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Member's Paper

A Practical Approach to Establishing Margins for Adverse Deviations in Going Concern Funding Valuations

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Abstract	**Résumé**
In response to the decline in defined benefit (DB) pension plans, some Canadian pension jurisdictions (e.g., Québec and Ontario) have revised, or propose to revise, their regulations to eliminate or ease the solvency funding requirements while enforcing a stronger going concern funding requirement. These new funding regimes require additional contributions to be made in respect of a provision for adverse deviations (PfAD) for normal cost and going concern liabilities. The PfAD is expressed as a fixed percentage of the going concern liabilities of a plan calculated using best estimate assumptions, and is included as a part of the plan's funding target. In this paper, we propose an alternative design for a PfAD through the development of a margin for incorporation in the going concern discount rate. The margin reflects a plan's investment policy, its level of maturity, as well as the current level of long-term interest rates. The paper demonstrates that adoption of our proposed approach to setting the going concern discount rate would enhance the funding of DB plans while facilitating the management of funding risk in a going concern context.	En réponse au recul des régimes de retraite à prestations déterminées (PD), certaines administrations des régimes de retraite au Canada (p. ex., le Québec et l'Ontario) ont revu, ou proposé de revoir, leur réglementation afin d'éliminer ou d'assouplir les exigences de capitalisation du déficit de solvabilité tout en appliquant une exigence plus rigoureuse de capitalisation selon l'approche de continuité. Ces nouveaux régimes de capitalisation exigent une augmentation des cotisations pour établir une provision pour écarts défavorables (PED) au titre du coût normal et du passif de continuité. La PED est exprimée en pourcentage fixe du passif de continuité d'un régime calculé à l'aide d'hypothèses de meilleure estimation, et elle fait partie de la cible de capitalisation du régime. Dans le présent document, nous proposons une conception alternative pour une PED par l'intermédiaire du développement d'une marge à inclure dans le taux d'actualisation selon l'approche de continuité. La marge reflète la politique de placement d'un régime, sa maturité et le niveau actuel des taux d'intérêt à long terme. Il est démontré que l'adoption de la démarche que nous proposons pour établir le taux d'actualisation selon l'approche de continuité permettrait d'améliorer la capitalisation des régimes PD tout en facilitant la gestion du risque de capitalisation dans un contexte de continuité.

Introduction

With some exceptions[1], employers of defined benefit (DB) pension plans in Canada are required to fund their plans on both a going concern basis and a solvency basis. Pension standards legislation prescribes that employers must contribute to their pension plans a minimum amount equal to the normal cost plus amortization of any unfunded liability every year. Both the normal cost and accrued liabilities are determined on the basis of a going concern valuation that assumes the plan would remain in place indefinitely. Additional contributions must 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 the market conditions at the date of valuation, namely, the market value of plan assets and long-term interest rates (CIA b., 2018) (CIA c., 2017). Long-term government bond yields have been trending downward from the 6 to 8 percent range in the 1990s to the 2 to 3 percent range in recent years. As a result, the solvency funding costs of DB plans have increased dramatically, and in some instances they are well in excess of the going concern funding costs (CIA d., 2018). Fluctuations in market bond yields mean that solvency funding costs are also unstable and unpredictable. Given these funding challenges, many employers have chosen to terminate or close their DB plans to new members and replace them with a defined contribution arrangement.

In response to the decline in DB sponsorship, some Canadian pension jurisdictions (e.g., Québec and Ontario) have revised, or propose to revise, their regulations to eliminate or ease the solvency funding requirements, while enforcing a stronger going concern funding requirement. To date, all new prescribed funding rules for DB plans require additional contributions to be made in respect of a provision for adverse deviations (PfAD) for normal cost and going concern liabilities. However, there are differences among jurisdictions in how the PfAD is determined and applied to determining the funding requirement for a pension plan. Appendix A highlights the new funding rules for DB plans that have been implemented in Québec and Ontario.

The PfAD provision as prescribed in Québec or Ontario would increase the going concern funding requirement but does not appear to address a funding risk that concerns most DB plan sponsors. Where there is no requirement for solvency funding, that risk is the unexpected increase in required contributions resulting from (1) adverse plan experience[2] that may arise from time to time, and/or (2) a reduction of going concern discount rate due to a decrease in expected long-term investment returns on plan assets. This paper proposes a practical approach to establishing a margin or provision for adverse deviations that would not only strengthen the going concern funding requirement but would also facilitate the management of ongoing funding risk faced by DB plan sponsors.

[1] Such as multi-employer and jointly sponsored pension plans in Ontario.

[2] For example, lower-than-expected investment returns or higher-than-expected salary growth (in salary-related plans).

The CIA Research

In March 2017, the Canadian Institute of Actuaries (CIA) and the Society of Actuaries (SOA) published a research paper on the establishment of a PfAD to be applied in going concern funding valuations (CIA-SOA a., 2017). The PfAD for a plan is determined as the amount that might be exhausted by economic losses over a three-year period for a certain level of confidence. It is expressed as a fixed percentage of the going concern liabilities of the plan calculated using best estimate assumptions, and is included as a part of the plan's funding target.

It appears that the CIA Research was not intended to address the funding risk described earlier. For instance,

- The addition of a PfAD to the going concern liabilities and normal cost would increase the contribution requirements, but would not reduce the likelihood of an increase in contributions that might result from a lower-than-expected investment return over an inter-valuation period.
- It would not lessen any adverse contribution impact due to a decrease in the going concern discount rate either. In fact, as noted from the bottom of page 4 of the CIA Research, it can magnify the increase in required contributions.

As the going concern discount rate increases due to rising long-term interest rates, the PfAD determined as a fixed percentage of going concern liabilities would be reduced in size when in fact it should have been increased to allow for possible interest rate reversals in the future.

A Proposed Approach to Determining Discount Rate Margins

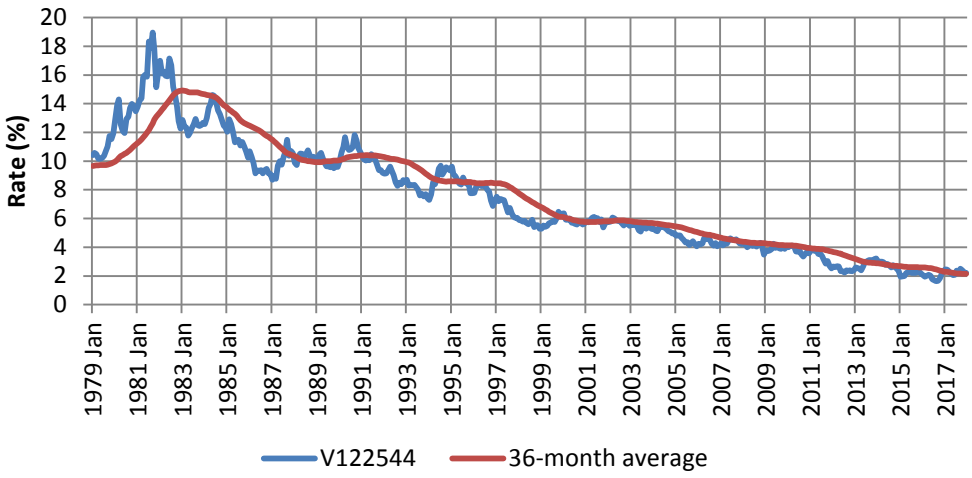
The CIA Standards of Practice (CIA b., 2018) provides that in performing a going concern funding valuation, the actuary should select either best estimate assumptions or best estimate assumptions modified to incorporate margins for adverse deviations if required by law or by the terms of the actuary's engagement. For the valuation of a funded pension plan, the actuary may establish the best estimate discount rate to reflect the expected investment return on the plan's assets based on the plan's investment policy, or the yields on fixed-income investments with cash flows which would reasonably match the plan's projected benefit payments. In Canada, it is more common for actuaries to set a discount rate based on the expected return approach.

The CIA provides guidance to actuaries who set a discount rate based on a best estimate of expected future investment returns (CIA e., 2015). It describes a building-block approach for establishing a best estimate discount rate which combines the best estimate long-term, expected future investment returns for different asset classes based on a plan's investment policy, and takes into account the effects of diversification and rebalancing, allowance for investment expenses, and/or additional return from active investment management. The guidance suggests that it is reasonable to assume a "risk premium" for equity investments in the range of 3 to 5 percent per annum over the yield on long-term Government of Canada (GoC) bonds depending on market conditions. For plans with allocation to multiple asset classes, the actuary may make an allowance for diversification return in the range of 0.3 percent to 0.5 percent per annum, in addition to the weighted average of the annual

compound returns on the plan assets. The guidance also provides an illustrative example that determines a best estimate discount rate with reference to the expected return on long-term GoC bonds at the valuation date, suggesting that the best estimate discount rate could vary according to the changes in long-term GoC bond yields.

From the historical data, we note considerable month-to-month volatility in the long-term GoC bond yields. Setting the best estimate discount rate based on the bond yield in the month of valuation[3] might result in funding volatility which is difficult to manage and control. To facilitate the management of ongoing funding risk, we propose to moderate the discount rate impact due to fluctuations in market interest rates by taking the average of the monthly bond yields over the 36-month period immediately preceding a valuation date[4]. Figure 1 below shows the historical 10-year GoC bond yields (CANSIM series V122544) and the corresponding 36-month averages from 1979 to 2017 inclusive. Appendix B contains an extract of the historical data we used to develop this graph.

Figure 1: Historical Long-Term GoC Bond Yields



The best estimate discount rate is a very important determinant in the valuation process. However, it is a long-term forecast based primarily on the actuary's judgment and does not come without error. The real-world peculiarities in the distribution of financial returns, combined with the dynamics of plan demographics, can have important implications on the long-term viability of pension plans. Those responsible for the financial management of pension plans should consider using a discount rate assumption that includes a plan-specific margin for adverse deviations for going concern funding purposes. To this end, we propose to develop a going concern discount rate by adding the components described in Table 1.

[3] It should be noted that there is no unique way to establish a best estimate discount rate. Some Canadian actuaries take the position that the best estimate discount rate should move in tandem with the changes in long-term GoC bond yields, while others do not necessarily agree.

[4] We chose this period to be consistent with the typical triennial valuation cycle under Canadian funding practice.

Table 1: Determination of discount rates for going concern funding valuations

Component	Best Estimate Discount Rate (set by actuary as per CIA guidance)[5]	Going Concern Discount Rate (set by regulatory authority or sponsor)
Risk-free rate	• Average of 10-year GoC bond yields (CANSIM series V122544) over a 36-month period preceding the date of valuation	• Best estimate with a dynamic margin described below
Equity risk premium	• Applied to the equity portion set out in a plan's investment policy • Best estimate, maximum: 5% per annum	• Applied to the equity portion set out in a plan's investment policy • Best estimate with a margin depending on the level of plan maturity[6] • The more mature the plan, the higher the margin applied
Fixed-income risk premium	• Applied to the fixed-income portion under a plan's investment policy • Best estimate, maximum: 1.5% per annum	• Applied to the fixed-income portion under a plan's investment policy • Best estimate with a margin
Diversification and rebalancing	• Best estimate, maximum: 0.5% per annum for balanced portfolios (i.e., 50% in fixed income; 50% in non-fixed income) • Graded down linearly to 0% for asset mix of 100/0 or 0/100 [7]	• Best estimate, with or without a margin
Return from active investment management	• Based on plan experience	• None
Expense allowance	• Best estimate	• Best estimate

Investment losses[8] over an inter-valuation period, if not offset by the existing funding excess and/or gains from other sources, must be funded by special payments over a period prescribed by pension regulations. Compared to the best estimate discount rate, use of a discount rate that incorporates a margin for adverse deviations would reduce the likelihood and extent of such investment losses. No additional special payments would be required if the plan assets were able to realize at least a return equal to the discount rate with margin, which is lower than the best estimate discount rate (and if no other losses occurred).

[5] In this formulation, it is assumed that the actuary will set the risk-free rate component of the best estimate discount rate as the average of 10-year GoC bond yields over a 36-month period preceding the date of valuation.
[6] Based on some measurement of plan maturity (e.g., proportion of pensioners).
[7] Full diversification return is allowed for portfolios with a 50/50 mix. For a target asset mix of $x/(100-x)$, where x is not equal to 50 and not more than 100, only a fraction of the full diversification return is allowed. The fraction is calculated as: $1 - abs(50 - x)/50$.
[8] Relative to the discount rate assumption used in the going concern funding valuation.

If the best estimate discount rate is used in a going concern valuation, decline in long-term GoC bond yields could generate an unfunded liability that must be met by additional funding contributions. To address this interest rate risk, we could establish a dynamic margin to absorb or mitigate the negative contribution impact resulting from a transient decline in GoC bond yields. The margin would move within a reasonable range and in a countercyclical fashion against the changes in best estimate liabilities[9]. An algorithm to develop such a margin is described below:

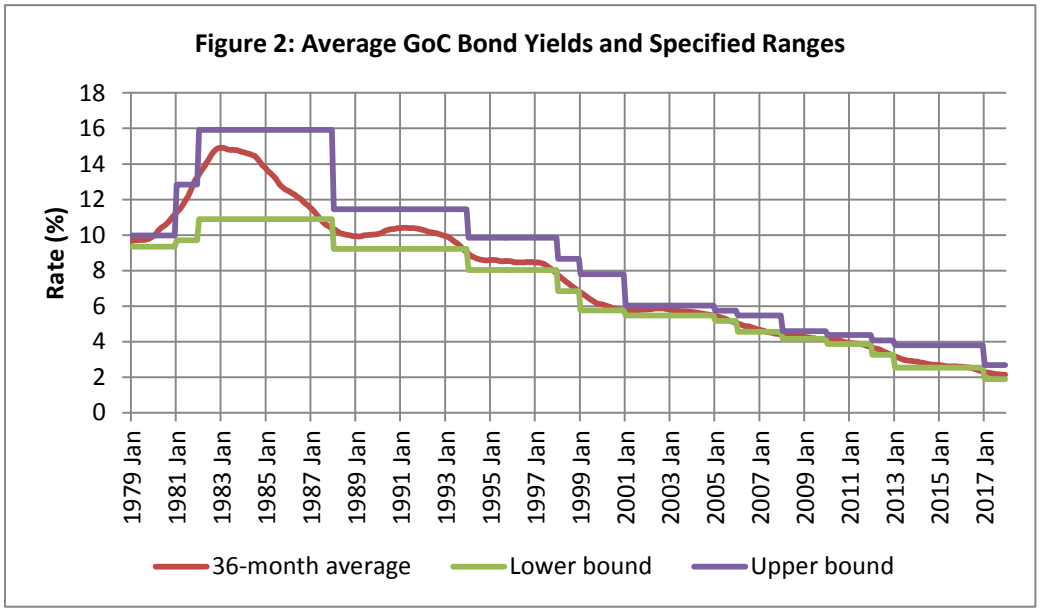
1. Historical data on long Government of Canada bond yields (CANSIM series V122544) are available as far back as January 1976. We select January 1979 as the algorithm start date.
2. Determine the average (m) and the standard deviation (s) of the monthly bond yields over the 36-month period preceding January 1979, and set a specified range as ($m - s$, $m + s$). The best estimate risk-free rate at January 1979 is m, and the risk-free rate component of the going concern discount rate is set as $m - s$. Thus, a margin of s is incorporated in the risk-free rate component at the start date.
3. At the next January:
    - If the average of V122544 rates over the 36-month period preceding the new date (i.e., the best estimate risk-free rate at the new date) falls within the preset specified range of ($m - s, m + s$), the risk-free rate component of the going concern discount rate is kept unchanged at $m - s$. The margin relative to the best estimate risk-free rate is allowed to vary between 0 and $2s$ without triggering a change to the going concern discount rate. It will be higher as the 36-month average moves up toward the upper bound of the specified range and lower as the 36-month average moves down toward the lower bound.
    - If the new 36-month average falls outside the preset specified range, the specified range is reset as ($m' - s', m' + s'$), where m' and s' are the new 36-month average and standard deviation. The new best estimate risk-free rate is m', and the risk-free rate component of the going concern discount rate is set as $m' - s'$. The margin to be incorporated at the new date is changed to s'.
4. Step 3 is repeated at each subsequent January to determine the risk-free rate component of the going concern discount rate.

Figure 2 depicts the 36-month averages of GoC bond yields and the specified ranges for the period January 1979 to January 2018. With a few exceptions, the 36-month averages would fall within the specified ranges.

In our discount rate model, the 36-month averages are taken as the best estimate risk-free rates and the lower bounds of the specified ranges are taken as the risk-free rate component of

[9] This means that the margin will increase when the best estimate risk-free rate rises (which would decrease the best estimate liabilities) and decrease when the best estimate risk-free rate falls (which would increase the best estimate liabilities).

the going concern discount rates. Within any specified range, the margin would become larger as the best estimate risk-free rate moves up and smaller as the best estimate rate moves down.



Numerical Illustration

To illustrate, we apply the above methodology to determine the best estimate discount rates and going concern discount rates based on the parameters shown below[10]. The margin included in the going concern discount rate would vary depending on a plan's investment policy as well as its level of maturity.

[10] The parameters shown here are for illustration only. In practical applications, the plan actuary, regulatory authority, or plan sponsor should select them based on their own analysis and judgment.

Date of valuation	Any date in 2018
36-month average of long GoC bond yields	• 2.13% at January 2018 (see Appendix B)
Specified range	• Best estimate risk-free rate may vary between 1.89% and 2.68% without triggering a change to going concern discount rate (see Appendix B)
Risk-free rate component of going concern discount rate	• Equal to 1.89% • If a valuation is performed at January 2018, a margin of 0.24% (= 2.13% - 1.89%) for the risk-free rate component is applied
Equity risk premium	• Best estimate: 5% • With margin: 3.5% for mature plans, 4.5% for immature plans, and 4% for average maturity plans
Fixed-income risk premium	• Best estimate: 1.5% • With margin: 1.25%
Diversification return	• Best estimate: 0.5% for balanced portfolios • With margin: 0.4% for balanced portfolios
Added return from active management	• None
Expense allowance	• Assumed to be zero

Table 2 gives the results of discount rate margins[11] for an average maturity plan, corresponding to the indicated asset mixes and best estimate risk-free rates. Appendix C provides the results for mature and immature plans.

Table 2: Discount rate margins

		Best estimate risk-free rate				
Target asset mix — Percent allocated to non-fixed income	Going concern discount rate	1.89%	2.00%	2.25%	2.50%	2.68%
0	3.14%	0.25%	0.36%	0.61%	0.86%	1.04%
10	3.50%	0.35%	0.46%	0.71%	0.96%	1.14%
20	3.85%	0.44%	0.55%	0.80%	1.05%	1.23%
30	4.21%	0.53%	0.65%	0.90%	1.15%	1.33%
40	4.56%	0.63%	0.74%	0.99%	1.24%	1.42%
50	4.92%	0.73%	0.84%	1.09%	1.34%	1.52%
60	5.11%	0.78%	0.89%	1.14%	1.39%	1.57%
70	5.31%	0.84%	0.95%	1.20%	1.45%	1.63%
80	5.50%	0.89%	1.00%	1.25%	1.50%	1.68%
90	5.70%	0.95%	1.06%	1.31%	1.56%	1.74%
100	5.89%	1.00%	1.11%	1.36%	1.61%	1.79%

[11] Calculated as the difference between the best estimate discount rate and the going concern discount rate.

Observe that the higher the proportion of pension fund invested in non-fixed income assets, the higher the discount rate margin required. On the other hand, for a given asset mix, if the best estimate risk-free rate (which is based on long GoC bond yields) moves upward, a higher discount rate margin is applied to allow for possible future interest rate reversals.

Also note from Appendix C that the discount rate margins applied to the more mature plans are higher than those applied to the less mature plans.

Consider a plan with a target asset mix of 60 percent in equities and 40 percent in fixed-income assets. If the best estimate risk-free rate at a valuation date is 2 percent, the best estimate discount rate and going concern discount rate are determined to be 6.00 percent and 5.11 percent, respectively. The discount rate margin is equal to 0.89 percent, which is the difference between 6.00 percent and 5.11 percent. Details of the calculation appear below.

Component	Best Estimate Discount Rate (%)	Going Concern Discount Rate (%)
Risk-free rate	2.00	1.89
Equity risk premium	60% x 5 = 3.00	60% x 4 = 2.40
Fixed-income risk premium	40% x 1.5 =0.60	40% x 1.25 = 0.50
Diversification and rebalancing	0.8 x 0.5 = 0.40	0.8 x 0.4 = 0.32
Return from active management	0	0
Expense allowance	0	0
Total	**6.00**	**5.11**

Margins Versus Provisions for Adverse Deviations

The CIA Standards of Practice (CIA a., 2018) defines a provision for adverse deviations in terms of the best estimate assumptions and the margins incorporated in the assumptions for going concern actuarial valuations:

- Margin for adverse deviations is the difference between the assumption for a calculation and the corresponding best estimate assumption.
- Provision for adverse deviations is the difference between the actual result of a calculation and the corresponding result using best estimate assumptions.

Thus, the PfAD related to going concern liabilities or normal cost can be calculated as the difference between the actual result of a calculation and the corresponding result using best estimate assumptions.

In a paper on discount rate sensitivities published by the CIA and the SOA (CIA-SOA b., 2017), the author of that paper estimates the effect of a change in liabilities for a pension plan due to a change in discount rate from i_0 to i_1, by multiplying the liabilities by the following factor:

$$\exp\left[-(18-10.5p)\times(i_1-i_0)\times\left(1-8\left(\frac{i_0+i_1}{2}-5.25\%\right)\right)\right]$$

where p is the proportion of liabilities that relates to pensions in pay. Using this approximation factor and assuming $p = 0.5$, we translate the discount rate margins in Table 2 into PfADs and express them as a percentage of liabilities calculated using the best estimate discount rate assumption. Table 3 provides the PfAD percentages.

As an illustration, consider the above case where the best estimate discount rate (denoted as i_0) is 6.00 percent and the going concern discount rate (denoted as i_1) is 5.11 percent. Let L^{i_0} and L^{i_1} be the liabilities corresponding to i_0 and i_1, respectively. Using the above approximate factor with $p = 0.5$, we arrive at the following relationship:

$$L^{i_1} = L^{i_0} \cdot \exp\left[-(18 - 10.5 \times 0.5) \times (0.0511 - 0.06) \times (1 - 8\left(\frac{0.0511 + 0.06}{2} - 0.0525\right)\right]$$
$$= 1.1171 \cdot L^{i_0}$$

Thus, the PfAD for liabilities, expressed as a percentage of the liability calculated using the best estimate discount rate, is 11.71 percent.

Table 3: Provisions for adverse deviations

	Best estimate risk-free rate				
Target asset mix – Percent allocated to non-fixed income	1.89%	2.00%	2.25%	2.50%	2.68%
0	3.76%	5.44%	9.31%	13.25%	16.12%
10	5.08%	6.73%	10.51%	14.36%	17.17%
20	6.33%	7.94%	11.65%	15.40%	18.14%
30	7.51%	9.09%	12.70%	16.36%	19.02%
40	8.63%	10.16%	13.68%	17.23%	19.81%
50	9.66%	11.16%	14.57%	18.02%	20.52%
60	10.24%	11.71%	15.07%	18.45%	20.91%
70	10.79%	12.23%	15.54%	18.86%	21.27%
80	11.31%	12.73%	15.98%	19.24%	21.59%
90	11.81%	13.21%	16.39%	19.59%	21.89%
100	12.29%	13.65%	16.78%	19.91%	22.16%

Conclusion

We have introduced a practical approach to establishing a discount rate margin for incorporation in the going concern discount rate. The margin reflects a plan's investment policy, its level of maturity, as well as the current level of long-term interest rates. It has the following desirable properties:

- It is higher for plans that adopt a riskier investment policy;
- It is higher for mature plans than for less mature plans; and

- It moves with long-term interest rates that fall within a specified range—a higher (lower) margin is applied when interest rates move up (down).

Going concern discount rates incorporating a margin as determined by our methodology would change less frequently than the best estimate discount rates. They would still track the trend of changes in long-term bond yields, albeit with a lag.

With a going concern discount rate so determined, sponsors and managers of pension plans would be in a better position (1) to anticipate any change in the funded status of their pension plans, and (2) to arrange for the funding of emerging losses or spending of emerging gains, well in advance of the scheduled date of valuation. Adoption of our proposed approach to setting the going concern discount rate would enhance the funding of DB plans while facilitating the management of ongoing funding risk.

This paper proposes a different design for a PfAD through the development of a margin to be incorporated in the going concern discount rate. It would be useful to project the funding outcomes (in terms of level and volatility of normal costs, special payments, total annual contributions, assets, liabilities, and funded ratios) under this PfAD design, and compare them with the projection results under the Québec and Ontario PfAD rules[12]. The projections should be developed for plans with different characteristics that include benefit design, plan maturity, investment policy, etc. The comparative results so derived would help shed light on the choices for a PfAD design for adoption by government policy makers or plan sponsors.

[12] Other elements of the Québec or Ontario funding rules (e.g., use of asset smoothing, amortization rules, use of surplus for contribution holidays, etc.) would be retained for projection purposes.

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Appendix A – Funding Reforms in Québec and Ontario

The funding reforms in Québec and Ontario pertaining to defined benefit pension plans have several key themes in common. They are as follows.

1. **Reduced solvency funding**. Adopting a lower threshold for solvency funding or no solvency funding requirement at all.
2. **Enhanced going concern (GC) funding requirement**. Requiring funding of an additional margin in GC liabilities and normal cost and a shorter amortization period.
3. **Use of best estimate assumptions with provision for adverse deviations.** Replacing margin in discount rate and other assumptions with a margin in liabilities and normal cost on a best-estimate basis.
4. **Benefit improvements**. Requiring separate amortization of benefit improvements with possible immediate payment to achieve minimum funding.
5. **Restriction on contribution holidays**. Requiring going concern and solvency funding thresholds be met before any application of surplus for contribution holidays.
6. **Transitional provision**. Allowing phase-in of contribution increases due to new funding rules over a three-year period.

The table below presents a summary comparison between the Québec's and Ontario's new funding rules.

Issue	Ontario	Québec
1. GC funding requirement		
– **Provision for adverse deviation (PfAD)** **(In Québec, it is referred to as "stabilization provision".)**	• Require to fund PfAD for both GC liabilities and normal cost (except for future indexation) • PfAD depends on whether a plan is open or closed to new members and the plan's target asset mix • Higher PfAD if GC discount rate exceeds prescribed benchmark discount rate (BDR)	• Require to fund PfAD minus 5% for GC liabilities and full PfAD on normal cost • PfAD is derived from a 2-dimensional grid based on a plan's target asset mix and level of mismatch in asset and liability duration
– **GC unfunded liabilities**	• Amortized over a maximum period of 10 years • No tracking of separate amortization schedules required - special payments for unfunded liabilities would be consolidated into a single 10-year schedule at each valuation date (i.e., a "fresh-start" approach)	• Same as Ontario

Issue	Ontario	Québec
2. Solvency funding requirement	• Require funding of any shortfall below 85% of adjusted solvency liabilities • Amortized over a maximum period of 5 years	• None required
3. Benefit improvements	• If solvency and GC funded ratios are at least 80% after improvement - cost of improvement is funded over a maximum period of 8 years • Otherwise, a lump sum payment to fund improvement is required; both solvency and GC funded ratios after improvement must not be less than what they were before improvement	• Unfunded liability resulted from improvement is funded over a maximum period of 5 years • If the plan has a funded ratio of less than 90%, a special improvement payment must be paid instead
4. Use of surplus assets	• Require full funding of GC liabilities and PfAD • Require funding to 105% level on wind-up basis (solvency basis for public sector plans) Note: In Ontario, indexation needs not be included in solvency valuation	• Require full funding of GC liabilities and PfAD plus 5% • Require funding to 105% level on solvency basis
5. Letter of credit (LC)	• Recognized only for solvency funding to get to 85% level	• Recognized for both solvency and GC funding • New LC can only be taking for funding of PfAD

Appendix B – Extract of Historical Long Government of Canada Bond Yields

Notes to the bond rate table:

- All figures are in percent.
- Annualized V122544 rates are calculated from the semi-annual rates posted on the Bank of Canada website[13].
- The 36-month average rates are taken as the best estimate risk-free rates.
- The "lower bound rates" are taken as the risk-free rate component of the going concern discount rates.

				Specified range		Margin
Date	Annualized V122544	36-month average (1)	36-month std dev (2)	Lower bound (3) = (1) - (2)	Upper bound (1) + (2)	(1) - (3)
1979 Jan	10.43	9.67	0.31	9.35	9.98	0.31
1979 Feb	10.58	9.69	0.34	9.35	9.98	0.33
1979 Mar	10.48	9.71	0.37	9.35	9.98	0.35
1979 Apr	10.17	9.71	0.38	9.35	9.98	0.36
1979 May	10.17	9.72	0.38	9.35	9.98	0.36
1979 Jun	10.23	9.72	0.39	9.35	9.98	0.37
1979 Jul	10.37	9.72	0.39	9.35	9.98	0.37
1979 Aug	10.72	9.73	0.40	9.35	9.98	0.38
1979 Sep	11.02	9.75	0.43	9.35	9.98	0.40
1979 Oct	11.76	9.79	0.48	9.35	9.98	0.43
1979 Nov	11.52	9.84	0.58	9.35	9.98	0.49
1979 Dec	11.94	9.90	0.64	9.35	9.98	0.55
1980 Jan	12.94	9.98	0.71	9.35	9.98	0.63
1980 Feb	13.92	10.09	0.85	9.35	9.98	0.73
1980 Mar	14.31	10.21	1.05	9.35	9.98	0.86
1980 Apr	12.56	10.34	1.25	9.35	9.98	0.99
1980 May	12.12	10.43	1.29	9.35	9.98	1.08
1980 Jun	11.97	10.50	1.31	9.35	9.98	1.15
1980 Jul	12.94	10.58	1.32	9.35	9.98	1.22
1980 Aug	13.09	10.68	1.36	9.35	9.98	1.32
1980 Sep	13.70	10.78	1.39	9.35	9.98	1.43
1980 Oct	13.98	10.91	1.45	9.35	9.98	1.55
1980 Nov	13.83	11.04	1.51	9.35	9.98	1.68
1980 Dec	13.47	11.16	1.55	9.35	9.98	1.81
1981 Jan	13.80	11.27	1.57	9.70	12.84	1.57
1981 Feb	14.23	11.39	1.60	9.70	12.84	1.68
1981 Mar	14.37	11.51	1.64	9.70	12.84	1.81
1981 Apr	15.86	11.64	1.68	9.70	12.84	1.94

[13] http://www.bankofcanada.ca/rates/interest-rates/lookup-bond-yields/

				Specified range		Margin
Date	Annualized V122544	36-month average (1)	36-month std dev (2)	Lower bound (3) = (1) - (2)	Upper bound (1) + (2)	(1) - (3)
1981 May	16.01	11.81	1.79	9.70	12.84	2.11
1981 Jun	15.89	11.99	1.88	9.70	12.84	2.28
1981 Jul	18.33	12.16	1.95	9.70	12.84	2.45
1981 Aug	17.91	12.40	2.16	9.70	12.84	2.69
1981 Sep	18.96	12.63	2.29	9.70	12.84	2.92
1981 Oct	17.80	12.89	2.47	9.70	12.84	3.18
1981 Nov	15.15	13.10	2.55	9.70	12.84	3.40
1981 Dec	16.12	13.24	2.52	9.70	12.84	3.54
1982 Jan	17.00	13.41	2.50	10.90	15.91	2.50
…	…	…	…	…	…	…
…	…	…	…	…	…	…
2015 Jan	1.94	2.69	0.28	2.54	3.81	0.14
2015 Feb	1.96	2.67	0.31	2.54	3.81	0.12
2015 Mar	1.98	2.65	0.33	2.54	3.81	0.11
2015 Apr	2.20	2.63	0.35	2.54	3.81	0.09
2015 May	2.26	2.61	0.36	2.54	3.81	0.07
2015 Jun	2.39	2.61	0.36	2.54	3.81	0.07
2015 Jul	2.21	2.61	0.36	2.54	3.81	0.07
2015 Aug	2.21	2.61	0.36	2.54	3.81	0.07
2015 Sep	2.22	2.61	0.36	2.54	3.81	0.07
2015 Oct	2.27	2.61	0.37	2.54	3.81	0.06
2015 Nov	2.30	2.60	0.37	2.54	3.81	0.06
2015 Dec	2.17	2.60	0.37	2.54	3.81	0.06
2016 Jan	2.06	2.60	0.37	2.54	3.81	0.05
2016 Feb	1.94	2.58	0.38	2.54	3.81	0.04
2016 Mar	2.01	2.56	0.40	2.54	3.81	0.02
2016 Apr	2.07	2.55	0.41	2.54	3.81	0.01
2016 May	2.02	2.54	0.42	2.54	3.81	0.00
2016 Jun	1.77	2.52	0.43	2.54	3.81	-0.02
2016 Jul	1.70	2.49	0.44	2.54	3.81	-0.05
2016 Aug	1.64	2.45	0.45	2.54	3.81	-0.09
2016 Sep	1.65	2.41	0.45	2.54	3.81	-0.13
2016 Oct	1.83	2.37	0.45	2.54	3.81	-0.17
2016 Nov	2.17	2.34	0.45	2.54	3.81	-0.20
2016 Dec	2.35	2.31	0.42	2.54	3.81	-0.23
2017 Jan	2.47	2.29	0.40	1.89	2.68	0.40
2017 Feb	2.43	2.27	0.38	1.89	2.68	0.38
2017 Mar	2.29	2.26	0.36	1.89	2.68	0.37
2017 Apr	2.17	2.24	0.34	1.89	2.68	0.35
2017 May	2.06	2.22	0.32	1.89	2.68	0.33

				Specified range		Margin
Date	Annualized V122544	36-month average (1)	36-month std dev (2)	Lower bound (3) = (1) - (2)	Upper bound (1) + (2)	(1) - (3)
2017 Jun	2.07	2.20	0.30	1.89	2.68	0.31
2017 Jul	2.36	2.18	0.28	1.89	2.68	0.28
2017 Aug	2.28	2.17	0.27	1.89	2.68	0.27
2017 Sep	2.51	2.16	0.26	1.89	2.68	0.27
2017 Oct	2.39	2.15	0.25	1.89	2.68	0.26
2017 Nov	2.24	2.14	0.24	1.89	2.68	0.25
2017 Dec	2.21	2.14	0.23	1.89	2.68	0.25
2018 Jan		2.13	0.23	1.89	2.68	0.24

Appendix C – Discount Rate Margins for Mature and Immature Plans

The following tables give the discount rate margins for mature and immature plans, developed based on our proposed methodology.

(a) Mature plans

		Best estimate risk-free rate				
Target asset mix - Percent allocated to non-fixed income	Going concern discount rate	1.89%	2.00%	2.25%	2.50%	2.68%
0	3.14%	0.25%	0.36%	0.61%	0.86%	1.04%
10	3.45%	0.40%	0.51%	0.76%	1.01%	1.19%
20	3.75%	0.54%	0.65%	0.90%	1.15%	1.33%
30	4.06%	0.68%	0.80%	1.05%	1.30%	1.48%
40	4.36%	0.83%	0.94%	1.19%	1.44%	1.62%
50	4.67%	0.98%	1.09%	1.34%	1.59%	1.77%
60	4.81%	1.08%	1.19%	1.44%	1.69%	1.87%
70	4.96%	1.19%	1.30%	1.55%	1.80%	1.98%
80	5.10%	1.29%	1.40%	1.65%	1.90%	2.08%
90	5.25%	1.40%	1.51%	1.76%	2.01%	2.19%
100	5.39%	1.50%	1.61%	1.86%	2.11%	2.29%

(b) Immature plans

		Best estimate risk-free rate				
Target asset mix - Percent allocated to non-fixed income	Going concern discount rate	1.89%	2.00%	2.25%	2.50%	2.68%
0	3.14%	0.25%	0.36%	0.61%	0.86%	1.04%
10	3.55%	0.30%	0.41%	0.66%	0.91%	1.09%
20	3.95%	0.34%	0.45%	0.70%	0.95%	1.13%
30	4.36%	0.39%	0.50%	0.75%	1.00%	1.18%
40	4.76%	0.43%	0.54%	0.79%	1.04%	1.22%
50	5.17%	0.48%	0.58%	0.84%	1.09%	1.27%
60	5.41%	0.48%	0.59%	0.84%	1.09%	1.27%
70	5.66%	0.48%	0.60%	0.85%	1.10%	1.28%
80	5.90%	0.49%	0.60%	0.85%	1.10%	1.28%
90	6.15%	0.50%	0.61%	0.86%	1.11%	1.29%
100	6.39%	0.50%	0.61%	0.86%	1.11%	1.29%