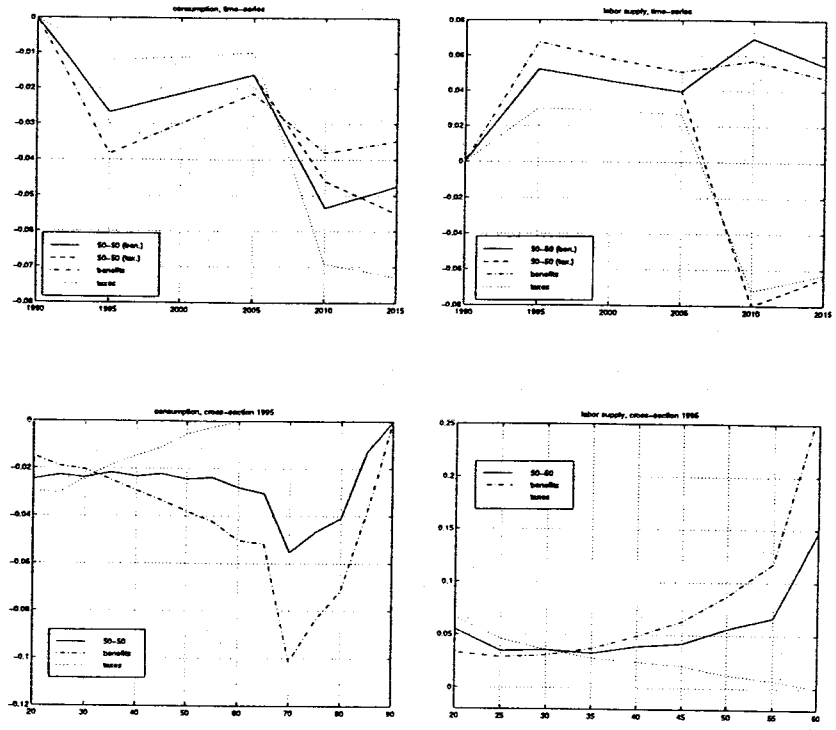

Figure 8:

Figure 8: Simulation results for experiment 8 ($p_{\{B\Downarrow\}} = p_{\{\tau\Uparrow\}} = 0.5$) and two different reform implementations in 2010.

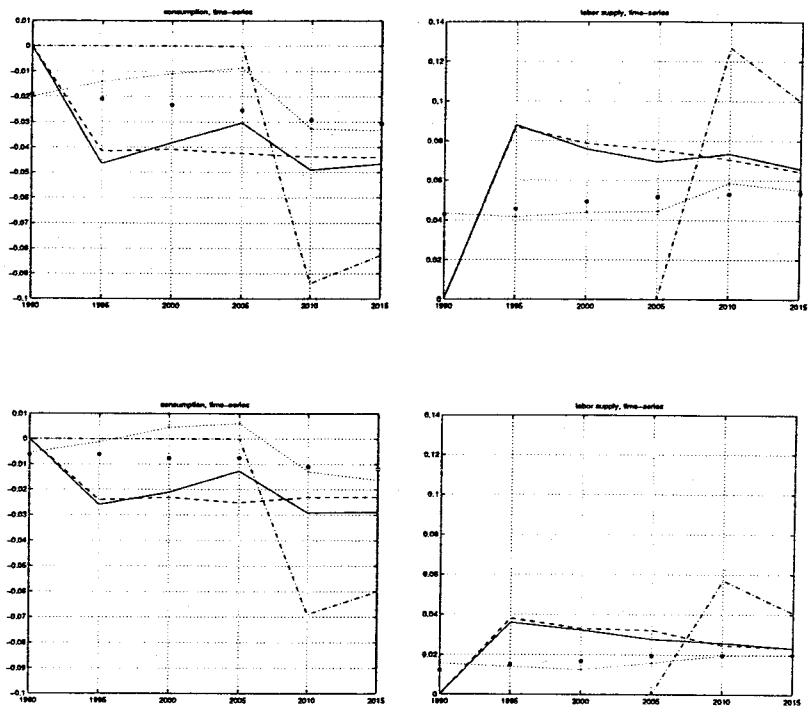

Figure 9:

Figure 9: Simulation results (sensitivity analysis) on the impact of an expected pension reform by a *benefit reduction* for alternative interest rates of 1% (experiment 9, upper panels) and 5% (experiment 10, lower panels).

(Solid lines = H, dashed lines = A, dash-dotted lines = S, dotted lines = h, * = a.)

than in standard rational expectations models. As a novel feature in this paper, timing uncertainty is accounted for by means of a subjective hazard function, where the state-dependent hazard rate depends on a measure of the public-pension system's expected financial burden.

The main conclusions we can draw from this exercise are the following: expectations are important and can lead to a substantial fall in consumption and an increase in labor supply well before any reform is implemented. While an immediate reduction in consumption reflects the desire to smooth consumption over time in the presence of a negative wealth effect, labor supply is also affected by substitution effects in view of expected future changes in tax rates. The size of the impact crucially depends on the nature of the expected policy change and the time the pension system's problems are recognized. The sooner the unsustainability of a PAYG system is perceived, the smaller the impact on consumption and labor supply, and consequently the smaller the welfare losses, both prior to the reform and after its implementation.

Timing uncertainty and policy uncertainty can increase the volatility of individual allocation plans and aggregate variables prior to the necessary reform. Expectations can change over time, moreover, and a wide range of possible trajectories of consumption and labor supply prior to a social security reform are consistent with rational expectations. Individual resource allocations are distorted more by policy uncertainty than by timing uncertainty (in case people anticipate the correct parameter changes).

There are considerable differences across age groups, as age groups will be affected differently by various reform options and by timing uncertainty. The way adjustment costs have to be borne by different generations presumably has a strong effect on the likelihood of a certain reform. Long-run efficiency differences between policy options play a minor role in explaining short-run impacts. Although cuts in the benefit level lead to a much more efficient outcome than tax increases in the long run, welfare losses prior to the reform's implementation are shown to be much larger in the former case.

Although the magnitudes of effects computed from simulation studies can not be taken literally, they provide a first estimate of the (immediate) impact of anticipated future pension reforms. As a possible extension, we could consider a situation in which the probability distribution over pension-reform options changes over time, due to news or changing perceptions. Every time such a shift in the probability structure takes place, we would observe a further impact in aggregate and individual consumption and labor supply. Pension-reform uncertainty can thus lead to higher volatility of aggregate variables. Along another avenue, the inclusion of endogenous political decision-making and consequently a more sophisticated model for political risk might strengthen the predictive power of the model.

The lesson we can draw from the presented simulations is the importance of informed agents. Well-defined reform plans facilitate and improve individual allocation of resources, and hence overall welfare. The example of long-horizon expectation patterns in the simulation shows that the more time people are given to adjust, the lower are short-run welfare losses of a future pension reform. Most importantly, people should have a good idea of what the future structure of a reform pension system might look like, even if the implementation date of the reform remains vague initially.

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Anticipation effects of looming public-pension reforms A comment

Christopher Phelan*
Federal Reserve Bank of Minneapolis
and
Kellogg Graduate School of Management
Northwestern University

In her paper, Monika Bütler states that if the Swiss public-pension system were to be reformed once and for all in the year 2010, so that it would be financially feasible in the long run, benefits would have to be cut roughly in half, labor taxes roughly doubled, or the retirement age increased by roughly eight years. In short, this is a pension system in serious trouble. There is no question about whether benefits, taxes, or the retirement age in Switzerland will change; at least one of them will. The only uncertainty is about precisely how and when they will change.

But how important is this uncertainty? If, quantitatively, the uncertainty itself is a big deal, Pareto improvements could perhaps be made by somehow committing the government to a future policy. If not, though, reformers should perhaps look elsewhere. I have two main comments on Bütler's paper. The first is that some uncertainty about government policy is unavoidable. Given this, we should focus on the importance of avoidable uncertainty. My second main comment is that most of the time and effort of this paper is spent not on measuring the effects of uncertainty (an important topic with a relevant policy question behind it), but instead on measuring the effects of implausible levels of ignorance about the world in which the model's inhabitants live.

How should one model uncertainty regarding government policy? Almost certainly, government policy must be stochastic. A generic problem of any

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government policy specified in terms of a benefit level per recipient and a tax level per worker is that periodic adjustments to the benefit level, the tax level, or the eligibility requirements must be made in response to changes in aggregate wages and demographics. Thus, an uncertainty-minimizing government policy would be a deterministic rule mapping real economic variables to benefit and tax levels and eligibility requirements. Given this, the kind of uncertainty over which there is a relevant policy question must refer to that which is over and above the level associated with such a rule. (To use Switzerland as an example, if it had an uncertainty-minimizing policy, we would already know its reaction to the aggregate wage growth and demographic shocks which have made pension reform necessary.) The appropriate experiment, then, seems to be a comparison between a world in which policy is a deterministic function of the real state of the economy and one in which policy depends on noise as well. After somehow calibrating the level of noise, one could consider the effects of eliminating it.

Bütler's method is to construct a deterministic many-period overlapping generations model and consider the effects (when the model is calibrated to Swiss data) of various reforms (cutting benefits, raising taxes, or raising the retirement age) under various "perceptions" of the population regarding how and when policy will change. For instance, in a simulation holding constant the outcome that benefits are cut in half in 2010, Bütler considers the effects of this on a population that has one of these five sets of beliefs:

1. Believes benefits will always stay constant and thus is completely surprised by the benefit cut in 2010.

2. First believes benefits will always stay constant, discovers in 1995 that benefits will be cut sometime around 2010, but is still uncertain until 2010 as to exactly when.

3. First believes benefits will always stay constant, but discovers in 1995 that benefits will be cut at exactly 2010.

4. Knows from birth that benefits will be cut sometime around 2010, but is still uncertain until 2010 as to exactly when.

5. Knows from birth that the benefit cut will occur at exactly 2010.

Other simulations compare these same five sets of beliefs for other once-and-for-all policy changes in 2010, including a doubling of taxes and an increase in the retirement age from 65 to 73.5 years. Welfare comparisons given these simulations are also performed.

By including in the simulations the first three sets of beliefs, each of which involves surprise in either 1995 or 2010, Bütler undercuts the very title of her paper, "Anticipation Effects of Looming Public-Pension Reforms."

The effects given these scenarios are precisely the nonanticipation effects of looming public-pension reforms. Comparisons regarding the first three sets of beliefs measure the effects of various levels of ignorance, not the effects of uncertainty. It is not surprising that there are large welfare gains to eliminating uncertainty in scenario 1, where households are completely incapable of minimizing the costs of uncertainty on their own. This is akin to looking at the effects of eliminating real wage uncertainty under an assumption that workers behave as if there is none and are surprised every time their real wage changes. Scenarios 2 and 3 are similar qualitatively, but the quantitative effect is less severe since their level of surprise is less severe: they discover the Swiss system is infeasible in 1995. To answer the question of how important uncertainty is, in and of itself, it seems to me the correct comparison is between scenarios 4 and 5, where all agents know the world, but the world either does or does not have uncertainty regarding government policy.[1]

Overall, Bütler pushes the idea that treating expectations as a free parameter is a valid and useful modeling choice for this problem. I disagree. Whether expectations should be considered a free parameter was settled by the profession two decades ago.[2] Since uncertainty about government policy is not so different from uncertainty about other things in life (say, stochastic wages), treating expectations as a free parameter is neither necessary nor justified. This seems especially true with regard to public-pension systems that are seriously underfunded. Given the magnitude of changes necessary to make the Swiss system solvent, how can anyone in Switzerland not know or have just discovered that the current system is going to change? Further, Bütler's contention that policy changes are low-frequency events (making learning about their probabilities difficult) seems contradicted by the data (at least U.S. data). If changes in how benefits are taxed are considered policy changes, then small changes in the U.S. social security program happen all the time.

To conclude, the framework of setting up a realistic overlapping generations model and using it to ask quantitative questions regarding the effects of uncertainty has much merit. In fact, comparing scenarios 4 and 5 using Bütler's deterministic model differs from the methodology I recommend only in that it assumes that certainty over government policy is feasible. Further, one could quibble over exactly how to set up the stochastic process for policy,

[1] In scenario 4, the world actually does not have uncertainty. The benefit cut is going to happen in 2010. The population simply thinks the date is uncertain and has the mean date correct. I am assuming the answers would not change much if the policy actually conformed to expectations.

[2] Exactly how one treats expectations is still unsettled. Nevertheless, among the competing sets of assumptions (say, rational expectations or learning models), none take expectations as simply free.

but this is a question which can be answered by the data. However, the fact that free expectations is simply a poor modeling decision is fundamental.

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Social security and institutions for intergenerational, intragenerational, and international risk-sharing*

Robert J. Shiller

Yale University, Cowles Foundation, New Haven, CT 06520

Abstract

Social security system old-age insurance systems are devices for the sharing of income risks of elderly people with others. Risks can be shared intergenerationally (with the young of the same country), intragenerationally (with other elderly of the same country), or internationally (with foreigners).

Barriers to individuals themselves sharing their risks intergenerationally, intragenerationally, or internationally are described. Optimal design of government-sponsored social security systems is considered in light of these barriers. Alternative benefits and contributions formulas for pay-as-you-go social security systems are defined and compared with existing and proposed formulas in terms of their ability to fulfill the government's role in promoting risk-sharing. Benefits for each retired person may be tied to that person's lifetime income without causing (as with the U.S. benefits formula today) aggregate benefits for all elderly today to be tied to their past aggregate income.

1 Introduction

The central function of social security old-age insurance is risk management, the management of the risk that some random turn of events will leave elderly people impoverished. The words "security" and "insurance" are there in the names of these programs to make this risk-management function clear. While

* *Correspondence to:* Robert J. Shiller, Yale University, Cowles Foundation, 30 Hillhouse Avenue, New Haven, CT 06520-8281.

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