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SUSTAINABILITY OF PENSION SCHEMES: BUILDING A SMOOTH AUTOMATIC BALANCE MECHANISM WITH AN APPLICATION TO THE US SOCIAL SECURITY

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SUSTAINABILITY OF PENSION SCHEMES:

BUILDING A SMOOTH AUTOMATIC BALANCE MECHANISM WITH AN APPLICATION TO THE US SOCIAL SECURITY[1]

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ABSTRACT

We build a "smooth" automatic balance mechanism (S–ABM) which would result from an optimal tradeoff between increasing the receipts and reducing the pension expenditures. The S-ABM obtains from minimizing an intertemporal discounted quadratic loss function under an intertemporal budget balance constraint. The main advantage of our model of "optimal" adjustment is its ability to analyse various configurations in terms of automatic balance mechanisms (ABM) by controlling the adjustment pace. This S-ABM permits to identify two limit cases: the "flat Swedish-type ABM" and the "fiscal-cliff US- type ABM". These cases are obtained by assuming very high adjustment costs on revenue (implying only pension benefit adjustment) and by choosing particular sequences of public discount rates. We then apply this ABM to the case of the United States Social Security to evaluate the adjustments necessary to ensure financial solvency. These assessments are made under various assumptions about forecast time horizon, public discount factor and weighting of social costs associated with increased receipts or lower expenditures.

Keywords: Pension scheme sustainability, automatic balance mechanisms, dynamic programming.

JEL codes: C61, H55, H68.

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INTRODUCTION

Most governments are reluctant to reform national pension systems for fear this might induce a too high political cost. In fact, the political debate about the pension issue may often be a source of conflicts (Blanchet and Legros, 2002; Marier, 2008; Weaver and Willén, 2014; Wisensale, 2013). As a consequence, governements tend to procrastinate and to postpone the adoption of measures that would guarantee solvency. Of course, faced with the insolvency of their pension systems, all governments have introduced reforms - some of them drastic - but without imposing 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".

To avoid pension systems to depend upon choices that politicians would not take willingly, governments can introduce specific and mandatory rules to allow for automatic adjustment mechanisms (AAMs). These AAMs contribute to improve solvency at any date without politicians stepping in, thus avoiding the "need for large program changes made in crisis mode" (Turner, 2009). Implementing AAMs requires not only straightforward and clear choices about transfers between generations, but also strong social acceptance. Automatic Balance Mechanisms (ABMs) may be viewed as stronger and efficient AAMs securing long-run solvency. Several countries (Sweden, Canada, Germany, Japan and Finland) have adopted different forms of ABM (Vidal-Meliá *et al*, 2009 ; Boado-Penas *et al*, 2010).

In this paper, we develop a general form of Automatic Balance Mechanism based on the intertemporal minimization of a discounted quadratic loss function. Building an ABM requires defining a measure of the intertemporal budget balance, to fix the time horizon and to adopt a criteria to be optimized. Our "smooth" ABM (hereafter denoted S-ABM) relies on the use of distortion indices, which makes it easy to be implemented in a realistic and practical prospect. Smooth, gradual adjustments replace immediate and abrupt changes, enhancing their short-term political acceptance.

The paper organizes as follows. First, we address the issue of AAMs: what part do they play in adjusting, stabilizing and balancing? Second, we build a "smooth" ABM, assuming a trade-off between present and future receipts and expenditures. Third, we apply this ABM to the U.S. Social Security. The last section concludes.

1. AUTOMATIC RULES: ADJUSTING, STABILIZING AND BALANCING

1.1. The Intertemporal Pension Budget Constraint

At the current period ($t = 0$), the forecast expenditures and receipts at time t are respectively denoted EXP_t and REC_t. Assuming negligible administrative costs, EXP_t can be computed as follows:

$$EXP_t = E_0\left(\sum_{j\in\Omega_t^R} p_{j,t}\right) \tag{1}$$

where Ω_t^R is the set of retirees for period t and $p_{j,t}$ is the pension paid to each retiree j.

REC_t is given by:

$$REC_t = E_0\left(\tau_t \times \sum_{k\in\Omega_t^E} w_{k,t}\right) \tag{2}$$

where Ω_t^E is the set of employees at period t, $w_{k,t}$ is the annual sum of monthly taxable wages paid to each employee k and τ_t is the payroll tax rate for period t.

The intertemporal budget balance of the pension system writes:

$$R_t \cdot F_{t-1} + REC_t = EXP_t + F_t \tag{3}$$

where $R_t = 1 + r_t$ is the riskless interest factor with r_t the interest rate and F_t the forecast value of the financial asset (reserve fund) for period t.

What about solvency? From an accounting point of view, the implicit liabilities and solvency of unfunded pension systems can be estimated through different methods. In practice, two measures of solvency are generally used.

The first is an evaluation of the discounted sum of receipts and expenditures. This valuation approach is adopted in the United States to assess the present value of the system's underfunding. This value, called "Unfunded Obligation", gives a financial (absolute) estimation of the tax gap. The US Social Security Administration defines it as: "the excess of the present value of the projected cost of the program through a specified date over the sum of: (1) the value of trust fund reserves at the beginning of the valuation period; and (2) the present value of the projected non-interest income of the program through a specified date, assuming scheduled tax rates and benefit levels". At the current period $t = 0$, the Unfunded Obligations compute as follows:

$$UO_0 = \sum_{t=1}^{T} \frac{EXP_t - REC_t}{\Pi_{i=1}^{t} R_i} - F_0 = -\frac{F_T}{\Pi_{i=1}^{T} R_i}. \tag{4}$$

Sweden has opted for another method: the asset-liability approach (Settergren, 2001). It defines its pension plan as solvent when:

Present value of contributions payable by current workers
+ Value of the reserve fund
=
Value of pension commitments towards current generations.

Hence, the Swedish balance ratio writes as an asset/liability ratio.

Solvency issues have been investigated by Vidal-Meliá and Boado-Penas (2010). They specify the connection between the contribution asset and the hidden asset (similar to the equivalent concepts of "implicit tax on pensions" or "PAYG asset" used in the literature) to evaluate whether using either of these to compile the actuarial balance in PAYG pension systems would provide a reliable solvency indicator. The contribution asset can be interpreted as the maximum level of liabilities that can be financed by the existing contribution rate without periodic supplements from the sponsor, ceteris paribus.

The tax gap ratio denoted TG is another interesting concept and a simple measure of pension scheme's insolvency. This ratio can be measured in two ways:

$$TG_A = \frac{\sum_{t=1}^{T} \frac{EXP_t}{\Pi_{i=0}^{t} R_i} - F_0}{\sum_{t=1}^{T} \frac{REC_t}{\Pi_{i=0}^{t} R_i}} \tag{5a}$$

or

$$TG_B = \frac{\sum_{t=1}^{T} \frac{EXP_t}{\Pi_{i=0}^{t} R_i}}{\sum_{t=1}^{T} \frac{REC_t}{\Pi_{i=0}^{t} R_i} + F_0} \tag{5b}$$

TG_A measures the excess of net-of-reserve expenditures with respect to receipts. TG_B measures the excess ot expenditures with respect to net-of-reserve receipts. These ratios can be interpreted as implicit debt/notional asset ratios.

An interesting illustration of two polar balancing adjustments can be computed from these tax gap ratios: a full adjustment operated either through receipts by indexing payroll tax on TG_A or through expenditures by indexing pension amount on TG_B^{-1}. Applying these concepts to the US Social Security, Kotlikoff (2011) stresses that: "Since the system's $16 trillion infinite horizon fiscal gap is 3.3 percent of the $483 trillion present value of its taxable wage base, the system is 27 percent (0.27 = 0.033/0.124) underfunded; that is, we could immediately and permanently raise the FICA contribution rate by 27 percent and make Social Security solvent" or "Another way is to cut Social Security benefits immediately and permanently by 20 percent".

1.2. How the standard Automatic Adjustment Mechanisms (AAMs) contribute to stabilizing pension schemes

The general problem facing social planners or governments is how to adjust parameters (payroll tax rate, retirement age, pension benefit calculus, pension index, etc.) with time. Adopting automatic adjusment rules implies choosing a law of motion for parameters as a function of economic, financial or demographic variables.

With the Automatic Adjustment Mechanisms (AAMs), the institutional parameters are adjusted according to predefined rules. Otherwise, the changes are considered as discretionary decisions and are likely to depend on the hazards of political choices.

Choosing a specific AAM requires the following actions to be taken (see Bosworth and Weaver, 2011): legitimate the adjustment rule (equity, social justice or solvency), stick to "one tool - one objective" rule, choose the frequency of review/assessment, define the elements on which the adjustment is made and fix the degree of automaticity (up to which level the adjustment is mandatory -no questioning-, which warrants credibility to the process).

To control for pension level, four main parameters are available :

(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 period can be connected to life expectancy.

(3) Retirement age: with a given frequency, this age could be revised with new 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.

About the pension-earnings links, it can be established according to two approaches: defined contribution (DC) or defined benefit (DB). In a DC pension scheme, as in Sweden, the coefficient of conversion of capital into an annuity can depend on the age and birth year. This coefficient can be revised to reflect the evolution of generation mortality tables and life expectancy (Life Expectancy Index). In the case of DB pension scheme (as in US, France or Germany), a replacement rate is used to convert average life-cycle wage into a pension. To control this replacement rate, the main adjusment parameter is the number of years to validate to be eligible for full pension (maximal value of the replacement rate). Additionally, the legislator can reward (bonus) long career or penalize (malus) short career. The index used to to give a current value to the past wages in a DB pension scheme or the value of the notional accounts in a DC pension scheme contributes to the link between wages and pensions. According to Settergren (2001), indexing notional pension savings on economic growth is stabilizing, since "(…) Pensions will grow (decline) at the same pace as average earnings".

The parametric changes induced by the AAMs can be determined either *ex ante* or *ex post*.

In the former case, demo-economic shocks are anticipated and parametric changes in law are planned. For example, as early as 1983, U.S. government launched a clear-cut long-run ex ante adjustment device by progressively increasing the payroll taxes and raising the full pension age. This reform prevented a pending Social Security crisis; moreover, it still potentially guarantees an intertemporal balanced budget for about half a century. Nethertheless, as stressed by Aaron (2011), the weakness of this reform is that it "virtually guaranteed the return of deficits and a funding gap, and the need for further legislation to close it".

In the latter case (*ex post* adjustments), the parametric values set by national legislation evolve with the knowledge of the states of nature. Changes alter pension formula parameters and contribution rate. Sweden is considered as a major pioneer in adopting automatic stabilizing devices relying on Notional Defined Contributions (NDC) plans in 1994.

1.3. Towards stronger AAMs: Automatic Balance Mechanisms (ABMs)

What happens if the adjusments brought by the standard AAMs do not lead to 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. The choice of an ABM raises four major questions:

- How pension budget balance is defined[2]?
- What are the criteria for choosing changes in current pension law?
- What room is left for optimization?
- What revising frequency and what planning time horizon for full balancing?

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 adjustments by resetting targeted parameters.

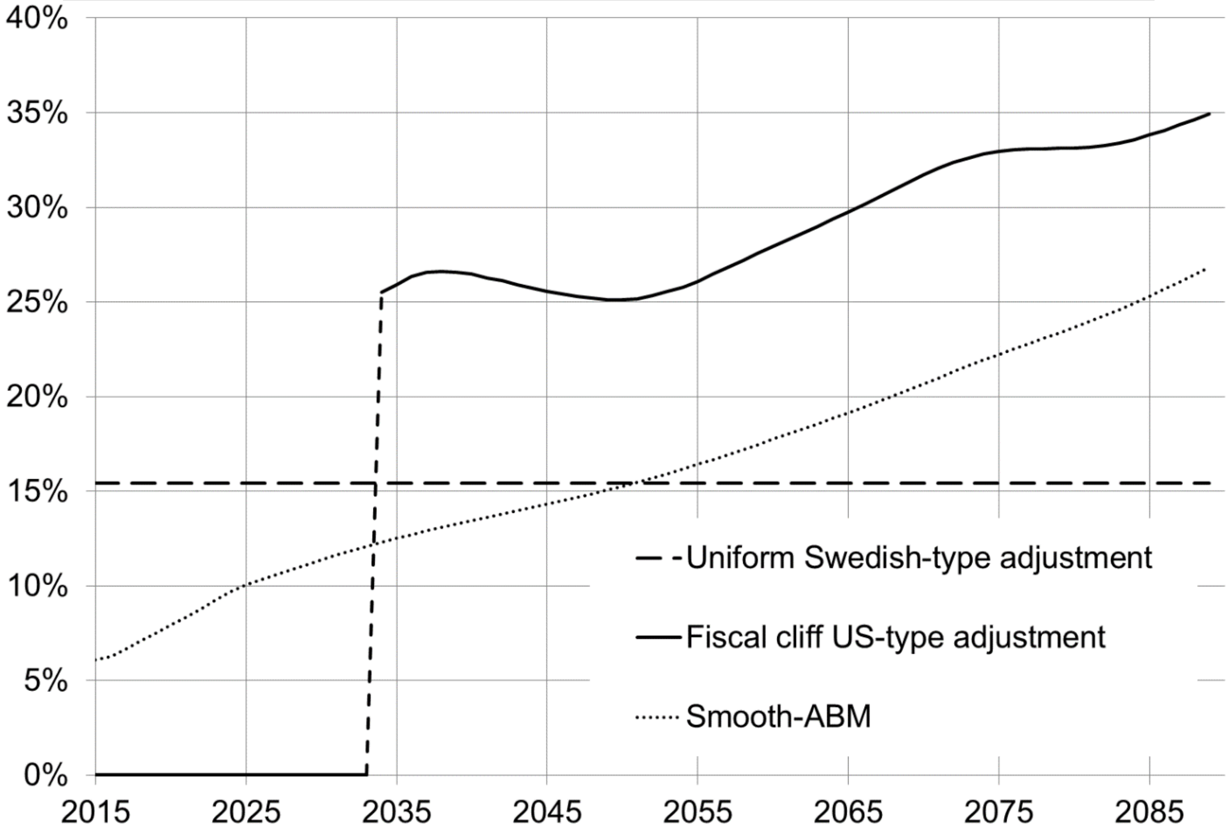
For example, to reinforce the solvency robustness of its pension system, Sweden adopted an ABM in 2001: a uniform and permanent adjustment of present and future pension benefits given the “balance ratio” secures solvency (Settergren, 2001). The return of the

[2] For example, in Canada and Sweden, the ABM adoption "was preceded by explicit legislative actions to create an initial reference of financial sustainability" (Bosworth and Weaver, 2011).

"savings" invested in the NDC crucially depends upon this indexation (Settergren and Buguslaw, 2005).

Other countries have followed Sweden and added specific indexation of pensions to strengthen solvency. This is the case of Japan and Germany (Sakamoto, 2013). However, we note that Canada has opted for a more binding ABM with a genuine search for a balanced budget (Ménard and Billig, 2013).

Figure 1. US Social Security (OASDI): expected adjustments by a pension reduction



A contrario, in the U.S. Social Security, there is no ABM. However, it has to be reminded that the U.S. Social Security trust funds are not allowed to borrow. This financial and legal constraint is a strong incentive to plan surpluses to compensate anticipated deficits, acting as a credible restoring force[3]. The 75-year annual forecast of Board of trustees (2015)

[3] Board of trustees (2013) explains that: "Maintaining a reasonable contingency reserve is important because the trust funds do not have borrowing authority. After reserves are depleted, the trust funds would be unable to pay benefits in full on a timely basis if annual revenue were less than annual cost. Unexpected events, such as severe economic recessions or large changes in other trends, can quickly deplete reserves. In such cases, a reasonable contingency reserve can maintain the ability to pay scheduled benefits while giving lawmakers time to address possible changes to the program."

allows a thorough analysis of solvency. Notably, it gives an estimation of the year when the system reaches bankruptcy: 2034 for the OASI trust fund and 2016 for the DI trust fund. After this critical year, 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 automatic and brutal.

Figure 1 compares these two contrasting balancing adjustments based on the 75 years’ Social Security administration forecast published in June 2015: the uniform Swedish-type adjustment vs. the fiscal cliff US-type adjustment. This figure illustrates the difficulty for lawmakers to restore solvency. A Swedish-type adjusment implies an immediate and permanent 15.5% pension decrease whereas a strong procrastination results in a fiscal cliff adjustment jump with a 25% pension decrease in 2034 and a 35% decrease in 2089.

None of these two potential adjusments is realistic both from a social and political point of view. However, the perspective of the fiscal cliff is a credible threat to adopt a progressive adjustment. Hence, the idea to devise a general framework for smooth automatic balance mechanisms.

The same figure 1 presents a simulation based on the model we develop hereafter**.** This simulation is based on a single pension adjustment. This result obtains from an intertemporal tradeoffs aiming at smoothing the whole adjustment process. As a matter of fact, integrating a public preference for the present tends to reduce high initial adjustments. By supposing a 2% annual rate of public preference for the present, the adjustment would require a 6.7% initial decline in 2015 and about 26.6% reduction in the long run (2090). If adjusting only by reducing pensions seems too rough, adjusting by increasing payroll taxes should also be considered.

2. IN SEARCH OF A SMOOTH ABM (S-ABM)

2.1. Minimizing a discounted quadratic loss function

Let us turn now to the building of a simple model[4] based on intertemporal optimization called “ smooth automatic balance mechanism” (S-ABM).

A similar approach applied to retirement has been adopted by Berger and Lavigne (2007). However very interesting, their approach suffers from two shortcomings. Firstly, the adjustment they propose relates solely to the contribution rate. Secondly, 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.

Godinez-Olivares *et al.* (2015) enrich the approach of Berger and Lavigne (2007) by proposing to estimate an ABM which is based on three parameters: the contribution rate, the replacement rate and the duration of activity. Inserting the duration of activity is interesting. However, it could be easier, instead, to adjust with a standard AAM that would simply seek to satisfy an objective of actuarial fairness (for example, a matching of retirement and activity durations). In our approach, the ABM is the ultimate AAM. In contrast, the dynamic optimization problem we tackle contemplates two adjustment modes, respectively through costs and/or through receipts by using a contingent pension indexation (on behalf of solvency) and a possible adjustment of the contribution rate. Moreover, it accounts for time preference which permits to design the pace of adjustment and to control the magnitude of the initial correction.

The objective function is defined as a quadratic loss function. Quadratic cost functions are commonly used in the analysis of monetary policy (Svensson, 2003). This analytical approach expresses in a straightforward and simple way the idea of "smoothing out" the

[4] An application of our model to the French PAYG system is given in Gannon *et al.* (2014).

changes in the current legislation.

For sake of simplicity, we present a non stochastic approach of our ABM. Our computations are based upon given forecast values of receipts (REC_t) and expenditures (EXP_t). Also, as the first order conditions are linear, the estimated adjustment variables could be considered as forecast values for the current period. In practice, these variables should be revised as the observed values and forecasts would adjust with time. The forecast uncertainty could be considered by using stochastic simulations. For example, Fujisawa and Li (2012) examine how the Japanses automatic balancing mechanism will affect the income of the extreme elderly (people who live beyond 100).

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

$$LF_t = \alpha \cdot (A_t - 1)^2 + (1 - \alpha) \cdot (B_t - 1)^2, \tag{6}$$

where A_t and B_t are two deformation coefficients modifying respectively the present and future payroll tax rates (receipts) and pension benefits (expenditures) relatively to those established by the current pension law. Note that the coefficient B_t can be interpreted as a pension index which is, *de facto*, a component of the pension rule. α (respectively $1-\alpha$) is the social weight given to the adjustment through receipts (respectively expenditures)[5]. $(A_t - 1)$ and $(B_t - 1)$ measure the relative gap with respect to the current legislation. This loss function captures the fact that changing parameters is costly (both socially and politically) and that, by minimizing it, the social planner seeks to limit the amplitude of changes. To achieve this goal, the social planner sets a time horizon T to match discounted receipts with discounted expenditures:

$$\sum_{t=1}^{T} \frac{A_t \cdot REC_t}{\Pi_{i=1}^{t} R_i} + F_0 = \sum_{t=1}^{T} \frac{B_t \cdot EXP_t}{\Pi_{i=1}^{t} R_i}. \tag{7}$$

[5] For sake of simplification, this parameter is denoted identically as the adjustment degree by pension.

The optimizing program is based on a sum of discounted losses during T periods:

$$\begin{cases} \min\limits_{\{A_t, B_t\}} \sum\limits_{t=1}^{T} \left(\frac{1}{1+\delta} \right)^{t-1} \cdot LF_t \\ \text{s.t.} (7) \end{cases}. \tag{8}$$

where δ, assumed here -for sake of simplicity- to be constant**,** is the public rate of time preference.

The advantage of our approach is that it only requires a public choice of three parameters (δ, α and T) and a long-term forecast of expenditures and receipts.

The first order conditions are:

$$\begin{cases} A_t : \left(\frac{1}{1+\delta} \right)^{t-1} \cdot 2 \cdot \alpha \cdot (A_t - 1) = \psi \cdot \frac{REC_t}{\Pi_{i=1}^{t} R_i} \\ B_t : \left(\frac{1}{1+\delta} \right)^{t-1} \cdot 2 \cdot (1-\alpha) \cdot (B_t - 1) = -\psi \cdot \frac{EXP_t}{\Pi_{i=1}^{t} R_i} \end{cases}. \tag{9}$$

where the Lagrange multiplier ψ measures the social value of the marginal slacking of the budget constraint. The problem is well behaved and the second order conditions are checked by strict quasi-concavity.

Proposition: *A smooth-ABM can be implemented by applying the two following rules:*

(i) *Estimation of the expected final adjustment target at time* $t = 0$:

$$\begin{cases} A_T = 1 + UO_0 / \sum\limits_{t=1}^{T} \left(\frac{REC_t^2 + \frac{\alpha}{1-\alpha} \cdot EXP_t^2}{\Pi_{i=1}^{t} R_i \cdot REC_T} \cdot \left(\frac{\Pi_{i=t+1}^{T} R_i}{(1+\delta)^{T-t}} \right) \right), \\ B_T = 1 - \frac{1-\alpha}{\alpha} \cdot (1 - A_T) \end{cases} \tag{10}$$

(ii) *Convergence rule to the expected final adjustment target*:

$$\begin{cases} (A_t - 1) = \frac{REC_t}{REC_T} \cdot \frac{\Pi_{i=t+1}^{T} R_i}{(1+\delta)^{T-t}} \cdot (A_T - 1) \\ (B_t - 1) = \frac{EXP_t}{EXP_T} \cdot \frac{\Pi_{i=t+1}^{T} R_i}{(1+\delta)^{T-t}} \cdot (B_T - 1) \end{cases}. \tag{11}$$

Proof: see appendix.

Our model gives a temporal key to finance the unfunded obligation UO_0.

From these adjustment processes, we deduce the forecast dynamics of the reserve funds:

$$F_t = A_t \cdot REC_t - B_t \cdot EXP_t - R_t \cdot F_{t-1} \tag{12}$$

The expected revision of the current levels of receipts and expenditures evolves approximately as follows with a backward representation:

$$\begin{cases} \dfrac{\Delta(A_t - 1)}{(A_{t-1} - 1)} \approx g_t^{REC} - (r_t - \delta) \\ \dfrac{\Delta(1 - B_t)}{(1 - B_{t-1})} \approx g_t^{EXP} - (r_t - \delta) \end{cases} \tag{13}$$

where g_t^{REC} and g_t^{EXP} are respectively the expected receipts and expenditures growth rates. We present here expected solutions. In a stochastic version, the adjustment would include the revision of the expected final adjustment target.

This adjustment rule is characterized by the following propriety: when $A_{t-1} > 1$ and $B_{t-1} < 1$, then $A_t > A_{t-1}$, i.e. a payroll tax increasing, (resp. $B_t < B_{t-1}$, i.e. a pension index decreasing) if receipts (resp. expenditures) growth rate is greater than the interest rate net of the present preference. The increase in the contribution rate (resp. lower pension) is even stronger than revenue growth (resp. spending) is strong.

This maximizing problem may be completed by adding constraints to the reserve fund level ($F_T > 0,$ for a terminal constraint or $F_t \geq 0 \;\; \forall t$ otherwise) or to the adjustment of the contribution rate ($\tau_t \leq \tau_{\max}$ as for example in Germany).

This S-ABM is resistant to time inconsistency problem of choice whenever the application of the adjustment rules is mandatory. In this case, the adjustments always apply.

2.2. Interpretations

In addition to identify rules of pension indexing and tax rate increase, our results can be interpreted in two other ways:

(i) Measuring A_t and B_t would allow to show how much the pension schemes are unbalanced in the long run;

(ii) Revealed preferences: reforms imply changes in legislation. The levels of expenditures and receipts are modified with respect to 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.

For example, assuming that the measure of financial sustainability we use here is quite equivalent to the asset/liability ratio, then the flat Swedish-type adjustment can be interpreted as the result of the following parameter choices:

$$\begin{cases} \alpha \to 1 \text{ (no adjustment through receipts)} \\ \delta_t = r_t - g_t^{EXP} \text{ (flat adjustment)} \end{cases}. \tag{14}$$

These values of parameters imply:

$$\begin{cases} A_T = \ldots = A_t = \ldots = A_1 = 1 \\ B_T = \ldots = B_t = \ldots = B_1 < 1 \end{cases}. \tag{15}$$

About the fiscal cliff US-type adjustment, the implicit values of δ_t satisfy :

$$1+\delta_t \to +\infty \text{ for } t < 2034,$$

$$1+\delta_t = \frac{EXP_t - REC_t}{EXP_{t-1} - REC_{t-1}} \left(\frac{EXP_{t-1}}{EXP_t}\right)^2 (1+r_t) \text{ for } t \geq 2034,$$

and $\alpha \to 1$.

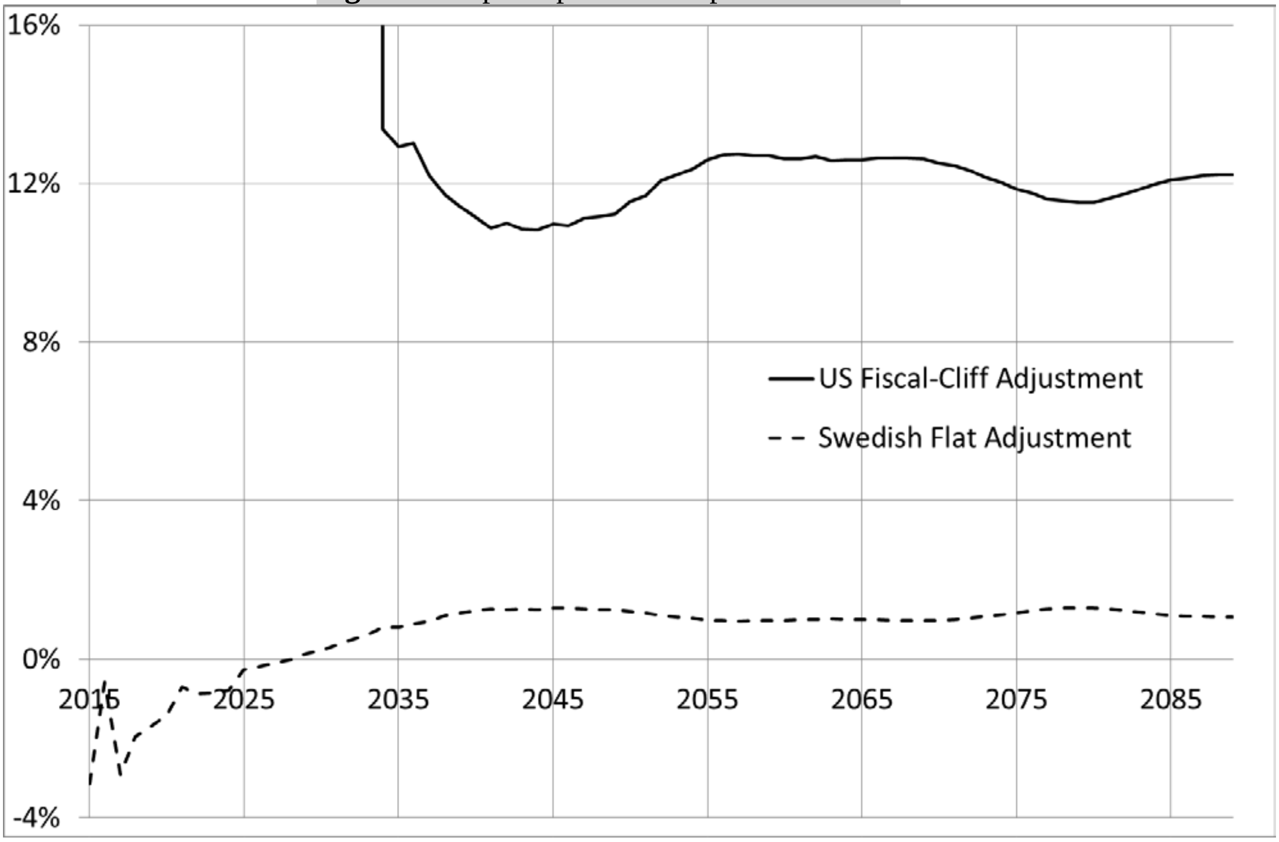
These values of parameters imply:

$$A_T = \ldots = A_t = \ldots = A_1 = 1$$

$$\begin{cases} B_t = 1 \text{ for } t < 2034 \\ B_t = \dfrac{REC_t}{EXP_t} < 1 \text{ for } t \geq 2034 \end{cases}$$

Figure 2 gives the time evolution of the implicit values of the time prefence rate necessary and sufficient to obtain a Swedish flat adjustment or a US fiscal cliff adjustment. These values are computed with forecast data from the Board of Trustees of the U.S. federal OASDI (2015).

Figure 2. Implicit public time preference rate



3. APPLYING THE S-ABM TO THE U.S. SOCIAL SECURITY

3.1. Sensitivity analysis

As mentioned earlier, the Board of trustees of the U.S. federal OASDI trust funds (2015) publishes annual forecasts with a 75-year horizon, contemplating three scenarios: pessimistic (“high-cost”), optimistic (“low-cost”) and middle (“intermediate”). This publication plays an important part to contribute to the public debate, by giving a clear idea of the likely survival duration of the pension system. In this section, we look at what the use of ABM requires in terms of increased revenues and spending cuts. In our computations, we rely on the forecast based upon the intermediate scenario.

We consider several parametric variants in, respectively, forecast horizon, time preference, weight of social adjustment through receipts (versus expenditures).

Figures 3, 4 and 5 respectively show parametric variants.

Figure 3. Sensitivity to social weighting (α)

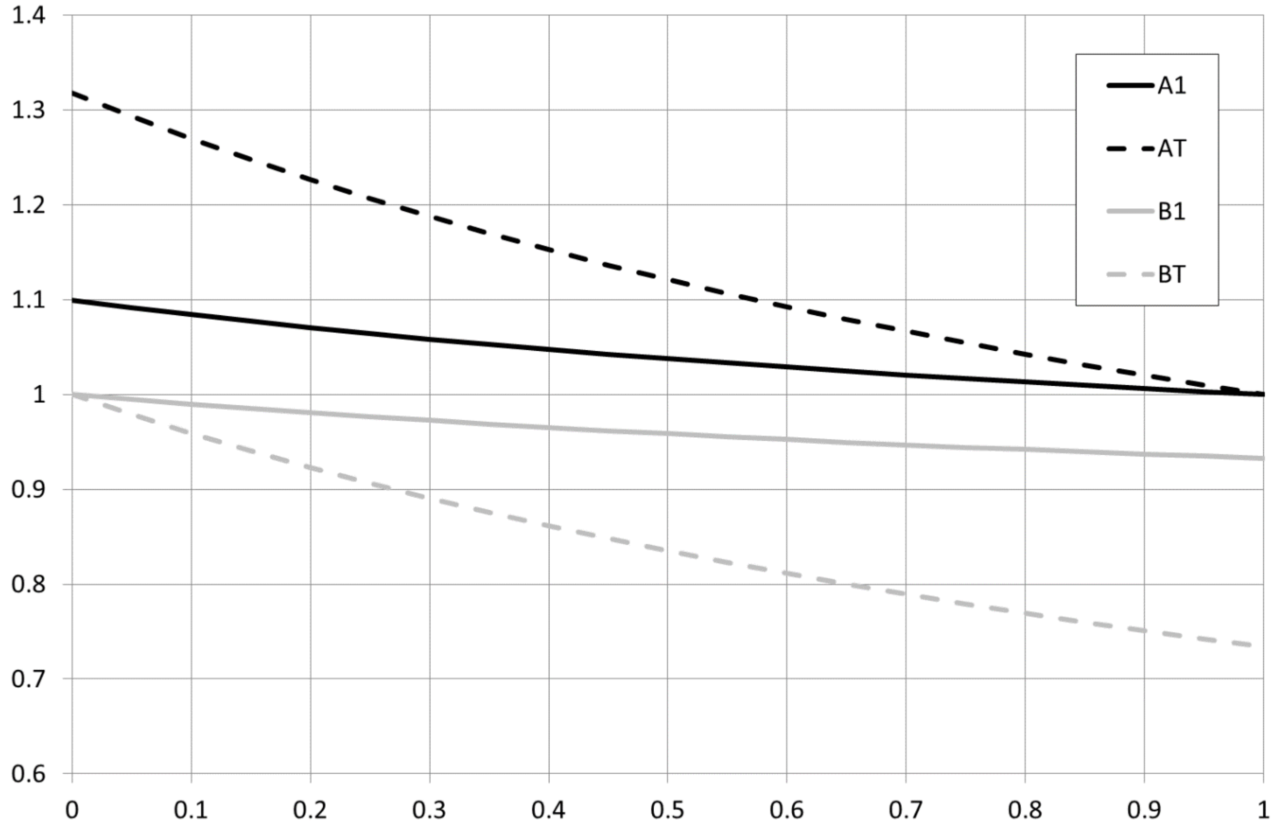


Figure 3 shows the profile of A and B for variants in the social weight (given respectively to receipts and expenditures) with $\delta = 0.025$ and $T = 75$. Choosing α is a crucial political decision because it determines the share of the fiscal burden between employees and pensioners. Not surprisingly, the adjustment through expenditures is more demanding for high values of α. Conversely, the adjustment through receipts is more demanding for low values of α.

For example, if α tends to 0, B_1 and B_T tend to 1, while A_1 tends to 1.1 and A_T to 1.32. That means a 10% increase in tax rate in the short run $(t = 1)$ and a 32% increase in the long run $(t = T = 75)$.

In contrast, if α tends to 1, A_1 and A_T tend to 1 while B_1 tends to 0.933 and B_T to 0.734. That means a 6.7% decrease in pensions in the short run $(t = 1)$ and a 26.6% decrease in the long run $(t = T = 75)$. This case is illustrated by Fig. 1.

Figure 4a. Sensitivity to time preference (δ)

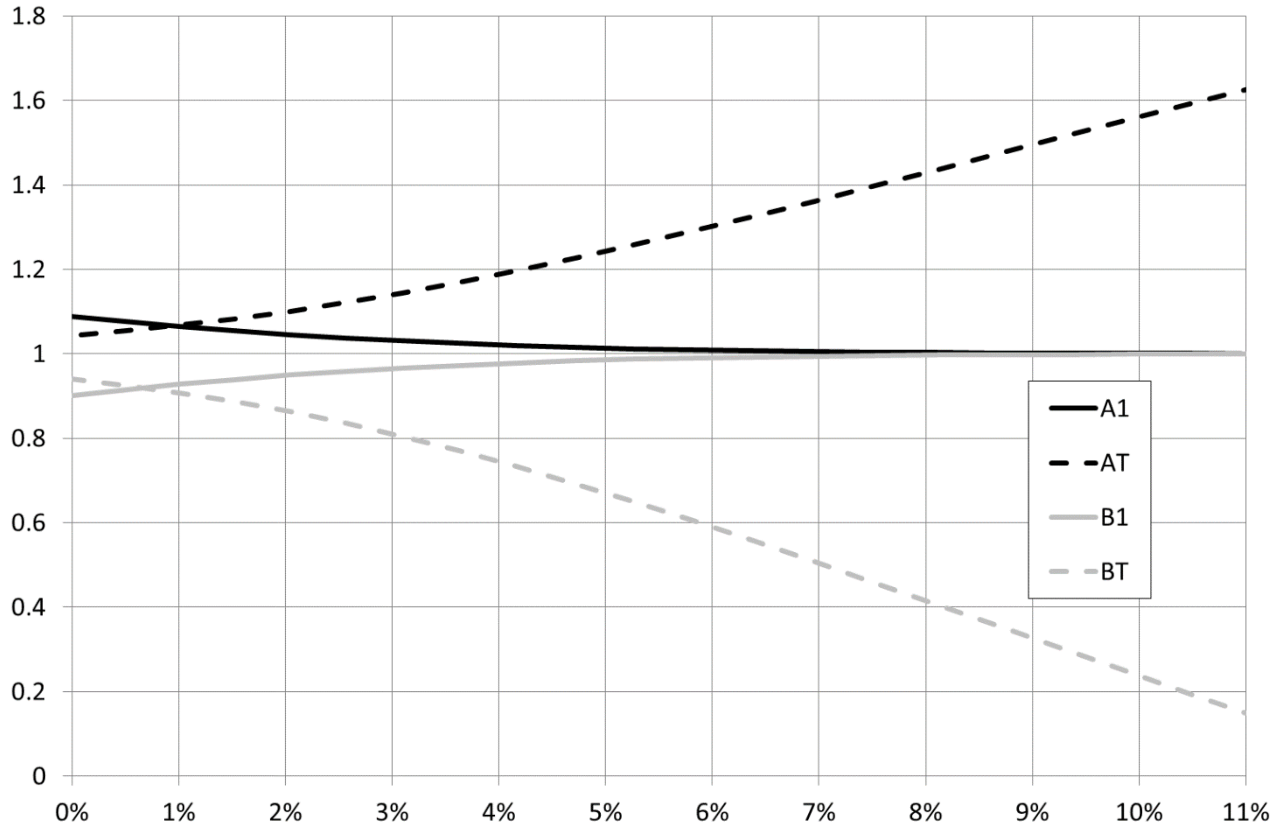
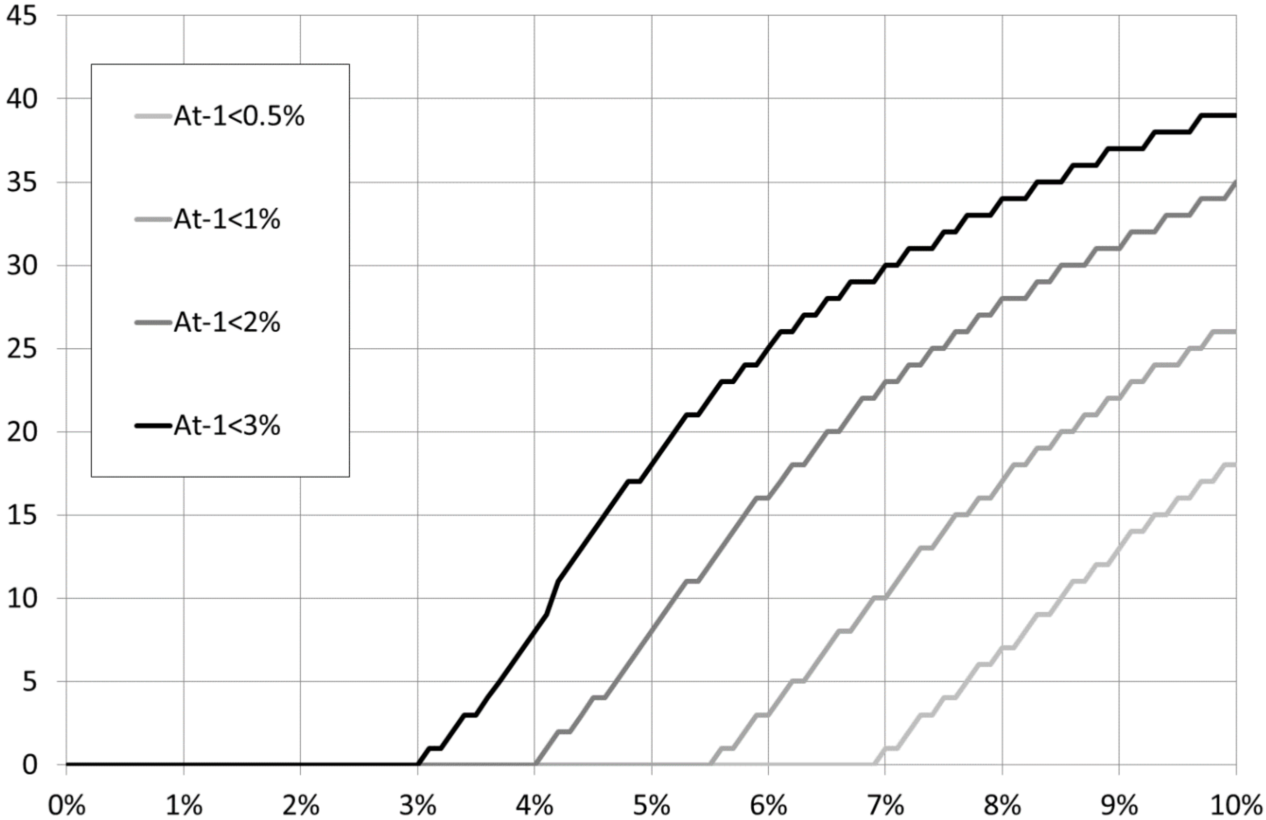


Figure 4b. Sensitivity to time preference: Time lag (number of years) - or procrastination duration - before a significant adjustment (A_t)



Variations in time preference (δ) clearly show the consequences of postponing adjustment mechanisms (figure 4a). Delaying adjusment induces very high adjustment costs in the future. The gap between short-run and long-run adjustment ($A_T - A_1$ or $B_T - B_1$) increases exponentially with δ. For example, if $\delta > 10\%,$ the gap exceeds 70% for B and 50% for A. Conversely, if $\delta < 2\%$, the gap is less than 5% for B and 8% for A. Note that for weak δ ($< 0.75\%$), adjustment is stronger in the short run than in the long run.

This coefficient induces procrastination since it is a component of adjustment of the growth rate. Indeed, when this coefficient becomes sufficiently high, it takes several years before significant adjustments**.** As an illustration (Figs. 4b and 4c), values of δ greater than 8.5% require more than ten years for adjustments through A and B above 0.5% as compared to twenty , twenty-five and thirty years for adjustments above 1, 2 and 3%, respectively.

Figure 4c. Sensitivity to time preference: Time lag (number of years) - or procrastination duration - before a significant adjustment (B_t)

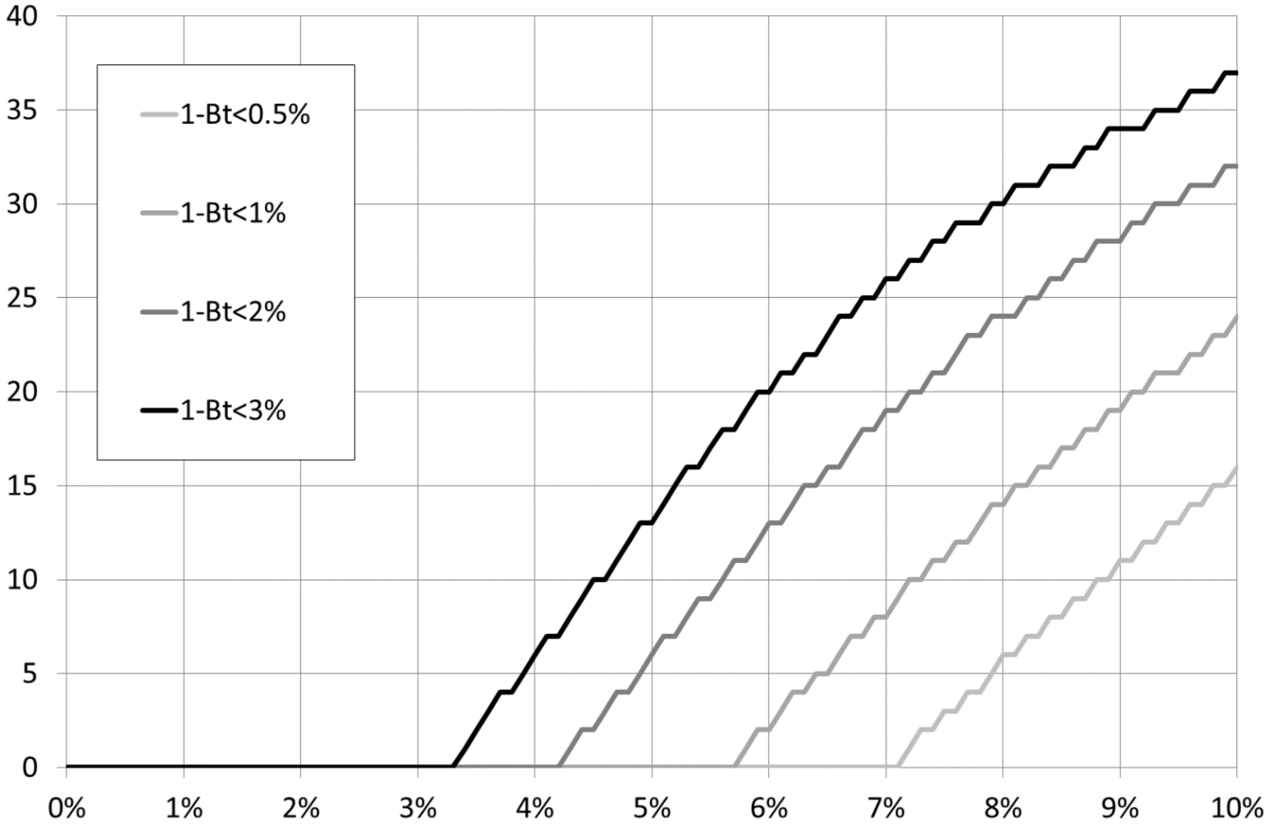
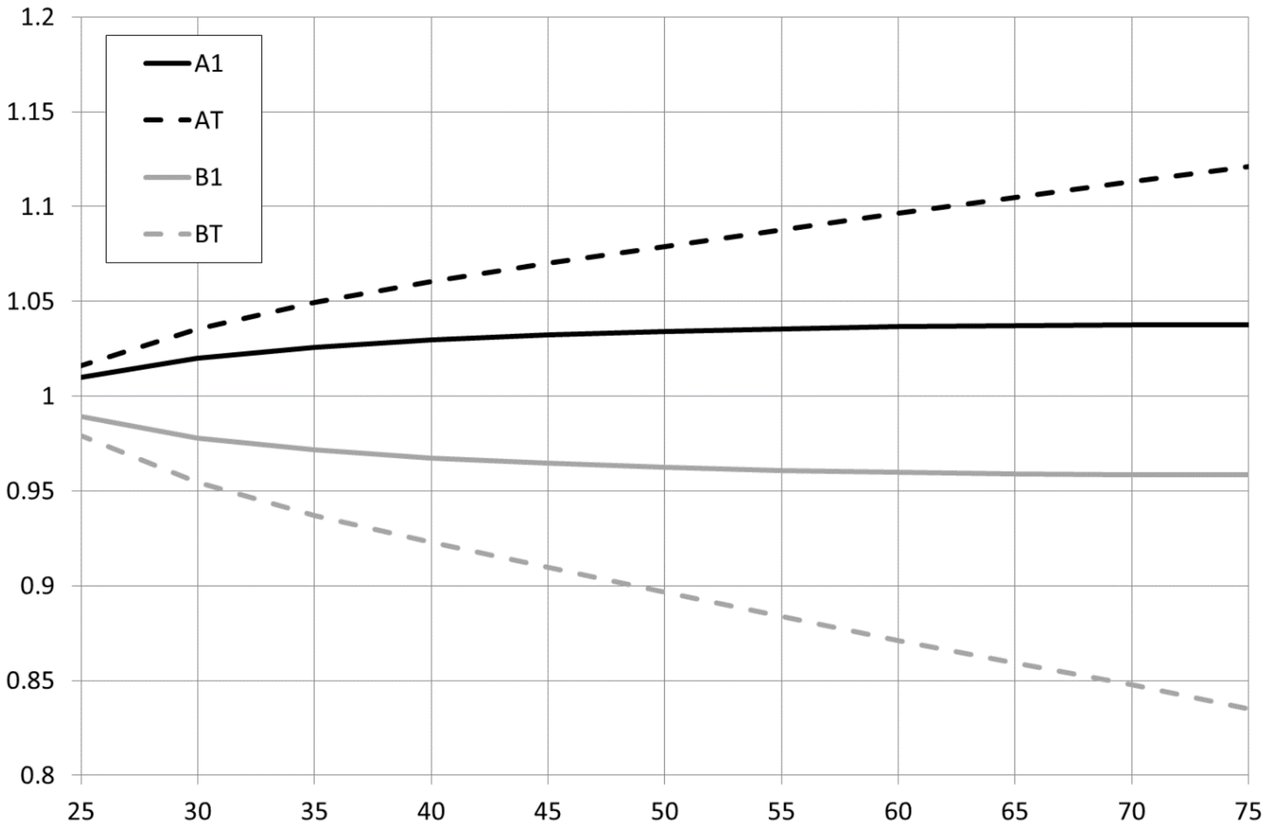


Figure 5. Sensitivity to time horizon (T)



The U.S. pension system performs surpluses until 2032 (intermediate scenario forecasting). Afterward, the U.S. government will be forced to reform (tax increase or decrease in pensions). The longer the time horizon, the more the planner integrates imbalance. This means the adjustments are very sensitive to time horizon. For a 25-year time horizon, the present value of the unfunded fraction of the liabilities is low. It increases with the forecast horizon.

Increasing T has two cumulated effects (figure 5):

- taking into account a larger period of deficit (A_t and B_t are larger);

- discounting more the value of the last period (A_T and B_T are larger).

3.2. Global analysis of a benchmark set of parameters

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

Figure 6. Automatic adjustments and reserve fund

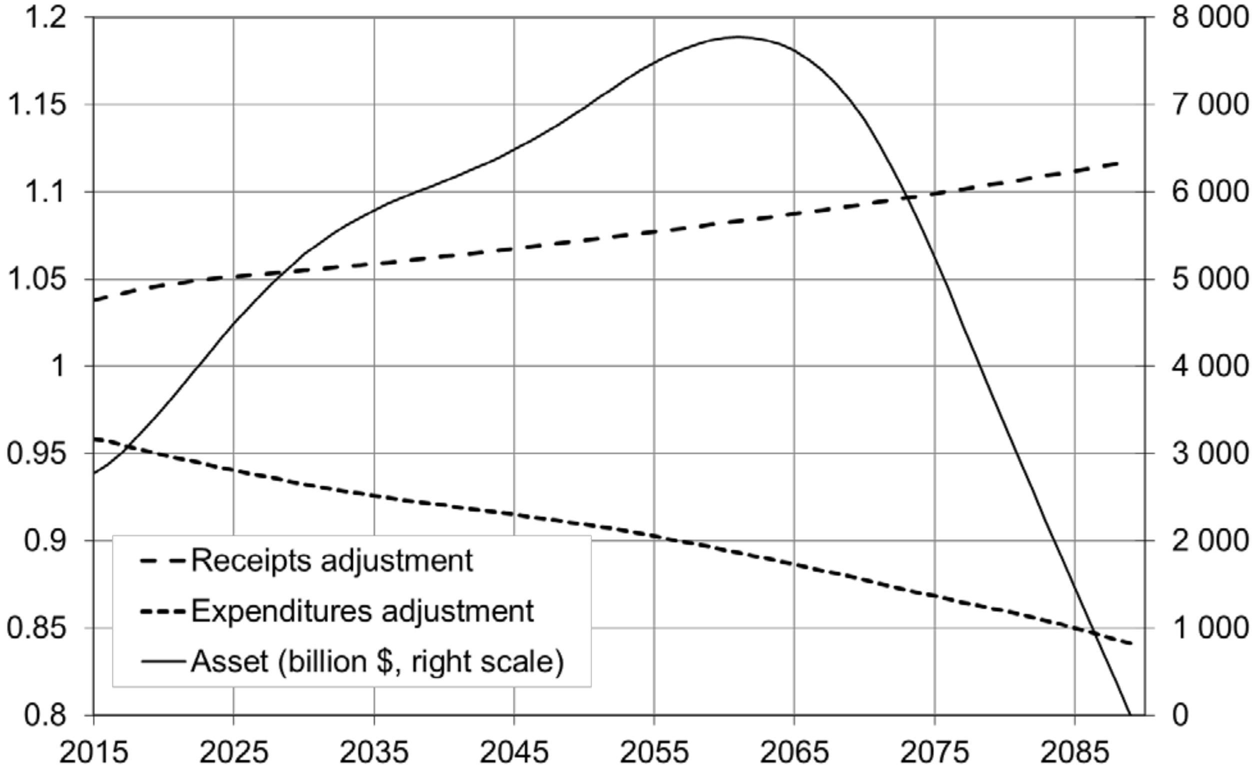
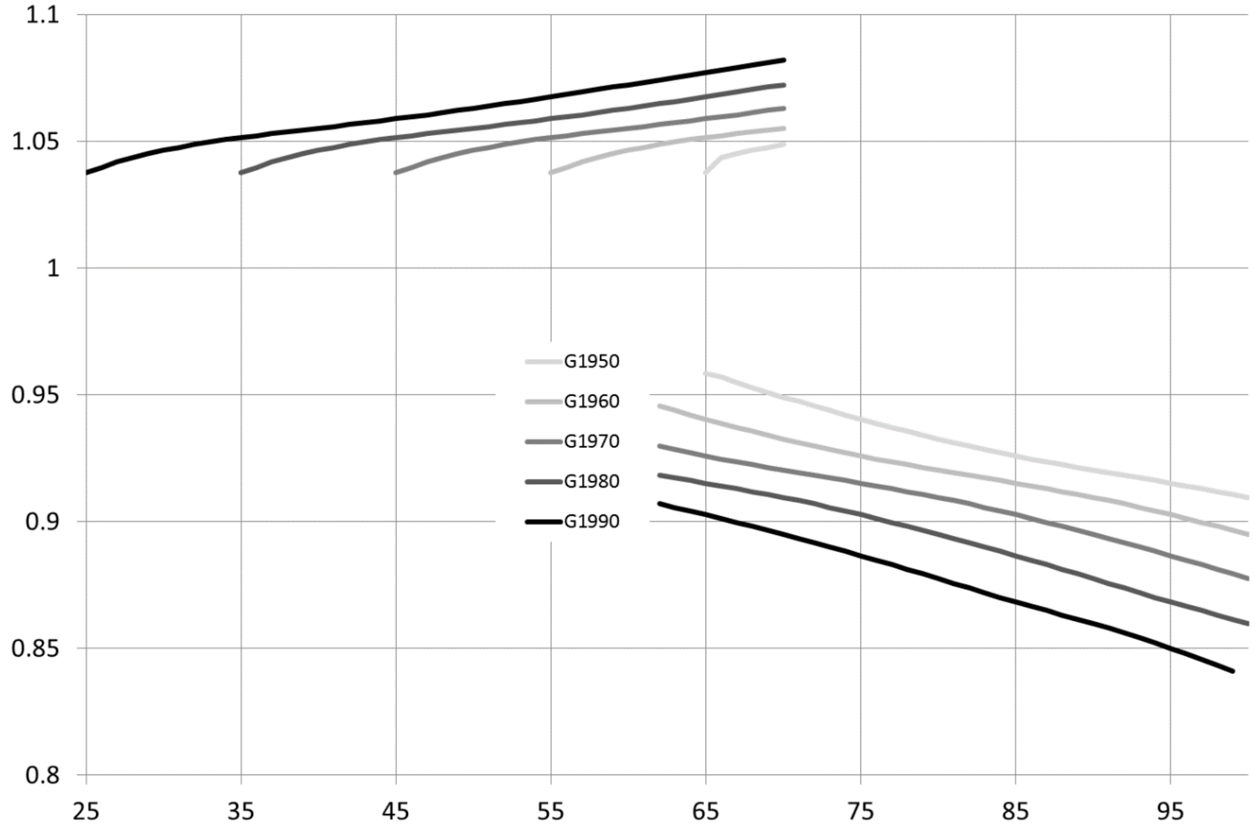


Figure 7. Generational impact per age



The ABM implies an immediate adjustment consisting in a 4% increase in tax rate and a 4% decrease in pension.

The adjustment gradually settles in and finally reaches a 12% increase in tax rate and a 16% decrease in pension.

Figure 6 represents the relative evolution of payroll tax rate and pensions and the amount of the reserve fund in the case where the parameters are the following:

$$\begin{cases} \alpha = 0.5 \\ \delta = 2.5\% \\ T = 75 \end{cases} \tag{16}$$

Low values of δ reduce procrastination. This results in an immediate adjustment through both A and B by 4%: contributions increase by 4% while pensions decrease by 4%.

In the long run, there is a continuous increase in tax rate and a continuous decrease in pensions over the whole 75-year period. At the end of this period, tax has increased by 10%

and the pensions have decreased by 16%.

During the first part of the period, the adjustment generates a surplus. Then, the reserve fund increases and reaches its maximum in 2060 when the pension scheme becomes unbalanced. From this period on, the reserve fund is used in order to finance pensions and decreases until the end of the period. The fund is depleted in 2085.

Figure 7 provides the corresponding intergenerational analysis. The upper part of the chart represents the increase in contributions for various generations. Of course, the older the generation, the shorter the period of contributions rising. In other words, the generation born in 1950 (G1950) "suffers" a short period of increased contributions (after age 60) while the youngest one – born in 1990 (G1990) – "suffers" an increase in its contributions over its whole working period.

Figure 8. Adjustment primary balance ($Billion, present value)

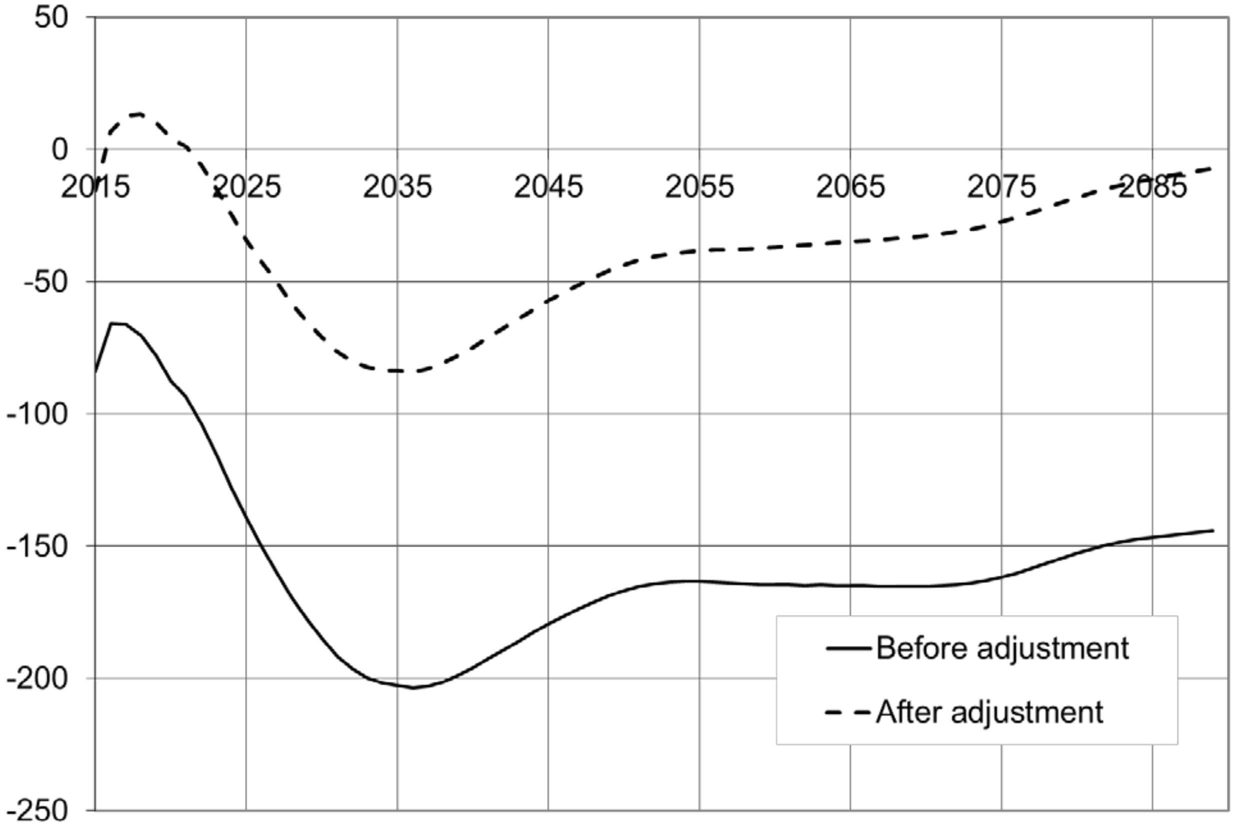
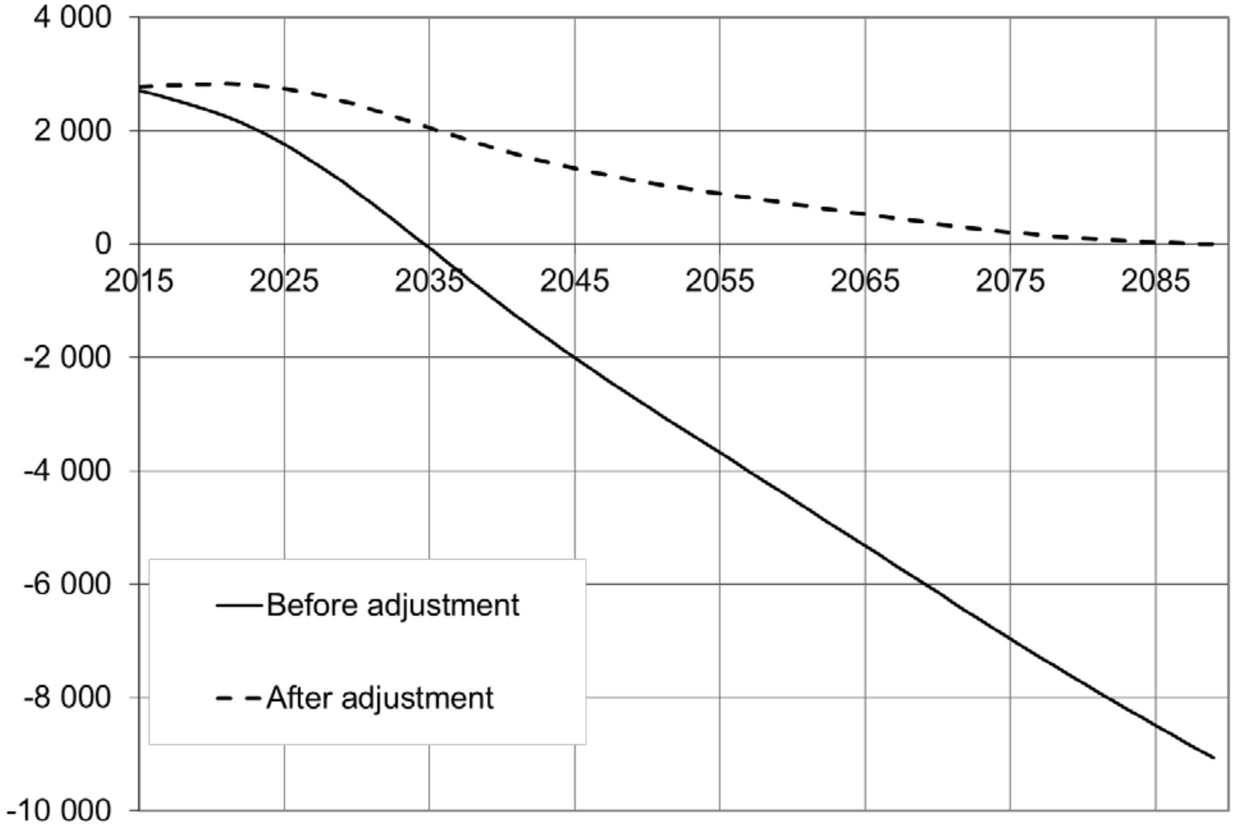


Figure 9. Reserve fund ($Billion, present value)



In contrast, all generations are affected by a decrease in their pensions. In terms of pension yields, this means the oldest generation will have a higher return from its pension scheme than the youngest one. We also observe that the reserve fund being depleted at the end of the simulation period (figures 8 and 9), other adjustments will have to be made that will undoubtedly decrease the younger generations' pension yields.

CONCLUSION

This article has identified different types of AAM that can be implemented and has shown how they contribute to a better solvency. Sweden is the only country that strengthens its AAMs with an ABM that ensures financial stability. Similarly, we propose to build an ABM starting from a dynamic optimization setting. For a given planning horizon, we obtain formulas that determine how receipts and expenditures must be adjusted at each period. That allows to consider the ABM chosen by Sweden as a special case. Indeed, the “flat Swedish-type ABM” or “fiscal-cliff US-type ABM” can be obtained by assuming very high adjustment costs on revenue (implying only pension benefit adjustment) and choosing particular sequences of public discount rates. We apply these formulas to the financial balances of the US Social Security (OASDI program). Using dynamic optimization avoids brutal adjustments and thus moderates or smooths out the marginal adjustments necessary for financial stability.

The balancing adjustment should result in incremental changes. Indeed, standard AAMs are hoped to lead to sufficient adjustments and to contribute to a better financial balance. The ABM is an ultimate safeguard setting that should be expected to be marginal when the other parameters are well calibrated. Too large adjustments suggest that a fondamental reform should recalibrate all parameters and include significant and efficient AAMs.

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). Future considerations could be given to adopt a high initial discount that would be gradually reduced. Such choice should permit to reduce strongly the initial adjustments and to obtain later a convergence to a flat adjustment scheme. Hence, low initial adjustments would make the adoption of ABM more politically acceptable whereas the convergence to a flat adjustment should be less costly in terms of inter-generational equity in the long run.

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APPENDIX

The two F.O.C express a tradeoff between increasing the social cost of adjustment and reducing the deficit. At each period, for a loss level given, the tradeoff between A and B implies to the following Marginal Substitution Rate (MRS):

$$\left(\frac{\Delta A}{\Delta B}\right)_{Loss\text{ given}} = -\frac{\Delta L/\Delta B}{\Delta L/\Delta A} = -\frac{(1-\alpha)\cdot(B_t-1)}{\alpha\cdot(A_t-1)}. \tag{A1}$$

By comparaison, the slide of the budget constraint for F_t and F_{t+1} given is such that:

$$\left(\frac{\Delta A}{\Delta B}\right)_{\text{Budget constraint given}} = \frac{EXP_t}{REC_t}, \tag{A2}$$

where $\frac{EXP_t}{REC_t}$ is the balance ratio. In case of problem of global insolvency, in general this ratio is always greater than 1. At the optimum, the tangency of the two curves implies:

$$-\frac{(1-\alpha)\cdot(B_t-1)}{\alpha\cdot(A_t-1)} = \frac{EXP_t}{REC_t}. \tag{A3}$$

From the FOC, we deduce that:

$$\begin{cases} (A_t-1) = \dfrac{REC_t}{REC_T}\cdot\left(\dfrac{1}{1+\delta}\right)^{T-(t+1)}\cdot\Pi_{i=t+1}^{T}R_i\cdot(A_T-1) \\ (B_t-1) = -\dfrac{EXP_t}{REC_T}\cdot\dfrac{\alpha}{1-\alpha}\left(\dfrac{1}{1+\delta}\right)^{T-(t+1)}\cdot\Pi_{i=t+1}^{T}R_i\cdot(A_T-1) \end{cases}. \tag{A4}$$

By incorporating these two expressions in the intertemporal budget constraint, we find the forecast final adjustment:

$$\begin{cases} (A_T-1) = UO_0/\sum_{t=1}^{T}\left(\dfrac{REC_t^2+\dfrac{\alpha}{1-\alpha}\cdot EXP_t^2}{REC_T}\cdot\left(\dfrac{1}{1+\delta}\right)^{T-(t+1)}\cdot\dfrac{\Pi_{i=t+1}^{T}R_i}{\Pi_{i=1}^{t}R_i}\right) \\ (B_T-1) = -\dfrac{\alpha}{1-\alpha}\cdot\dfrac{EXP_t}{REC_t}\cdot(A_T-1) \end{cases}. \tag{21}$$