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Funding of Public Sector Pension Plans

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Abstract

Public sector pension plans in Canada have moved toward more risk sharing with plan participants. Economic literature indicates that well-designed intergenerational risk sharing within collectively funded pension plans can be welfare-enhancing vis-à-vis an individual benchmark based on optimal life-cycle savings and investments. In this paper, we examine the funding approach currently applied to defined benefit pension plans in Canada and find that it does not allocate the cost of pension benefits across different generations of stakeholders in an ex ante fair manner. This has prompted us to redesign the funding model to better address the issues of intergenerational equity and long-term sustainability related to public sector pension plans. The paper ends with a discussion on a number of issues that will have to be resolved to enable our proposed model to legally and effectively operate in Canada.

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1. Introduction

In Canada, 86 percent of employees employed in the public sector are covered by workplace pension plans of which 91 percent are participants of defined benefit (DB) pension plans.[1] In recent years, public sector pension plans have moved toward more risk sharing with plan participants. For example, several large public sector pension plans in Ontario are now organized as jointly sponsored pension plans (JSPPs),[2] under which gains or losses are shared by both employers (by drawing on government tax revenues, directly or indirectly) and plan participants. Inflation protection, used to be guaranteed, is gradually changed to be provided only to the extent the funding of the plan is determined to be sufficiently healthy. Other forms of risk sharing, such as the target benefit or shared-risk plan model, have also been introduced or proposed by the federal and provincial governments (Alberta, 2014; British Columbia, 2015; New Brunswick, 2015; House of Commons of Canada, 2016).

Against a background of low interest rates, higher stock market volatility and increasing longevity, plan trustees and those responsible for funding pension plans (the "funding entities"), in either the public or

[1] According to the latest available information from Statistics Canada as of October 2017.

[2] These include the Ontario Teachers' Pension Plan (OTPP), the Healthcare of Ontario Pension Plan (HOOPP), the Ontario Municipal Employees Retirement System (OMERS), the Colleges of Applied Arts and Technology Pension Plan (CAAT) and the OPSEU Pension Trust (OPT).

private sector, face many challenges in managing the current and future financial health of their pension plans. In the space of public sector pension plans, these challenges include:

- **Security.** How to ensure that the pension benefits promised to or targeted for employees are adequately protected?
- **Affordability.** How to ensure that the pension benefits are met with a reasonable level of costs that does not take financial resources away from other societal needs?
- **Intergenerational equity.** How to ensure that the cost of pension benefits is fairly distributed across different generations of taxpayers and/or employees?
- **Cost stability and predictability.** How to maintain a stable and predictable pension budget, without compromising the needs for security, affordability and intergenerational equity?

Typically, collective pension funds in Canada invest partly in fixed income assets and partly in equity (e.g., stocks) and other real assets. The risk premium from equity and other real assets, if realized, can help lower the cost of benefits and make the pension plan more affordable. However, fluctuations in market returns could lead to mismatch between the pension fund assets and liabilities. Consequently, contributions or benefits (or both) are often required to be adjusted as a function of the surplus or deficit of the plan.[3] Frequent contribution adjustments, however, would make it difficult for the funding entities to budget for their pension costs. Despite this potential drawback, it may still be desirable for public sector pension plans to invest in risky assets in anticipation of higher returns. Given their long-term nature, systematic investment risks can be shared among many generations during a long period of time. This inter-temporal risk smoothing, if properly designed and managed, can potentially enhance the welfare of the plan stakeholders (including taxpayers and employees.)

In this paper, we re-examine the Canadian regulatory funding framework for DB plans from a risk-sharing standpoint and find that it is not conducive to the fair allocation of pension costs across different generations of stakeholders. We then consider trade-offs between benefit security, cost stability as well as intergenerational equity within collectively funded pension plans, and propose a new funding model to better address the issue of intergenerational equity for public sector pension plans in Canada. Our model is designed based on the following concept: "The cost of pension benefits provided to a generation of participants should be funded, to the extent possible, over the service periods of that generation."

The balance of the paper is organized as follows. Section 2 provides an overview of the Canadian regulatory approach to assessing the funded status of a DB plan as well as the approach advocated by financial economists (the "financial economics" approach). Section 3 discusses the risk-sharing characteristics of collectively funded pension plans. Section 4 looks at the issue of intergenerational equity from several perspectives, and suggests a definition of it for the purpose of funding public sector pension plans. Section 5 evaluates the current Canadian funding approach from the standpoint of intergenerational equity. Section 6 proposes an alternative funding model with a focus on promoting intergenerational fairness. The model includes an explicit funding margin to mitigate discontinuity risk. Monte Carlo simulations are conducted on a model plan to demonstrate the potential funding outcomes

[3] A plan is said to have a deficit if the value of its assets falls short of the value of its liabilities (both values are determined based on a valuation of the plan). On the other hand, a plan is said to have a surplus if the value of its assets exceeds the value of its liabilities.

under the proposed funding model. Section 7 discusses a number of issues that need to be resolved to enable the proposed funding model to legally and effectively operate in Canada. Section 8 concludes.

2. Funding Assessment of DB plans

There are different approaches to assessing the funding position of a DB plan, which can produce different results in terms of costs and liabilities. In this section, we provide a brief summary of two funding approaches that are known to pension practitioners in Canada.

2.1 Canadian Regulatory Approach

In Canada, sponsors of employment-based DB plans have been required to fund their pension plans on both a going concern basis and a solvency basis. Pension standards legislation such as the Ontario Pension Benefits Regulation (Ontario, 2017) prescribes that the funding entity must contribute a minimum amount equal to the normal cost plus amortization of any unfunded liabilities every year. Both the normal cost and plan liabilities are determined based on the assumption that the plan would remain in place indefinitely. They are dependent on the actuarial cost method (also referred to as "funding method") used to allocate the cost of pension benefits to different periods of service. Additional contributions are required to be made if a solvency deficiency is determined to exist. A valuation based on solvency assumes that the plan terminates immediately and looks at whether it holds enough assets to pay out all benefits accrued to-date by the plan beneficiaries. The results of a solvency valuation are highly dependent on current market conditions. When interest rates are low and equity markets are volatile (the way they have been in recent years), they have the effect of increasing the obligations that must be borne by the funding entities.

Public sector pension plans in Canada are for the most part exempt from the volatile solvency funding requirement. In the meantime, there has been a move to reduce the volatility of contribution obligations for DB plan sponsors in the private sector as well. In 2016, Quebec passed a law to remove the requirement to fund DB plans on a solvency basis across the board (Quebec National Assembly, 2015). As a trade-off for eliminating the need for solvency funding, employers will have to put money in a stabilization reserve even when they have fully funded their plans on a going concern basis. It is intended that the reserve will help pension plans to better withstand future financial and demographic shocks. Ontario, the largest pension jurisdiction in Canada, has also introduced a new funding framework based on an enhanced going concern requirement while requiring funding on a solvency basis only if a plan's solvency funded status falls below 85 percent (Ministry of Finance, Ontario, 2017).

A noticeable feature of Canadian funding regulations is that the going concern funding requirement is invariably determined using a funding method called the unit credit cost method.[4] It will be argued that this is an inappropriate method for funding public sector pension plans as it would infringe the principle of intergenerational equity.

[4] This funding method falls into the family of benefit allocation methods. It may go by different names such as "traditional unit credit," "accrued benefit," "projected unit credit" and "projected benefit method prorated on service." A comprehensive treatise on funding methods can be found in *Pension Mathematics for Actuaries* (Anderson, 1992).

2.2 Financial Economics Approach

In the United States, there has been an ongoing controversy over what funding method and discount rate should be used to measure the funding obligations of DB plans.

Traditionally, actuaries in the United States have used (1) the entry age normal cost method[5] to allocate the cost of pension benefits and (2) a discount rate based on the expected rate of return on plan assets. On the other hand, financial economists have advocated for the application of financial economics principles (e.g., the law of one price) to pension finance (Joint AAA/SOA Task Force, 2006; Bartholomew, Gold, Pitts, & Pollack, 2016). They argue that DB plan obligations should be determined using (1) the traditional unit credit cost method, without the projection of future salaries, and (2) a discount rate based on the observed market yields on risk-free traded securities (e.g., U.S. Treasuries) that match the benefit cash flows in amount and timing but payment is assumed to be certain. They further argue that pension funds should be invested to hedge the accrued liabilities so as to facilitate the maintenance of full funding across time, minimize risk adjusted costs, and avoid potentially costly risk taking.

The funding measures advocated by financial economists are similar to the solvency normal cost and solvency liability stipulated in the Canadian funding standards.

3. Risk-Sharing Characteristics of Collectively Funded Pension Plans

In Canada, typical employment-based pension plans in the public sector are collectively funded and involve pooling of risks (e.g., investments, longevity) among stakeholders including taxpayers, current and future employees and/or retirees. Where there is a funding deficit arising from negative experience under a plan, it is met with an increase in the contributions from the employer (and participants if applicable), or a decrease in the benefits payable to participants if the law permits. The burden of deficit funding is typically spread over a number of years and is thus shared not only by current stakeholders but also by future stakeholders. On the other hand, a funding excess arising from positive plan experience could potentially benefit current and/or future stakeholders in the form of benefit improvements, contribution holidays or surplus refunds.

The long-term nature of public sector pension plans allows for smoothing of risks among many generations of stakeholders. Economic literature suggests that intergenerational risk sharing can yield welfare gains vis-à-vis an individual benchmark based on optimal life-cycle savings and investments from an ex ante perspective (Cui, Jong, & Ponds, 2011). Where a plan is free from the risk of winding up, it is optimal to diversity risk over as many generations and as many time periods as possible. In this way, financial and demographic shocks are smoothed out as broadly as possible across both individuals and periods so that each individual in each period is affected as little as possible. It is also worthy of note that plans that adjust both contributions and benefits, as a function of surplus or deficit, are better able to withstand risks (financial or demographic) than plans that allow for adjustments only in contributions or benefits.

In reality, there is a limit to the scope for intergenerational risk sharing. If a plan becomes seriously underfunded as a result of past adverse experience, today's taxpayers and/or young employees may voice

[5] This funding method falls into the family of cost allocation methods.

their concerns by exerting pressures to change the rules that force them to pay for the materialized deficits from the past. This political risk could jeopardize the sustainability of the plan.

4. How Is Intergenerational Equity Defined?

Where there is no sharing of risks as in individual defined contribution (DC) pension plans, the issue of equity would not normally arise as (1) the same rate of contributions is paid on account of each participant, and (2) the benefits received by participants are simply equal to what their contributions and accompanied investment earnings provide. Other types of pension plans normally involve a varying degree of risk pooling or sharing. Any deviation between the actual and expected plan experiences would give rise to either a gain or loss, which in turn would cause a change to the plan's funding requirement or a change in the benefits payable to participants or retirees. A contribution or benefit change made in response to a funding shortfall or excess is a form of risk sharing, which would not only affect the financial well-being of current stakeholders but could also affect future stakeholders. More pooling of risk would seem to contribute more to the risk of inequity, either intragenerational or intergenerational.

In the context of public sector pension plans, intergenerational equity can be looked at from more than one perspective (TheTerryGroup, 2015):

- **Government budget office.** The financial director may take the view that "taxpayers should be required to pay the same cost (as a percentage of pay) for pension benefits." As such, they may want to maintain a stable pension cost budget over time. If a large funding shortfall arises as a result of poor investment performance, the budget office may decide to cut future benefits for younger employees to make room for funding the cost of benefits accrued by older employees. This would seem to compromise intergenerational equity at the employee level.
- **Covered employees.** They (or their representing unions) may take the view that "employees who perform the same service should receive the same pension benefits, regardless of when they are employed." While individual equity is achieved among employees, equity between today's and future taxpayers may be in question. Rising taxes to fund promised benefits as a result of unfavorable plan experience could impair taxpayer equity.
- **Advocates for other public services.** The pension benefit accrued by an employee is not paid until some time in the future. As a consequence, taxpayers may not want to fully pay the cost of pension benefits earned by public employees, especially if doing so means cutting back on other vital services such as health care or education. This would tend to shift a portion of the costs of public services[6] received by today's taxpayers to future generations of taxpayers. Furthermore, absence of advance funding could impair the security of benefits promised to employees.

For the purpose of exploring the issue of intergenerational equity, we define a generation of participants in a plan as a group of employees who join the plan within a specific time frame, say, a calendar year after the plan inception. Employees who joined the plan in the year of plan inception are grouped together as the initial generation. In the context of funding a pension plan, one intuitive definition of intergenerational equity might be as follows: "The cost of pension benefits provided to a generation of participants should be funded over the service periods of that generation." However, there are some

[6] Public employees' pension benefits are a part of the costs of public services.

complexities in applying this seemingly simple concept to pension plans where there is a significant degree of risk pooling across overlapping generations of participants.

The first issue is how to attribute the cost of future benefits to different periods of service. Different funding methods (i.e., actuarial cost methods) produce different cost patterns over an employee's career. Which one is more suitable for use with public sector pension plans?

The second issue is how to determine the cost of future benefits. We need to make assumptions about employees' future life spans (before and after retirement), future salary growth and/or inflation with respect to benefits that are adjusted according to wage or price inflation. Furthermore, we need to discount the projected benefit cash flows to the present. Due to the uncertain nature of these assumptions, the calculated cost is always an estimate. If we use overly conservative assumptions, we may overestimate the cost; the current generation of taxpayers may likely overpay and, in effect, transfer wealth to a future generation. If we use overly optimistic assumptions, the current generation may underpay and, in effect, transfer a financial burden to a future generation.

This brings us to the third issue. More often than not, the assumptions used to determine the cost of future benefits will not be exactly realized in the future. To the extent that the actual experience deviates from the expected experience, a gain or loss will arise. Should such a gain or loss be fully and immediately reflected in the cost to be paid by today's taxpayers (and/or covered employees if applicable), or should it be spread over a number of years and shared with future taxpayers? How would a particular amortization method of gains and losses impact the financial well-being of different generations of stakeholders?

5. Issues with the Canadian Approach to Funding Public Sector Pension Plans

Most public sector pension plans in Canada are prefunded DB arrangements that are complementary to the nation's social security system. The sponsoring entities and, in many instances, the covered employees, are required to contribute toward the cost of pension benefits as those benefits are accrued.

5.1 Funding Method

The funding requirements under Canadian pension legislation are typically drafted based on the unit credit cost method (the "UC method"). This method defines:

- A **normal cost**, being the present value of retirement and other benefits[7] accrued by participants in the year following the valuation date
- An **accrued** or **actuarial liability,** being the present value of retirement and other benefits accrued by participants, pensioners and other beneficiaries for service up to the valuation date

As noted in Section 2, financial economists also propose to allocate the cost of pension benefits using the UC method, but the benefits are computed without the projection of future salaries even if the benefits are salary-related.

[7] Projected with future salary growth, if applicable.

A DB pension plan typically provides a uniform benefit accrual rate with respect to service. Under the UC method, the normal cost for a participant would increase with the age of the participant. The normal cost of a plan is the sum of the normal costs for all participants in the plan, which is typically expressed as a fixed rate per participant (in either dollar amount or percentage of pay). This fixed rate would be the contribution rate applied to every participant in the plan for current service accruals. Clearly, the rate is higher than the UC normal cost rate for young participants and lower than that for older participants.

The contribution rate developed under the UC method has the effect of passing the buck to future generations of taxpayers. The taxpayers' funding burden against employees' current service accruals would increase with the passage of time. Appendix A shows how the funding burden related to participants' benefits is shifted from the present to the future.

To limit the shifting of costs from today's taxpayers to future taxpayers, we contend that the pension benefits provided to each generation of participants should be funded over the service periods of the participants in that generation, by either a level dollar amount or a level percentage of pay (as the case may be). A level cost method such as the entry age normal cost method would serve to achieve this purpose.

5.2 Discount Rate

Another contentious issue regarding the funding of public sector pension plans is what discount rate should be used to calculate the cost of pension benefits. The choice of the discount rate has a material impact on the calculated cost values. For the purpose of a going concern valuation, actuaries have traditionally used a discount rate that includes an expected additional return from equity and other risky investments (the "expected return" discount rate). On the other hand, financial economists have advocated that DB plan obligations should be valued using a discount rate based on the market yields on safe assets[8] (the "risk-free" discount rate). Either approach is acceptable in Canada, but it is more common for actuaries to calculate the plan's funding obligations using the expected return discount rate (Canadian Institute of Actuaries, 2015).

While the use of a risk-free discount rate would provide a market value proxy for participants' accrued pension rights, it is not suitable for determining the cost of pension benefits for funding purposes. Public sector pension plans are entities that are designed to exist for the long term. The contributions made to fund the pension benefits are typically invested in a portfolio of assets, which include equity and other risky assets. Regardless of which discount rate is used to measure the plan obligations, there will always be a mismatch in values between the plan's assets and liabilities. To keep a DB plan in financial balance, the contribution rate will need to be adjusted periodically to absorb any surplus or deficit. We will show that using the expected return discount rate (based on the *median* expectation about future fund returns[9]), in combination with a properly designed amortization rule for surpluses and deficits, will add to intergenerational equity, while the use of a risk-free discount rate will not.

In Appendix A, we apply both discount rate assumptions to a model DB plan and project the funding outcomes by Monte Carlo simulations. As the risk-free discount rate does not reflect the risk premium that the pension fund can expect to earn, taxpayers are required to pay contributions at a higher level

[8] For example, long government bonds

[9] The return, which is estimated to be realizable 50 percent of the time

upfront. As experience unfolds later, the reserve buildup through higher contributions might likely turn out to be too large. Excess reserve would then be released from the pension fund via contribution holidays or surplus refunds.[10] This appears to contravene the principle of intergenerational equity, as today's taxpayers are forced to pay more to the potential benefit of future taxpayers. Use of the expected return discount rate would avoid this ex ante unfair outcome.

5.3 Amortization Method

Mismatch between assets and liabilities would give rise to either a surplus or deficit. Under Canadian pension legislation, any deficit reported in a regulatory filing for a DB plan must be amortized by means of a level annual dollar amount or percentage of pay, over a period of not more than 15 years. However, a surplus up to a certain limit may be retained in the plan (or used to improve benefits) and needs not be amortized as in the case of a deficit.

In a public sector DB plan where participants' benefits are predefined while the contributions made to fund the benefits are adjustable, the taxpayers would bear the funding risk. If the contributions currently being paid are adjusted to fully absorb any deficit or surplus, no part of the funding imbalance would be shifted to future taxpayers but contributions could fluctuate markedly from year to year. On the other hand, if deficit and surplus are both amortized over a long time period, part of the funding imbalance would be absorbed by future taxpayers. Variability of contributions would be less pronounced, but a portion of the surplus or deficit would remain unamortized until some time in the future.

In a target benefit plan where contributions are predefined (CIA, 2015), participants would bear the funding risk through adjustments to their benefits. In a JSPP, the employer(s) and participants are jointly responsible for correcting any funding imbalance through adjustments to contributions and/or benefits.

The choice of an amortization method would affect the variability of contributions (or benefit payments). The longer the amortization period, the more gradual will be the adjustments to the contributions (or benefit payments) and the greater the tendency of a transfer of funding burden (i.e., deficits) or wealth (i.e., surpluses) to future generations of stakeholders. The future funded status of the plan would vary over a wider range relative to that resulting from a shorter period of amortization.

Another issue to be considered is the manner by which surplus and deficit are amortized. If surplus and deficit are amortized in separate and different ways (e.g., surplus is immediately recognized whereas deficit is spread over an extended period), the equity balance between different generations of stakeholders might potentially be upset.

In Appendix A, we apply several amortization periods to a model DB plan and show how they might impact the distributions of future contribution rates.

6. Design of a Funding Model for Public Sector Pension Plans

In the financial management of a pension plan, the trustees may be given multiple mandates, which could include (1) benefit security, (2) cost affordability, (3) intergenerational equity and (4) contribution (or

[10] Assume that there is no legal barrier.

benefit) stability. These mandates do not always align with each other. For instance, measures taken to strengthen the security of benefits (e.g., use of conservative assumptions, immediate funding of deficits, buildup of a solvency reserve, taking less investment risk) could adversely affect the fulfillment of the other mandates. A key challenge is to design a funding model that would enable the trustees to manage these competing goals, in the light of the stakeholders' needs.

6.1 Design Considerations

Generally speaking, the government as a sponsor of public sector pension plans has the power to tax and the ability to survive the ups and downs of the business cycle. As such, public sector employers tend to be less concerned with insolvency risk[11] than their private sector counterparts and can follow a long-term approach in funding their pension plans. Given the trend toward more risk sharing within the public sector space, a greater emphasis should be placed on the fair allocation of pension costs (or benefits) among different generations of stakeholders than to the protection of participants' accrued pension rights in the event of employer insolvency.

For plans with an adopted investment policy that reflects the risk plan stakeholders can bear, we design a funding model based on the following three considerations:

1. Intergenerational equity
2. Contribution (or benefit) stability
3. Benefit security

We have excluded cost affordability from our deliberation, as we believe that it should be considered separately in conjunction with the retirement income goal of and the investment risk assumed by the plan.

6.2 Intergenerational Equity

As discussed in Section 5, ex ante intergenerational equity can be achieved by adopting the funding approach described here.

Funding Method. Use of a funding method to allocate the cost of pension benefits over the service periods of plan participants such that the allocated costs are as level as possible.

- The *aggregate entry age normal* cost method (Anderson, 1992) is appropriate for this purpose. Under this method, a target normal cost rate is defined for the plan based on the representative attributes (e.g., gender, entry age, salary) of new entrants. The accrued liability for participants who are accruing pension benefits is calculated as the present value of their future benefits less the present value of their future contributions based on the target normal cost rate. The accrued liability for pensioners and other beneficiaries is calculated as the present value of the pension benefits payable to them.

Discount Rate. Use of the expected rate of return on plan assets as the discount rate.

- Contrary to the position taken by financial economists, we argue that there is a direct connection between how much is required to pay for the cost of pension benefits and what pension fund assets will earn. The higher the realized return from pension fund investments, the lower will be the contributions required. Thus a discount rate based on the expected return on plan assets

[11] It is noted however that there have been instances of municipal bankruptcies in the United States (e.g., the city of Detroit), putting additional financial strains on their already underfunded pension systems.

should be used to estimate the cost of pension benefits for funding purposes. Doing so would avoid ex ante unfair distributions of contributions[12] across different generations of stakeholders.

Amortization Method. Use of the expected average remaining service or lifetime as the amortization period.

- In a plan where only contributions are adjustable, it is reasonable to amortize any surplus or deficit through contribution adjustments over the future service periods of the participants who are currently in the plan.[13] This would moderate the fluctuations in contributions relative to shorter periods of amortization while limiting the transfer of past deficits or surpluses to future generations of taxpayers.
- If only pensions in pay are adjustable, it is reasonable to amortize any deficit or surplus through pension adjustments over the future lifetimes of the individuals who are in receipt of a pension.

6.3 Funding Outcomes—An Illustration

To gain some insights into the impacts of the funding approach described in Section 6.2, we apply it to the model plan described in Appendix B together with the risk-sharing mechanisms described in Table 1, and simulate the future funding outcomes in terms of contribution rates, pension payments and funded ratios.[14]

Table 1. Risk Sharing Mechanisms

Risk Sharing Mechanism	Description
RS1	Funding imbalance is absorbed by adjusting the contribution rate to be paid on account of the current participants in the plan, over their expected future service periods
RS2	Funding imbalance is absorbed by adjusting the pension payment to the current pensioners, over their expected future lifetimes
RS3	Funding imbalance is absorbed by adjusting the contribution rate (as in RS1) and pension payment (as in RS2) simultaneously, on a 50/50 basis
RS4	Same as RS3, but the adjustment is limited to not more than 15% (either upside or downside) of the target contribution rate or target pension payment

Figures 1(a), (b) and (c) show the percentile distributions (5%, 25%, 50%, 75%, 95%) of funding outcomes over the projection period.

[12] Or benefits, in the case of a plan where the benefits payable to participants are adjustable according to the plan experience

[13] This is also consistent with one of the recommendations by a Blue Ribbon Panel commissioned by the Society of Actuaries. (Society of Actuaries, 2014)

[14] The funded ratio of a plan is the ratio of plan assets to liabilities (however calculated), which is a measure of the financial status of the plan.

Figure 1(a). Distribution of Contribution Rate per Participant

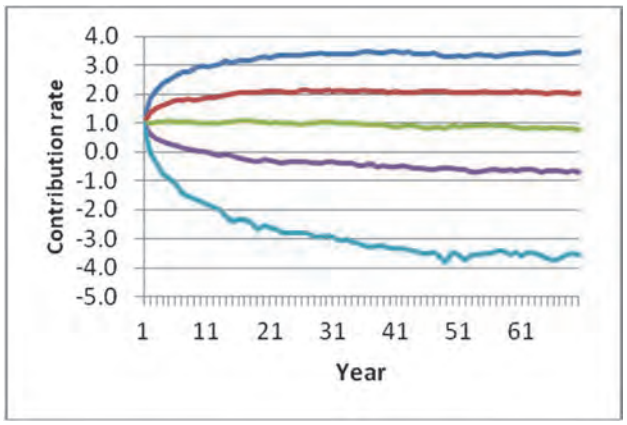
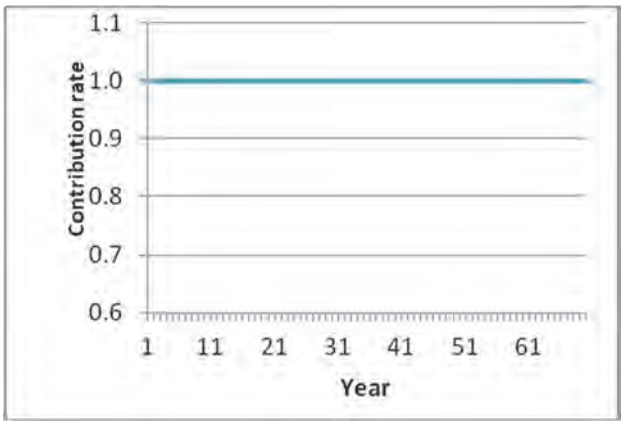
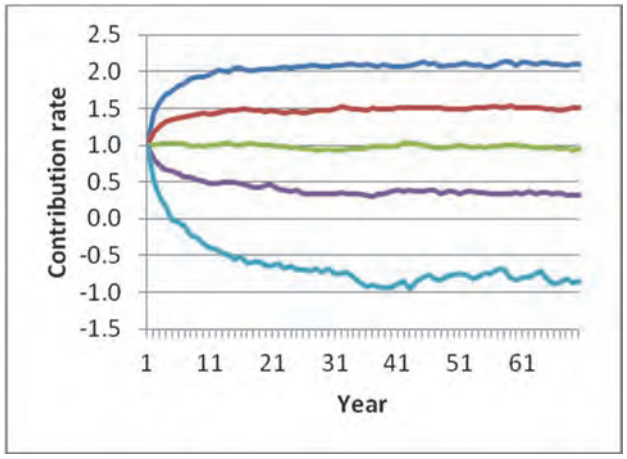
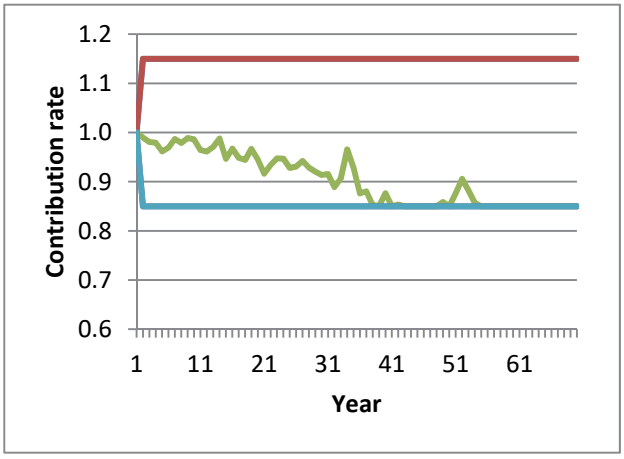
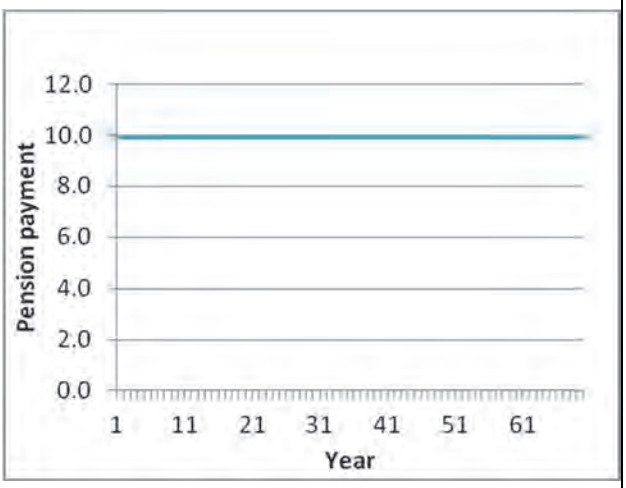
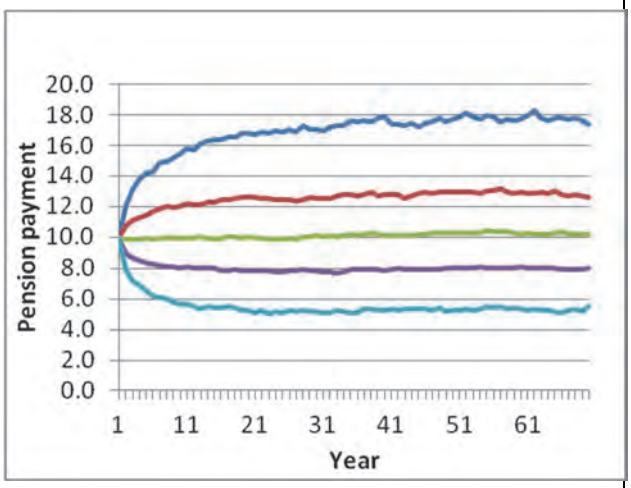
RS1	RS2
	
RS3	**RS4**
	

Figure 1(b). Distribution of Pension Payment per Pensioner

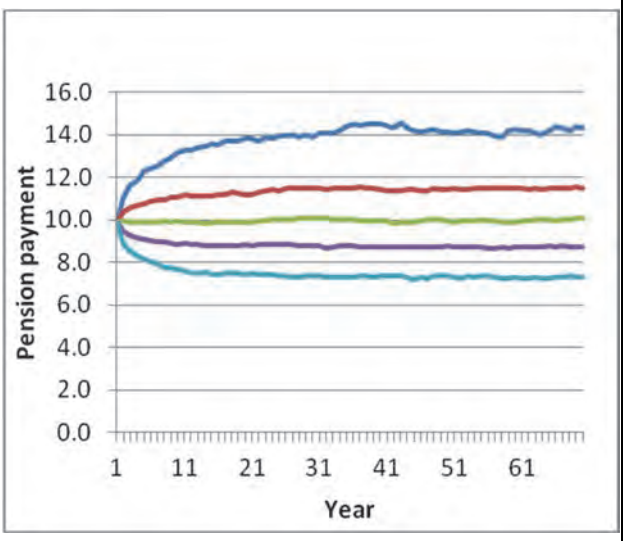
RS1



RS2



RS3



RS4

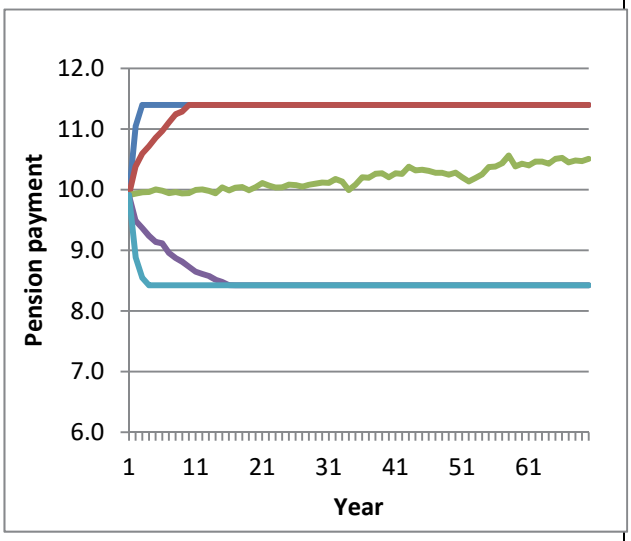
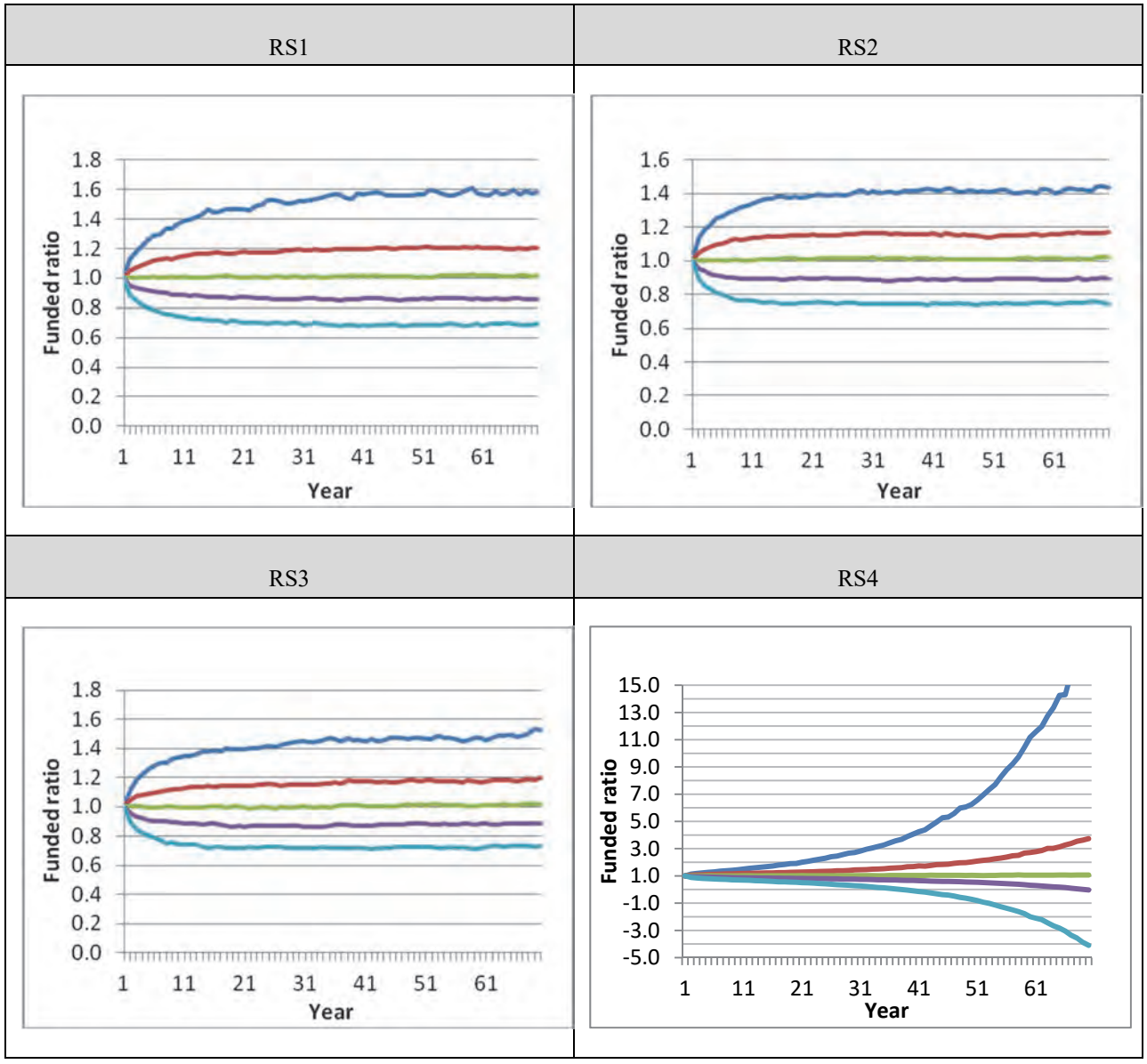


Figure 1(c). Distribution of Funded Ratio



Under RS1, RS2 and RS3, the *median* funding outcomes are all close to the target level, but there could be a large variance between the actual and target outcomes at a future point in time. Risk-sharing mechanism RS3 requires the funding imbalance be borne by both active participants and retirees, and thus allocates risks over a broader base than RS1 and RS2. As a consequence, the contribution rate range under RS3 is narrower than that under RS1, and the pension payment range under RS3 is narrower than that under RS2.

The extent to which contribution rates or pension payments vary could be confined via policy such as RS4, but the application of policy boundaries could lead to very different funding outcomes. As shown in Table 2, the distribution of contribution rate or pension payment under RS4 has clusters at the lower

bound (85% of target) and the upper bound (115% of target). In contrast, the corresponding distributions under RS3 extend beyond the policy bounds of RS4 and are more or less symmetrical.[15]

Table 2. Distribution of Contribution Rate and Pension Payment Under RS4

Contribution Rate Range	Percent Frequency (%) Distribution of Contribution Rate				
	Year 5	Year 10	Year 20	Year 40	Year 60
0.85–0.90	44.9	46.3	48.9	50.6	51.2
0.90–0.95	4.2	2.2	1.3	0.8	0.7
0.95–1.00	3.4	2.5	2.0	1.2	0.8
1.00–1.05	3.8	2.4	1.9	1.2	0.6
1.05–1.10	3.5	2.6	1.2	1.4	1.0
1.10–1.15	40.3	44.1	44.8	44.9	45.9
All	100.0	100.0	100.0	100.0	100.0

Pension Payment Range	Percent Frequency (%) Distribution of Pension Payment				
	Year 5	Year 10	Year 20	Year 40	Year 60
8.0–8.5	11.1	21.1	28.4	35.6	38.7
8.5–9.0	10.4	9.3	7.2	3.5	2.9
9.0–9.5	13.6	10.3	6.8	4.2	3.2
9.5–10.0	14.9	10.4	7.0	5.1	3.4
10.0–10.5	16.1	9.0	6.8	4.2	2.2
10.5–11.0	12.1	8.1	6.2	3.8	1.9
11.0–11.5	22.0	32.1	37.7	43.8	48.0
All	100.0	100.0	100.0	100.0	100.0

Furthermore, the distribution of funded ratio under RS4 is expected to expand over time. It could reach extreme levels (either upside or downside) in later years with the possibility of ruins (as the pension fund runs out of money, i.e., when the funded ratio becomes negative). In contrast, the funded ratio under RS3 falls within a relatively uniform range after 35 years or so and does not fall below 0.7 in most times (to be specific, 95% of the time).

6.4 Sustainability

While ex ante intergenerational equity can be achieved by adopting the funding approach described in Section 6.2, some generations may be worse off from an ex post perspective if they inherit a material

[15] In fact, the distribution of contribution rate (pension payment) under RS3 is somewhat left (right)-skewed. This asymmetry is due to the effect on contribution or benefit adjustment associated with investment gains (relative to the discount rate) being greater than that associated with investment losses.

deficit from previous generations as a result of an adverse shock (financial or demographic) in the past. Serious underfunding could potentially endanger the sustainability of the plan, as in such situations future taxpayers or employees may not want to commit to or participate in the plan (Bovenberg & Mehlokopf, 2014). To mitigate this risk, the trustees may undertake measures to limit the size of deficits transferred from older to younger generations.

We show by example how a funding buffer can be put in place to reduce the downside risk. Consider the model plan with risk-sharing mechanism RS3 (see Section 6.3). Table 3 shows the distributions of projected funded ratios at selected years, based on a funded ratio of 1.0 at the valuation date (referred to hereinafter as the "starting funded ratio" or FR0).

Table 3. Distribution of Funded Ratio, FR0 = 1.0

Percentile Distribution	Projected Funded Ratio at End of Year			
	5	10	15	EARSL = 18
95%	1.269	1.345	1.392	1.411
75%	1.109	1.126	1.148	1.148
50%	1.000	0.996	1.003	0.996
25%	0.903	0.885	0.874	0.871
5%	0.784	0.736	0.724	0.720

For a given projection period, we set the minimum funded ratio to be reached at the end of the period (the "target funded ratio") together with a success probability. We calculate the amount of funding shortfall based on the target funded ratio and discount it to the present using the funding discount rate. The discounted value is taken as the "value at risk," which is spread equally among all active participants in the plan and amortized over the indicated period by means of an additional contribution to be paid on account of each participant (the "contribution margin"). Table 4 shows the results for selected target funded ratios in combination with a success probability of 95 percent. For each target funded ratio, the contribution margin varies according to the length of the projection period. Generally speaking, the longer the period, the smaller is the required contribution margin.[16]

Table 4. Contribution Margin

Target Funded Ratio = 1.00				
Year to which funded ratio is projected	5	10	15	18
Projected funded ratio at the 5th percentile	0.784	0.736	0.724	0.720
Projected funding shortfall[17]	61,326	75,027	78,345	79,631
Value at risk	46,337	42,833	33,795	29,033
Contribution margin	2.95	1.55	0.93	0.71
Target Funded Ratio = 0.90				
Year to which funded ratio is projected	5	10	15	18

[16] With one exception—see the bottom panel of Table 4

[17] Calculated based on the target liability of $284,100

Projected funded ratio at the 5th percentile	0.784	0.736	0.724	0.720
Projected funding shortfall	32916	46617	49935	51221
Value at risk	24871	26614	21540	18675
Contribution margin	1.58	0.97	0.59	0.46
Target Funded Ratio = 0.80				
Year to which funded ratio is projected	5	10	15	18
Projected funded ratio at the 5th percentile	0.784	0.736	0.724	0.720
Projected funding shortfall	4506	18207	21525	22812
Value at risk	3405	10394	9285	8317
Contribution margin	0.22	0.38	0.25	0.20

It is reasonable to limit the funding shortfall that may potentially exist when the current participants cease employment. To this end, we suggest to use the expected average remaining service life for the current participants (EARSL) as the projection period for determining a contribution margin. To ensure that the plan's funded ratio is not less than 0.9 at the end of EARSL (18 years) with a probability of 95%, we see from Table 4 that a contribution margin of 0.46 (over and above the target contribution rate of 1.0) is needed.

Clearly, the setting of a contribution margin for a plan should take into account the desired level of benefit security (in terms of *minimum* funded ratio to be reached at a certain level of confidence) as well as the level of contributions the funding entity can afford to pay.

6.5 Overfunded or Underfunded Plan

The distributions of funded ratios shown in Table 4 were derived based on a starting funded ratio of 1.0. Different starting funding positions (before any contribution or benefit adjustments to restore financial balance) would lead to different distributions of funded ratios over time, as illustrated in Table 5.

Table 5. Distribution of Funded Ratio, FR0 = 0.9 & 1.1

	FR0 = 0.9				**FR0 = 1.1**			
Percentile Distribution	**Projected Funded Ratio at End of Year**				**Projected Funded Ratio at End of Year**			
	5	**10**	**15**	**EARSL = 18**	**5**	**10**	**15**	**EARSL = 18**
95%	1.178	1.292	1.345	1.386	1.358	1.440	1.456	1.475
75%	1.021	1.071	1.110	1.112	1.187	1.200	1.200	1.199
50%	0.929	0.949	0.968	0.971	1.079	1.065	1.056	1.050
25%	0.841	0.843	0.842	0.853	0.982	0.946	0.931	0.916
5%	0.736	0.720	0.709	0.703	0.850	0.789	0.763	0.753

When the funded ratio starts at 0.9 (1.1), the range of funded ratios is upward (downward) sloping over time and stays below (above) that resulted from FR0 of 1.0 (see Table 4 and Table 5). With a target funded ratio of 0.9 at the end of EARSL and a success probability of 95%, the contribution margins for

FR0 of 0.9 and 1.1 are determined to be 0.50 and 0.37, respectively, which compare to 0.46 for FR0 of 1.0. As can be seen, the contribution margin varies according to the starting funding position of the plan; the lower the starting funded ratio, the higher the contribution margin needed.

The contribution margin to be paid each year is not a static amount. Rather, it is to be determined at each valuation date based on the then funded ratio of the plan.

6.6 The Proposed Model

Based on the foregoing analysis, we propose a funding model with the following key features. The model can be applied to assess and manage the funded status of a public sector pension plan, with either adjustable contribution rates or adjustable benefits, or both.

a. Actuarial valuations to assess the funded status of a plan are performed periodically (e.g., annual or triennial).

b. A *target normal cost* rate is determined for the plan, using the *aggregate entry age normal* cost method and based on the representative profile of new entrants to the plan. If a plan provides a salary-related pension benefit, the target normal cost rate (as a percentage of salary) is determined by the following formula:

$$U = \frac{\sum_N PVFB_e^j}{\sum_N PVFS_e^j} \tag{1}$$

where N is a representative set of new entrants, j is any individual in N, $PVFB_e^j$ is the present value of future benefits (promised or targeted by the plan) for j calculated at j's entry age e, and $PVFS_e^j$ is the present value of future salaries for j calculated at j's entry age e.

The set N and rate U should be updated to reflect any material shift in the entry profile of plan participants over time.

The contribution rate to be paid on account of each active participant is the target normal cost rate, with adjustments to reflect any emerging plan experience pursuant to the plan's risk-sharing policy; see paragraph (h) below.

c. The plan's *funding target* at a valuation date is determined by reference to the benefits provided under the plan (either promised or targeted) and the target normal cost rate described earlier in paragraph (b).

The accrued liability for pensioners and other beneficiaries is calculated as the present value of their accrued benefits. The accrued liability for participants who are accruing pension benefits is calculated as the present value of their future benefits less the present value of their future contributions based on the target normal cost rate. In formula, it can be expressed as follows:

$$AL_t^a = \sum_{A_t} PVFB_t^j - U \sum_{A_t} PVFS_t^j \tag{2}$$

where t is the time of valuation, A_t is the set of participants who are accruing pension benefits at time t, $PVFB_t^j$ is the present value of future benefits for individual j calculated as at time t, and $PVFS_t^j$ is the present value of future salaries for j calculated as at time t. The total of these accrued liabilities represents the plan's funding target at the valuation date that is to be met by plan assets.

d. A discount rate based on the expected long-term return on plan assets is used to calculate the target normal cost rate and the accrued liabilities described previously. Other assumptions used in the valuation reflect best estimate plan experience. To provide an "actuarially fair" representation of the financial position of the plan, no margins should be included in the setting of assumptions.

e. If the pension benefits provided under the plan are adjustable based on the funding level of the plan, they should be adjusted according to the plan's risk-sharing policy.

f. The financial position of the plan at the valuation date, before the application of any balancing measures (see paragraph (h)), is presented as an actuarial balance sheet similar to that described in (Ma, 2017). We have omitted the entry of contribution asset (CA_t) contained therein as only participants who are in the plan at the valuation date are included for the purpose of the valuation.[18] This obviates the need for making an assumption about future new entrants.

Table 6. Actuarial Balance Sheet Before Application of Balancing Measures

Assets	**Liabilities**
Fund assets (F_t)	Liability for pensioners and other inactive participants (AL_t^r)
	Past service liability for active participants (PSL_t^a)
Accumulated deficit (surplus) (D_t)	Future service liability for active participants (FSL_t^a)
Total assets	**Total liabilities**

All entries in Table 6 are as those defined in Section 4.2 of *An Actuarial Balance Sheet Approach to Assessing Sustainability of Target Benefit Plans* (Ma, 2017):

- F_t is the fair value of the financial and real assets held in the pension fund at time t
- AL_t^r is the present value of the pension benefits payable to pensioners and other inactive participants at time t
- PSL_t^a is the present value of accrued benefits for active participants at time t
- FSL_t^a is the difference between the present value of benefits expected to accrue for service after time t and the present value of future contributions based on the target normal cost rate
- D_t is defined as $(AL_t^r + PSL_t^a + FSL_t^a) - (F_t + CA_t)$; a negative value of D_t means that the plan is in surplus

The sum of PSL_t^a and FSL_t^a is equal to the AL_t^a defined by Equation (2).

[18] The rationale for omitting the entry of contribution asset is as follows. The contribution rate expected to be paid on account of future plan participants is set equal to the target normal cost rate. As such, the contribution asset would be a zero entry.

In addition, we define the balance ratio[19] of the plan at time t as follows:

$$BR_t \equiv \frac{F_t}{AL_t^r + PSL_t^a + FSL_t^a} \tag{3}$$

The balance ratio provides an indication of the financial status of the plan, based on the plan's target normal cost rate. If $BR_t = 1$, the plan is deemed to be in financial balance and no adjustments to contributions or benefits would be necessary.

g. Where a balancing measure(s) is applied, the actuarial balance sheet should be restated to reflect its impact on the financial balance of the plan. For clarity, the following entries are included in the actuarial balance sheet displayed in Table 7:
   i. The effect of a contribution rate adjustment would be reflected as a *contribution asset* on the assets side (denoted as CA_t), being the difference (positive or negative) between the present value of future contributions for current active participants based on the adjusted contribution rate and that based on the target normal cost rate
   ii. The effect of benefit adjustments would be reflected as a *liability adjustment* (separately for each category of participants where applicable) on the liabilities side (denoted as ΔL_t^r and ΔL_t^a), being the difference between the present values of participants' benefits before and after adjustments

Table 7. Actuarial Balance Sheet After Application of Balancing Measures

Assets	**Liabilities**
Fund assets ($\boldsymbol{F_t}$)	Liability for pensioners and other inactive participants (AL_t^r)
Contribution asset ($\boldsymbol{CA_t}$)	Past service liability for active participants (PSL_t^a)
	Future service liability for active participants (FSL_t^a)
	Liability adjustment in respect of pensioners and other participants (ΔL_t^r)
Accumulated deficit (surplus) ($\boldsymbol{D_t'}$)	Liability adjustment in respect of active participants (ΔL_t^a)
Total assets	**Total liabilities**

The accumulated deficit (D_t') in Table 7 and the balance ratio (BR_t') of the plan are defined, respectively, as follows:

$$D_t' \equiv (AL_t^r + PSL_t^a + FSL_t^a + \Delta L_t^r + \Delta L_t^a) - (F_t + CA_t) \tag{4}$$

$$BR_t' \equiv \frac{F_t + CA_t}{AL_t^r + PSL_t^a + FSL_t^a + \Delta L_t^r + \Delta L_t^a} \tag{5}$$

[19] We have substituted the name of "balance ratio" for "funded ratio" referred to hereinbefore, in order to avoid potential misinterpretations of the latter term. Under our proposed funding model, the fact that the balance ratio of a plan is 1.0 means that the plan's financial resources (i.e., fund assets plus future contributions) are expected to be sufficient to meet the plan's obligations 50 percent of the time.

h. The plan is required to adopt a risk-sharing policy that sets out the triggers for actions to address any financial imbalance (i.e., when the balance ratio deviates significantly from 1.0) as well as the measures to be taken. Different measures can be applied to restore a plan's financial balance; they are collectively referred to as automatic balance mechanism (ABM). Following is a sample design of risk-sharing policy.

Example
Consider a plan whose membership at time t comprises of both active participants and pensioners. Balancing measures will be triggered if the balance ratio of the plan, BR_t, falls outside the interval (0.95, 1.05). Where balancing actions are triggered, the accumulated deficit or surplus (i.e., D_t in Table 6) is first allocated between the active participants and pensioners in proportion to their accrued liabilities at time t. The portion allocated to the active participants, i.e., $D_t^a = D_t \cdot \left(\frac{AL_t^a}{AL_t^a + AL_t^r}\right)$, is amortized by means of an adjustment to the contribution rate to be paid on account of the active participants over their expected remaining service periods. The portion allocated to the pensioners, $D_t^r = D_t \cdot \left(\frac{AL_t^r}{AL_t^a + AL_t^r}\right)$, is amortized by means of a proportionate adjustment to the pensions payable to the pensioners over their expected future lifetimes. Adjustments made to the contribution rate and pension payments are to be redetermined at each valuation date based on the accumulated deficit or surplus then exists.

i. To limit the size of funding deficits (if materialized) transferred from older to younger generations, the funding entity is required to make an extra contribution, over and above the contribution rate determined in accordance with paragraph (b) earlier, for each active participant in the plan. This contribution margin is dynamic in nature. It is to be determined at each valuation date in a manner such that the balance ratio of the plan is projected to reach a certain target level (e.g., 0.9) at the end of the expected average remaining service period for the current participants, with a specified level of confidence (say, 95%); see Sections 6.4 and 6.5.

The contribution margin will form a part of the fund assets once it is paid into the pension fund.

7. Implementation Issues in Canada

We have proposed a funding model for public sector pension plans that, in our view, is more balanced than the existing funding approaches from a risk-sharing standpoint. In this section, we consider a number of issues that will have to be resolved to enable the model to legally and effectively operate in Canada. These issues are grouped under the following two headings:

- Legislative/regulatory considerations
- Policy considerations

7.1 Legislative/Regulatory Considerations

a. Definition of Public Sector

The funding model is being proposed for public sector pension plans in Canada. However, which pension plans are considered to be in the public sector domain is less than clear. Traditionally, the linkage has been based on direct or indirect government funding to and sponsorship of these plans. However, these traditional linkages have evolved and will continue to evolve over time. The legislation should provide a clear definition of the application boundaries.

b. Plan Design

A possible design feature of a shared-risk plan is that any funding deficit or surplus could be shared between the employer(s) and the active participants as well as the retirees. Pension standards legislation should allow for some flexibility in determining the contribution rate and benefit payments for such a plan. For example, if a plan is underfunded, increasing employer contributions should not be legislatively required. Instead, the legislation should permit the deficit to be met by either an increase in contributions or a reduction in benefits.

The plan text should be required to clearly set out whether employer (and employee) contributions are fixed at a predetermined level or are allowed to increase to repair any funding deficit. Likewise, the plan text should clearly specify whether benefit reductions are permissible and how they will be applied. The legislation should permit a plan to adopt different benefit reduction profiles in the plan text, for example, providing more benefit protection to older or lower income pensioners.

The plan text should also deal with surplus situations. It should specify when and how the surplus will be applied. For instance, surplus may be used to improve benefits or to provide for contribution rate reductions.

c. Funding Requirements

The current legislative funding framework in Canada was developed based on a policy that focused on the protection of employees' accrued pension rights, whereas our proposed model emphasizes the equity balance among different generations of stakeholders. To enable the proposed model, some changes to the legislative funding requirements will be needed.

First, most existing funding rules across Canada are written based on benefit allocation methods (e.g., unit credit cost method). While cost allocation methods (e.g., entry age normal cost method) could also be used, special provisions are at times required to be retrofitted with other funding provisions, which are benefit allocation based.

If not already the case, the legislation should provide that public sector pension plans are required to fund on a going concern basis only. A valuation on windup or solvency basis is only required for disclosure purposes. The entry age normal cost method (individual or aggregate) should be prescribed as the funding method for determining the normal cost of the plan.

Second, the current funding regulations allow the application of a wide array of actuarial tools, including the making of a provision for adverse deviations (the "PfADs") and the smoothing of assets and liabilities. Our proposed model calls for the development of an actuarial balance sheet based on market value of assets and best estimate discount rate that is reflective of the expected return on plan assets with no margins included. Presumably, the existing actuarial tools will continue to be allowed and their application might well provide a funding buffer or less volatile contributions (and/or benefit payments). However, we consider it to be more transparent to present an actuarial balance sheet that is free of the application of PfADs or smoothing, while developing an explicit funding margin to limit the extent of potential cost transfers from old to young generations. The balance ratio derived from the actuarial balance sheet would serve as a trigger for actions to address any funding imbalance that may exist at a valuation date. In the interest of clarity and transparency, the regulations should require a plan to report its financial position, before and after the application of any balancing measures, in an actuarial balance sheet similar to that described in Section 6.6.

Third, Canadian regulatory funding regime is trending toward stronger going concern requirements such as shortening the amortization period for any funding deficit from the current 15 years to 10 years. The proposed framework calls for rebalancing (through automatic balance mechanism) and the buildup of a funding margin over the expected average remaining service period of the plan participants. This would most likely be different from the fixed amortization period prescribed by current legislation. The amended regulations should allow plan stakeholders to choose an amortization method based on their funding objectives (in terms of benefit security, contribution stability and intergenerational equity).

d. Need for Harmonization

Pension regulations and funding rules across Canada are becoming progressively more diverse since their early days of adoption. While most public sector pension plans are not multijurisdictional in nature, continued harmonization of cross country funding rules would facilitate the extension of the proposed funding framework to beyond the broader public sector.

e. Tax Issue

Apart from making changes to pension standards legislation to recognize the unique characteristics of public sector pension plans, it is also necessary to amend the tax legislation (namely, the Income Tax Act): (1) to recognize plans with a risk-sharing arrangement involving both the employer(s) and participants as a legal type of retirement savings plans, and (2) to ensure that variable contributions and/or benefits determined under the terms of those plans meet the prescribed requirements.

f. Transitional Rules

In order to transition to the proposed funding framework, a plan should determine whether the fund assets are sufficient to cover the accrued liabilities determined under the new funding method as of the date of transition. Where there is a funding shortfall, it should be recognized as a debt in the budget of the pension providers and funded by way of special payments paid over a relatively short period of time (say, no more than 10 years). The present value of outstanding special payments in accordance with this fixed payment schedule will form a part of the plan assets for determining the balance ratio of the plan at any

future valuation date. Where there is a funding excess as of the transition date, it should be dealt with in accordance with the plan's risk-sharing policy.

7.2 Policy Considerations

The proposed funding model calls for periodical rebalancing (through an automatic balance mechanism) and the buildup of a funding buffer to reduce downside risk. These can be best implemented by having a well-designed risk-sharing policy.

The purpose of a risk-sharing policy is to establish a blueprint and agreement upfront regarding how gains and losses are to be shared among the various stakeholder groups. The ultimate goal is to address the questions of when and who has to pay or receive, how much and for what.

A well-designed risk-sharing policy should include the following key elements:

1. **Identification of stakeholders.** This addresses the question of "who" share the risk. Traditionally, they are the employer(s), active and retired participants. It can also be defined more broadly to include tax/rate paying public and the various generations within a stakeholder group. The identification of what constitutes a generation within a stakeholder group is particularly important in defining the time period over which rebalancing and the buildup of a funding margin are to be achieved.[20]
2. **Balancing mechanism.** This addresses the question of "what" are and "how much" is at stake—adjustments made to future contributions and/or future benefit accruals (or accrued benefits to the extent permitted by legislation) to achieve a state of financial balance. In reality, there will be a limit to these adjustments—these limits are de facto the "price" that the stakeholders are willing to pay and should be specified in the policy (see the following paragraph 3). The balancing mechanism may also be expanded to include other tools such as investment strategy options, or the deployment of extra funding margins to allow for any errors around the best estimate number[21] and the release thereof for spending. These tools can be used to manage the plan's evolving risk profile either for de-risking or for additional risk taking.
3. **Action triggers.** This addresses the remaining question of when certain rebalancing actions have to be taken. Different measures can be triggered to a different extent at different situations or levels of pain or advantage—the pain or advantage points can be tiered based on the balance ratio of the plan. To avoid unnecessary frequent actions that may translate into excessive volatility (in terms of contribution and/or benefit adjustments), some policy flexibility should be allowed—for example, rebalancing is not required if the balance ratio is within a certain tolerable range. Where actions are necessary, such actions can be permanent or temporary. Restoration of previous actions (e.g., when risk profile reverse) should also be spelled out in the policy—for example, if benefits were temporarily reduced in the past, and if the plan's financial situation improves, how the benefits are to be restored (prospectively or retroactively) and the priority order of restoration are important specifications.

[20] Practical implementation of the funding model may necessitate the replacement of the average expected service period for the current participants (or expected remaining lifetimes for retirees) with a predetermined period or a range of periods that is representative of a generation.

[21] This is the balance ratio upon which balancing actions are based.

A final comment: To develop a workable risk-sharing policy, buy-in amongst key stakeholders is important. The key to a successful consensus building begins with upfront education and stakeholder engagement regarding the plan's risk exposures and available risk management tools and levers. Through this process, insights can be obtained regarding each group's baselines, their principles or objectives, priorities and the price they are willing to pay (e.g., what benefits are plan participants willing to put at risk, what benefits are not to be cut and whether there should be any caps or floors). These insights will help inform what an agreeable risk-sharing policy might look like.

A well-thought-out risk-sharing policy should be detailed enough to provide a way forward; however, it should not be too prescriptive to handicap the trustees' ability to deal with any unforeseeable conditions. The policy should be reviewed periodically to ensure continued relevance under changing internal and external environments.

8. Conclusion

Public sector pension plans in Canada have moved toward more risk sharing with plan participants. The old funding model that placed an emphasis on the protection of participants' accrued pension rights is no longer compatible with the risk-sharing mandate of intergenerational equity. We show that the funding method employed in the Canadian regulatory funding regime does not allocate the cost of pension benefits across generations in an ex ante fair manner. We reject the use of a risk-free discount rate that has been advocated by financial economists for liability measurement. We show by example that, from an ex ante perspective, use of a risk-free discount rate could lead more likely to a transfer of pension wealth from early generations to later generations. We further explore the issue of risk sharing by surplus and deficit amortizations, and conclude that (1) the amortization period should match the expected average remaining service period of current plan participants and (2) the manners by which surplus and deficit are amortized should be reasonably consistent. As to the risk-sharing design, plans where risks are shared between employers and active participants (via contribution and/or benefit adjustments) as well as retired participants (via pension adjustments) would be better able to withstand financial or demographic shocks than plans where risks are borne by a single group of stakeholders only.

While a funding approach can be designed to mitigate unfair cost (or wealth) transfers across generations from an ex ante perspective, some generations may be worse off from an ex post perspective if they have to pay for a material deficit due to adverse events that occurred in the past. This exposes the plan to discontinuity risk and raises concerns about its sustainability. To address this risk, we show how a funding margin can be put in place to limit the extent of potential cost transfers from older to younger generations.

With these considerations, we design a funding model for public sector pension plans based on the premise that the pension benefits provided to a generation of participants should be funded, to the extent possible, by level costs paid over the service periods of that generation. Our model requires the adoption of a risk-sharing policy with automatic balance mechanism, as well as the provision of a dynamic funding margin to limit downside risk.

Finally, we discuss a number of issues that will have to be resolved by government policy makers and plan stakeholders to enable the proposed model to legally and effectively operate in Canada.

Appendix A: Illustration of Funding Impacts Due to Funding Method, Discount Rate and Amortization Method

In this appendix, we demonstrate by example how the choice of funding method, discount rate and amortization method would impact the funding outcomes, as were discussed in Section 5. We consider a model DB plan that provides an annual pension of b for each year of service, so an employee who retires with 35 years of service will receive an annual pension of $35b$. We assume that one employee enters the plan at the plan inception and at each anniversary thereafter, and all employees start working at age e and retire at age y.

To be consistent with the principle of intergenerational equity, the pension benefits provided to each generation of participants would be funded by the end of their service periods. The "actuarially fair" contribution rate c, to be paid at the beginning of each year over the service period of a generation, can be solved from the following actuarial equivalence equation:

$$c \cdot \ddot{a}_{e:\overline{y-e|}} = [(y-e) \cdot b] \cdot v^{y-e} \cdot {}_{y-e}p_e \cdot \ddot{a}_y^{(12)} \tag{6}$$

where,

$\ddot{a}_y^{(12)}$ is the monthly life annuity factor at age y;

i is the discount rate used in the valuation, and v is the inverse of 1+i;

$\ddot{a}_{e:\overline{y-e|}}$ is a temporary life annuity calculated using a service table and an interest rate of i;

${}_{y-x}p_x$ is the probability that a participant currently aged x will remain in the plan until age y, computed using a service table; this probability is equal to 1 in our example.

This is the normal cost rate determined under the entry age normal cost method (the "EAN method"), which is dependent on the generation's entry age e but not on their attained age.

A.1 Funding Method

For each age cohort $x < y$, the normal cost rate determined under the UC method is as follows:

$$NC_x^{UC} = b \cdot v^{y-x} \cdot {}_{y-x}p_x \cdot \ddot{a}_y^{(12)} \tag{7}$$

At time $t < y - e$, assume the plan is populated by $t + 1$ overlapping generations of participants (from age e to $e + t$) and each has one person. The contribution rate under the UC method is the average of the UC normal cost rates for all participants who are in the plan at that time:

$$c_t = \left(\frac{1}{t+1}\right)\left(\sum_{k=0}^{t} NC_{e+k}^{UC}\right) \tag{8}$$

Since the UC normal cost rate increases with the age of the participants, it follows that:

$$c_0 < c_1 < \cdots < c_t, \text{ for } t < y - e \tag{9}$$

Thus taxpayers are expected to pay a progressively higher rate of contributions for participants' benefit accruals as time passes.

When a cohort of participants reaches the retirement age y, we assume that their pension benefits would be immediately settled by a lump sum payment equal to their liability of $b \cdot (y - e) \cdot \ddot{a}_y^{(12)}$, which is denoted as B. Once the plan reaches a steady state (i.e., at $t \geq y - e$), the membership has a stationary age composition. The accrued liability and normal cost of the plan would be time-invariant (regardless of which funding method is used), and the following relationship holds:

$$AL^{UC} = (AL^{UC} + NC^{UC})(1 + i) - B \tag{10}$$

where AL^{UC} and NC^{UC} are, respectively, the sum of the UC accrued liabilities and normal costs for all age cohorts in the plan.

Thus,

$$NC^{UC} = \left(\frac{B - AL^{UC} \cdot i}{1 + i}\right) \tag{11}$$

Likewise,

$$NC^{EAN} = \left(\frac{B - AL^{EAN} \cdot i}{1 + i}\right) \tag{12}$$

where AL^{EAN} and NC^{EAN} are, respectively, the sum of the EAN accrued liabilities and normal costs for all age cohorts in the plan.

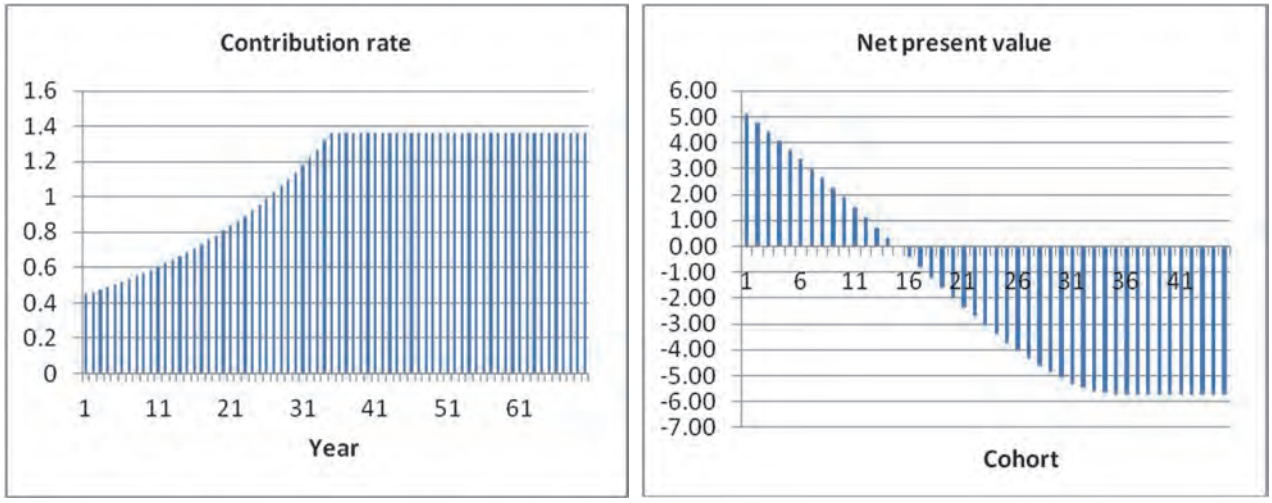
Since AL^{EAN} is always greater than AL^{UC} (see Ma, 2017)), it follows that NC^{UC} is greater than NC^{EAN}. Thus when the plan reaches a steady state, the required contribution rate determined under the UC method would be greater than that determined under the EAN method. In other words, if a plan is funded according to the UC method, taxpayers are expected to pay a contribution rate for current service accruals higher than the "actuarially fair" rate once the plan has reached a mature state.

Another way to look at the issue of intergenerational equity is to compare the net present values pertaining to different generations of participants. The *net* present value for a generation of participants is defined as the difference between the present value of pension benefits and the present value of contributions made on account of that generation, where the present values are calculated as of the generation's entry age using the funding discount rate.

For the model plan described in Appendix B, we postulate that one employee enters the plan (with entry age 30) at the plan inception and at each anniversary thereafter. The plan eventually reaches a steady state with 35 overlapping generations of active participants (from age 30 to 64). Figure A1 plots (1) the contribution rate by year under the UC method and (2) the net present value by cohort of participants, based on the expected return discount rate of 5.75 percent per annum. It can be seen that:

- The contribution rate is lower than the actuarially fair contribution rate of 1.0 before year 27 and is higher than 1.0 from that year onward. It increases to 1.36 in year 35 and remains at that level thereafter.
- The net present values for the older generations (1st to 14th cohort) are positive, whereas those for the younger generations (15th cohort and later) are negative. Older generations of participants enjoy a net benefit gain relative to the contributions paid on account of them. This net benefit has come at the expense of the younger generations who receive a lower benefit relative to the contributions paid.

Figure A1. Contribution Rate and Net Present Value Under UC Method



In conclusion, if a plan is funded according to the UC method, it would be an ex ante unfair arrangement for future taxpayers as they are expected to pay a higher rate of contributions for participants' benefit accruals than their predecessors. In fact, for participants who join the plan beyond a certain date, taxpayers are expected to pay a cost higher than the actuarially fair contribution rate throughout the service periods of those participants. On the other hand, if a plan is funded according to the EAN method (or its variant), taxpayers at different times are expected to pay the same cost for participants' benefit accruals. There is no transfer of funding burden across generations ex ante.

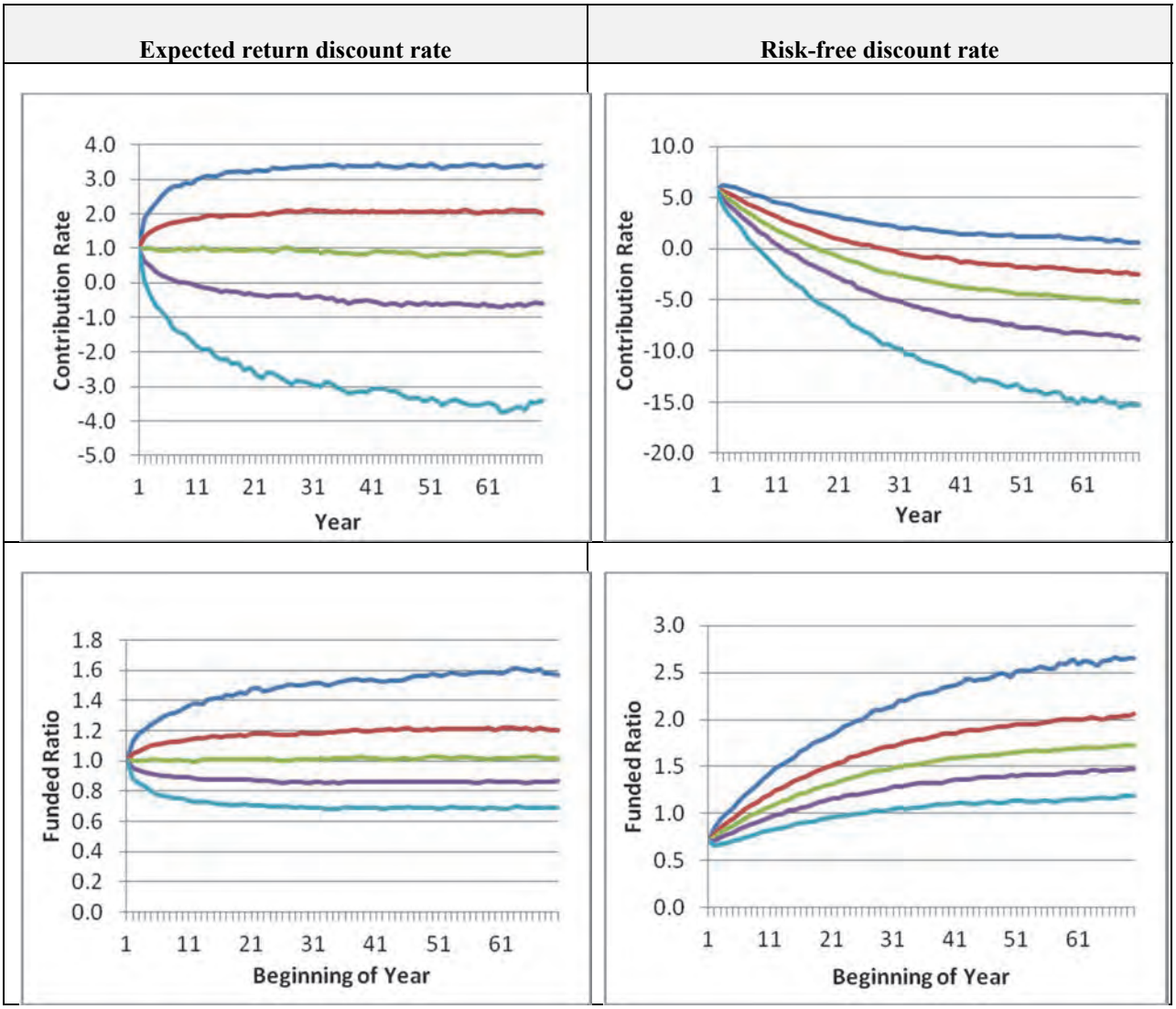
A.2 Discount Rate

We conduct Monte Carlo simulations to examine the funding impacts due to the choice of discount rate assumption, using the model parameters described in Appendix B.

Figure A2 shows the (5%, 25%, 50%, 75%, 95%) percentile distributions of contribution rate and funded ratio, under the two discount rate assumptions: *expected return vs. risk-free*. The EAN method is used as the funding method for these simulations. The following observations can be made:

- Under the expected return discount rate assumption, the median contribution rate is close to the target level of 1.0 and the median funded ratio is also close to 1.0 throughout the simulation periods.
- Under the risk-free discount rate assumption, the median contribution rate drops from the initial level of 5.8, which is well above the target contribution rate of 1.0, and turns negative (i.e., a refund of surplus) in the 18th year. On the other hand, the median funded ratio rises from the initial level of 0.7 and begins to exceed 1.0 in the 9th year. It continues to rise to the level of 1.7 in the 50th year.

Figure A2. Distribution of Contribution Rate and Funded Ratio, by Discount Rate



What would the funding outcomes be if the model plan is funded according to the financial economics approach, that is, use of the UC method and the risk-free discount rate? We assume that the initial fund balance equals the accrued liability of the model plan, which is estimated to be $378,600 under the particular funding basis. The UC normal cost rate is estimated to be $2.79 per participant per year. Our

simulations indicate that the contribution rate starts at $2.79 and its distribution is downward sloping over time, whereas the funded ratio starts at 1.0 and its distribution is upward sloping over time. The funding outcomes follow similar patterns as those shown on the right panel of Figure A2.

From an intergenerational fairness standpoint, we have provided a demonstration to refute the idea put forth by financial economists that the UC method and risk-free discount rate should be used to assess the funded status of a DB plan. With the use of a risk-free discount rate, early generations of taxpayers might likely overpay, whereas later generations could potentially profit from the wealth (i.e., excess reserve) transferred from previous generations. Use of the expected return discount rate together with the EAN method would avoid such ex ante unfair wealth transfers.

A.3 Amortization Method

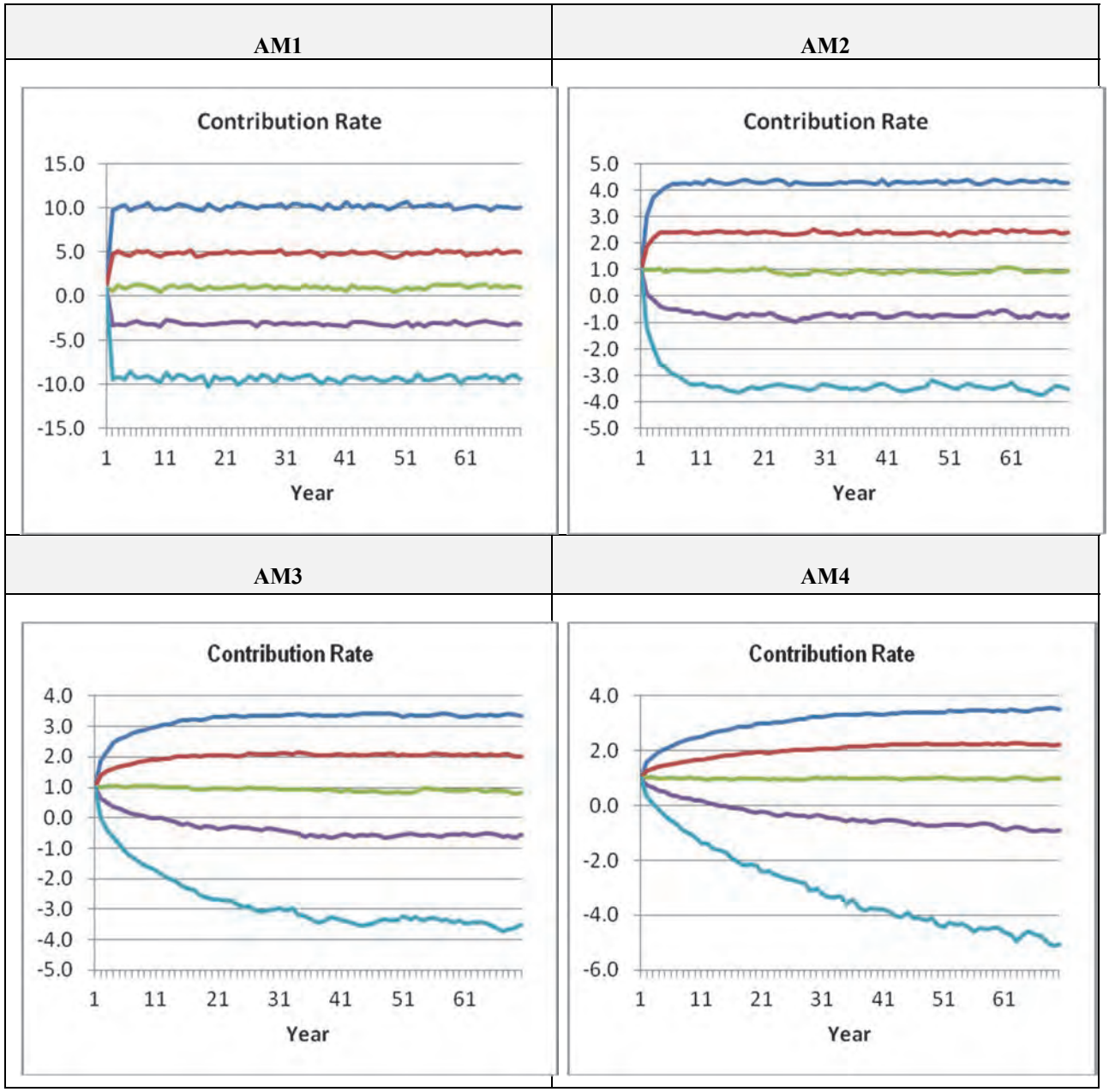
We conduct Monte Carlo simulations to examine the funding outcomes due to the use of different amortization methods, using the model parameters described in Appendix B. Four amortization methods are considered in Table A1.

Table A1. Amortization Method

Amortization Method	Description
AM1	Immediate and full recognition of deficit and surplus, by adjusting the contributions that are to be paid in the current year
AM2	Both deficit and surplus are amortized, by means of level dollar adjustments to the contributions that are to be paid over the next 5 years
AM3	Both deficit and surplus are amortized, by means of an adjustment to the contribution rate that is to be paid by the current plan participants over their expected future service periods
AM4	Both deficit and surplus are amortized, by means of level dollar adjustments to the contributions that are to be paid over the next 35 years

All of the preceding amortization methods are applied on a “fresh-start” basis at each valuation date, meaning that the amortization schedule established at the preceding valuation date is not carried forward to the current valuation date. Figure A3 shows the (5%, 25%, 50%, 75%, 95%) percentile distribution of the contribution rate, under the four amortization methods. The contribution rate is determined based on the expected return discount rate.

Figure A3. Distribution of Contribution Rate, by Amortization Method



The following observations can be made from Figure A3:

- Under AM1 and AM2, the surplus or deficit pertaining to the current plan participants is fully absorbed within a short period of time. The contribution rate thus fluctuates dramatically from year to year. The contribution rate range[22] is broadly consistent over time and is generally wider than the other two methods. The shorter the amortization period, the wider is the range.
- Under AM3 and AM4, the year to year change in the contribution rate is less pronounced than AM1 and AM2 (at least in the early periods), due to the spreading of surpluses and deficits over

[22] This is measured as the difference between simulated contribution rates at the 5th and 95th percentiles.

longer periods. The contribution rate range expands over time as a result of the manifestation of unamortized surpluses or deficits from prior years.

- The contribution rate range under AM3 becomes broadly consistent after 35 years or so,[23] whereas that under AM4 continues to expand after 35 years. Amortization method AM3 aligns reasonably well with the proposition that the cost of pension benefits for a generation of participants should be funded over the expected service periods of those participants.

[23] While not shown here, the distribution of funded ratio under AM3 is also broadly consistent after 35 years. All participants who are active at time 0 will have retired at or before the end of 35 years.

Appendix B: Parameters Used for Monte Carlo Simulations

Model Plan (DB or shared-risk)

- For retired participants with 35 years of service, the target pension payable at age 65 is $9.91 per annum, payable annually in advance.
- Initial plan membership consists of:
    - Active participants: 35 cohorts from age 30 to age 64 and each has 100 participants
    - Pensioners: 35 cohorts from age 65 to age 99 shown as follows; the annual pension payable to each pensioner is $9.91

Age	65	66	67	68	69	70	71	72	73	74	75	76
#	100	98.8	97.4	95.9	94.3	92.6	90.8	88.8	86.7	84.5	82.1	79.5

Age	77	78	79	80	81	82	83	84	85	86	87	88
#	76.8	73.8	70.6	67.1	63.3	59.3	55.1	50.8	46.5	42.2	37.9	33.6

Age	89	90	91	92	93	94	95	96	97	98	99	
#	29.4	25.4	21.5	17.9	14.6	11.6	9	6.8	5	3.6	2.5	

- Target contribution rate: $1 per participant, payable at the beginning of each year of employment. This is the normal cost rate determined under the EAN method and the expected return discount rate assumption indicated as follows.

Funding Basis

- Funding method: EAN method
- Two alternative discount rates are considered: (1) expected return on plan assets of 5.75% per annum; (2) risk-free rate of 2.5% per annum
- No pre-retirement decrements before age 65
- Static mortality decrements after age 65
- For simulation purposes, it is assumed that the funding basis is fixed throughout the simulation period

Projection Basis

- Initial fund balance is set equal to the plan liability based on the expected return discount rate assumption, estimated to be $284,100; thus, the initial funded ratio is 1.0 under the expected return discount rate scenario
- Static investment policy: 50% in bonds and 50% in equities, periodically rebalanced to maintain the same asset mix
- Pension fund returns:
    - Future years' distributions of fund returns are independently and identically (IID) distributed

    - Return factor over any one-year period, $1 + R$, is assumed to follow a lognormal distribution with a mean of 5.6% and standard deviation of 7.26%
    - Expected value of R is 5.75% p.a.
- Membership with stationery age composition: In this circumstance, the plan liability is time-invariant under either discount rate assumption
- Unless otherwise indicated, both deficit and surplus are amortized, on a fresh-start basis, by means of an adjustment to the target contribution rate that is to be paid by the active participants over their future service periods

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