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Analysis of Target Benefit Plan Design Options

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SPONSOR Pension Section

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1. Background and Motivation

Target benefit plans have received considerable attention over the last five years in Canada. In a Canadian context, target benefit plans (TBPs) are collective pension schemes where the target benefit that members can expect to receive is defined in advance but is not guaranteed. Instead, actual benefit payments are contingent on plan experience and may exceed or fall short of the target set *a priori*. The plan sponsor's contributions are usually fixed, or they may vary slightly in response to plan experience. Consequently, the sponsor bears (almost) none of the economic or demographic risks associated with the plan. All of these risks are instead borne by the members, but as a group rather than as individuals, since contributions are commingled in a single fund.

Detailed legislation specific to TBPs exists in three Canadian jurisdictions: New Brunswick (where they are referred to as "Shared Risk Plans"), Alberta, and British Columbia. Several other provinces have passed enabling laws but do not yet have regulations in place.[1]

Given the readiness of several stakeholders (including regulators and some plan sponsors) to endorse and implement TBPs, there is a need for easily accessible, actuarially sound information about the key elements of design and funding that can significantly affect the performance of such plans. Our project begins to address this need by investigating through stochastic modeling the way in which different design features and funding strategies impact performance over the short- and long-term. The key objectives of the research were to:

- Identify basic dynamics of target benefit plans under specific key designs, starting from the simplest ones and noting the impact of more complex design elements.
- Identify appropriate performance metrics for TBPs.
- Identify some areas where future research may be needed.

The purpose of this report is to document the models used, and to provide background and context for the Issue Briefs relating to this work.

2. Process

The Project Oversight Group (POG) appointed by the SOA included several practitioners with extensive experience in modeling the behavior of target benefit plans. POG members provided important practical feedback both on the direction of the research and on the findings. Specifically, the POG assisted the research team in selecting plan designs to explore in detail, suggesting and commenting on performance metrics, and suggesting further areas for exploration.

Stochastic modeling was conducted using scenarios generated by a commercial Economic Scenario Generator (ESG) purchased from Moody's Analytics, and a liability model built by the research team in the R software environment. The various designs were then compared based on the performance metrics selected.

[1] Most jurisdictions also have regulations in place for negotiated-cost multiemployer plans (MEPs). These are usually plans covering workers in a particular industry or union; the sponsor's commitment is limited to the contributions negotiated during the collective bargaining process, and both future and accrued benefits can be reduced if an actuarial valuation reveals that the negotiated contributions are not sufficient to support the benefits set out in the plan, pursuant to the test prescribed in the regulations. Major differences between the operation of negotiated-cost MEPs and TBPs include the flexibility of responses to emerging experience (ad hoc in MEPs, subject to specific triggers and priorities articulated *a priori* for TBPs), and the adoption of an explicit risk-management culture (always present in TBPs, optional in MEPs).

3. Performance Metrics

In selecting performance metrics, we considered the following:

- The plan has two competing objectives (adequacy and security of benefits), both of which should be measured.
- There is significant emphasis placed by regulators on "benefit security" in target benefit plans but the meaning of this term is somewhat ambiguous. To some, it implies a high likelihood that actual benefits meet or exceed the target. To others, it implies a sense of "stability", that is, limited year-over-year changes in benefits. Performance metrics would have to differ depending on the preferred meaning.[2]
- Some complexity may be unavoidable, but the metrics should be reasonably easy to interpret.
- One of the metrics should address intergenerational equity by allowing meaningful comparisons between different cohorts of members.

The following performance metrics were chosen for comparing different designs:

1.	Probability of benefit reductions/increases, by valuation year
2.	Probability of at least one benefit reduction in the first 1-, 3-, 9-, and 15 years after inception
3.	Distribution of annual benefit adjustments by size (%), by valuation year
4.	Distribution of replacement ratio at retirement, by cohort
5.	Distribution of average replacement ratio throughout retirement, by cohort
6.	Distribution of the ratio of actual pension (weighted average over retirement) to nominal target, by cohort
7.	Probability of actual pension falling below 100%, 80%, 60% or 40% of initial pension at any point during the retirement period, by cohort
8.	Probability of actual pension falling below 100%, 80%, 60% or 40% of the nominal target pension at any point during the retirement period, by cohort
9.	Distribution of the average year-over-year change in pension amount, by cohort[3]
10.	Probability of benefit adjustment reversals[4] over the first and second 15 years after inception

Examples of the outputs produced for each performance metric are given in Appendix A.

[2] For example, many traditional measures of risk (e.g., variance/standard deviation, interquartile range) treat upside and downside risk the same way. If the emphasis is on assessing benefit stability then this is fine. If the goal, however, is to assess benefit risk in the sense of falling below the target, then such a risk measure would be inappropriate.

[3] Geometric average.

[4] A "benefit adjustment reversal" is defined as a benefit increase in one year, immediately followed by a benefit reduction in the following year.

4. Asset Model

The research team had access to 10000 economic scenarios supplied by Moody's Analytics. The scenario set provided real-world (rather than risk-neutral) projections given prevailing market conditions as at December 31, 2012. It included projected yield curves for a variety of bond issues,[5] projected total returns in Canadian dollars for a variety of asset classes, projected inflation, and projected increases in average wages over a 100-year period. Not all of this information was used in the project. Specifically, we only used the first 1000 of the 10000 available scenarios, as there was no material difference in outputs beyond this.

Economic scenario generators are used by Moody's for a variety of insurance and pension consulting assignments, including to help measure and manage the risks facing defined benefit pension schemes. There is thoughtful calibration of the model asset returns to the projected bond yields and other financial variables that drive our calculation of pension liabilities. Moody's offers a number of choices in how the model is calibrated, to facilitate preferences of individual clients or closer linkage with the manner in which liabilities will be calculated. We have accepted their preferred approach to model calibration in each instance. In particular:

- Nominal yield curves at the beginning of the projection match market conditions. Changes in short-term interest rates, credit spreads and term premiums from year to year are stochastic, but the central tendency in the early years of the projection reflects forward rates and Moody's view of expected trends in short-term interest rates. The central tendency in the long term is towards levels that are based upon an economic justification, rather than current market forward rates. Year-to-year volatility in interest rates is larger when interest rates are higher.

- The equity model is calibrated to initial dividend yields and volatility levels. The option for volatility of returns that varies stochastically over the projection period has been included.

- Inflation includes an optional independent stochastic component, in addition to fluctuations directly linked to the spread between nominal and real return bond yields.

Three pieces of information were used from the asset model:

- Projected yields on long-term (30-year) Canadian government and corporate bonds were used in setting the valuation discount rate (see below for construction).
- Projected total returns on various asset classes were combined to model returns on the pension fund, assuming annual rebalancing.[6]
- Projected inflation was used to model a component of future salary increases.

The distribution of some of these quantities over the projection horizon of 100 years is illustrated in Figures 1-3. A significant feature of the asset model for our purposes is that long-term interest rates are projected to rise from a starting point of 2.5% to a median of about 4% in 40 years, and 5% in 100 years.

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[5] Canadian/US government bonds and Canadian/US corporate bonds.

[6] We deducted 25 bps from the returns generated by the ESG to account for investment and administrative fees.

Figure 1 – Evolution of distribution of yields on 30-year Canadian government bonds (5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles shown)

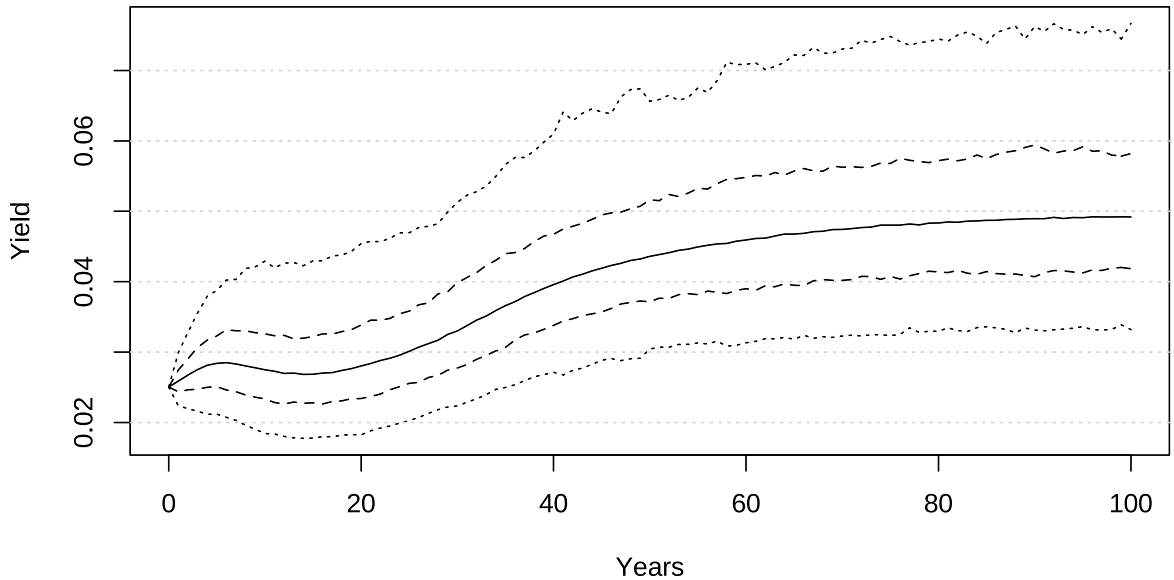
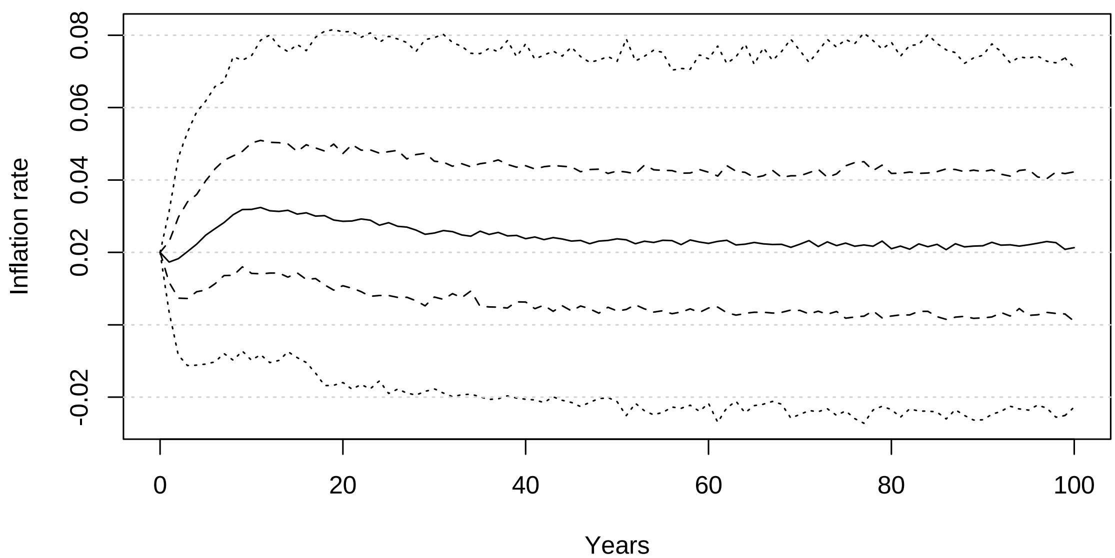


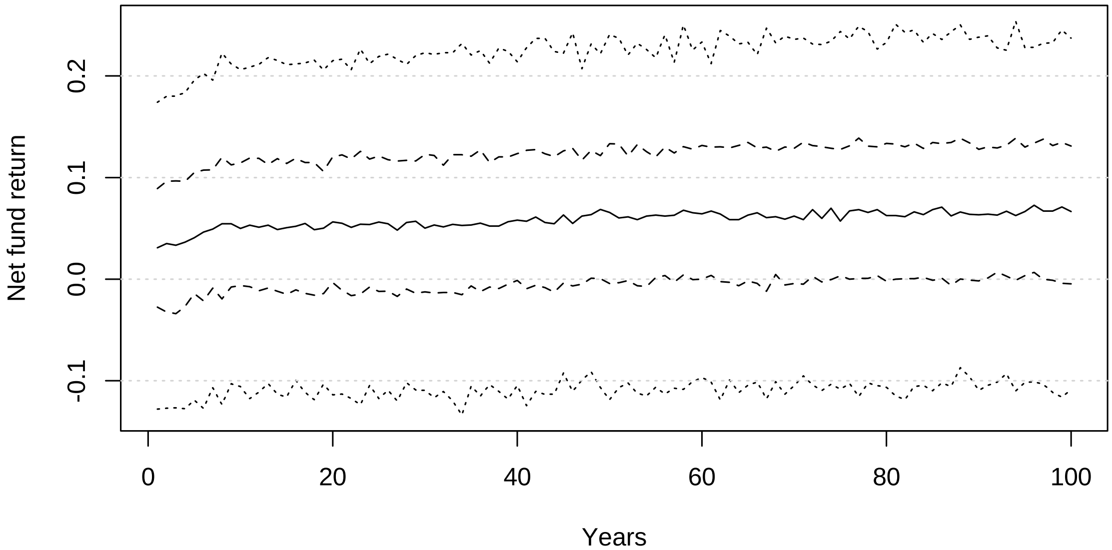
Figure 2 – Evolution of the distribution of projected inflation (5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles shown)



For modeling total returns on the pension fund, we needed to make an assumption about asset mix. We considered the following three static asset mixes:

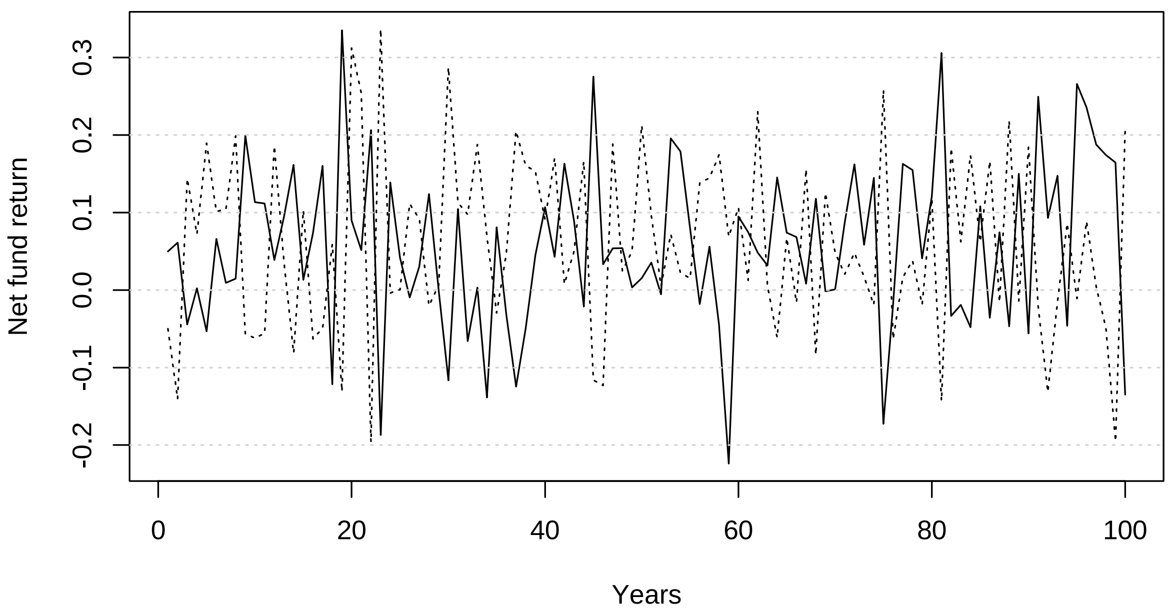
	Low equity content mix	**Medium equity content mix**	**High equity content mix**
Canadian equities	15%	25%	35%
US equities	15%	25%	35%
Canadian long bonds (duration: 16.2 yrs)	35%	25%	15%
Canadian corporate bonds (duration 7.3 yrs)	35%	25%	15%

Figure 3 – Evolution of the distribution of fund returns under medium equity content asset mix, net of fees (5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles shown)



Note that although the distribution of the fund return is relatively stable over time, the fund returns along any given path (scenario) are quite volatile. Figure 4 illustrates this, showing 2 of the 1000 scenarios considered.

Figure 4 – Net fund returns under two economic scenarios



5. Liability Model

The liability model consisted of a specific plan membership profile, as well as a variety of plan provisions and assumptions. Since part of our goal was to identify the impact of different elements of the target benefit design, simplicity was maintained in the membership profile. In exploring different plan designs, we started with the simplest one and gradually added more complex elements.

Plan membership

A stationary membership model was chosen with the following characteristics:

- 100 new members enter each year at age 25
- No preretirement decrements
- Members retire at age 65 (100 each year)
- After retirement, group is subject to deterministic mortality following the 2014 Canadian Pensioners Mortality Tables (combined) for males, without mortality improvements.

Consideration was given to whether the membership should be built up gradually or be stationary from the outset, and if the latter, whether any past service should be recognized. The POG decided to start the model (at t=0) with a mature membership profile and recognize past service accrued under a predecessor defined benefit (DB) plan, as this setup was seen as most critical for practitioners to understand.

Elements of TBP design

The operation of a target benefit plan is guided by its combined benefits/funding/investment (BFI) policy[7], which has the following key elements:

- **Contribution rate** – This is typically a fixed amount or a fixed percentage of payroll. In some plans, the sponsor's contribution rate may fluctuate depending on the financial position of the plan, but such fluctuations would normally be restricted to a relatively narrow band defined in the BFI policy *ex ante*. In either case, the sponsor's funding obligation is limited to the contributions stipulated in the BFI policy. Higher contributions normally allow for a higher target benefit and/or a higher probability of delivering the targeted benefits, all other things being equal.

- **Target benefit** – Expressed in terms similar to a defined benefit plan (e.g. 1% of career average earnings times years of service), this is the benefit the plan aspires to provide. Actual benefits may exceed or fall short of this target, dependent on the economic and demographic experience of the plan.

- **Affordability test** – The actuarial test that is used to assess whether the target benefit is affordable. It includes the asset valuation method as well as the methods and assumptions used to put a value on the benefits the plan aspires to provide (the "funding target"[8]). The affordability test is often expressed as a funded ratio (FR), that is, a ratio of assets to the funding target. It can be based on a single deterministic valuation, on scenario testing, on stochastic projections, or a combination of these.[9] The deterministic valuation may be based on

[7] The term "BFI policy" was first used in the *Report of the Task Force on Target Benefit Plans* issued by the Canadian Institute of Actuaries, available at http://www.cia-ica.ca/publications/publication-details/215043.
[8] Typically called a "liability" in a defined benefit plan context.
[9] For example, the Alberta and BC regulations prescribe a single deterministic test. The New Brunswick regulations require a deterministic valuation, supplemented in certain situations by stochastic projections.

a closed membership group (as in Alberta) or may allow for new entrants (as in New Brunswick).

- **Triggers and actions** – A key part of the BFI policy is the series of predefined actions to take (e.g., to increase or reduce benefits) when specific triggers are hit. The triggers should be related to the outputs of the affordability test (e.g., reduce benefits in pay if funded ratio is below X%). Actions can include adjustments to the benefits (past and/or future accruals), contributions (in a plan where contributions can fluctuate within a narrow range), or investments (e.g. changing the allocation to risky assets as the funded ratio changes).

Plan provisions

Our project explored nine (9) plan designs with different affordability tests and triggers. All designs had the following elements in common:

- A fixed contribution rate equal to 10% of payroll.
- The same starting asset value (F_0), representing assets transferred from a predecessor plan in respect of past service benefits recognized at the inception of the target benefit plan.
- A target benefit expressed as a percentage of career average earnings (CAE) times years of service, without an explicit indexation provision either before or after retirement.[10]
- A single-life form of pension.
- An affordability test based on the market value of assets and a deterministic valuation using the traditional unit credit (TUC) method.

The first two points ensured consistency of plan costs across the various designs.

With respect to triggers and actions, **Design 1** was our baseline design. It is the simplest possible setup with a single trigger point, where any deviation from a 100% funded ratio (determined on the basis of the affordability test) is corrected immediately: any funding excess is spent on proportionate increases to accrued benefits, and any funding deficiency is eliminated by decreasing accrued benefits. If the affordability test is carried out annually, benefits are adjusted (up or down) every year. Adjustments are only applied to benefits in relation to past service; future benefit accruals remain as originally targeted. The benefits of active and retired members are adjusted by the same percentage (i.e., there is no extra protection provided to pensioners). Adjustments are cumulative, so that a 10% increase in one year followed by a 3% decrease the next year leads to a benefit that is (1.10)(0.97) – 1 = 6.7% higher than two years prior in respect of the same service.

Design 2 adds some stability to the benefits by introducing a relatively narrow "no-action range" for funded ratios between 90% and 110%. This range is deliberately centered around a funded ratio of 100%. Benefits are unchanged until the funded ratio moves outside this range, at which point adjustments are made to bring the funded ratio back to the edge (rather than the middle) of the range. For example, if the funded ratio is found to be 130%, then all accrued benefits are adjusted by a factor

[10] A target benefit that is a function of career average earnings is expected to be higher in nominal terms for later cohorts, on account of inflation and the resulting salary growth. An advantage of this approach is that the target is likely to represent similar replacement ratios at retirement for different cohorts; therefore, knowing that actual benefits exceed the target for a given cohort under a particular scenario, we can be reasonably certain that the benefit is, in fact, adequate. This would not be the case if the target were a flat benefit, which would become inadequate over time. A disadvantage of this approach is that different patterns of future inflation and wage increases under the different economic scenarios lead to different targets for the same cohort. Consequently, when we then say that "the target is exceeded in 80% of the scenarios" for a given cohort, there isn't a unique benchmark (in dollar terms) that we can refer to.

or 130/110 (that is, an increase of about 18.1%) to bring the funded ratio back to 110%. **Design 3** adds further stability by expanding the "no-action range" to funded ratios between 80% and 120%.

Design 4 is the same as Design 2 but with the lower end of the "no-action range" set at 100%, rather than the range being centered around 100%. Here, the trigger points are deliberately biased to saving. **Design 5** combines the wider "no-action range" from Design 3 with this bias to saving, resulting in trigger points at 100% and 140%.

Design 6 has trigger points at 90% and 110% but the action taken in response to positive experience is more conservative than under Design 2: only one-half of excess assets are spent. For example, if the funded ratio is 130%, benefits are only increased by a factor of 130/120 (an increase of about 8.3%, compared to 18.1% under Design 2) and the funded ratio is brought down to 120% (as opposed to 110% under Design 2). If the funded ratio remains above the upper trigger point the following year (which is more likely than under Design 2) then another increase is granted. Increases are always smaller under Design 6 than under Design 2, but more frequent. The treatment of funding deficiencies is the same under Designs 2 and 6; that is, the "half-way rule" is only applied on the upside.

Designs 7-9 use an entirely different affordability test, with a 15-year open group projection[11] replacing the closed group valuations under Designs 1-6. **Design 7** is a replica of Design 5 with triggers at 100% and 140%, but using an open group projection.

Design 8 is similar to Design 7 in that action is taken only when the open group funded ratio falls outside the no-action range spreading from 100%-140%; however, the benefit adjustment mechanism is different, with the target accrual rate (applicable to all future years) and past accruals changing by the same percentage simultaneously under Design 8 whenever action is required. For example, if accrued benefits are increased by 10% and the target accrual rate before the valuation was 1.00% of CAE per year of service, then the target accrual rate going forward is increased to 1.10% of CAE per year of service. Both types of adjustments are cumulative, so if a 3% reduction is applied to the accrued benefits the following year then the new target accrual rate becomes 1.10% x 0.97 = 1.067% of CAE per year of service.

Design 9 alters the adjustment mechanism in Design 8 by giving priority to changes to the target accrual rate, creating more stability for past service benefits. Under this design if the funded ratio falls outside the "no-action range" of 100% to 140%, the target accrual rate is adjusted first, attempting to return the funded ratio to the edge of the range without changing past service benefits at all. The resulting target accrual rate is constrained to a reasonable range, with a minimum of 1% and a maximum of 2% of CAE per year of service. If the target accrual rate reaches the ends of this range but the funded ratio is still not returned to the nearest trigger point, then past service benefits are adjusted as well. For example, suppose the open group funded ratio is 148%. This is above the upper trigger point of 140% so benefit increases are warranted: the first step is to increase the target accrual rate. Suppose also that increasing the target accrual rate to its maximum value (2% per year of service) only reduces the open group funded ratio to 145%. Since this value is still above the upper trigger point, further spending is warranted. Past service benefits are therefore increased accordingly to bring the funded ratio down from 145% to 140%. The adjustments work similarly on the downside, with the target accruals being reduced first and past service benefits being reduced only when necessary.[12]

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[11] The open group funded ratio is defined as (A+B)/(C+D), where A is the market value of plan assets, B is the present value of contributions expected to be received over the 15-year projection horizon, C is the actuarial present value of accrued benefits as of the valuation date, and D is the actuarial present value of benefits expected to be accrued over the projection horizon. Both B and D take into account new entrants. Note that this is slightly different from the New Brunswick implementation, which defines the open group funded ratio as (A+B–D)/C.

[12] This design captures an aspect of the New Brunswick regulations, where future service accruals may be adjusted (subject to some limits) before past service benefits.

Similar to Design 8, Design 9 creates more year-to-year stability for retired members by making active members' future benefits more volatile.

Table 1 summarizes the designs considered.

Table 1 – Design matrix (affordability test, triggers, and actions)

Design	Affordability test	Trigger(s)	Actions
1	TUC, closed group	FR =100%	Adjust past service benefits immediately
2	TUC, closed group	90% and 110%	Adjust past service benefits immediately if outside "no-action" range
3	TUC, closed group	80% and 120%	Adjust past service benefits immediately if outside "no-action" range
4	TUC, closed group	100% and 120%	Adjust past service benefits immediately if outside "no-action" range
5	TUC, closed group	100% and 140%	Adjust past service benefits immediately if outside "no-action" range
6	TUC, closed group	90% and 110%	Adjust past service benefits immediately if outside "no-action" range; spend only half of excess on benefit improvements
7	TUC, 15-year open group projection	100% and 140%	Adjust past service benefits immediately if outside "no-action" range
8	TUC, 15-year open group projection	100% and 140%	Adjust past service benefits and target accrual by same percentage if outside "no-action range"
9	TUC, 15-year open group projection	100% and 140%	Adjust target accruals first, then adjust past service benefits, if necessary, if outside "no-action range"

Assumptions

The liability model also contained assumptions about the frequency of valuations, the evolution of salaries over time, and the discount rate applied.

Valuation frequency

Our model assumed annual valuations. Depending on the design, corrective action could be taken by the plan every year (if triggers were very sensitive) or less frequently. For a few early designs we also modeled triennial valuations, which are the norm for traditional defined benefit plans; however, annual valuations were preferred, as they allow stakeholders to better monitor emerging experience.

It should be stressed that in a TBP, the frequency of the valuations and the frequency of benefit changes are mediated by the plan design, so that annual valuations do not necessarily mean immediately reacting (perhaps "overreacting") to experience. They simply mean having up-to-date information, which the plan may or may not act on, depending on its predefined triggers and actions.

Salary progression

The model assumed a starting salary of $50,000 in real terms (i.e., in 2013 dollars) for new entrants at age 25. After entry to the plan, salaries were projected to increase at the rate of inflation plus 0.5% per year. Inflation was a stochastic variable that differed both by year and by economic scenario, therefore projected salaries varied stochastically as well.

Since the plan started off with a mature membership and recognized past service at inception, we also needed to generate "historical" salary information. For past service, salaries were "backcasted" at a fixed rate of 2.5% per year.

Discount rate

The discount rate is used for three purposes in a TBP:

1. To establish, at plan inception, the link between the fixed contribution rate (e.g., 10% of pay) and the target benefit level (e.g., 1% of CAE per year of service);

2. To establish, at plan inception, the link between the cost of accrued benefits recognized under the plan and the starting asset value (F0); and

3. In the affordability test at each valuation, to determine the position of the plan and the resulting actions to be taken, if any.

In practice, the discount rate used for each purpose would fall between:

- the "risk-free rate", that is, the yield on safe assets matching the payment characteristics of the targeted benefits (e.g. long-term government bonds), and
- the "best-estimate rate", that is, the median of projected long-term future return on plan assets.

The discount rate used for items 2 and 3 should be the same, otherwise the assets determined to be required at inception will exceed or fall short of the funding target established by the affordability test. This would lead to any extra assets being spent (or past service benefits being reduced) relatively quickly after inception. However, it is possible for the discount rate used for item 1 to be different.

We focused on the extreme positions, which gave rise to the four initial combinations of discount rate assumptions shown in Table 2. Of these, we later focused on options A and B.

Table 2 – Discount rate combinations

	Discount rate for linking contributions to target benefit	Discount rate used in affordability test, and to establish starting asset value	Comments
A	risk-free rate	risk-free rate	Conservative: • contributions fund target as if guaranteed • only spends risk premium after it is earned
B	best-estimate rate	best-estimate rate	Aggressive: • contributions fund target in median only • spends expected risk premium up front; adjusts benefits after the fact if expectations do not materialize

	Discount rate for linking contributions to target benefit	Discount rate used in affordability test, and to establish starting asset value	Comments
C	risk-free rate	best-estimate rate	• Conservative with respect to future service (contributions fund target as if guaranteed) • Aggressive with respect to benefits related to past service (spends expected risk premium up front, adjusts benefits after the fact if expectations do not materialize)
D	best-estimate rate	risk-free rate	• Aggressive with respect to future service (contributions fund target in median only) • Conservative with respect to benefits related to past service

In our model, the risk-free rate at each valuation date was set as the then-current yield on 30-year Canadian government bonds, truncated to 10 bps.

The best-estimate rate at each valuation date was set following a building block approach that mimicked the Benchmark Discount Rate found in the Alberta regulations for TBPs:[13]

- The future expected return on the equity portion of the portfolio was estimated as the then-current nominal yield on 30-year Government of Canada bonds plus an equity risk-premium of 4%;
- The future expected return on the bond portion of the portfolio was estimated as the then-current yield on 30-year corporate bonds rated AA or better.
- These returns were weighted in accordance with the equity/bond split in the portfolio.
- An additional 0.25% per annum was added to capture the benefit of diversification.
- The resulting rate was truncated to 10 bps.

Since the market yields used in these forward-looking constructions of the discount rate were modeled stochastically by the ESG, the discount rates applied at each future valuation were also stochastic. Consequently, movements in asset values linked to changes in yields were consistent with movements in the funding target due to changing discount rates.

In order to generate comparable outputs, it was important that all combinations of plan designs and assumptions be based on the same level of contributions and starting asset values. Consequently, different assumption bases called for different benefit accrual rates.

- For assumption set A, using the risk-free rate, we found that a 1% target accrual rate applicable to future service corresponded to a 10.36% annual contribution rate. Likewise, a 1% accrual rate in respect of past service corresponded to a starting asset value of $670 million ($F_0$). This became our baseline for the sponsor’s commitment.

[13] While not all actuaries establish the best-estimate discount rate in this manner, the POG considered this approach to be reflective of common practice.

- When the link between the contribution rate and the target was based on the best-estimate rate instead of the risk-free rate (assumption bases B and D), we increased the target accrual rate applicable to future service so that the normal cost of benefits accruing in the first year after inception determined under the Traditional Unit Credit (TUC) method matched the sponsor's contribution commitment (i.e., 10.36% of pay). For example, using the best-estimate rate based on the medium equity content mix, the 10.36% annual contribution rate corresponded to a 1.90% target accrual rate.[14]

- Similarly, when the link between the starting asset value and past service benefits was based on the best-estimate rate instead of the risk-free rate (assumption bases B and C), we increased the past accrual rate credited under the TBP until the TUC liability for past service matched the sponsor's commitment for starting asset value ($670 million). For example, using the best-estimate rate based on the medium equity content mix, the starting asset value of $670 million corresponded a 1.45% accrual rate in respect of past service.[14]

7. Key Findings

The various plan designs considered in this project are the result of an incremental process of exploration. We started from the simplest possible design and, much like in practice, the decision to add a particular new element was informed by the results of previous choices. A summary of selected model outputs is provided in Appendix B. Key observations from the POG's discussions are as follows.

- We started from a very simple design that treats active and retired members the same and attempts to settle experience immediately, similar to a variable payout annuity without any explicit buffers or smoothing. This approach results in considerable volatility in the benefit, as evidenced by the annual probability of benefit cuts/improvements and the likelihood of benefit reversals.[15]

Choice of asset mix

- The choice of investment mix has a greater impact on the size of adjustments than on their frequency. In particular, a higher equity content may not drastically change the probability of shortfalls over a relatively short horizon (2% increase in the annual probability of benefit reductions, going from the medium equity content mix to the high equity content mix)[16] but it does increase the probability of *extreme* adjustments (corresponding change of 6% in the probability of accrued benefits being reduced by more than 5%).[17]

- The cumulative impact of these annual adjustments can be significant: the probability that actual pensions drop far below a retiree's initial pension at some point during the retirement period is much smaller using the low equity content asset mix (4%) than it is under the high equity content asset mix (30%).[18]

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[14] The accrual rates differ slightly for the low equity content mix and the high equity content mix.
[15] See performance metrics 1 and 10 for plan designs 1A-1D in Appendix B.
[16] See performance metric 1 for plan design 1A in Appendix B.
[17] See performance metric 3 for plan design 1A in Appendix B.
[18] Compare performance metric 7b for plan design 1A with various equity contents in Appendix B.

- With the static (traditional) asset mixes considered in this study, the lower risk of shortfalls comes at the cost of less upside potential: the median annualized growth rate in pensions after retirement is considerably smaller under the low equity content asset mix (1.9%-2.3% per year, depending on cohort) than it is under the high equity content asset mix (2.6% -2.8% per year).[19]

Choice of discount rate

- When using the *risk-free rate* to value all benefits (assumption set A):
    - The pension starts out relatively low: the median replacement ratio is ~28% for the first cohort of retirees,[20] which exceeds the conservative, 1%-accrual target but falls short of the higher target actually "aspired to" (that is, the target based on the best-estimate rate).[21]
    - Volatility is mostly on the upside, as evidenced by the annual probabilities of benefit adjustments and the annualized growth rate in pensions applicable after retirement.[22] Benefit increases are financed by gains that are primarily due to realized equity risk premia and the impact of rising bond yields.
    - Nonetheless, there is still a significant probability of falling below the initial pension during a particular member's retirement period (anywhere from 54% chance with the low equity content asset mix, to 68% with the high equity content asset mix),[23] simply because the period in question is very long (30-40 years) and adjustments are frequent.
    - Benefits are back-loaded, with significant differences between the distribution of outcomes for different cohorts of retirees: the median replacement ratio is only 27% for those retiring at inception, compared to 40-50% for those retiring 50 years later.[24]

- Using the *best-estimate discount rate* for valuing past and future benefits (assumption set B) changes the plan's risk/reward profile considerably.
    - It increases the likelihood of annual accrued benefit reductions: 47% chance of benefit cuts at each valuation, versus 36% using the risk-free rate.[25] It also increases the probability of extreme accrued benefit cuts: 27% chance of accrued benefits being reduced by more than 5% in any given year, compared to 20% using the risk-free rate.[26]
    - It reduces the likelihood and size of annual benefit increases.[27]
    - The combined effect is that the median annualized growth rate of pensions after retirement is near zero or slightly negative each year when using the best-estimate discount rate, compared to over 2% a year when using the risk-free rate.[28]

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[19] See performance metric 9a for plan design 1A with various equity contents in Appendix B for the difference in rewards. The difference in risk is visible in performance metric 9b.
[20] See performance metric 5 for plan design 1A in Appendix B.
[21] See performance metric 6 for plan design 1A in Appendix B.
[22] See performance metrics 1 and 9a for plan design 1A in Appendix B.
[23] See performance metric 7a for plan design 1A in Appendix B.
[24] See performance metric 5 for plan design 1A in Appendix B.
[25] See performance metric 1 for plan design 1B in Appendix B, compared to plan design 1A.
[26] See performance metric 3 for plan design 1B in Appendix B, compared to plan design 1A.
[27] See performance metrics 1 and 3 for plan designs 1A and 1B in Appendix B.

[28] See performance metric 9a for plan design 1B in Appendix B, compared to plan design 1A.

- At the same time, the pension payable to earlier cohorts is higher: the median replacement ratio is 34% for the first cohort of retirees, compared to 28% using the risk-free discount rate.[29]

- Cohorts retiring far in the future still see higher replacement ratios (45% for the cohort retiring in 50 years) but this is a function of the rising interest rate environment projected by the asset model, which makes the cost of future benefits much lower than the contribution rate that was set at inception (10% of earnings).

- Overall, upside risk is reduced and downside risk is increased in exchange for a higher expected benefit earlier on.

- Using the best-estimate discount rate to value converted benefits at inception and the risk-free rate to perform the affordability test (assumption set C) shifts even more of the benefits to earlier cohorts: the median replacement ratio is nearly identical for all cohorts around 37%.[30]

- By contrast, using the risk-free rate to value converted benefits at inception and using the best-estimate rate for the affordability test (assumption set D) exacerbates the differences between cohorts: The median replacement ratio ranges from 23% for the first cohort of retirees to 56% for those who retire 50 years later.[31]

Triggers and actions

- When the plan has only a single trigger for action, benefits are volatile. A “no-action range” can reduce the frequency of benefit changes. It corresponds to a countercyclical buffer, which is built up with positive experience and drawn down with negative experience.

- A wider no-action range or buffer provides more protection from benefit cuts but, in the absence of other tools, the range would have to be very wide in order to bring the kind of security envisioned in the New Brunswick regulations (97.5% probability of no benefit reductions in the first 15 years), even when using the risk-free discount rate.[32]

- When using a “no-action range”, the distribution of the funded ratio tends to be centered at or near the middle of the range. If the plan starts off with a different funded ratio,[33] the distribution will drift towards the center of the range over time. In these situations, the behavior of the plan may differ during the “transition period” (while the distribution is shifting; that is, the buffer is being built up) and the “ultimate period” (when the distribution becomes more stable; that is, when the buffer is already expected to be in place).

- Plan designs where the “no-action range” is centered on a funded ratio of 100% (designs 2 and 3) appear to generate more stable pension outcomes[34] at seemingly no cost[35]. It should be noted that these results are dependent on a stable demographic profile, which is not likely to exist in the real world.

[29] See performance metric 5 for plan design 1B in Appendix B, compared to plan design 1A.
[30] See performance metric 5 for plan design 1C in Appendix B.
[31] See performance metric 5 for plan design 1D in Appendix B.
[32] Compare performance metrics 1, 2 and 3 for plan design 2B-5B in Appendix B.
[33] For example under Design 4, where the no-action range goes from 100% funded to 120% funded, and the initial funded ratio is 100% instead of being in the middle of the range at 110%.
[34] See performance metrics 1, 2, 3, 7 and 10 for plan designs 2B and 3B in Appendix B, compared to design 1B.
[35] Performance metrics 5 and 9 hardly change under plan designs 2B and 3B, compared to design 1B.

- Designs with "no-action ranges" that are biased to saving (with lower trigger point at 100%, as in designs 4 and 5) deliver better results in the ultimate period,[36] but there is a shift in rewards from early cohorts to later cohorts.[37]

- The higher benefit security and stability during the ultimate period (applicable to later cohorts) is in contrast with higher risk during the transition period (applicable to earlier cohorts) under Designs 4 and 5. In practice, there may be a desire for the opposite pattern (i.e., a more stable or even increasing risk profile over time).[38]

- Design 6 did not generate noticeably different outcomes relative to Design 2. This is partly due to the valuation basis used: the "half-way rule" works better with setups that bias plan experience towards gains, which are then distributed more slowly.

Adjusting the target accrual rate

- In the first seven designs considered, the accrued benefit is adjusted, if needed, but the target accrual rate (applicable for future service) always remains the same. In practice, there is often a desire to reduce the target either *at the same time* or *before* adjusting accrued benefits. Designs 8 and 9 explored the effectiveness of these approaches in terms of the risks and rewards of various cohorts of members.

- When the target accrual rate is adjusted *at the same time and by the same proportion* as accrued benefits:

    - There is hardly any change in the probabilities of annual accrued benefit increases/cuts.[39]
    - The probabilities of extreme adjustments to accrued benefits are reduced, as expected.[40]
    - There is very little change in the median replacement ratio,[41] but the variability of the replacement ratio itself is reduced for all cohorts.
    - The median pension in relation to the target appears to be the same, but this can be misleading: since the "target" is no longer fixed, comparisons are more difficult to make.[42]
    - The cumulative effect is favourable for earlier cohorts as they experience smaller benefit cuts during the early years of the plan (while the countercyclical buffer is being built up) than they otherwise would. This comes directly at the expense of later cohorts who tend to see lower benefit increases after retirement than they did otherwise.[43]
    - All retired members benefit from less uncertain outcomes.[44]

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[36] See performance metrics 1 and 7 for plan designs 4B and 5B, compared to designs 2B and 3B, respectively.
[37] See performance metrics 5 and 9a for plan designs 4B and 5B, compared to designs 2B and 3B, respectively. The shift is subtle when looking at median replacement ratios (metric 5) and is more noticeable looking at annualized growth rates (metric 9a).
[38] In a situation with converted benefits accrued under a DB plan, stakeholders may prefer to aim for greater security for earlier cohorts and possibly less for later ones.
[39] See performance metric 1 for plan design 8B, compared to design 5B (and 7B).
[40] See performance metric 3 for plan design 8B, compared to design 5B (and 7B).
[41] See performance metric 5 for plan design 8B, compared to design 5B (and 7B).
[42] See performance metric 6 for plan design 8B, compared to design 5B (and 7B).
[43] See performance metric 9a for plan design 8B, compared to design 5B (and 7B).
[44] See performance metric 9b for plan design 8B, compared to design 5B (and 7B).

- When the target accrual rate is adjusted *first* and accrued benefits are adjusted *only as a last resort*:

    - There is a significant drop in the annual probability of accrued benefit cuts, from 10% to 4%.[45]
    - The probability of accrued benefits needing to be reduced at least once during the first 15 years after inception is still very high (52%) relative to the threshold contemplated in the New Brunswick regulations (2.5%).[46]
    - Outcomes for earlier cohorts of retirees are improved, at the expense of later cohorts.[47]
    - The risk and reward dynamics between different cohorts become more complex. For example, a trend that appears between the first and 10th cohorts of retirees may not continue to the 25th or 50th cohorts, and may even reverse. Better tools are needed to capture the tradeoffs between groups of members.[48]

Other comments

- When plan costs are fixed, each design choice and assumption affects the distribution of benefits payable to different cohorts of members. In other words, as we change a design element or an assumption, we should be able to see a change in the median size of the benefit or in the variability of that benefit, with the shifts usually being uneven across the different cohorts. The performance metrics we considered capture part of these shifts but not all. Better metrics are needed, in particular to assess intergenerational impact.

- Many of our metrics were deficient in that they treated upside and downside in the same way and/or netted them against each other. Other metrics focused exclusively on the downside, without noting differences in the upside. The ideal metric (or combination of metrics) would capture both the upside and downside potential fully but separately.

- The psychology of adjustments to pensions in pay should not be ignored.
    - The probability of reversions[49] can be reduced by using a "no-action range" between trigger points.
    - Members may prefer starting with a smaller pension and receiving increases instead of starting with a slightly higher pension and experiencing benefit cuts. In this case, using a discount rate that is lower than best-estimate may be beneficial. This approach biases the plan to benefit increases and is a variant of conditional indexation.

- If what we ultimately care about is the long-term experience of pensioners over their entire retirement period (potentially 30-40 years) then the probability of a shortfall over a relatively short horizon (e.g., until the next valuation) is only a proxy, and not a very good one at that. The distribution of the frequency of benefit adjustments, combined, over long periods of time, with the distribution of the sizes of those adjustments creates a complex benefit distribution. As a result, focusing on the frequency of reductions without considering the size of those reductions can be misleading.

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[45] See performance metric 1 for plan design 9B, compared to design 8B.
[46] See performance metric 2 for plan design 9B.
[47] See performance metrics 5 and 9a for plan design 9B, compared to design 8B.
[48] See, for example, the change in the median replacement ratio (metric 5) from the 1st to the 25th to the 50th cohort.
[49] Where a benefit is increased one year and immediately reduced the following year, or vice versa.

8. Areas for Further Exploration

The POG identified the following areas of interest for future study of target benefit plans:

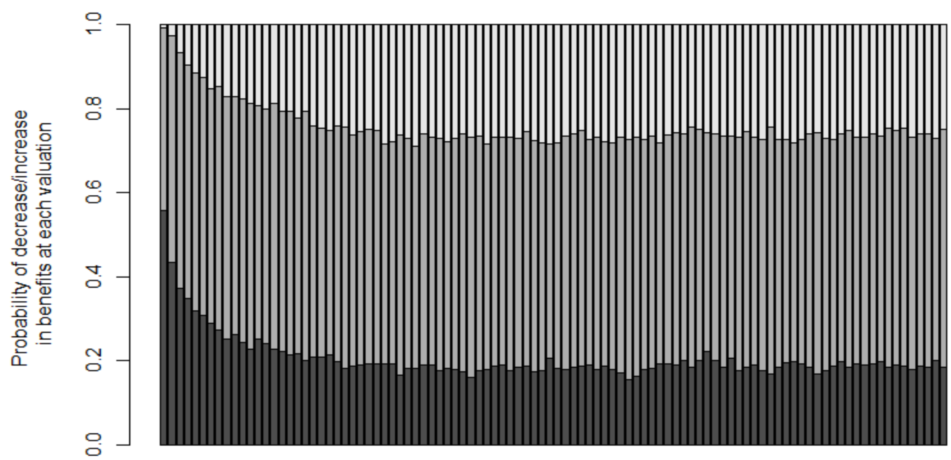
- Performance metrics that are easy to communicate and which can capture shifts in the distribution of benefits in response to changes in plan design or assumptions.
- Affordability tests based on alternative valuation methods, such as Entry Age Normal or Aggregate.
- Separate fund for pensioner assets, invested more conservatively, to provide explicit, enhanced protection to pensions in pay.
- Plan designs with accrual rates based on final-average earnings, rather than career-average earnings.
- Plan designs that allow contributions to vary within a narrow range.
- Alternative population models, suitable for plans that are set up for future service accruals only, or for future members only, or plans in which the number of new entrants declines over time.
- More realistic population models that can take into account termination prior to retirement and the impact of lump sum payouts.
- The impact of plan size on the sustainability of a TBP.

Appendix A – Examples of Performance Metrics

A graphical summary of each performance metric was generated for the POG for each design and assumption set considered. The results for Design 4 with assumption set B (best-estimate/best-estimate) and the medium equity content asset mix are shown below, for illustrative purposes.

Metric 1: Probability of benefit reductions/increases, by valuation year

The x-axis represents valuation years 1-100. The darkest bar on the bottom represents the probability of benefit reductions in a particular year, the lightest bar on top represents the probability of benefit increases in the same year, and the bar in the middle is the probability that the benefit does not change in that particular year (applicable when there is a “no-action range”). The total of these three probabilities must be 1.00 each year.



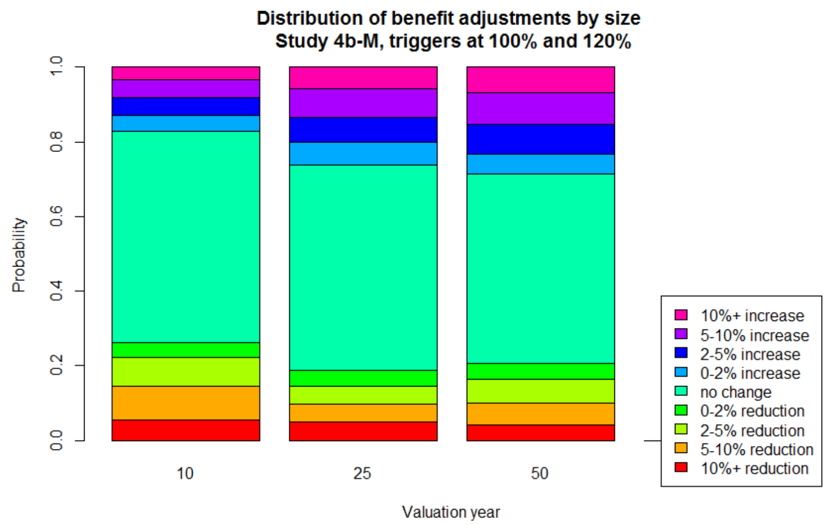
Metric 2: Probability of AT LEAST ONE benefit reduction over a 1-, 3-, 9-, 15-year horizon

The annual benefit adjustments (whose distribution is shown above) are applied consecutively. Their combined impact over a specific horizon is reflected in Metric 2, which is concerned with downside risk. The time frames selected reflect actual practice: annual probabilities are often considered at the design phase, 3-year probabilities are similar to the horizon reflected in the Alberta regulations for target benefit plans, and the 15-year horizon is referenced in the New Brunswick regulations for Shared Risk Plans. Each timeframe begins at plan inception; “starting the clock” at a different point in time (for example, 10 years after plan inception) can change the corresponding probabilities significantly.

1 year	3 years	9 years	15 years
56%	77%	91%	95%

Metric 3: Distribution of annual benefit adjustments by size (%), by valuation year

Metric 3 is a refinement of Metric 1, with the probabilities of benefit improvements and reductions further classified by size. Altogether, adjustments are grouped into 9 categories (see legend in lower right corner of chart below). Instead of showing the resulting probabilities for each valuation year, as is done on the previous page, three representative years (10, 25, and 50 years after inception) are plotted for comparison in the figure below. Placing the plots side-by-side helps trace the evolution of members' annual benefit risk (upside and downside) over time.



Metric 4: Distribution of replacement ratio at retirement, by cohort[50]

Metric 4 shows the cumulative effect of annual benefit adjustments applied during members' active working lives. The distribution of the replacement ratio (annual pension at age 65, as a proportion of annual salary during the previous year) for different cohorts of retirees reflects the growing uncertainty inherent in the asset model.

Cohort	1	10	25	50
25th percentile	36%	29%	29%	37%
50th percentile	36%	33%	36%	47%
75th percentile	36%	38%	43%	57%
IQR	0%	9%	14%	20%
Mean	36%	33%	38%	50%

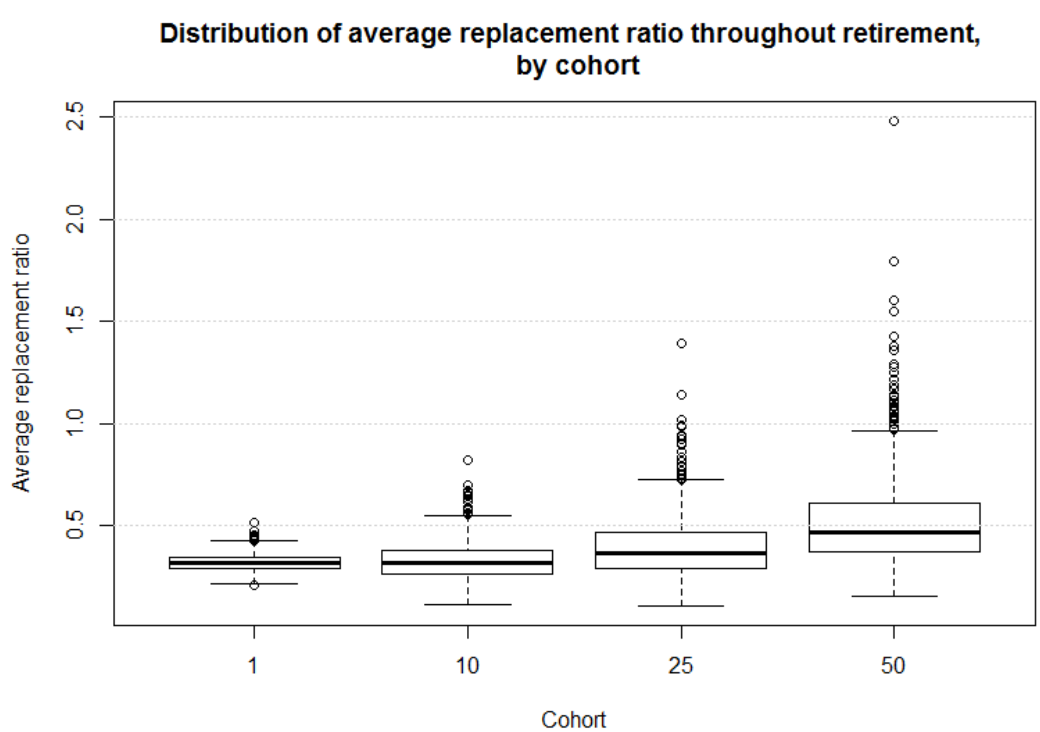
[50] "Cohort" refers to members retiring in a given year. Cohort 1 is the group of members who turn age 65 and retire immediately at inception of the TBP (i.e. all of their service is brought in from the predecessor plan). Their retirement years span from inception to year 38. Cohort 10 is the group of members who are age 56 at plan inception and retire 9 years after plan inception. Their retirement years span year 9 to year 47. Cohort 50 is the group of members who join the plan 9 years after plan inception (at age 25) and retire 49 years after plan inception (at age 65). Their retirement years span year 49 to year 87.

Metric 5: Distribution of average replacement ratio throughout retirement

While Metric 4 captures the cumulative impact of benefit adjustments *up until* retirement, Metric 5 also takes into account the impact of adjustments *after* retirement. For each cohort of retirees, the annual pensions payable in each year after retirement are weighted in proportion to the member's probability of survival to that year. The resulting "weighted average pension during retirement" is then converted into a replacement ratio, dividing by the member's salary during their last year of employment. The distribution of the resulting weighted average replacement ratio is shown in the table below, for four representative cohorts of retirees. Note that using Metric 5 the variability in the first retiring cohort's actual pensions is also captured (this was not the case under Metric 4).

Cohort	1	10	25	50
25th percentile	29%	27%	29%	37%
50th percentile	32%	32%	37%	47%
75th percentile	35%	38%	47%	61%
IQR	5%	11%	17%	24%
Mean	32%	33%	39%	52%

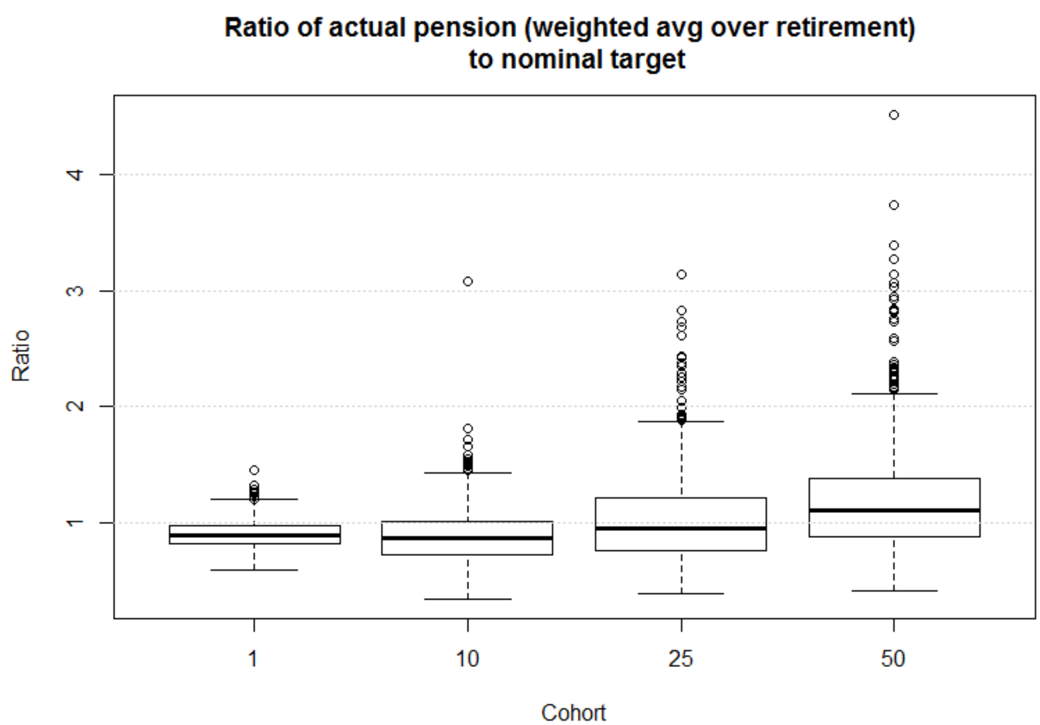
The figure below presents classic box-and-whisker plots of the distribution of the "weighted average replacement ratios" for the same four cohorts of retirees. Each cohort's plot shows the median (the thick line inside the rectangular box), the first and third quartiles (upper and lower edges of the box, so that the entire box contains the middle 50% of the distribution), "whiskers" extending to the lowest and highest data points still within 1.5 IQRs from the edges of the box, and circles marking simulated outcomes beyond these thresholds (i.e., more than 1.5 IQR from the first or third quartiles, usually classified as outliers). The plots effectively illustrate the location, dispersion and skewness of the distributions in question, allowing for side-by-side comparison of different cohorts.



Metric 6: Ratio of actual pension to nominal target (weighted average over retirement)

Metric 6 takes the same "weighted average pension during retirement" calculated under Metric 5 and expresses it as a proportion of the targeted pension applicable at the time of retirement. Since the target is based on a career-average-earnings formula, it partially takes into account wage inflation during the member's working life; however, the target is only applied in nominal terms after retirement. The figures in the table below indicate that, under this design and these particular assumptions, on average, the actual pension received over a member's retirement years can be expected to be at or near the nominal target, but would likely not be able to keep up with inflation after retirement.

Cohort	1	10	25	50
25th percentile	0.8	0.7	0.8	0.9
50th percentile	0.9	0.9	1.0	1.1
75th percentile	1.0	1.0	1.2	1.4
IQR	0.2	0.3	0.4	0.5
Mean	0.9	0.9	1.0	1.2



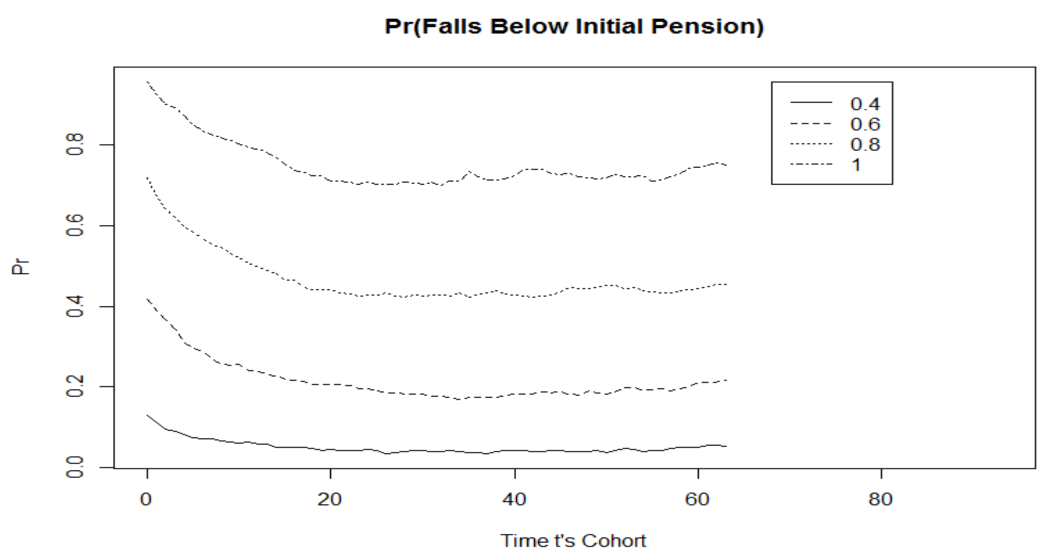
Metric 7: Probability of actual pension payment falling below 100%/80%/60%/40% of INITIAL pension at any point during the retirement period

Each of the four lines in the chart below represents probabilities of actual pensions falling below a specific threshold, where the thresholds are set as 100%, 80%, 60% and 40% of the member's initial pension payable at age 65, respectively. Each line consists of 64 distinct points, corresponding to the simulated experience of 64 different cohorts of retirees, starting with those who retire immediately at inception, to those who retire 64 years after inception.

On the chart below, the leftmost point of the top line (corresponding to a value of 0 on the x-axis and a value of 0.96 on the y-axis) denotes a 96% probability that the pension of a member who retires immediately at inception (at time 0) will see their pension drop below its initial amount (that is, the amount payable at age 65) *at some point during their retirement*. Similarly, the rightmost point of the second line from the top (corresponding to a value of 64 on the x-axis and a value of 0.44 on the y-axis) denotes a 44% probability that the pension of a member who retires 64 years after inception will see their pension drop below 80% of its initial amount *at some point during their retirement*.

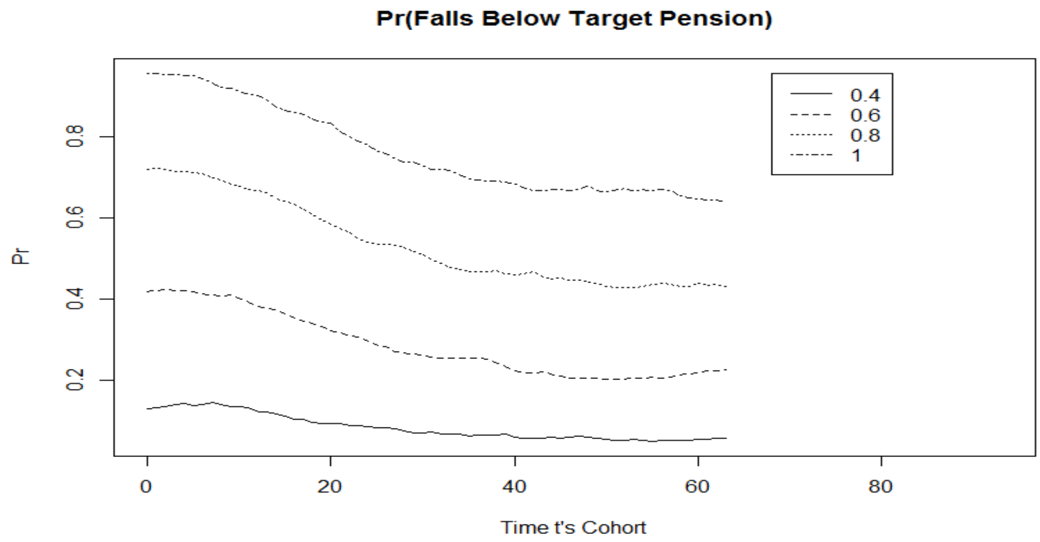
Near-horizontal lines mean the shortfall probabilities do not change much from cohort to cohort, whereas lines with steep slopes indicate rapidly changing downside risk profiles.

Importantly, Metric 7 does not capture the adequacy of the pension received. Specifically, a low probability of shortfall may correspond to a low pension amount, but this is not indicated anywhere on this chart.



Metric 8: Probability of actual pension payment falling below 100%/80%/60%/40% of TARGET pension at any point during the retirement period

Metric 8 is similar to Metric 7, but it takes the nominal target pension as the relevant threshold, instead of the member's initial pension at retirement. The points on each line have similar interpretations to those for Metric 7. Note that Metric 8 is not directly comparable when the target accrual is not the same (for example, when comparing outputs based on the risk-free discount rate versus the best-estimate discount rate).

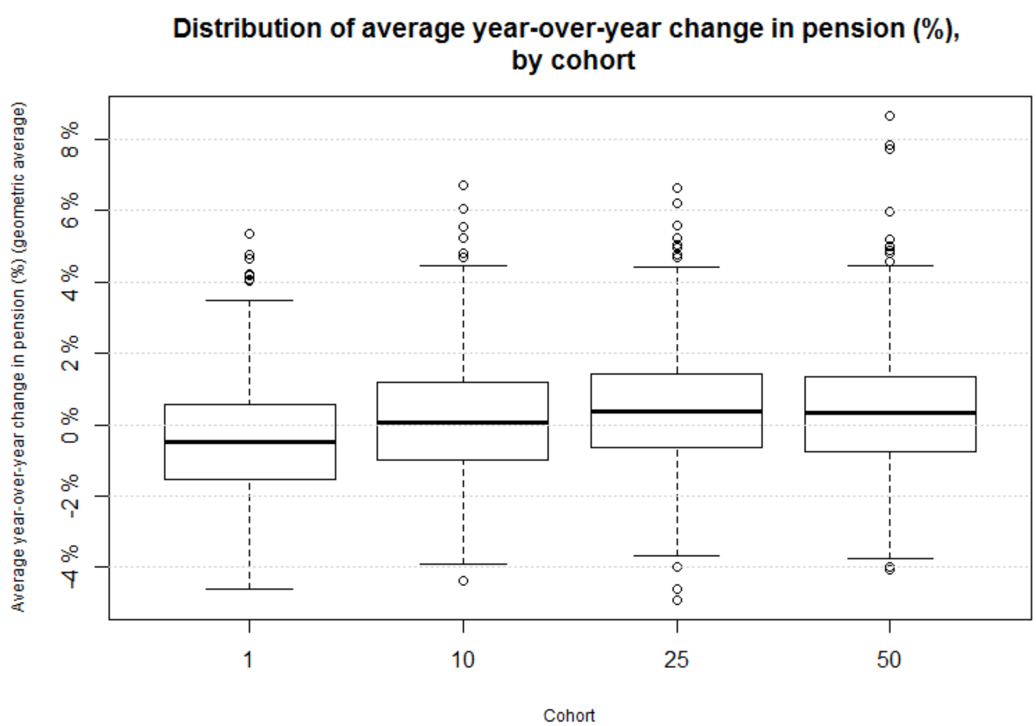


Metric 9: Distribution of average year-over-year change in pension amount by cohort

For this metric, the cumulative impact of annual benefit adjustments is translated into a single annual compound rate of change applicable over each retiring cohort's life. The resulting rate can be interpreted as the "average growth rate" applicable to the pension of a particular cohort of members over their retirement years.[51] This transformation removes information about the year-to-year volatility of the pension amount, but it does capture the general direction and magnitude of changes over a long horizon.

The distribution of these rates is shown in the table below for four illustrative cohorts. Note that, in this particular example, the distribution of average adjustments is skewed towards negative values for the first cohort of pensioners under the plan (those who retire immediately at inception) with the median value of the "average growth rate" being -0.5% a year. In other words, half the time in our simulations under this setup, the changes in the pension payable to the first cohort were *equivalent to* a reduction of half a percent *every year after age 65*. Later cohorts are likely to experience better outcomes, with the median value of the "average growth rate" being +0.4% and +0.3% per year during the retirement period of members who retire 25 or 50 years after plan inception, respectively.

Cohort	1	10	25	50
25th percentile	-1.5%	-1.0%	-0.6%	-0.7%
50th percentile	-0.5%	0.1%	0.4%	0.3%
75th percentile	0.6%	1.2%	1.4%	1.4%
IQR	2.1%	2.2%	2.1%	2.1%
Mean	-0.5%	0.1%	0.4%	0.4%



[51] An adjustment is made for the probability of survival to each age beyond 65.

Metric 10: Probability of benefit adjustment reversals over the first and second 15 years after inception

Stability of benefit increases can be important to stakeholders: it is often viewed as undesirable to give a benefit increase which is “clawed back” or “reversed” shortly thereafter. Metric 10 measures the probability of benefit adjustment reversals over a 15-year horizon, where a reversal is classified as a benefit reduction immediately following on the heels of a benefit increase. Note that this metric can be sensitive to the plan’s funded ratio at the beginning of the horizon in question; under Design 4, reversals are twice as likely in the second 15 years as they are in the first 15 years.

	First 15 years	Second 15 years
Probability of reversal	4.8%	8.7%

Appendix B – Summary of Model Outputs

The tables below summarize model outputs for a variety of plan designs (indicated by the numbers in the headings) and assumption sets (indicated by the letters A-D in the headings). The shaded columns can be used as a baseline for comparing variants on the same page. For more information about the various performance metrics and their interpretation, refer to Appendix A.

		1A	1A	1A	1B	1C	1D
Equity content		low	medium	high	medium	medium	medium
Accrual rate applicable to past service on conversion[52]		1.0% (RF)	1.0% (RF)	1.0% (RF)	1.45% (BE)	1.45% (BE)	1.0% (RF)
Target accruals for service after conversion[20]		1.0% (RF)	1.0% (RF)	1.0% (RF)	1.90% (BE)	1.0% (RF)	1.90% (BE)
Trigger point		FR=100%	FR=100%	FR=100%	FR=100%	FR=100%	FR=100%
Performance metric:							
1	Annual probability of - benefit cuts - no change - improvements	33% 0% 67%	36% 0% 64%	38% 0% 62%	47% 0% 53%	39% 0% 61%	43% 0% 57%
2	Probability of **at least** one reduction in first 15 years	100%	100%	100%	100%	100%	100%
3	Probability of accrued benefits being reduced by more than 5% - in year 10 - in year 50	12% 11%	20% 18%	26% 23%	27% 25%	22% 20%	29% 23%
5	Median RR[53]: - 1st cohort of retirees - 25th cohort - 50th cohort	27% 33% 41%	28% 37% 45%	28% 40% 50%	34% 37% 45%	37% 35% 37%	23% 38% 56%
6	Median pension as multiple of target:[54] - 1st cohort - 50th cohort	1.2 (0.8) 2.1 (1.1)	1.1 (0.8) 2.0 (1.1)	1.1 (0.7) 2.2 (1.0)	0.9 1.1	1.0 1.6	0.9 1.3
7a	Probability of falling below initial pension[55]	54% (74%)	62% (76%)	68% (77%)	90% (96%)	71% (85%)	80% (95%)
7b	Probability of falling below 80% of initial pension[54]	4% (11%)	16% (26%)	30% (40%)	60% (74%)	24% (40%)	40% (71%)
9a	Median annualized growth rate during retirement period - 1st cohort - 50th cohort	1.9% 2.3%	2.3% 2.5%	2.6% 2.8%	-0.4% 0.0%	1.5% 1.8%	0.0% 1.0%
9b	IQR of annualized growth rate	~1.5%	~2.0%	~2.7%	~2.0%	1.7%-2.0%	2.5%-2.2%
10	Probability of benefit reversal (years 15-30)	100%	100%	100%	100%	100%	100%

[52] RF = based on risk-free rate; BE = based on best-estimate rate
[53] Weighted average replacement ratio, taking into account benefit adjustments after retirement.
[54] Target depends on assumption basis. For studies basing future accruals on the risk-free rate (1A, 1C), the number in brackets is multiple of best-estimate target, provided for comparability with other designs.
[55] Long-term probability. For comparison, corresponding probability for first cohort of retirees given in brackets.

		1B	2B	3B	4B	5B	6B
Equity content		medium	medium	medium	medium	medium	medium
Accrual rate applicable to past service on conversion		1.45% (BE)	1.45%	1.45%	1.45%	1.45%	1.45%
Target accruals for service after conversion		1.90% (BE)	1.90%	1.90%	1.90%	1.90%	1.90%
Trigger points		FR=100%	FR=90% FR=110%	FR=80% FR=120%	FR=100% FR=120%	FR=100% FR=140%	FR=90% FR=110%
Performance metric							
1	Annual probability of - benefit cuts - no change - improvements	47% 0% 53%	19% 58% 23%	13% 71% 16%	18% 55% 27%	11% 67% 22%	17% 50% 33%
2	Probability of **at least** one reduction in first 15 years[56]	100%	87%	61%	95%	93%	84%
3	Probability of accrued benefits being reduced by more than 5% - in year 10 - in year 50	27% 25%	14% 11%	11% 6%	15% 10%	14% 6%	13% 9%
5	Median RR[57]: - 1st cohort of retirees - 25th cohort - 50th cohort	34% 37% 45%	34% 37% 45%	35% 36% 44%	32% 37% 47%	32% 35% 49%	34% 36% 46%
6	Median pension as multiple of target: - 1st cohort - 50th cohort	0.9 1.1	1.0 1.0	1.0 1.0	0.9 1.1	0.9 1.1	1.0 1.1
7a	Probability of falling below initial pension[58]	90% (96%)	76% (87%)	64% (76%)	72% (96%)	55% (96%)	71% (86%)
7b	Probability of falling below 80% of initial pension[57]	60% (74%)	49% (64%)	43% (54%)	44% (72%)	32% (71%)	46% (64%)
9a	Median annualized growth rate during retirement period - 1st cohort - 50th cohort	-0.4% 0.0%	-0.4% 0.0%	-0.4% 0.0%	-0.5% 0.3%	-0.7% 0.7%	-0.4% 0.1%
9b	IQR of annualized growth rate	~2.0%	~2.1%	~2.1%	~2.1%	~2.2%	~2.1%
10	Probability of benefit reversal (years 15-30)	100%	5.4%	0.1%	8.7%	0.4%	4.1%

[56] This probability is high for studies 4B and 5B because the funded ratio at inception is at the lower trigger point. Over time, the distribution of the funded ratio drifts up to be centered around the midpoint of the affordability range, and the resulting probabilities would be more like those shown for studies 2B and 3B, respectively.
[57] Weighted average replacement ratio, taking into account benefit adjustments after retirement.
[58] Long-term probability. For comparison, corresponding probability for first cohort of retirees given in brackets.

		5B	7B	8B	9B
Equity content		medium	medium	medium	medium
Accrual rate applicable to past service on conversion		1.45%	1.45%	1.45%	1.45%
Target accruals for service after conversion		1.90%	1.90%	1.90%	1.90%
Trigger points		FR=100% FR=140%	FR=100% FR=140%	FR=100% FR=140%	FR=100% FR=140%
Performance metric:					
1	Annual probability of - benefit cuts - no change - improvements	11% 67% 22%	10% 71% 19%	10% 72% 18%	4% 77% 19%
2	Probability of **at least** one reduction in first 15 years[59]	93%	91%	91%	52%
3	Probability of accrued benefits being reduced by more than 5% - in year 10 - in year 50	14% 6%	9% 6%	9% 3%	5% 1%
5	Median RR[60]: - 1st cohort of retirees - 25th cohort - 50th cohort	32% 35% 49%	32% 35% 50%	33% 34% 46%	36% 31% 46%
6	Median pension as multiple of target: - 1st cohort - 50th cohort	0.9 1.1	0.9 1.2	0.92 1.15	1.00 1.21
7a	Probability of falling below initial pension[61]	55% (96%)	49% (94%)	50% (94%)	29% (61%)
7b	Probability of falling below 80% of initial pension[60]	32% (71%)	28% (68%)	22% (53%)	10% (19%)
9a	Median annualized growth rate during retirement period - 1st cohort - 50th cohort	-0.7% 0.7%	-0.7% 0.5%	-0.2% 0.3%	0.1% 0.0%
9b	IQR of annualized growth rate	~2.2%	~2.2%	~1.4%	~1.5%
10	Probability of benefit reversal (years 15-30)	0.4%	0.2%	0.2%	0.1%

[59] This probability is high for studies 5B, 7B, 8B and 9B because the funded ratio at inception is at the lower trigger point.

[60] Weighted average replacement ratio, taking into account benefit adjustments after retirement.

[61] Long-term probability. For comparison, corresponding probability for first cohort of retirees given in brackets.