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EDUCATIONAL NOTE SUPPLEMENT

Changes to the Reference Curves' Ultimate Risk-free Rate Development Approach Outlined in the Committee on Life Insurance Financial Reporting's Educational Note on IFRS 17 Discount Rates

July 12, 2023

Changes to the reference curves' ultimate risk-free rate development approach outlined in the Committee on Life Insurance Financial Reporting's educational note on IFRS 17 discount rates

Committee on Life Insurance Financial Reporting

The Committee on Life Insurance Financial Reporting (CLIFR) would like to acknowledge the contribution of its subcommittee that assisted in the development of this document: Amal Rajwani (Co-chair), Simon Fortin (Co-chair), Steve Bocking, Craig Fyfe, Saul Gercowsky, Marc-André Lépine and Nicolas Lévesque.

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The actuary should be familiar with relevant other guidance. They expand or update the guidance provided in an educational note. They do not constitute standards of practice and are, therefore, not binding. They are, however, intended to illustrate the application of the Standards of Practice, so there should be no conflict between them. The actuary should note however that a practice that the other guidance describe for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation. Responsibility for the manner of application of standards of practice in specific circumstances remains that of the members. As standards of practice evolve, other guidance may not reference the most current version of the Standards of Practice; and as such, the actuary should cross-reference with current Standards.

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Preamble

The principles-based nature of IFRS 17 could lead to a wide range of practice among actuaries, particularly when setting discount rates beyond the observable period. Consequently, the Committee on Life Insurance Financial Reporting (CLIFR) and the Committee on Property and Casualty Insurance Financial Reporting (PCFRC) have adopted a set of liquid and illiquid reference curves to facilitate comparison of discount rates among entities. Canadian regulators require a comparison of the entity's discount curves to the reference curves in the Appointed Actuary's Report.

In the process of updating the parameters of the reference curves for 2023, it was observed that the significant rise in short-term inflation relative to long-term inflation expectation had a material impact on the reference curves' ultimate risk-free rate (URFR). As this was not expected, a subcommittee of CLIFR was formed to review the approach to determine the reference curves' URFR.

The purpose of this educational note supplement is to provide a summary of the changes to the reference curves' URFR development approach that are expected to be reflected later this year in the IFRS 17 educational notes related to discount rates. CLIFR is releasing this summary of changes ahead of publishing an update to the affected educational notes. Educational notes that will be impacted by this change are as follows:

- *IFRS 17 Discount Rates for Life and Health Insurance Contracts* published by CLIFR in June 2022. Section 2 within Chapter 2 of this educational note outlines the approach used to define the reference curves. This educational note will be updated to reflect the changes described herein.
- *IFRS 17 Discount Rates and Cash Flow Considerations for Property and Casualty Insurance Contracts* published by the PCFRC in November 2022. Section 4 discusses discount rates and Section 5 discusses the reference curves. Both sections refer to CLIFR's educational note for guidance on this topic which will be updated, as referenced above.
- *Application of IFRS 17 Insurance Contracts to Public Personal Injury Compensation Plans* published by the Committee on Workers' Compensation (CWC), in June 2022. Section 5.2.2 "Discount Rates" refers to CLIFR's educational note.

As such, this update to CLIFR's discount rate educational note applies to members in the life insurance, property and casualty insurance, and public personal injury compensation plan areas.

Process

A preliminary version of this document was shared with the following committees:

- Actuarial Guidance Council (AGC)
- Committee on Life Insurance Financial Reporting (CLIFR)
- Property and Casualty Insurance Financial Reporting Committee (PCFRC)
- Committee on Risk Management and Capital Requirements
- Appointed/Valuation Actuary Committee
- Committee on Workers' Compensation

CLIFR is satisfied that comments received have been sufficiently addressed. The creation of this educational note supplement has followed the AGC's protocol for the adoption of educational notes and other material. In accordance with the Institute's *Policy on Due Process for the Approval of Guidance Material other than Standards of Practice and Research Documents*, this educational note supplement has been prepared by CLIFR and has received approval for distribution from the AGC on July 11, 2023.

Responsibility of the actuary

The actuary should be familiar with relevant other guidance. They expand or update the guidance provided in an educational note. They do not constitute standards of practice and are, therefore, not binding. They are, however, intended to illustrate the application of the Standards of Practice, so there should be no conflict between them. The actuary should note however that a practice that the other guidance describe for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation. Responsibility for the manner of application of standards of practice in specific circumstances remains that of the members. As standards of practice evolve, other guidance may not reference the most current version of the Standards of Practice; and as such, the actuary should cross-reference with current Standards.

Your feedback

Questions or comments regarding this educational note supplement may be directed to the chair of CLIFR and the co-chairs of this subcommittee (noted above).

1. Reference curves' ultimate risk-free rate – current approach

The reference curves' ultimate risk-free rate (URFR) is set based on historical interest rate information and the inflation target of the Bank of Canada (BoC). The interest rate components consist of the estimated short-term real rate and the estimated term premium. A 25-year exponential moving average (EMA), applied to monthly data starting at December 31, 1960, is used both for the estimated short-term real rates and the estimated term premiums. The EMA formula used is as follows:

$$EMA(t) = Data(t) \times \alpha + EMA(t-1) \times (1 - \alpha)$$

Where:

- Data(t) represents the most recent observation at time t;
- $\alpha = 2 / (N + 1)$ and N is equal to 300 months (i. e., $\alpha = 2/301$).

The URFR is then calculated as follows:

$$URFR(t) = EMA(t)_{\text{estimated short-term real rates}} + EMA(t)_{\text{estimated term premiums}} + \text{inflation target}(t)$$

Where:

- The estimated short-term real rates are derived using the monthly BoC V122541 series (BoC's three-month treasury bill nominal rates) from which the monthly year over year growth of the V108785713 index (CPI-Common) is subtracted.
- The estimated term premiums are derived as the difference between the monthly BoC V122487 (BoC's nominal long-term bond rates) and V122541 (BoC's three-month treasury bill nominal rates) series.
- The inflation target(t) is the midpoint of the BoC inflation target range, which is 2% at the time of publication of this educational note supplement.

Based on the formula, the reference curves' URFR currently in effect (and in effect up to October 14, 2023) is 3.65%. The next update to the URFR will be effective on October 15, 2023, and will utilize actual data up to the end of 2022. The current approach caps annual changes to the URFR at 15 basis points to avoid unwarranted volatility.

2. Observations regarding current approach

Two observations regarding the current approach were made by the subcommittee:

1. Rise of short-term inflation in 2022 led to unintended consequences.
2. Use of an EMA in the reference curves' URFR calculation leads to unwarranted volatility.

1. Rise of short-term inflation in 2022 led to unintended consequences

Conceptually, the current approach can be simplified as follows:

$$URFR(t) = EMA(t)_{\text{estimated short-term real rates}} + EMA(t)_{\text{estimated term premiums}} + \text{inflation target}(t) \quad \langle \textit{current approach} \rangle$$

$$= [EMA(t)_{\text{short-term nominal rates}} - EMA(t)_{\text{CPI Common YoY Growth}}] + [EMA(t)_{\text{long term nominal rates}} - EMA(t)_{\text{short-term nominal rates}}] + \text{inflation target}(t)$$

$$= EMA(t)_{\text{long-term nominal rates}} - EMA(t)_{\text{CPI Common YoY Growth}} + \text{inflation target}(t) \quad \langle \textit{simplified} \rangle$$

Where:

- Long-term nominal rates use the monthly BoC V122487 series.
- CPI Common YoY Growth is the monthly year over year growth of the V108785713 index.
- The inflation target(t) is the mid range of the BoC inflation target, which is 2% at the time of publication of this educational note supplement.

Given that the short-term nominal rates in the formula above cancel out, the current approach is essentially approximating long-term real rates by subtracting short-term inflation (CPI-Common) from long-term nominal rates. However, long-term real rates should conceptually be derived by subtracting long-term inflation from the long-term nominal rate. The use of short-term inflation within this calculation as a proxy for long-term inflation is only reasonable when short-term inflation is consistent with long-term inflation expectations within the market. Short-term inflation had been consistent with long-term inflation expectations at the time the current approach was developed and in the previous two decades. However, this may not always be the case since short-term inflation is much more reactive to current market conditions than long-term inflation expectations.

In 2022, short-term inflation rose sharply, and the existing methodology produced materially negative long-term real rates; however, long-term real rate expectations within the market were positive. This results in negative data being added to the reference curves' URFR calculation and the use of the EMA formula, which places more weight on recent data, put material downward pressure on the URFR (see the table below). Under the current approach, the unrounded URFR would move from 3.63% using data up to December 31, 2021, to 3.27% using data up to December 31, 2022. This is the unintended consequence of the implicit assumption embedded in the current approach that short-term inflation could be used in a long-term estimate.

URFR calculation under the current approach and comparison of the actual long-term real rate to estimated long-term real rate used in the URFR

Month	Long-term nominal rate	CPI-common YoY growth	Inflation target	Data added to the EMA formula	Calculated URFR (unrounded)	Estimated long-term real rate	Actual long-term real rate[1]
	(A)	(B)	(C)	(A - B + C)		(A - B)	
Dec 2021	1.76%	3.70%	2.00%	0.06%	3.63%	-1.94%	-0.04%
Jan 2022	2.08%	4.10%	2.00%	-0.02%	3.61%	-2.02%	0.33%
Feb 2022	2.25%	4.60%	2.00%	-0.35%	3.58%	-2.35%	0.56%
Mar 2022	2.47%	5.20%	2.00%	-0.73%	3.56%	-2.73%	0.58%
Apr 2022	2.84%	5.60%	2.00%	-0.76%	3.53%	-2.76%	0.91%
May 2022	2.82%	6.30%	2.00%	-1.48%	3.49%	-3.48%	1.05%
Jun 2022	3.27%	6.50%	2.00%	-1.23%	3.46%	-3.23%	1.41%
Jul 2022	2.87%	6.80%	2.00%	-1.93%	3.43%	-3.93%	1.05%
Aug 2022	3.08%	6.50%	2.00%	-1.42%	3.39%	-3.42%	1.24%
Sep 2022	3.05%	6.50%	2.00%	-1.45%	3.36%	-3.45%	1.26%
Oct 2022	3.46%	6.50%	2.00%	-1.04%	3.33%	-3.04%	1.39%
Nov 2022	3.04%	6.80%	2.00%	-1.76%	3.30%	-3.76%	1.14%
Dec 2022	3.34%	6.60%	2.00%	-1.26%	3.27%	-3.26%	1.22%
Jan 2023	2.94%	6.60%	2.00%	-1.66%	3.24%	-3.66%	1.08%
Feb 2023	3.37%	6.40%	2.00%	-1.03%	3.21%	-3.03%	1.35%

The material difference in short-term inflation versus long-term inflation expectations led to the assumption (i.e., short-term inflation tends to be consistent with long-term inflation expectations) within the current methodology to be broken. Therefore, the methodology should be reviewed to eliminate such assumption and to be appropriate across various economic environments.

2. Use of an exponential moving average in the reference curves' URFR calculation leads to unwarranted volatility

During the review of the approach to determine the URFR, the subcommittee conducted a wider range of tests covering various economic environments (see the appendix for details). Under persistent stagflation and deflation scenarios (leading respectively to higher and lower than recent interest rate environments), the calculated annual changes in URFRs (either calculated under the current approach or alternative ones, and before the 15 bps cap) would be significantly more than 15 bps for each year of the scenarios. A direct cause of this unwarranted volatility is the use of the EMA that places more weight on recent data. The illustrative scenarios in the appendix show that the use of a 25-year EMA using data from December 31, 1960, makes the reference curves' URFR approximately twice as volatile versus the use of a cumulative average using data from January 1998.

The 15 bps cap for annual changes in the reference curves' URFR represents a level of volatility that is deemed unwarranted in the context of the very long-term nature of the URFRs. When this cap was introduced, expectations were that the cap would rarely be breached given the methodology to set the URFR was expected to be relatively stable. The goal for such a cap was instead to limit volatility from structural changes such as a change in the Bank of Canada's inflation target.

[1] Sourced via monthly long-term real rates (BoC V122553 series).

In conclusion, the volatility observed by the sub-committee suggested that the use of an EMA leads to unwarranted volatility in the reference curves' URFR.

3. Reference curves' ultimate risk-free rate – revised approach

1. Revised approach

The reference curves' URFR is set based on the average of the monthly historical nominal interest rates (BoC V122487 series) from January 1998 to the end of the preceding calendar year in which the rate becomes effective.

Based on this new approach, the URFR to be effective on October 15, 2023, would be **3.65%** (3.64% rounded to the nearest five basis point, using monthly data from January 1998 to December 2022).

Each future annual review will consider an additional year of data (e.g., data from January 1998 to December 2023 to set the URFR effective on October 15, 2024) and the new effective reference curves' URFR will be set as follows to avoid undue volatility:

Absolute difference between new calculated URFR (unrounded) and the current effective URFR	New effective URFR
Less than 10 bps	Current effective URFR is maintained
Greater or equal to 10 bps and less than 15 bps	± 10 bps as appropriate (vs. current effective URFR)
15 bps or more	± 15 bps as appropriate (vs. current effective URFR)

The following table illustrates how the new effective URFR on October 15, 2024, would be determined based on the new calculated URFR under four hypothetical scenarios (and knowing the current effective URFR is 3.65%):

Hypothetical scenario	New calculated URFR	New effective URFR	Commentary
#1	3.69%	3.65%	No change since the new calculated URFR was within +/-10 bps of the current effective URFR.
#2	3.56%	3.65%	No change since the new calculated URFR was within +/-10 bps of the current effective URFR.
#3	3.54%	3.55%	A 10 bps decrease since the new calculated URFR was more than -10 bps but less than -15 bps versus the current effective URFR.
#4	3.44%	3.50%	Decrease capped at 15 bps since the new calculated URFR was more than -15 bps versus the current effective URFR.

CLIFR will monitor the approach and assess its appropriateness on a periodic basis. Furthermore, if a structural change in the economy happens (e.g., change in the BoC's inflation target), CLIFR will review whether any changes to the approach to determine the reference curves' URFR are warranted.

2. Rationale for the use of historical nominal rates

The following three approaches were considered by the subcommittee:

1. Historical nominal rates, which is the revised approach.
2. Historical real rates plus inflation target, with long-term real rates directly set using BoC's long-term real rates (V122553 series.) This is conceptually like the current approach (historical estimated long-term real rates + BoC inflation target).
3. The BoC's nominal neutral short-term rate plus historical term premium. The BoC nominal neutral short-term rate (mid-point of a target range), which is the "*policy rate consistent with output at its potential level after the effects of all cyclical shocks have dissipated*", represents forward-looking information directly available (see Section 2.2.3 of CLIFR's IFRS 17 discount rates educational note for more details). This rate was first published in 2014 and is updated annually. A term premium must be added, since the BoC's policy rate is a short-term rate.

The table below is a summary of the assessment of these three approaches based on the following considerations:

- Stability: Due to the very long-term nature of the URFR (i.e., a long-term rate far into the future), the influences of the current business cycle and short-term economic fluctuations on the URFR would be limited.
- Simplicity: The approach would be easy to understand and implement.
- Predictability: The approach would be easy to forecast under various economic scenarios.
- Technical robustness: The approach would be based on reliable data and would align with economic theory.

Consideration	Historical nominal rates	Historical real rates + inflation target	BoC nominal neutral short-term rate + historical term premium
Stability	Historical approach provides stability.	Historical approach provides stability.	Significant volatility as forward-looking approach puts significant weight on short-term fluctuations. The BoC nominal neutral short-term rate was 3.50% in 2014 and decreased over the next six years to reach 2.25% in 2020. It is now at 2.50% (as at April 2023).
Simplicity	Easy to understand and implement.	Easy to understand and implement.	BoC neutral rate involves complex macroeconomic concepts.

Consideration	Historical nominal rates	Historical real rates + inflation target	BoC nominal neutral short-term rate + historical term premium
Predictability	Forecasts require an assumption on long-term nominal rates.	Forecasts require an assumption on long-term real rates or long-term inflation rates.	BoC neutral rate involves complex macroeconomic concepts.
Technical robustness – data	Data available since 1936. Most reliable historical data as transactions on Canada long-term bonds take place with significant frequency and volume.	Data only available since 2001. Less robust historical data as transactions on Canada real return bonds take place with lower frequency and volume. Potential challenges with future data, as the Canadian government noted in late 2022 that they plan to suspend new issuances of real return bonds.	Data only available since 2014. Approach mostly relies on the modelling and judgments of the experts of the BoC. Past changes to the neutral rate have been partially explained by model refinements.
Technical robustness – theory	Does not use a forward-looking approach. It assumes that rates would be mean-reverting and there is no theoretical evidence that it is the case in Canada. Influenced by inflationary economic growth and future inflation expectation may be different than the past.	The real rates do not use forward-looking information, but the future inflation expectation is forward-looking. Theory suggests that real rates may exhibit greater mean reversion than nominal ones, but mean reversion for real rates is debatable as it assumes real economic growth is stable over time. Real rates are influenced less by inflationary growth than nominal rates.	Uses forward-looking information. Neutral rate informs on the trends in interest rates on a short-to-mid term basis, but it is not estimated for the purpose of URFR (far in the future).

The historical nominal rates approach was chosen considering the analysis above. It is the best choice with regard to almost all of the considerations.

The drawbacks of this choice relate to its theoretical robustness, which aligns with external stakeholder feedback received in 2020. While the “historical real rates + inflation target” approach may have a stronger theoretical foundation, this approach was not chosen due to concerns over the data robustness and the slightly increased complexity of forecasting these amounts in the future. Since the long-term inflation implicit in nominal long-term rates over the last two decades have been very close to BoC

inflation target of 2%,[2] this approach would yield a similar URFR to the one obtained using the historical nominal rates approach selected.

The approach of using the BoC neutral rate was not chosen as its sole advantage is to be forward-looking; however, it is more complex, has limited data to consider, and is focused on forecasting short-term rates in the short-to-medium term (i.e., about five years in the future). There is still value to this data point, and, as mentioned in Section 2.2.3 of CLIFR's IFRS 17 discount rates educational note, the BoC neutral rate is an additional input that could serve as a barometer to ensure the formula used to set the reference curves' URFR remains appropriate.

3. Rationale for using a cumulative average using data from January 1998

Context of the introduction of the EMA

The use of a 25-year EMA was introduced into the reference curves' URFR determination as a response to external stakeholder feedback received in 2020. At the time, comments were requested regarding the following four methodologies:

1. Historical long term nominal rate median using data since 1991
2. Average historical long-term real interest rate using data since 1936 + inflation target
3. Organisation for Economic Co-operation and Development GDP growth expectation + inflation target
4. Historical GDP growth using data since 1999

One general comment received from commenters on these methodologies is that more weight should be placed on recent data. Using an EMA(25) on data since December 31, 1960, was one of the possible approaches to address this feedback. Instead of using an EMA, one other approach to put more weight on recent data would be to shorten the historical data period used.

Analysis for the revised approach

The historical average methodology was set by looking at the following considerations:

- Stability: Due to the very long-term nature of the URFR (i.e., a long-term rate far into the future), the influences of the current business cycle and short-term economic fluctuations on the URFR would be limited. This view aligns with IFRS 17.B82(c)(i): "the entity might place more weight on long-term estimates than on short-term fluctuations" to "develop unobservable inputs."
- Simplicity: The approach would be easy to understand and implement.
- Appropriateness of the data: The data used should be appropriate to the purpose of the calculation performed. The following would be considered:
    - Appropriate experience years: Consideration of any structural changes that would make historical nominal rates not relevant for estimating future rates. Notably, data prior to 1991 would be excluded because it predates the establishment by the BoC of a monetary policy with an inflation target. Moreover, data from 1991 to 1997 would be excluded to reflect that there was a lag between the introduction of the monetary policy and its effect on long-term interest rates.
    - Use of multiple economic cycles: The appropriate experience would include a historical period covering multiple economic cycles. This is pertinent in the context of the very long-

[2] Difference between monthly long-term nominal rates (BoC V122487 series) and long-term real rates (BoC V122553 series) over 2001-2022 has been 1.98%. Long-term real rates data only available since 2001.

term nature of the URFR, where the current economic cycle does not represent more credible data than previous economic cycles that are considered relevant to estimating future interest rates.

The following three approaches were considered by the subcommittee:

1. Cumulative average using data from January 1998 to present (revised approach)
2. 25-year EMA using data from January 1998 to present
3. 25-year EMA using data from December 31, 1960, to present (current approach)

The following table shows the weights by experience year under these three approaches:

Type of average:	Simple average	EMA 25yr	EMA 25yr
Historical period:	**Jan 1998-2022**	**Jan 1998-2022**	**Dec 1960-2022**
<1987			6%
1988-1992			3%
1993-1997			4%
1998-2002	20%	20%*	7%
2003-2007	20%	10%	10%
2008-2012	20%	15%	15%
2013-2017	20%	22%	22%
2018-2022	20%	33%	33%
Total	100%	100%	100%

*13% on the rate as at January 31, 1998

The following table is a summary of the assessment of these three approaches:

Consideration	Cumulative average from January 1998	EMA(25) on data since January 1998	EMA(25) on data since December 1960
Stability	Limited volatility due to equal weights among relevant experience years. Each new additional year will have a weight of about 4% (e.g., 1/25th when adding 2022 experience year) of the total.	Additional volatility caused by more weight put on recent data (each new additional year will have a weight about 8% of the total), i.e., approximately twice as volatile vs. the use of a cumulative average on data from January 1998. Under stagflation and deflation scenarios (see the appendix), calculated annual changes in URFRs would be significantly more than 15 bps. Moving average approaches cause additional volatility due to the removal of past experience years in the experience period used for the average. Each year, for simple moving average, the oldest experience year is removed. For EMA approaches, the weights on older experience years are reduced.	

Consideration	Cumulative average from January 1998	EMA(25) on data since January 1998	EMA(25) on data since December 1960
Simplicity	Easy to understand and implement.	Easy to understand and implement.	
Appropriateness of the data	No weight on data prior 1998.	No weight on data prior 1998. Abnormal weight (13%) on the interest rate as at January 31, 1998.	Weight of 13% on data prior 1998 (calculation with data up to 2022).

First, based on the analysis above, the cumulative average from January 1998 was chosen. By assigning equal weights to all relevant experience years, this approach does not cause unwarranted volatility and places the same weight on all appropriate economic data. The EMA approaches were found to create unwarranted volatility as these approaches implicitly assume that recent data is a better indicator for estimating risk-free rates very far in the future than older data. While this is true in certain circumstances (e.g., the assumption that data from 1998-2022 is more appropriate for estimating future risk free rates than data from 1980-1998), there is no evidence that within shorter periods of time, the most recent data (e.g., 2018-2022) should have more weight than prior recent data (e.g., 2013-2017).

Second, the cumulative average approach can use the data from 1998 onward without any challenges regarding the appropriateness of the data. Alternatively, using the EMA(25) on data since January 1998 would put an abnormal weight (13%) on the interest rate as at January 31, 1998. As for the EMA(25) on data since December 1960, a 13% weight placed on data between 1960-1997 would not be appropriate since the revised URFR approach uses historical nominal rates[3] and monetary policy changes were made in the 1990s.

Third, the weights between the potential approaches are not different enough to discriminate one approach over another with respect of IFRS 17 requirements.

Finally, the subcommittee believes that removing experience years 1991-1997 addresses the comments raised by commenters in 2020 related to using appropriate economic data.

[3] The context was different under the current URFR approach (based on real interest rates and an inflation target)

Appendix – Illustrative scenarios of reference curves' ultimate risk-free rate

During the review of the approach to determine the reference curves' URFR, the subcommittee conducted a wider range of tests covering various economic environments. This appendix presents four illustrative scenarios and their impact on the estimated reference curves' URFR under three different approaches:

A. Current approach (historical real rate + inflation target, EMA25 on data from December 31, 1960)

B. Revised approach (historical nominal rates, cumulative average on data from January 1998)

C. Other considered approach (historical nominal rates, EMA25 on data from December 31, 1960)

The following table briefly summarizes the illustrative scenarios. The objective of some of these scenarios is to observe the behaviour of the estimated URFR under different approaches and under economic environments where inflation is very different from the BoC inflation target. Since these scenarios are for illustration only, the subcommittee has not assessed their probability of occurrence.

	Illustrative scenario	**Summary**
1	2022YE Environment Constant Projection	Economic environment at December 31, 2022 assumed constant in the future
2	4% LT nominal rate and 2% inflation	At December 31, 2023, and thereafter: - Long-term nominal rate: 4% - CPI-common year-over-year growth: 2%
3	Stagflation	During the years 2025, 2026 and 2027: - Long-term nominal rate: 8% - CPI-common year-over-year growth: 6%
4	Deflation	During the years 2025, 2026 and 2027: - Long-term nominal rate: 1% - CPI-common year-over-year growth: 0.5%

Long-term nominal rate: BoC V122487 series

CPI-common: BoC V108785713 index

Finally, by comparing the results of approaches B. and C., we can observe that the use of a 25-year EMA using data from December 31, 1960, makes the URFR approximately twice as volatile vs. the use of a cumulative average on data from January 1998.

Estimated reference curves' URFR (unrounded) by illustrative scenario

Annual changes that are larger than +/- 15 bps are highlighted in red.

1 - 2022YE Environment Constant Projection

			A. Current approach			B. Revised approach		C. Other considered approach	
			Historical real rate + inflation target EMA25 (data from Dec. 1960)			Historical nominal rates Cum. avg. (data from Jan. 1998)		Historical nominal rates EMA25 (data from Dec. 1960)	
Using data up to	Long-term nominal rate (A)	CPI-common YoY growth (B)	Data added to EMA formula (A - B + 2%)	Estimated URFR	Annual change	Estimated URFR	Annual change	Estimated URFR	Annual change
2021-12-31	1.76%	3.70%	0.06%	3.63%		3.67%		3.82%	
2022-12-31	3.34%	6.60%	(1.26%)	3.27%	(0.37%)	3.64%	(0.03%)	3.75%	(0.07%)
2023-12-31	3.34%	6.60%	(1.26%)	2.92%	(0.35%)	3.63%	(0.01%)	3.71%	(0.03%)
2024-12-31	3.34%	6.60%	(1.26%)	2.60%	(0.32%)	3.62%	(0.01%)	3.69%	(0.03%)
2025-12-31	3.34%	6.60%	(1.26%)	2.30%	(0.30%)	3.61%	(0.01%)	3.66%	(0.03%)
2026-12-31	3.34%	6.60%	(1.26%)	2.03%	(0.27%)	3.60%	(0.01%)	3.63%	(0.02%)
2027-12-31	3.34%	6.60%	(1.26%)	1.77%	(0.25%)	3.59%	(0.01%)	3.61%	(0.02%)
2028-12-31	3.34%	6.60%	(1.26%)	1.54%	(0.23%)	3.58%	(0.01%)	3.59%	(0.02%)
2029-12-31	3.34%	6.60%	(1.26%)	1.33%	(0.22%)	3.58%	(0.01%)	3.57%	(0.02%)
2030-12-31	3.34%	6.60%	(1.26%)	1.13%	(0.20%)	3.57%	(0.01%)	3.55%	(0.02%)
2031-12-31	3.34%	6.60%	(1.26%)	0.94%	(0.18%)	3.56%	(0.01%)	3.54%	(0.02%)
2032-12-31	3.34%	6.60%	(1.26%)	0.77%	(0.17%)	3.56%	(0.01%)	3.52%	(0.02%)
2033-12-31	3.34%	6.60%	(1.26%)	0.62%	(0.16%)	3.55%	(0.01%)	3.51%	(0.01%)
2034-12-31	3.34%	6.60%	(1.26%)	0.47%	(0.14%)	3.54%	(0.01%)	3.49%	(0.01%)
2035-12-31	3.34%	6.60%	(1.26%)	0.34%	(0.13%)	3.54%	(0.01%)	3.48%	(0.01%)
2036-12-31	3.34%	6.60%	(1.26%)	0.22%	(0.12%)	3.53%	(0.01%)	3.47%	(0.01%)
2037-12-31	3.34%	6.60%	(1.26%)	0.10%	(0.11%)	3.53%	(0.00%)	3.46%	(0.01%)

2 - 4% LT nominal rate and 2% inflation

			A. Current approach			B. Revised approach		C. Other considered approach	
			Historical real rate + inflation target EMA25 (data from Dec. 1960)			Historical nominal rates Cum. avg. (data from Jan. 1998)		Historical nominal rates EMA25 (data from Dec. 1960)	
Using data up to	Long-term nominal rate (A)	CPI-common YoY growth (B)	Data added to EMA formula (A - B + 2%)	Estimated URFR	Annual change	Estimated URFR	Annual change	Estimated URFR	Annual change
2021-12-31	1.76%	3.70%	0.06%	3.63%		3.67%		3.82%	
2022-12-31	3.34%	6.60%	(1.26%)	3.27%	(0.37%)	3.64%	(0.03%)	3.75%	(0.07%)
2023-12-31	4.00%	2.00%	4.00%	3.14%	(0.13%)	3.64%	0.00%	3.74%	(0.00%)
2024-12-31	4.00%	2.00%	4.00%	3.21%	0.07%	3.66%	0.01%	3.76%	0.02%
2025-12-31	4.00%	2.00%	4.00%	3.27%	0.06%	3.67%	0.01%	3.78%	0.02%
2026-12-31	4.00%	2.00%	4.00%	3.33%	0.06%	3.68%	0.01%	3.80%	0.02%
2027-12-31	4.00%	2.00%	4.00%	3.38%	0.05%	3.69%	0.01%	3.81%	0.02%
2028-12-31	4.00%	2.00%	4.00%	3.42%	0.05%	3.70%	0.01%	3.83%	0.01%
2029-12-31	4.00%	2.00%	4.00%	3.47%	0.04%	3.71%	0.01%	3.84%	0.01%
2030-12-31	4.00%	2.00%	4.00%	3.51%	0.04%	3.72%	0.01%	3.85%	0.01%
2031-12-31	4.00%	2.00%	4.00%	3.55%	0.04%	3.73%	0.01%	3.86%	0.01%
2032-12-31	4.00%	2.00%	4.00%	3.58%	0.03%	3.74%	0.01%	3.87%	0.01%
2033-12-31	4.00%	2.00%	4.00%	3.61%	0.03%	3.74%	0.01%	3.88%	0.01%
2034-12-31	4.00%	2.00%	4.00%	3.64%	0.03%	3.75%	0.01%	3.89%	0.01%
2035-12-31	4.00%	2.00%	4.00%	3.67%	0.03%	3.76%	0.01%	3.90%	0.01%
2036-12-31	4.00%	2.00%	4.00%	3.70%	0.03%	3.76%	0.01%	3.91%	0.01%
2037-12-31	4.00%	2.00%	4.00%	3.72%	0.02%	3.77%	0.01%	3.92%	0.01%

3 – Stagflation

			A. Current approach			B. Revised approach		C. Other considered approach	
			Historical real rate + inflation target EMA25 (data from Dec. 1960)			Historical nominal rates Cum. avg. (data from Jan. 1998)		Historical nominal rates EMA25 (data from Dec. 1960)	
Using data up to	Long-term nominal rate (A)	CPI-common YoY growth (B)	Data added to EMA formula (A - B + 2%)	Estimated URFR	Annual change	Estimated URFR	Annual change	Estimated URFR	Annual change
2021-12-31	1.76%	3.70%	0.06%	3.63%		3.67%		3.82%	
2022-12-31	3.34%	6.60%	(1.26%)	3.27%	(0.37%)	3.64%	(0.03%)	3.75%	(0.07%)
2023-12-31	5.67%	6.30%	1.37%	3.03%	(0.24%)	3.68%	0.04%	3.81%	0.07%
2024-12-31	8.00%	6.00%	4.00%	3.01%	(0.02%)	3.80%	0.12%	4.05%	0.24%
2025-12-31	8.00%	6.00%	4.00%	3.09%	0.08%	3.95%	0.15%	4.36%	0.30%
2026-12-31	8.00%	6.00%	4.00%	3.16%	0.07%	4.09%	0.14%	4.64%	0.28%
2027-12-31	8.00%	6.00%	4.00%	3.22%	0.06%	4.22%	0.13%	4.90%	0.26%
2028-12-31	6.00%	4.00%	4.00%	3.28%	0.06%	4.31%	0.09%	5.05%	0.15%
2029-12-31	4.00%	2.00%	4.00%	3.34%	0.06%	4.33%	0.02%	5.04%	(0.01%)
2030-12-31	4.00%	2.00%	4.00%	3.39%	0.05%	4.32%	(0.01%)	4.96%	(0.08%)
2031-12-31	4.00%	2.00%	4.00%	3.44%	0.05%	4.31%	(0.01%)	4.89%	(0.07%)
2032-12-31	4.00%	2.00%	4.00%	3.48%	0.04%	4.30%	(0.01%)	4.82%	(0.07%)
2033-12-31	4.00%	2.00%	4.00%	3.52%	0.04%	4.29%	(0.01%)	4.75%	(0.06%)
2034-12-31	4.00%	2.00%	4.00%	3.56%	0.04%	4.28%	(0.01%)	4.70%	(0.06%)
2035-12-31	4.00%	2.00%	4.00%	3.59%	0.03%	4.27%	(0.01%)	4.64%	(0.05%)
2036-12-31	4.00%	2.00%	4.00%	3.62%	0.03%	4.27%	(0.01%)	4.59%	(0.05%)
2037-12-31	4.00%	2.00%	4.00%	3.65%	0.03%	4.26%	(0.01%)	4.55%	(0.05%)

4 – Deflation

			A. Current approach			B. Revised approach		C. Other considered approach	
			Historical real rate + inflation target EMA25 (data from Dec. 1960)			Historical nominal rates Cum. avg. (data from Jan. 1998)		Historical nominal rates EMA25 (data from Dec. 1960)	
Using data up to	Long-term nominal rate (A)	CPI-common YoY growth (B)	Data added to EMA formula (A - B + 2%)	Estimated URFR	Annual change	Estimated URFR	Annual change	Estimated URFR	Annual change
2021-12-31	1.76%	3.70%	0.06%	3.63%		3.67%		3.82%	
2022-12-31	3.34%	6.60%	(1.26%)	3.27%	(0.37%)	3.64%	(0.03%)	3.75%	(0.07%)
2023-12-31	2.17%	3.55%	0.62%	3.00%	(0.27%)	3.61%	(0.04%)	3.67%	(0.08%)
2024-12-31	1.00%	0.50%	2.50%	2.90%	(0.10%)	3.53%	(0.08%)	3.50%	(0.16%)
2025-12-31	1.00%	0.50%	2.50%	2.87%	(0.03%)	3.44%	(0.09%)	3.31%	(0.19%)
2026-12-31	1.00%	0.50%	2.50%	2.84%	(0.03%)	3.36%	(0.08%)	3.13%	(0.18%)
2027-12-31	1.00%	0.50%	2.50%	2.81%	(0.03%)	3.28%	(0.08%)	2.97%	(0.16%)
2028-12-31	2.50%	1.25%	3.25%	2.82%	0.01%	3.23%	(0.05%)	2.88%	(0.09%)
2029-12-31	4.00%	2.00%	4.00%	2.88%	0.06%	3.23%	0.00%	2.91%	0.03%
2030-12-31	4.00%	2.00%	4.00%	2.97%	0.09%	3.26%	0.02%	3.00%	0.08%
2031-12-31	4.00%	2.00%	4.00%	3.05%	0.08%	3.28%	0.02%	3.07%	0.08%
2032-12-31	4.00%	2.00%	4.00%	3.12%	0.07%	3.30%	0.02%	3.15%	0.07%
2033-12-31	4.00%	2.00%	4.00%	3.19%	0.07%	3.32%	0.02%	3.21%	0.07%
2034-12-31	4.00%	2.00%	4.00%	3.25%	0.06%	3.34%	0.02%	3.27%	0.06%
2035-12-31	4.00%	2.00%	4.00%	3.31%	0.06%	3.35%	0.02%	3.33%	0.06%
2036-12-31	4.00%	2.00%	4.00%	3.36%	0.05%	3.37%	0.02%	3.38%	0.05%
2037-12-31	4.00%	2.00%	4.00%	3.41%	0.05%	3.39%	0.02%	3.43%	0.05%

Canadian Institute of Actuaries
360 Albert Street, Suite 1740
Ottawa, ON K1R 7X7
613-236-8196
head.office@cia-ica.ca
cia-ica.ca
seeingbeyondrisk.ca

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