Sustainability of Pension Schemes: Building a Smooth Automatic Balance Mechanism with an Application to the US Social Security

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- Of course, faced with the emergency of the insolvency of their pension systems, all governments have conducted reforms - some of them very substantial - but without setting restoring forces. The problem with *ad hoc* reforms is that, quoting Turner (2009), "(they) have a high degree of political risk because their timing and magnitude are unknown".

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Introduction

Preliminary remarks (2)

- To avoid that the future states of the pension system depend on choices that politicians would not take willingly, a strategy consists in:
    - Introducing new rules to allow for "standard" **Automatic Adjustment Mechanisms (AAM)** completed by **Automatic Balance Mechanisms** . $\Longrightarrow$ guarantee the solvency of the system at any date without needing political intervention and eliminating the "need for large program changes made in crisis mode" (Turner, 2009).

$\Rightarrow$Proposing a general form of **Automatic Balance Mechanism** (ABM) based on dynamic programming and the **minimization of a quadratic loss function**.

1. Definition of the intertemporal pension budget constraint.

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2. Building a "smooth" ABM, assuming a trade-off between present and future receipts and expenditures.

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3. Application of our ABM to U.S. Social Security.

The intertemporal pension budget balance

Budget constraint

The budget constraint of the pension system writes at time t:

$$\underbrace{F_{t-1}}_{\text{Reserve fund}} + \underbrace{r_t \cdot F_{t-1}}_{\text{Interest income}} + \underbrace{REC_t}_{\text{Receipts}} = \underbrace{EXP_t}_{\text{Total expenses}} + \underbrace{F_t}_{\text{Reserve fund}}$$

The intertemporal pension budget constraint

What about solvency (Boado-Penas, Vidal-Meliá and Sakamoto, 2010)?

Accountancy point of view: different methods to estimate the implicit liabilities and the solvency of unfunded pension systems. In practice, two measures of solvency are used:

- Assessing the discounted sum of revenues and expenditures: this value, called "Unfunded Obligation" defines it as (US Social Security Administration):

$$UO_0 = \sum_{t=1}^{T} \frac{EXP_t - REC_t}{\Pi_{j=1}^{t} R_j} = -\frac{F_T}{\Pi_{j=1}^{T} R_j} \quad (1)$$

Solvency would imply $UO_0 = 0$.

The intertemporal pension budget constraint

What about solvency (Boado-Penas, Vidal-Meliá and Sakamoto, 2010)?

- Another method is adopted by Sweden (Settergren, 2001). It defines its pension plan is solvent when (asset/liability approach):
  Present value of contributions payable by workers alive today
  $+$ Value of the reserve fund
  $=$
  Value of pension commitments towards generations alive today.

The intertemporal pension budget constraint

The standard Automatic Adjustment Mechanisms (AAMs) contribute to stabilizing pension schemes:
(1) Benefit index: the main objective of the benefit index is to preserve the level of pension purchasing power.
(2) Contributory period: eligibility for full pension requires validating a sufficient number of quarters. The contributory periodcan be connected to life expectancy.
(3) Retirement age:with a given frequency, this age could be revised withnew informations about each cohort's changes in life expectancy.
(4) Pension-earnings links: index rule of past contributions (defined contribution) or past wages (defined benefit), link between the amount of the pension (replacement rate or accumulated-contributions-to-rent coefficient) and the life expectancy at the retirement, etc.

What happens if the adjusments brought by the standard AAMs failed to yield enough stability?

One solution could consist in adopting a clear obligation of financial sustainability in a given time horizon: this is precisely what Automatic Balance Mechanisms (ABMs) are devised for.

At each period of revision, the ideal pension scheme's timing ought to be:

- First step (standard AAMs): setting the values of the pension parameters;
- Second step (intertemporal sustainability): checking the solvency of the pension schemes;
- Third step (ABM): triggering adjustements by resetting targeted parameters.

The intertemporal pension budget constraint

How to garantee solvency?

- **Sweden** adopted an ABM in 2001: a **uniform and permanent adjustment** of present and future pension benefits given the "balance ratio"secures solvency (Settergren, 2001).
- A contrario, in the **U.S. Social Security**, no ABM but a long-run proved-efficient reform in 1983. However, the U.S. Social Security trust funds are not allowed to borrow.
  - Bankruptcy = 2034 for the OASI trust fund and 2016 for the DI trust fund.
  - After these critical years, if no corrective governmental measures have been taken, the so-called **"fiscal cliff" adjustment** –obligation to reduce pensions to achieve a financial balance between pension payments and social contributions– is *de facto* both an automatic and brutal ABM.

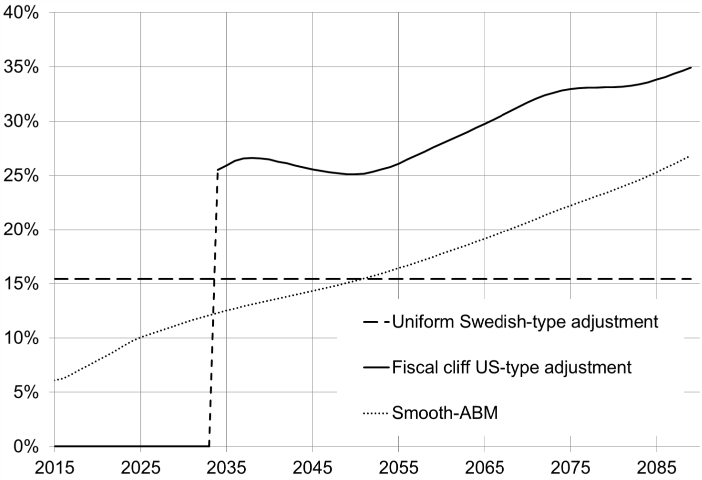

Figure: US Social Security (OASDI): expected adjustments by a pension reduction

In search of a smooth-ABM (S-ABM)

- We develop a "simple" method.
- The objective function is defined as a quadratic loss function. Quadratic cost functions are commonly used in the analysis of monetary policy (Svensson, 2003).
- A similar approach applied to retirement has been adopted by Berger and Lavigne (2007). However very interesting, their approach suffers from two shortcomings:
  - The adjustment they propose relates solely to the contribution rate.
  - The social cost is measured by the square of the change in each period and there is no time preference, which discards the possibility to monitor the adjustment lag.

In search of a smooth-ABM (S-ABM)

The value of the loss associated to each period is measured by a quadratic function:

$$LF_t = \alpha \cdot (A_t - 1)^2 + (1 - \alpha) \cdot (B_t - 1)^2 . \qquad (2)$$

where A_t and B_t are two deformation coefficients which modify respectively the present and future payroll taxes and pension expenditures relatively to those established by the current law. This loss function captures the fact that changing parameters is costly (both socially and politically) and that minimizing it means the social planner hopes to limit changes.

In search of a smooth-ABM (S-ABM)

The social planner sets a time horizon T to balance the sum of discounted receipts and the sum of discounted expenditures. δ denotes the public time preference rate (public discount factor).
The optimizing program is:

$$\begin{cases} \min\limits_{\{\mathbf{A}_t,\mathbf{B}_t\}} \sum_{t=1}^{T} \left(\frac{1}{1+\delta}\right)^{t-1} \cdot LF_t \\ s.t.\ \sum_{t=1}^{T} \frac{A_t \cdot REC_t}{\Pi_{i=1}^{t} R_i} + F_0 = \sum_{t=1}^{T} \frac{B_t \cdot EXP_t}{\Pi_{i=1}^{t} R_i} \end{cases} . \tag{3}$$

In search of a smooth-ABM (S-ABM)

The F.O.C gives:

$$\begin{cases} A_t : \left(\frac{1}{1+\delta}\right)^{t-1} \cdot 2 \cdot \alpha \cdot (A_t - 1) = \psi \cdot \frac{REC_t}{\Pi_{i=1}^{t} R_i} \\ B_t : \left(\frac{1}{1+\delta}\right)^{t-1} \cdot 2 \cdot (1-\alpha) \cdot (B_t - 1) = -\psi \cdot \frac{EXP_t}{\Pi_{i=1}^{t} R_i} \end{cases} . \quad (4)$$

where ψ is the Lagrange multiplier.

In search of a smooth-ABM (S-ABM)

Proposition: *A smooth-ABM can be implemented by applying the two following rules:*
(i) E*stimation of the final adjustment target at time* $t = 0$:

$$\begin{cases} A_T = 1 + UO_0 / \sum_{t=1}^{T} \left(\frac{REC_t^2 + \frac{\alpha}{1-\alpha} \cdot EXP_t^2}{\Pi_{i=1}^{t} R_i \cdot REC_T} \cdot \left(\frac{\Pi_{i=t+1}^{T} R_i}{(1+\delta)^{T-t}} \right) \right) \\ B_T = 1 - \frac{1-\alpha}{\alpha} \cdot (1 - A_T) \end{cases} , \quad (5)$$

(i) *Convergence rule to the final adjustment target:*

$$\begin{cases} (A_t - 1) = \frac{REC_t}{REC_T} \cdot \frac{\Pi_{i=t+1}^{T} R_i}{(1+\delta)^{T-(t+1)}} \cdot (A_T - 1) \\ (B_t - 1) = -\frac{EXP_t}{EXP_T} \cdot \frac{\Pi_{i=t+1}^{T} R_i}{(1+\delta)^{T-(t+1)}} \cdot (B_T - 1) \end{cases} . \quad (6)$$

In search of a smooth-ABM (S-ABM)

This maximizing problem can be completed by adding constraints on the level of the reserve fund ($F_T > 0$ or $F_t \geq 0 \ \forall t$ without debt constraint) or the adjustment parameters.

In search of a smooth-ABM (S-ABM)

These results can be interpreted in three ways:

- A_t and B_t can induce practical implications in terms of pension reforms. They define distances to a fixed target in terms of payroll taxes (receipts) and pension benefits (expenditures).

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- Measuring A_t and B_t would show how the pension schemes are strongly unbalanced in the long run;
- Revealed preferences: reforms imply changes in legislation. The levels of expenditures and receipts are modified w.r.t a previous scenario without reform. Assuming A_t and B_t to be measured with accuracy would associate public decisions with an implicit function of public preferences.

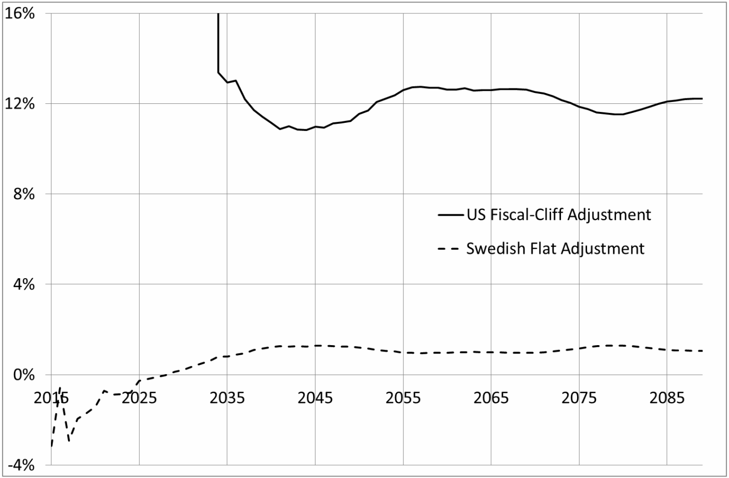

Figure: Implicit public time preference rate

For the following set of parameters, $\alpha = 0.5$, $\delta = 2.5\%$ and $T = 75$, we compute the evolution of the adjustment coefficients.

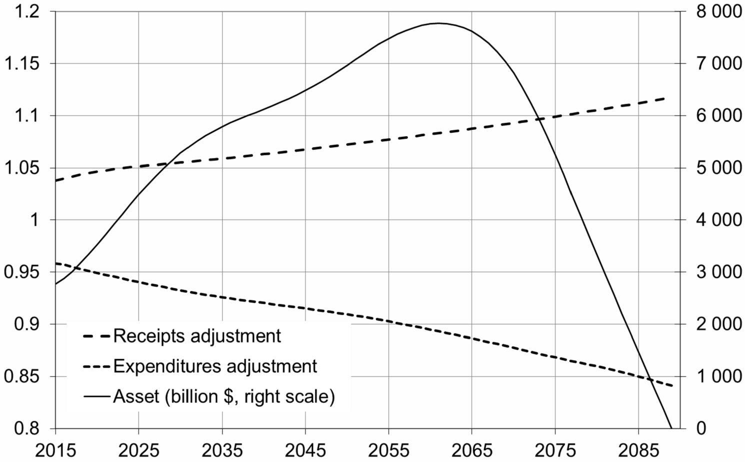

Figure: Automatic adjustments and reserve fund

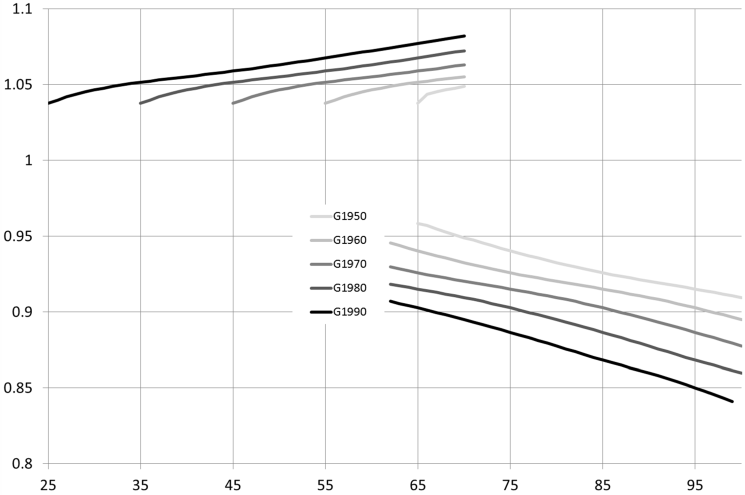

Figure: Generational impact per age: contribution increasing

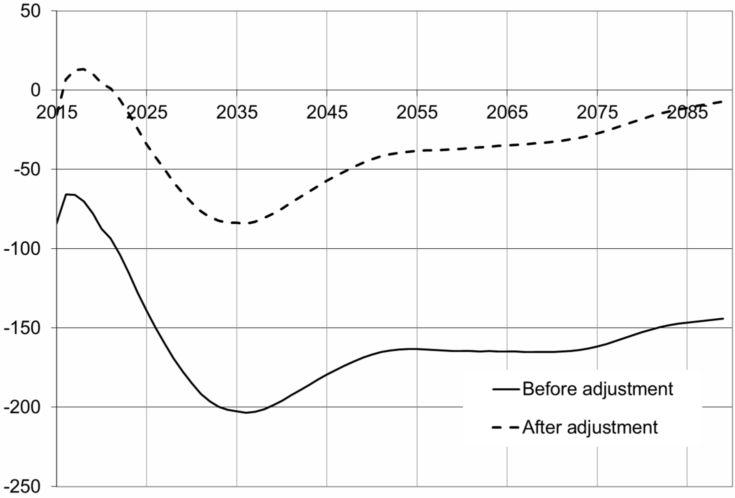

Figure: Adjustment primary balance ($Billion, present value)

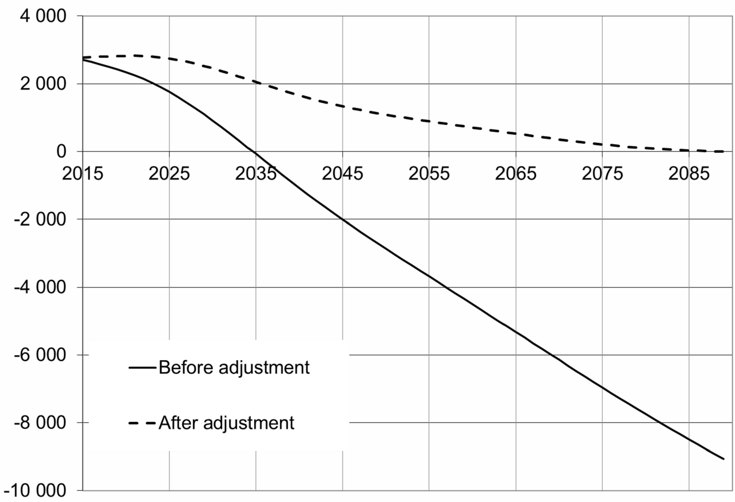

Figure: Reserve fund ($Billion, present value)

Conclusion

- We build an ABM in a dynamic programming setting: For a given planning horizon, we obtain formulas that determine how at each period revenues and expenses must be adjusted. That allows to consider the ABM chosen by Sweden as a special case.

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- We apply these formulas to the financial balances of the US pension system. Using dynamic programming avoids brutal adjustments and thus moderates or smooths the marginal adjustments necessary for financial stability.

Conclusion

- We build an ABM in a dynamic programming setting: For a given planning horizon, we obtain formulas that determine how at each period revenues and expenses must be adjusted. That allows to consider the ABM chosen by Sweden as a special case.
- We apply these formulas to the financial balances of the US pension system. Using dynamic programming avoids brutal adjustments and thus moderates or smooths the marginal adjustments necessary for financial stability.
- We suppose a fixed public discount factor. As regards the choice of discount rate, there arises an ethical problem of dictatorship of the present or the future (Chichilnisky, 1996 and 1997). Considerations could be given to a high initial discount that would tend gradually towards 0.

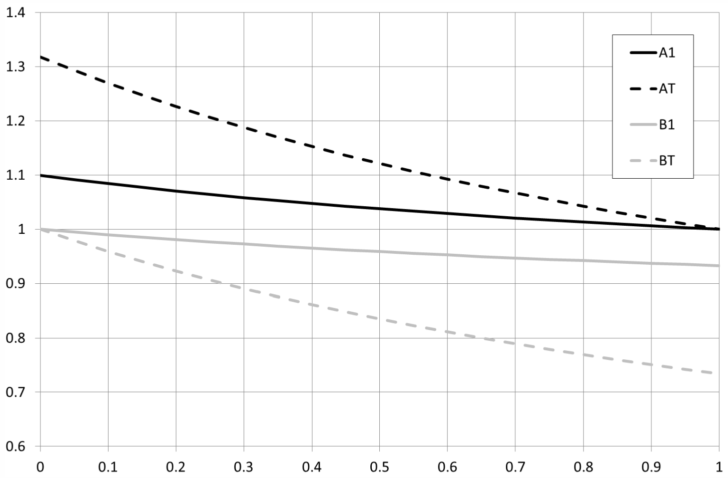

Figure: Sensitivity to social weighting (α)

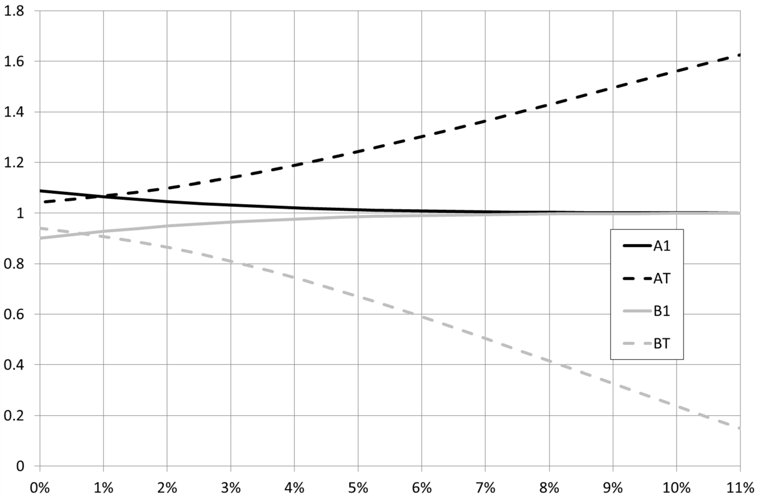

Figure: Sensitivity to time preference (δ)

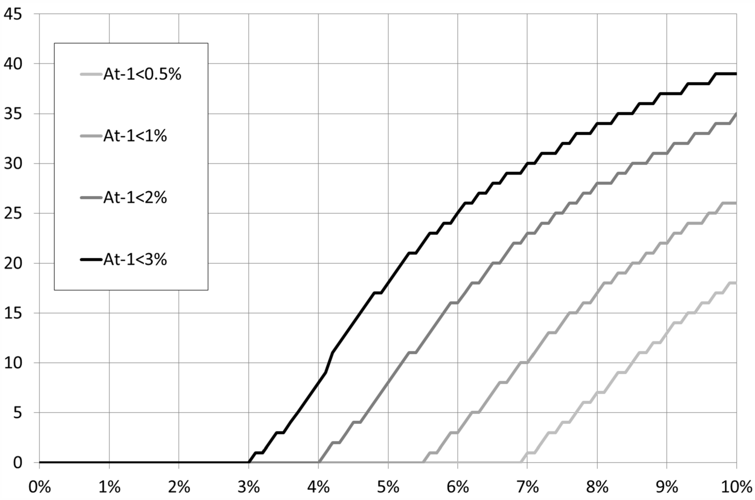

Figure: Sensitivity to time preference: Time lag (number of years) - or procrastination duration - before a significant adjustment (A_t)

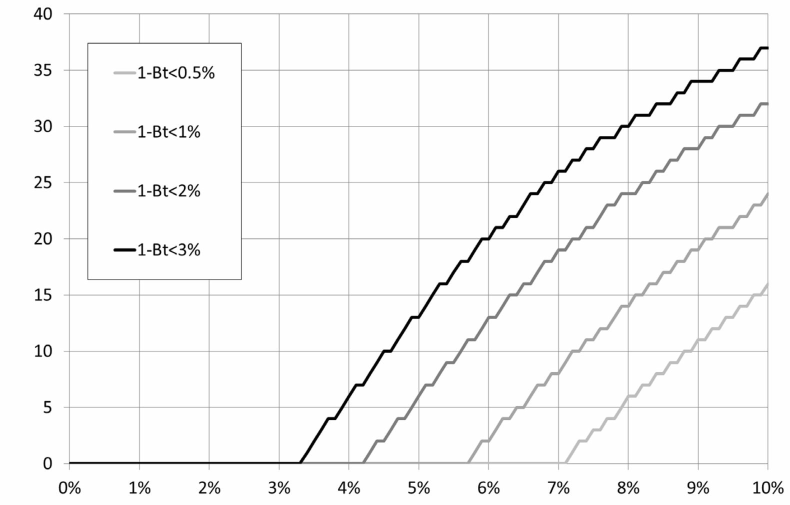

Figure: Sensitivity to time preference: Time lag (number of years) - or procrastination duration - before a significant adjustment (B_t)

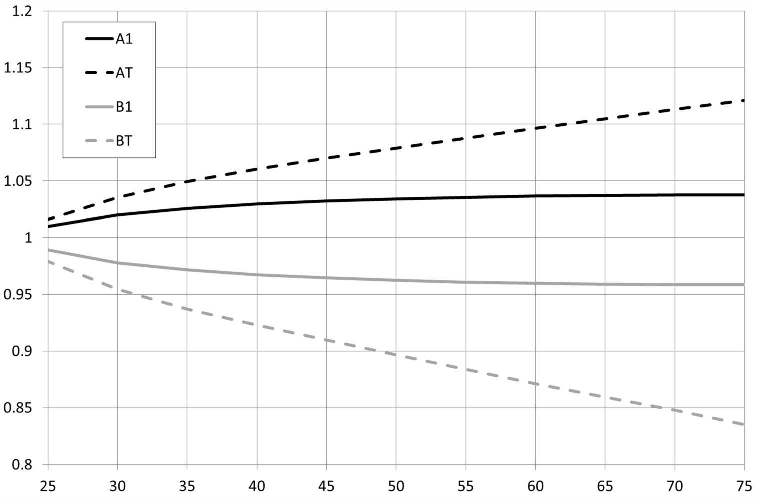

Figure: Sensitivity to time horizon (T)