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.

1.0 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.

The details of these self-adjusting mechanisms can be quite complicated and are understandable only within the context of the particular country's SSRS. There are a number of sources that provide this detail. To facilitate the reading of this paper by those who may not be familiar with the individual countries' self-adjusting mechanisms, a brief overview of the self-adjusting mechanisms for Canada, Germany, Japan, and Sweden is included in Appendix A. When I refer to the four countries, I will be referring to these four countries, unless otherwise noted.

This paper relies on work by Andrews (2008), which provides background information that supports the guiding principles presented in this paper. Interested readers may refer to that work for details on the ABM of the various countries' SSRS or to other works, such as: Turner (2009) who reviews adjusting mechanisms in 12 countries; or Sakamoto (2013) who describes the ABM in Canada, Germany, Japan and Sweden and lists advantages and disadvantages of each country's ABM; or Appendix 1 in Godinez-Olivares et al. (2015) that provides a table with comments for 13 countries showing the type of plan, whether an actuarial balance sheet is prepared, and whether there is an ABM.

This paper is organized as follows. The balance of this section provides general information on how systems involving self-adjusting mechanisms may be classified. Section 2 presents the five guiding principles. Section 3 elaborates on these five principles and the rationale leading to their identification as a guiding principle. Section 4 applies the guiding principles to a recent paper by Godinez-Olivares et al. (2015) and then Section 5 concludes.

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 is the actuarial valuation period of both the Canadian and U.S. SSRS and is a reasonable choice given that it is sufficiently long to involve impacts for multiple generations; however, one could present arguments for longer periods, and possibly even argue that an infinite horizon be used.

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. A balancing mechanism will make financial adjustments to the system. In any social system involving multiple generations of participants any adjustment must be judged on the basis of equitability. In my view, for an approach to be sustainable it must be both sustainable socially, and economically, i.e., both equitable and financially sound.

I reviewed the ABM of the 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. I am not aware of any country's balancing mechanism that meets the robustness standard. Nonetheless there is value in reviewing and analysing the balancing mechanisms of these four countries.

2.0 Some Guiding Principles for a Sustainable Self-Adjusting Mechanism

A basic requirement for being able to apply a self-adjusting mechanism is the determination of the need for adjustment. Turner (2009) discuss four dimensions of adjustments: frequency of adjustments, triggering event, whether the trigger is a hard trigger or a soft trigger, that change that is triggered. Boada-Penas et al. (2010) discuss the importance of the drawing up of an actuarial balance sheet in paygo systems to improve transparency, credibility, and solvency.

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. Several of them could be described as expanding upon the position taken by Menard et al. (2013) that intergenerational equity is a condition for sustainable social security. In the next section, subsections 3.1 to 3.5 explain the research and background that led to each of these principles.

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.

3.0 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 growth in average income. However, it is the change in total contributions, 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 growth in the average income 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. 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"* - once a benefit has been promised then any change is inequitable. This definition does not question whether the promise was equitable in the first place.
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"* – while desirable this definition rests on the specification of the acceptable 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. Throughout the literature, various mathematical formulae have been used to estimate the utility function, e.g., exponential, logarithmic, power, or iso-elastic (Johnson 2007). Although I am aware of no definitive empirical research demonstrating that one of these formulae correctly represents the utility function. Moreover, in such analysis, we are concerned with the expected utility of a cohort and it is certainly possible that members of a cohort have different individual utility functions.

To illustrate this approach, I used data for the CPP, and evaluated 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:

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

This ratio has an actuarial underpinning as it compares the present value of future benefits to the accumulated value of contributions. Age 65 was chosen since it is the retirement age for full benefit entitlement for the CPP.

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.

If the adjustment provision were triggered for the CPP and it were applied for a number of years, there would be considerations of intragenerational equity. Older pensioners, especially those who died during the adjustment period, would be less affected than younger pensioners who lived well beyond the adjustment period. Also younger contributors who paid a higher contribution rate for a longer period, without any increase in pension, would bear a heavier burden than older contributors.

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 immediate changes in pension will generally have a larger impact on expected utility of pensioners than any immediate 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 zero per cent (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; Andersen (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. Andersen (2006) claims consumption of the younger generation is also reduced. If Andersen 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 rigourous 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. Over successive periods of adjustment, there is a compounding effect that could become significant. The Swedish mechanism also includes a number of approximations, such as the method of estimating the contribution asset using turnover duration.

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.

As an aside, it is interesting to note that in the German mandatory insurance for long-term care, there is an adjustment to increase the premiums paid by those who are age 23 or older who do not have children (Schulz 2010). The rationale is that care provision is affected by demographics. Those without children may place greater care requirements on the state.

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.

4.0 Illustration

Before concluding, I illustrate the application of these principles with respect to a recent paper by Godinez-Olivares et al. (2015) that was presented to the International Actuarial Association Colloquium in Oslo in 2015. The paper uses a nonlinear optimization method with respect to three main variables: contribution rate, normal retirement age, and indexation rate of pensions. The paper's calculations are based on a normalization of projected demographic data regarding the European Union for the period 2013 to 2087. The projected demographics during this period

change significantly, as described in the paper (Ibid), and briefly summarized by the following indicators:

- The old-dependency ratio declines from 3.63 in 2013 to 1.93 by 2087;
- The median age of the population increases from 55 in 2013 to 64 by 2087;
- The shape of the population "pyramid" changes from having a single peak in 2013 at ages 40 to 50 to having no clear peaks in 2087.

The paper makes some interesting distinctions. It distinguishes between liquidity and solvency indicators. To be able to pay pensions in any year, a paygo SSRS must be liquid. However, regardless of maintaining liquidity in each year the SSRS may or may not be considered solvent. The paper applies a liquidity test, considering the availability of a buffer fund and without reference to such a fund.

The paper also distinguishes between an ABM that is applied symmetrically and one that is applied asymmetrically. In the symmetric case surpluses and deficits are allocated by the ABM. Whereas in the asymmetric ABM only deficits will trigger the ABM. Asymmetric ABM are more common in practice; undoubtedly because ABM have been developed as part of the solution for SSRS that are facing financial pressures.

The paper uses the term sustainability on many occasions. However, it appears to refer only to financial sustainability, so it is not using sustainability in the sense used in this paper. Godinez-Olivares et al. (2015) state that a successful paygo SSRS requires intergenerational solidarity, which they define as requiring the willingness of different groups of people to participate in a common pool, sharing actual experience, including any losses emerging. However, their modelling does not appear to incorporate a measure of willingness to participate. They do not test for intergenerational solidarity, which is an equity measure. As I have argued in this paper for a sustainable ABM both financial and equitable balance must be present.

We can see this point by examining the results of their numerical example and comparing the outcomes with the guiding principles set out herein. They base their calculations on an initial pension at retirement age of 55 per cent of last salary, which they state is in line with the average replacement rate in Europe. They report the contribution rate, retirement age, and indexation of pensions stabilize by the end of the period of analysis (2087) at 19 per cent, age 67.5 years, and minus 1 percent.

The ABM does relate directly the factors which affect inflows to factors which affect outflows. Contribution rate affects inflows, indexation rate affects outflows, and the retirement age affects both inflows and outflows. *The first guiding principle is satisfied.*

In assessing the equitable distribution of the burden of adjustment, the change in expected utility should be considered by class of participants. There is no recognition of the concept of expected utility in the paper. But let us consider the results to see if the burden of adjustment might be considered equitable.

With an annual rate of indexation of pensions of 1 per cent, after 35 years on pension, the pension would be equal to approximately 38 percent of last salary. In Statistics Canada (2010) it is reported that for a single individual in Canada general living expenses represent 38 percent of average household income, which for a pensioner would be last salary in the year of retirement. My calculations suggest that a comparable figure holds for the United States, approximately 39 percent; hence, this is a kind of indicator of minimum living standards for single individuals. For elderly pensioners annual reductions in pension would have a high level of expected disutility. Moreover, the annual salary growth rate for active workers is assumed to be 2.5 per cent. Hence those who had retired in previous years would be receiving disproportionately smaller pensions compared to new retirees, as shown in the last column of Table 3. It is hard to believe that older pensioners would consider the burden of adjustment to be equitable. *The second guiding principle is not satisfied.*

Table 3: Loss of Purchasing Power of Pensions Reduced 1% Annually

Years Since Retirement	Pension As % of Last Salary	Pension As % of Last Salary of New Retiree
5	52	46
15	47	32
25	43	23
35	39	16

The greater financial burden of adjustment should be borne by contributors rather than by pensioners. There is a considerable burden of adjustment borne by contributors. Over the projection period contributions increase from 15 percent to 19 percent, which is more than a 25 per cent increase. Moreover the retirement age also increases, which affects both contributors and prospective pensioners. However, as noted above the burden borne by older pensioners would be significant and possibly unbearable. I suggest that some minimum pension threshold be set, below which pensions would not be further reduced, e.g., 38 per cent of average final salary for new retirees. *It is not clear whether or not this guiding principle has been satisfied.*

The ABM should be able to restore balance without recourse to extra-systematic flows. The paper (Ibid) demonstrates that this is the case, both considering the presence or absence of a buffer fund. *This guiding principle is satisfied.*

Where approximations are used, the financial condition and equity of the SSRS should be reviewed periodically and adjustments made as warranted. The paper (Ibid) notes that there are many possible solutions to the optimization problem. Accordingly a number of ranges are set for the main variables, which suggests the use of approximations. The optimal path of the main

variables is derived in a static framework. As such, it is unlikely that economics and demographics will unfold as projected, so the values calculated are approximations. The authors note that an area for future research might be to calculate the optimal path of the variables in a dynamic scenario, e.g., recalculating the optimal path every few years and recalibrate the parameters. The authors do provide sensitivity analysis to support their work, so I conclude that *this guiding principle has been satisfied.*

In summary, the paper (Ibid) provides a demonstration of a robust financial ABM. It is capable of bringing about balance regardless of the demographic and economic changes. However, the ABM does not result in equitable balance. Given the burden of adjustment borne by pensioners I consider the equitable balance to be transitory. Nonetheless, if certain limitations were imposed, such as imposing a minimum threshold for the pension to be received, then this ABM has the potential to be robust with respect to equitable balance.

5.0 Conclusion

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. I recommend that expected utility of the affected cohorts be used in assessing the burden of adjustment. Because pensioners have little ability to absorb changes to their income, adjustments will have higher expected (dis)utility for them. Therefore I recommend that equity considerations require a greater burden of adjustment to be borne by contributors than by pensioners.

In Section 4 I examined a recent paper by Godinez-Olivares et al. (2015), which demonstrates how financial balance may be achieved. It provides an example of how an optimal adjustment from a financial perspective might not be considered sustainable based on equity considerations.

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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Appendix A – Overview of the Four Balancing Mechanisms

A1 - Canada

The Canada Pension Plan (CPP) is a defined benefit earnings-related pension plan, currently requiring contributions from employers and their employees, and from the self-employed, of

9.9% of covered earnings, in aggregate, which is approximately equal to, although slightly higher than, the steady-state contribution rate, determined over a 75 year horizon. The Canada Pension Plan Act (the "Act") contains a provision that has some similarities to an ABM. Briefly, this Act provides that if the actuary has recommended that the contribution rate be increased, which would occur if the contribution rate were less than the required steady-state contribution rate, and if the federal finance minister, after consultation with the provincial finance ministers, is not able to make a recommendation, then the following changes will occur: the contribution rate will increase by 50% of the increase recommended by the actuary; and the benefits will be frozen for three years, the time until the next actuary's report, by treating the cost-of-living adjustment factor as 1 so no increase in benefit is prescribed.

A2 – Germany

The Rurup Reform introduced two significant provisions to enhance the financial stability of the system. It provides for a gradual increase in the normal retirement age from 65 to 67 years, in monthly steps from 2011 to 2035. It also introduced a sustainability factor that is a part of the mechanism that modifies pension benefits in relation to the system dependency ratio.

The reforms have transformed a pay-go career-average defined benefit retirement insurance system that provided a high level of net income replacement, approximately 70%, to a worker who had earned average lifetime earnings and participated for 45 years to a design similar to a notional defined contribution (NDC) system. The "normal" pension is available at age 65 after 5 years of service. Benefits are computed on a lifetime basis and adjusted according to the type of pension and the retirement age, as follows:

$P_{t,i} = EP_i$ x SY_i x AF_i x PV_t

where in respect of pensioner i :

$P_{t\,i,}$ is the annual value of a pension in year t,

EP_i are earnings points expressed as a multiple of the average annual contribution in each historical working year,

AF_i is an adjustment factor that is 1 for the normal old-age pension,

PV_t represents the current pension value in year t and is the crucial link between workers' earnings and pensioners' benefits. It is indexed to the annual changes in the level of wages and salaries, net of pension contributions.

The mechanism follows the following formula:

$$PV_t = PV_{t-1}\left(\frac{AGI_{t-2}}{AGI_{t-3}}\right)\left(\frac{1-\delta_{t-2}-\tau_{t-2}}{1-\delta_{t-3}-\tau_{t-3}}\right)\left(\left(1-\frac{PQ_{t-2}}{PQ_{t-3}}\right)\alpha+1\right)$$

where PV_t, PV_{t-1} are current pension value in year t and year $t-1$ respectively

AGI_{t-2}, AGI_{t-3} represent average gross income in year $t-2$ and year $t-3$ respectively

δ_{t-2}, δ_{t-3} represent the assumed contribution rate to supplementary pensions in year $t-2$ and year $t-3$ respectively, which is gradually increased from 0.5% in 2003 to 4%, which is the ultimate level, in 2009 and thereafter

τ_{t-2}, τ_{t-3} represent the contribution rate to social security in year $t-2$ and year $t-3$ respectively

PQ_{t-2}, PQ_{t-3} represent the ratio of the number of pensioners to the sum of the number of contributors and the unemployed in year $t-2$ and year $t-3$ respectively

α is the sustainability parameter that is set (at least for some time) at 0.25, which shares the burden of the adjustment between pensioners and workers, but with a dampening impact for pensioners

A3 – Japan

Recognizing that an increasing ratio of pensioners to active workers increases the costs of a pay-go system and is de-stabilizing, Japan introduced an ABM that incorporates adjustments for the factors creating this increasing ratio. The ABM is a method of reducing earnings-related benefits from the Employees' Pension Insurance scheme until financial equilibrium is achieved. There are two prongs to the benefit reduction: the one adjusts the initial level of benefits earned by adjusting the factor for revaluing average earnings; the second adjusts the indexation of pensions being paid. However, the contribution rate remains fixed according to a set schedule.

In Japan's case, this increasing ratio of pensioners to active workers is attributable both to a declining active work force due to below replacement level fertility rates and to increased life expectancy. Thus the traditional adjustments, discussed in the foregoing paragraph, are modified by the rate of decline of active contributors. The traditional revaluation of earnings or indexation of benefits is modified by subtracting a modifier from the traditional increase factor. The modifier is equal to the rate of decline of active participants in social security pension schemes plus the yearly rate of increase in life expectancy at age 65. An approximation for the increase in life expectancy is used, namely a constant adjustment of 0.3 percent per year.

Should financial balance be achieved through the application of the ABM then the system reverts to indexation without the modifier.

A4 – Sweden

The Swedish SSRS requires a contribution of 16% is to the NDC part of the system. This contribution rate is fixed. The contributions are credited notionally to the account of the contributor. The credit is notional because benefits paid to pensioners are financed using contribution income and any contribution income that exceeds pension payments is deposited in a buffer fund which is invested.

At retirement, the contributor's notional account balance is used to purchase the contributor's initial pension. The pension is calculated using an annuity factor that incorporates a 1.6% per annum discount (interest) rate and a mortality factor that is reflective of the mortality improvement by cohort. Once pensions commence they are adjusted annually by the increase in the average wage per capita, the same rate that is used to adjust the notional accounts of contributors (taking into account the 1.6% discount factor already incorporated in the pension calculation). The postponement of the age of full benefit entitlement to reflect increases in life expectancy is one component of the mechanism to achieve balance.

There is another component of the system referred to as the automatic balance mechanism, which is based on a balance sheet. The total assets equal the contribution asset plus any assets in the buffer fund. The contribution asset is defined as one year's contributions multiplied by the expected turnover duration. The total pension liabilities of the NDC component are defined as the accumulated notional account balances of non-pensioners plus the sum over all pensioners of the product of their current pension times their remaining life expectancy.

To determine if there is financial balance, a balance ratio is calculated. The balance ratio is total assets divided by total pension liabilities. When the balance ratio is less than 1 then the automatic balance mechanism is triggered, affecting the credit to contributions and the indexation of pensions, in the next and subsequent years until financial balance is restored. After the automatic balance mechanism has been triggered and it is subsequently determined that the balance ratio exceeds 1 then indexing of pensions and crediting of (notional) interest to notional accounts continues at the product of the balance ratio and the rate of increase in average income until the pension liability attains the level it would have been at if indexing had been (continuously) at the rate of increase in the average income.