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How can we maintain pension levels in pay-as-you-go schemes?

Some guiding principles for the development of self-adjusting mechanisms for sustainable retirement systems

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Abstract

Most of the developed countries are experiencing fertility rates below population replacement levels and increasing life expectancy. These demographic factors are exerting a financial strain on the delivery of social security retirement benefits. In response to these and other pressures, some countries have adopted mechanisms that are designed to make the system self-adjust, so that it is sustainable. A sustainable system is one that delivers on its financial commitments in such a way that the financial burden is borne equitably by participants over the long term. Based on a review of the analysis of the self-adjustment mechanisms of Canada, Germany, Japan and Sweden, this paper derives five guiding principles for the development of self-adjustment mechanisms for sustainable social security retirement systems. The list is not presented as complete, but is a starting point for those designing or adopting adjustment mechanisms and for researchers.

1. Introduction

Social security retirement systems ("SSRS") providing pension benefits under the defined benefit ("DB") principle are under strain around the world. The primary cause has been demographic developments different from assumed. Increased longevity and population aging have led to pensions being paid longer and to greater numbers than expected, while the decrease in the fertility rate, especially below population replacement levels, has resulted in a decrease in the relative magnitude of the contribution base. Other causes include economic performance worse than anticipated, where the SSRS has some invested reserves, and delays in increasing the contribution rate to a sustainable level. Certain SSRS have adopted automatic balancing mechanisms ("ABM") in order to respond to the stresses and maintain balance.

Some countries, such as Canada, have taken action to revise the system's parameters to place the system on a sound financial basis. Other countries have taken action to replace the defined benefit approach by another approach, such as notional defined contribution ("NDC") in Sweden's case. Still other countries, such as Germany and Japan, have modified their systems, but the changes are unlikely to make the SSRS sustainable financially, unless

some very optimistic assumptions are realized. In revising their systems, all four of these countries introduced a type of self-adjusting mechanism.

This paper relies on my recent work (Andrews 2008). Interested readers may refer to that work for details on the ABM of the various countries' SSRS and for background information that supports the guiding principles presented in this paper. Through an examination of the changes made by Canada, Germany, Japan and Sweden, I consider the socio-economic impact of changing the financing approach of the SSRS, examine the policies developed on the employment and social protection in each country and suggest guiding principles for the development of self-adjusting mechanisms for sustainable SSRS.

1.1. Self-adjusting and Automatic Balancing Mechanisms

The focus of this paper is on self-adjusting mechanisms that are sustainable. To be sustainable in the long run, the SSRS must be able to deliver on its financial commitments and it must share the burden of delivery in an equitable manner among participants. For example, the SSRS in the United States has a self-adjusting mechanism because the law requires that when the funds are insufficient to pay the full amount of promised benefits as they fall due, the benefit amounts are reduced; thereby correcting the financial imbalance. However, such an adjustment does not provide an appropriate and equitable adjustment among contributors, pensioners and other beneficiaries. It is likely that some other adjustments would be made in order to make the adjustments more equitable. Accordingly, I do not consider the self-adjusting mechanism for the United States' SSRS as an example of a mechanism that is sustainable. I shall refer to self-adjusting mechanisms that are sustainable as balancing mechanisms, where balance is examined from both a financial and an equitable perspective.

1.2. Characteristics and terminology

For a balancing mechanism to operate effectively, it should possess the following characteristics:

- Gradual – the adjustments take place over a period of time without any sudden significant adjustment being borne by any single participant or cohort of participants.
- Equitable – the adjustments should be borne by cohorts of participants in a manner that each cohort would consider fair, i.e., although the adjustment may be viewed negatively, it should be implemented so that the method of implementation is not viewed as being distributed unevenly among cohorts.
- Sustainable – the adjustments should be sufficient to deal with the stress for a reasonable period of time on some reasonable set of assumptions not merely a temporary fix which simply delays the stress for a short period of time. For the purpose of assessing the effectiveness of an ABM, the critical assessment period will be the long run. Seventy-five years will be used as the evaluation period.

There are also some characteristics of an adjustment mechanism that may not be essential but might be considered ideal.

- Automatic – Adjustments would occur as stresses develop in order to keep the SSRS in balance.
- Transparent – The nature of the adjustment would be open and understandable by all cohorts.

One may also distinguish between ABM that make an adjustment according to set formulae and procedures without any intervention or approval by authorities, and those which require

an approval by authorities before they are triggered in response to certain defined warning indicators. The former shall be referred to as "mechanistic" and the latter as "discretionary".

Truly robust ABM are relatively scarce, perhaps non-existent. However, there is an immediate appeal to the concept of an ABM, i.e., an effective balancing mechanism that makes the necessary adjustments in response to stresses that have occurred. I reviewed the ABM of these four countries with respect to financial balance and also equitable balance, using a very high standard of robustness, namely whether the adjustment mechanism is able to adjust to stresses regardless of the demographics or economics, however remote the likelihood of occurrence of the demographic or economic stress may be. If the system is able to adjust to stresses regardless of the demographics or economics, however remote the likelihood of occurrence, it will be considered robust. If the system achieves balance in most circumstances other than those considered extreme and quite unlikely, it will be considered to achieve partial balance. If the system does not achieve financial balance even in relatively likely circumstances it will be considered transitory. A similar terminology was applied to equitable balance as was applied to financial balance.

The final classification of purported ABM is:

- Completely robust, if they achieve both financial and equitable balance over the long run.
- Robust on one dimension of balance that will be included in the label, if they achieve either financial and equitable balance over the long run, but not both.
- Partial, if they achieve either partial financial or partial equitable balance in the long run.
- Transitory, if they achieve not even partial financial or partial equitable balance in the long run.

This standard of robustness is very high and none of the ABM are robust, according to this definition.

The following table summarizes the analysis of the balancing mechanisms in the four countries and applies the classification terminology.

Table 1. ***Classification of balancing mechanisms***

Does the balancing mechanism				
Country	**Work automatically**	**Achieve financial balance**	**Achieve equitable balance**	**Classification**
Canada	No	Partial	Transitory	Discretionary partial
Germany	Yes	Transitory	Transitory	Mechanistic transitory
Japan	Yes	Transitory	Transitory	Mechanistic transitory
Sweden	Yes	Transitory	Partial	Mechanistic partial

The conclusion is that none of the four countries' systems examined has a balancing mechanism that is robust in achieving both financial and equitable balance.

A theme of the conference is the socio-economic impact of adjustment approaches. In my view, for an approach to be sustainable it must be both sustainable socially, i.e., equitable, and economically, i.e., financially sound. The next section of this paper lists the guiding principles developed for a sustainable adjustment mechanism. The subsequent section presents findings from the research which led to the identification of the guiding principle. The fourth section provides some concluding remarks.

2. Some guiding principles for a sustainable self-adjusting mechanism

This section lists some guiding principles for a sustainable self-adjusting mechanism. The list has been developed from a review and analysis of the existing ABM of Canada, Germany, Japan and Sweden. I do not contend that the list is complete. There may well be additional guiding principles. For example, Robalino and Bodor (2006) suggest that the correct determination of the internal rate of return for a NDC will lead to a sustainable system. Also, I do not contend that how the guiding principles are implemented by particular countries is necessarily applicable to other countries. The objectives of individual countries in designing their systems may vary significantly and reflect differences regarding what is the normal and acceptable level of social protection in the country. For example, Germany's SSRS is targeted at a 67% net replacement ratio whereas Canada's Canada Pension Plan (CPP) is targeted at a 25% gross replacement rate, of the average wage. With such differences among countries, it is possible that different guiding principles may emerge.

The list of some guiding principles for a sustainable self-adjusting mechanism follows. In the next section, elaboration on the research that led to each of these principles is provided.

1. The ABM should relate directly the factors which affect inflows to factors which affect outflows.

2. In assessing the equitable distribution of the burden of adjustment, the change in expected utility should be considered by class of participants.

3. The greater financial burden of adjustment should be borne by contributors rather than by pensioners.

4. The ABM should be able to restore balance without recourse to extra-systematic flows.

5. Where approximations are used, the financial condition and equity of the SSRS should be reviewed periodically and adjustments made as warranted.

3. Elaboration on guiding principles

In this section, I elaborate on the each of the guiding principles with reference to the research on the four countries' ABM.

3.1. The ABM should relate directly the factors which affect inflows to factors which affect outflows

For a variety of administrative reasons and as a consequence of historical developments, most SSRS have some reserves, even if the SSRS is considered to be paygo. However, if a paygo

SSRS is to be sustainable in the long term, there must be a mechanism that ensures that the amount of inflows, mainly contributions but also government subsidies and investment earnings, equals or exceeds the amount of the outflows, mainly pension and benefit payments but also administrative expenses, at the time that the outflows are due.

Put very simply, in a paygo system, to maintain financial balance, contribution income must equal benefit outflow, and so change in contribution income must equal change in benefit outflow. None of the mechanisms reviewed have a direct link between contribution incomes and benefit outflows.

The factors affecting the contribution income are the gross income of the contributory group that is subject to contributions and the contribution rate. The factors affecting the benefit outflows are the benefit payments to each pensioner and the number of pensioners. By writing this relationship in the form of an equation to equate the change between year t and $t+1$ year, of income and of outflow, and then rearranging the equation produces an informative result.

$$\Delta \text{ income} = AI_{t+1}NC_{t+1} - AI_tNC_t$$

$$\Delta \text{ outflow} = AP_{t+1}NP_{t+1} - AP_tNP_t$$

so
$$\left\{\frac{AI_{t+1}NC_{t+1}}{AI_tNC_t} - 1\right\} = \left\{\frac{AP_tNP_t}{AI_tNC_t}\right\}\left\{\frac{AP_{t+1}NP_{t+1}}{AP_tNP_t} - 1\right\}$$

where AI_k represents average contributory income per contributor in year k

NC_k represents number of contributors in year k

AP_k represents average pension per pensioner in year k

NP_k represents number of pensioners in year k

The last equation shows that the rate of change in gross contributory income from t to $t+1$ minus 1, is equal to the ratio of the pension outflow to the contribution income in year t multiplied by the rate of change in pension outflow from t to $t+1$ minus 1.

The Japanese and German adjustment mechanisms come close to incorporating these components, but do not include them completely. The Japanese mechanism adjusts pensions based on a proxy for the change in the contribution volume but the mechanism does not have a component that represents the ratio of the pension outflow in year t to the contribution volume in year t. The German mechanism adjusts pensions based on a proxy for the change in contribution volume and for the change in the number of pensioners to the total potential contributory group, i.e., both contributors and the unemployed. However, this latter adjustment is with respect to numbers and not to dollar flows. If the pensions per capita and the income per capita were constant, the two ratios would be equivalent; however, neither pensions per capita nor income per capita are constants. Furthermore, the German system adjusts the demographic ratio by a sustainability parameter, currently 25%, which moves the balance further away from equivalence. Finally, for reasons of administration, the German system uses ratios based on lagged data.

The Canadian adjustment mechanism makes adjustments both to contributions and to payments to pensioners; thus giving consideration to factors that affect inflows and outflows.

However, because the CPP is a partially funded system with (what will become) significant reserves, investment return is another significant source of flow that cannot be excluded from an assessment of whether the mechanism will achieve financial balance automatically. I recognize that the actual investment return affects the financial position and thereby the magnitude of the future required adjustments; and also that the assumption regarding expected investment return affects the determination of the steady-state contribution rate and thereby the need for adjustment. However, on my assessment, these considerations are indirect. The adjustment mechanism itself lacks a direct adjustment in respect of a main determinant of flows, i.e., investment returns.

The Swedish SSRS credits the notional accounts and adjusts the pensions by the rate of change in the average wage. However, it is the change in total contributions, which is a function of the change in total covered wages, which determines the amount of funds available for increases to pensioners' pensions and for crediting to the notional accounts. On some standard assumptions regarding employment and wage growth, the increase in the average wage may be a good proxy for the increase in total contributions, but there are certain situations where such standard assumptions do not apply. For example, Cichon (2005) states that a central problem will be negative or low economic growth rates that could potentially be triggered by a contraction of the labour force, and Letzner and Tippelmann (2004) observe that "when the work force decreases, the average income growth can be higher than the growth rate of the total wage bill and benefits and pension rights will grow faster than the contribution base from which benefits are paid". In such a situation, financial balance can only be achieved by the use of buffer funds or the ABM.

3.2. In assessing the equitable distribution of the burden of adjustment, the change in expected utility should be considered by class of participants

There are many possible definitions of equity, some of which are completely incompatible with each other. In my research (Andrews 2008), I consider six possible families of definitions and identify two definitions for further evaluation. The six families are listed below, with the last two definitions being considered suitable for use in evaluating the impact of adjustments.

1. *"Hard line-No Changes"*

2. *"Paying the same contribution rate"* or *"Paying the same contributions"*

3. *"The lifetime net benefit rate is zero for all cohorts"*

4. *"Equity requires achieving certain social welfare goals"*

5. *"Having a constant relationship between the present value of pensions and the present value of contributions across cohorts"* – There is a family of definitions of equity here. The key elements of this family of definitions are:
   - both pensions and contributions are considered
   - there is a comparison across cohorts
   - a present value is calculated for the purpose of the comparison.

This family of definitions seems to be valid; although, the choice of discount rate could affect the validity of the definition.

6. *"Having an equivalent change in the expected utility among cohorts"* – This definition is not a way of measuring equity prior to a change but it is a way of measuring the equity of a change. A prime difference in this family of definitions of equity, from any of the other definitions considered, is that it introduces the notion of expected utility. This changes the perspective from simply measuring the amount of the change, expressed in some form (such as a ratio), and then comparing across cohorts, to one of considering the impact of the change using the cohort's utility measure. In this regard, it is arguable that a change in the future level of expected pension of x% may have quite a significantly different impact on expected utility if the change in expected pension is a long way in the future with much time to adjust lifestyle, savings plans, etc., as would be the case for a 20-year old, than if the change is immediate as in the case of a 75-year old pensioner. Such a consideration is not included in definition 5 above.

Expected utility will be affected by a number of factors such as the amount of pension income and its share of total income. It is likely to vary by proximity to retirement. Because proximity to retirement is readily calculable, I have used it as a proxy for expected utility.

Using data for the CPP, I evaluate income streams using the following personal discount rates:

Table 2. ***Personal discount rates***

	Discount rate	
Period (current age x)	**For period of life expectancy**	**Thereafter**
$65 - x > 30$	4%	4%
$30 \geq 65 - x > 20$	3%	3%
$20 \geq 65 - x > 10$	2%	3%
$10 \geq 65 - x > 0$	1%	3%
$0 \geq 65 - x$	0%	3%

and compare the following ratio after-change to before-change:

$$\frac{\text{Present Value of Pension}}{\text{Accumulated Value of Contributions to 65}}$$

For equity to exist, I require that ratios be not more than 5% different in any one year and be not more than 10% different in any five-year period (Andrews 2008). I conclude that the CPP adjustment mechanism is not equitable because it places too great a burden of adjustment on pensioners. In a recent paper Monk and Sass (2009) also draw this conclusion, using a different evaluation procedure.

With respect to what are the appropriate personal discount rates to use, I propose the following approach. A general rule of thumb is that a well-functioning economy with well-developed capital markets should permit investors to achieve a real rate of return of 3% per annum over the long term. Provided that an individual is assessing an investment over the long term, it is a reasonable assumption to discount future income at a real rate of 3% per annum. Consumers, in our case pensioners or future pensioners, view their prospective pension like an investment. It is reasonable to apply the discount rate that reflects time preference. For my calculations, I will assume that the long term is defined as the minimum of the individual's years of life expectancy and 30 years. So, for example, an individual age 20 with a life expectancy of 60 years would treat the long term as 30 years whereas an individual age 75 with a life expectancy of 9 years would treat the long term as 9 years.

In terms of personal discount rates, if the long term is at least 30 years, it is reasonable to use a real rate of return of 3%; however, for much longer terms a higher discount rate may be used and for much shorter horizons a lower discount rate may be used. The relevant considerations in developing this approach are:

- in capital markets, the normal shape of the yield curve for risk-free bonds is upward sloping by term to maturity;
- individuals place higher present value on events that will affect them immediately or in the near future. A higher present value means that the future income to be received closer to the present is discounted at a lower rate than future income to be received further into the future is discounted.

In calculating the period, age 65 is used as a proxy for the normal age at retirement. So in this model, individuals determine how far they are from the age at which the pension will commence and adjust their discount rate accordingly. This decreasing discount rate, as time to normal age at retirement decreases, is consistent with the theory that individuals are risk averse, which is consistent with a concave-shaped utility function.

3.3. The greater financial burden of adjustment should be borne by contributors rather than by pensioners

This guiding principle follows from the previous one, since any changes in pension will generally have a larger impact on expected utility of pensioners than any changes in contributions and/or future pensions will have on the expected utility of contributors. Hence, adjustments are more likely be viewed as equitable if they are borne by contributors, but they may also be equitable if their impact is shared between contributors and pensioners. However, where there is a sharing, the greater share should be borne by contributors recognizing that they are more able to adapt to such an adjustment, both because they are working and also because they have a longer time horizon for adaptation. Such considerations can be incorporated in the assessment of equity, by using different personal discount rates, which vary by time to retirement, as discussed above.

As noted above, the adjustment mechanism in Canada is inequitable, since it places a heavier burden of adjustment on pensioners than on contributors. In their current form the adjustment mechanisms of Germany and Japan are inequitable because the contribution rate is fixed and the adjustment is borne primarily by pensioners after retirement. Although the contribution rate is fixed in the Swedish system because the age for full benefit entitlement is adjusted based on life expectancy, there is a sharing of the burden of adjustment between contributors and pensioners; hence, Sweden is judged to be partially equitable.

Although it is not a guiding principle, in this regard, an adjustment mechanism that is equitable and that provides a degree of financial stability is adjusting the age of full benefit entitlement to take into account changes in life expectancy. Such an adjustment can be applied in any type of system, not just in an NDC system such as in Sweden. For example, Brazil has a DB system that includes an adjustment for changing life expectancy. This is a type of balancing mechanism that attempts to create some form of balance between the contributory period of work and the retirement period of benefit receipt.

Turner (2008) classifies countries' method of adjustment for life expectancy into two categories: those that correct for the percentage increase in life expectancy; those that correct for the percentage increase in the present value of benefits caused by the increase in life expectancy. He places countries such as Brazil, Finland and Portugal in the first category and

countries such as Sweden, Italy, Norway, Poland, Latvia in the second category. From an actuarial perspective, if the discount rate is 0% (which is often assumed) then the two methods are the same.

Such methods achieve financial balance, in the sense of limiting the benefits paid. They also provide a type of equitable balance across cohorts, since each cohort receives benefits for approximately the same expected period of time or of the same expected present value (after suitable adjustments for salary and economic differences across cohorts). However, such methods may not be considered to achieve individual equity because the individual is expected to contribute for a longer period of time (since the period to full-benefit retirement age has been extended) for the equivalent initial level of benefits received by earlier cohorts.

An alternative method of adjusting for changes in life expectancy would be to maintain a constant ratio of expected period during which contributions will be made up until the age of full benefit entitlement to the expected period of benefit receipt after full-benefit retirement age (or some similar ratio, such as the inverse of the above, or such as the ratio of the expected period of benefit receipt to the expected period of life from work commencement, etc.). Such an approach maintains individual equity across cohorts and within cohorts. Such an approach would also maintain financial balance. According to Turner (2008) such an approach was proposed in the United Kingdom in discussions on how the full-benefit retirement age should be adjusted; however, in the discussions and implementation it was discarded for a simpler approach of scheduled increases in the retirement age. I am unaware of this approach having been adopted by any country; although, Whitehouse (2007) states that France has begun a tightening of the qualifying conditions for the public pension, such that after 2012, the ratio of the period of pension receipt to the period of working will be kept constant.

Using an Overlapping Generations model, the assumption that life length is deterministic and increasing, a legislative approach implying that all living generations have an influence on the social security scheme and have a veto power; Anderson (2006) claims to show that in a paygo scheme the complete solution to increasing longevity cannot be obtained by indexing the retirement age and the consumption of the older generation to longevity. Anderson (2006) claims consumption of the younger generation is also reduced. If Anderson is correct, increasing the retirement age to adjust for increases in life expectancy may be a beneficial adjustment, but it is not a guiding principle.

3.4. The ABM should be able to restore balance without recourse to extra-systematic flows

The logic for this guiding principle is straightforward. If the ABM is not able to sustain balance without extra-systematic flows, then it is not self-adjusting. Neither the Swedish nor the Japanese adjustment mechanisms meet this guiding principle. Both of these SSRS provide for a minimum pension benefit, which from the viewpoints of benefit adequacy and poverty alleviation is a desirable characteristic. However, the ABM in both these countries is able to reduce the pension below the minimum and then another funding source, i.e., an extra-systematic flow, tops up the pension from the system to the minimum benefit level. Accordingly the ABM is not able to self-adjust to attain a sustainable position on its own, without the extra-systematic flow.

3.5. Where approximations are used, the financial condition and equity of the SSRS should be reviewed periodically and adjustments made as warranted

The maintenance of financial balance of an SSRS that does not have fully funded individual accounts, in a changing environment, is a complex, dynamic problem. One approach to the problem would be to formulate it as a stochastic control problem. Likely due to the complexity of not only the solution but even the formulation and specification of the stochastic optimal control problem, none of the international SSRS analyzed uses a stochastic control approach. In the absence of a rigorous stochastic control process, the ABM will use approximations. Approximations may also be used for administrative ease and ease of communication. Where approximations are used, it is possible that the system will move out of financial balance that will not be corrected by the application of the ABM. It is also possible that inequities may develop. Accordingly, it is appropriate to review the financial condition and equity of the SSRS periodically and make adjustments as warranted.

An example of an approximation is that the adjustment rates may be calculated by addition rather than by multiplication, viz., the application of the Japanese mechanism. For relatively small adjustments that are close to 1, which most of these adjustments are, these two methods are approximately the same; however, it is worth noting that this is only an approximate mathematical relationship. Similarly, the Swedish mechanism only makes an approximate adjustment. It multiplies the rates by the adjustment factor rather than multiplying the accounts or the pensions by the adjustment factor. For example, if the rate of real wage growth is 0.016, the rate of inflation is 0.025 and the adjustment factor is 0.99, to achieve balance, the adjustments should be 0.99 (1 + 0.016 + 0.025) = 1.03059 to the accounts and 0.99 (1 + 0.025) = 1.01475 to the pensions. The actual adjustment would be 1 + 0.99 (0.016 + 0.025) = 1.04059 and 1+ 0.99 (0.025) = 1.02475 respectively, so the resulting liabilities are higher than they should be if the adjustment had been applied correctly. Once again, for relatively small adjustments that are close to 1, which most of these adjustments are expected to be, the two methods are approximately equal. However, over successive periods of adjustment, there is a compounding effect that could become significant.

According to Toft (2007) and Borsch-Supan et al. (2003, 2006), the choice of 0.25 for the sustainability parameter in the German ABM, is thought to be deliberate in order for the SSRS to appear to be able to be in financial balance. This parameter shares the burden of adjustment between contributors (75%) and pensioners (25%). It is a type of approximation that might need review and adjustment in the future.

For a SSRS to be financially sustainable it must balance money capital and human capital to provide adequate retirement income for those who have ceased to work from the wages of workers of past, current and future generations. Sinn (2000) has argued that to make SSRS financially sustainable and more equitable, generations that do not have a sufficiently high fertility rate to replace themselves should have their social security adjusted in some manner. The adjustment might be in the form of higher contributions or reduced benefits.

Alho et al. (2006) describe an approach that they refer to as fertility-dependent prefunding. In Finland, there is some prefunding of the defined benefit pensions. The extent of prefunding does not affect the benefit levels. Alho et al. (2006) propose that the standard prefunding formula be multiplied by a factor for each cohort that estimates its size at working age to the estimated size of all working age cohorts. The factor is as follows:

$$b(i,t) = B(t-i) / \sum_{j=0}^{i-1} w(j,i) B(t-j-1)$$

where $b(i,t)$ is the adjustment factor in year t for those age i

$B(t-i)$ is size of cohort $t-i$

$w(j,i)$ are weights calculated so that they approximate the shares of the various cohorts in the working-age population when the funding cohort (those in age i at t) has retired

and $w(j,i) \geq 0$ add up to 1 for each i

If the funding cohort is bigger than the younger cohorts (on average) then b exceeds 1 and funding is increased, whereas if the funding cohort is smaller than the younger cohorts (on average) then b is less than 1 and funding is decreased. In the absence of such a formal adjustment mechanism, the ABM of other countries are trying to address the problem of maintaining the balance of money capital and human capital in an approximate manner. As such, further adjustments may be required periodically.

4. Conclusions

This paper has used previous research and analysis to develop some guiding principles regarding self-adjustment mechanisms designed to render a SSRS sustainable. The research focused on the ABM of Canada, Germany, Japan and Sweden. By deriving guiding principles from a review of certain countries' SSRS and ABM, it is unlikely that the list of guiding principles is complete. It is hoped that this paper will encourage others to suggest additional principles.

However, it is my belief that for a SSRS, which is a social system, to be sustainable, it is necessary but not sufficient that the SSRS achieve financial balance. As a social system, a SSRS must be equitable on a long-term basis. How equity is to be defined is not universally agreed. I have considered a number of possible definitions.

In my view, where changes are taking place in the SSRS, as is the case when an ABM is operating, an assessment of equity must consider the expected utility of the participants. Moreover, the definition of equity will vary from country to country, depending on many factors such as culture, degree of social solidarity, income, taxation practices, etc. As such, even if the guiding principles set out in this paper are followed, it is likely that different countries will adopt different ABM and SSRS. Provided that the guiding principles have been met, all such ABM and SSRS might be considered sustainable. However, in my opinion, none of the ABM adopted by Canada, Germany, Japan or Sweden is sustainable.

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