

# 2023 Repo Haircuts in the Canadian Context

Investment Industry Association of Canada

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## Executive Summary

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The Canadian repo market comprises large counterparties of high creditworthiness who trade predominantly high-quality Government, Provincial, and agency assets. As a result of the longstanding stability in the market, there is limited observable application of risk mitigants in the market, including haircuts, for repo dealers that support this activity. Similar to regulated intermediaries in other adjacent repo markets, dealers in Canada support the transformation of collateral and manage counterparty and duration risk which allows participants to access core functions including short-cover, cash management, leverage, and liquidity. The underlying fixed income collateral is subject to interest rate risk; given the recent volatility in global rates it is worthwhile to reexamine the exposures in the Canadian market and to identify potential risks to market functioning.

The Canadian repo market has not historically included haircuts on the high-quality collateral underlying these financing trades. Short-term government bonds will generally experience less significant price volatility from interest rate moves; conversely, longer-term bond prices are highly sensitive to rate volatility which has been evidenced over the past 18 months. Cash providers are indirectly exposed to collateral price declines through the secured lending (reverse repo transactions) they provide to the demand side. This is because in the unlikely scenario that a demand-side counterparty should default, the cash provider(s) would need to liquidate the bond collateral to recover their deployed cash.

The contents of this paper are organized as follows: an industry and product overview, a review of global repo haircut conventions, key highlights and quantification of indirect collateral price movement over time, followed by concluding remarks and supporting material contained within appendices.

## Section 1: Introduction

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A well-functioning financial system is underpinned by an efficient securities financing market. Specifically, the repo market consisting of repurchase (“repo”) and reverse repurchase (“reverse repo”) transactions provides borrowers access to liquidity and funding on a secured basis and is an important source of funding and balance sheet management for financial institutions. This market also provides a means to source access to securities for market participants with cash liquidity (through reverse repo transactions).

Market-makers use the repo market to provide access to client demand for securities or to facilitate the ability to sell a security short. The spot market is intrinsically linked to the repo and securities lending markets by participants’ requirements to locate either cash or securities for a variety of reasons, including accessing cash for inventory management, financing leveraged positions, meeting payment obligations such as margin calls, purchasing other securities, or obtaining temporary possession of securities for hedging or speculation purposes<sup>1</sup>.

Financial entities holding securities and seeking liquidity enter a repo by pledging a security against a loan of cash for a predefined period. The transaction is structured as an initial sale of the security collateral from the borrower to the lender, followed by a subsequent requirement for the borrower to repurchase the security at a predetermined price at a pre-specified later date (often the following business day). The cost of the cash loan is embedded into the repurchase price and is known as the repo rate. Cash providers may choose to require a haircut on the securities collateral; this represents the amount of over-collateralization versus the amount of cash lent<sup>2</sup>.

A 2018 IIAC survey recorded industry perspectives on the state of the Canadian repo market<sup>3</sup>. The survey indicated that while participants acknowledge the Canadian repo market has undergone significant transformations post the 2008-2009 global financial crisis, they agree that improvement opportunities remain. Notably, the global liquidity regulations brought into place in the years following the crisis have affected the execution of repo activities and the pricing and usage of collateral. Participants also indicated the need for continued investment in market infrastructure including central clearing and tri-party repo, which provide opportunities to expand and diversify participation in the domestic market.

Most transactions in the Canadian repo market continue to be executed on a bilateral basis through voice-directed trading. Both lenders and borrowers are bilaterally exposed to counterparty credit risk through the potential for default of the other party. Upon the default of the borrower, the lender of cash would need to dispose of the securities collateral in order to recover its cash loan. Should the lender default, the borrower would need to use its borrowed cash to purchase in the market the security it sold upfront.

Although repo and reverse repo transactions are collateralized and generally subject to daily margining, adverse collateral price movements during an event of default may expose either counterparty to the

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<sup>1</sup> A discussion of the inter-linkages between the spot, repo, and securities lending markets is found in the Bank of Canada Staff Discussion Paper: Government of Canada Securities in the Cash, Repo and Securities Lending Markets <https://www.bankofcanada.ca/wp-content/uploads/2018/01/sdp2018-4.pdf>

<sup>2</sup> Further details on the mechanics of the Canadian repo market are found in the Bank of Canada Staff Discussion Paper: Canadian Repo Market Ecology <https://www.bankofcanada.ca/wp-content/uploads/2016/03/sdp2016-8.pdf>

<sup>3</sup> IIAC: Industry Perspectives on the Current State of Canadian Repo Markets <https://iiac-accvm.ca/wp-content/uploads/Industry-Perspectives-on-repo-markets.pdf>

possibility of loss. Collateral haircuts are an effective risk mitigant to cash lenders, particularly for volatile securities when facing less credit-worthy counterparts. The remainder of this paper reviews significant recent events connected to the global repo market, discusses how haircuts are used across various facets of the financial markets and compares repo haircuts in the Canadian market relative to other select jurisdictions, provides a quantitative analysis of fixed income collateral price movement during periods of stress, and ends with concluding thoughts and recommendations.

## Section 2: Background and Context

### Section 3: Market Practices and Margin Regimes

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Upon undertaking a survey of the qualities of the repo markets, it becomes clear that markets in different jurisdictions are much more alike than they are unlike. There are structural similarities such as the standardization of contracts / arrangements for all parties, consistent market participants comprising banks, brokers/dealers, funds, and other large financial institutions, the use of repo by central banks to conduct open market operations by altering the amount of cash or reserves available in an economy and the control of the interest rate floor by central banking authorities' monetary policy targets.

There are also contractual similarities given the widespread adoption of standard repo contracts and the use of master repurchase agreements (MRA) and global master repurchase agreements (GMRA) as designed and published by the International Capital Market Association (ICMA). Notwithstanding some legal details (e.g., New York State title transfer laws), the counterparties either provide securities collateral for cash (repo) or provide cash for securities (reverse repo) for a fixed term using legal securities sales and purchases.

There are also similarities in general market practices. For instance, the securities use for collateral are generally High-Quality Liquid Assets (HQLA), such as government bonds. The contractual lending rate considers the creditworthiness of the collateral-selling counterparty. To the extent that collateral haircuts are used, these are applied according to the risk profile of the collateral (stability, liquidity), the term (tenor) of the agreement, and any exchange-rate risk. Haircuts increase the amount of collateral required to exchange for the agreed cash amount.

In certain jurisdictions such as the US, participants can not only transact through a bilateral agreement but can also (in certain circumstances) engage with a central clearing counterparty (CCP) to enter a tripartite agreement, paying a few bps higher rate for transaction netting and the stability of being better shielded against counterparty default.

There are a variety of differences across jurisdictions, several of which are captured for several leading repo markets in Appendix 1. Differences between the various markets' transparency, securities structures, and reporting standards offer obstacles for a straightforward comparison across all relevant aspects, however certain commonalities should be noted such as the prevalence of short-term (often overnight or <1-week term) transactions as well as the proposed usage of mandatory haircuts under the Basel III reforms. That said, there are still differences in contemplated haircut regimes across the various regulatory jurisdictions, and implementation is still in progress.

Basel III recommendations are generally either implemented or pending across major markets; a noteworthy item is mandatory supervisory haircuts, which have been under consideration by regulators and industry participants trying to create workable and beneficial regulations. Supervisory haircuts must be applied by regulated financial institutions to eligible securities serving as collateral in repo and securities lending transactions for capital calculation purposes, regardless of the haircuts present in the underlying contracts.

As an example, in the Canadian context the Office of the Superintendent of Financial Institutions (OSFI) supervisory haircuts for securities financing transactions undertaken by regulated financial institutions

are delineated by issuer type (sovereigns versus other issuers versus securitization exposures), security risk rating, and remaining term to maturity. Under the standard supervisory haircuts for the comprehensive approach, for sovereign issuers rated AA- and above, the shortest-tenor ( $\leq 1$  year) bonds receive a 0.5% haircut, while 1-5-year sovereign bonds receive a 2% haircut, and bonds over 5 years to maturity receive a 4% haircut<sup>19</sup>. Non-sovereign and lower-rated issuers receive higher supervisory haircuts. It should also be noted that eligible repo transactions referencing Canadian Government and Provincial bond collateral or repo transactions with eligible core market participants may be permitted to use a supervisory haircut of zero<sup>20</sup>.

OSFI's supervisory haircut requirements are generally based on the Basel Committee on Banking Supervision's Calculation of RWA for credit risk requirements (CRE). Sections that may be referenced in relation to haircuts include section 22 and 56<sup>21</sup>. Regulators will also mandate securities haircut in relation to supervisory liquidity requirements. For instance, OSFI maintains standardized haircuts for the various classes of securities eligible for use against the Liquidity Coverage Ratio; Canadian Government and Provincial securities are classified as HQLA level 1 assets and receive a 0% haircut in this context<sup>22</sup>.

Regulatory bodies have also imposed haircuts related to margin required for non-centrally cleared derivative transactions. This may relate to initial and/or variation margin, and haircut requirements vary across the various regulatory jurisdictions, as well as by the type of collateral – though US PR and CFTC margin requirements for sovereign bond initial margin collateral are the same as those mentioned above for OSFI. Latham & Watkins maintains a comparative summary of US and UK/EU margin rules that differentiates between PR, CFTC, and SEC requirements in the US<sup>23</sup>. Further details can also be found for instance in the official SEC filings<sup>24</sup>.

The International Swaps and Derivatives Association (ISDA) has published a useful table of high-level haircut guidance for derivative collateral initial margin across a wide number of jurisdictions<sup>25</sup>. The maximum haircut for the highest-quality (highest-rated) sovereign bonds is generally 4% (for bonds with residual maturity of 5 years or greater). In addition, central banks publish the required haircuts for various security types eligible as collateral against their lending operations; see for instance the Bank of England's

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<sup>19</sup> OSFI Capital Adequacy Requirements Chapter 4 paragraph 239 [Capital Adequacy Requirements \(CAR\) Chapter 4 – Credit Risk – Standardized Approach \(osfi-bsif.gc.ca\)](https://www.osfi-bsif.gc.ca/eng/capital-adequacy-requirements-car-chapter-4-credit-risk-standardized-approach)

<sup>20</sup> OSFI Capital Adequacy Requirements Chapter 4 paragraphs 249 & 250 [Capital Adequacy Requirements \(CAR\) Chapter 4 – Credit Risk – Standardized Approach \(osfi-bsif.gc.ca\)](https://www.osfi-bsif.gc.ca/eng/capital-adequacy-requirements-car-chapter-4-credit-risk-standardized-approach)

<sup>21</sup> BIS Basel Committee for Banking Supervision CRE Chapters 22 & 56  
[https://www.bis.org/basel\\_framework/chapter/CRE/22.htm?inforce=20230101&published=20201126](https://www.bis.org/basel_framework/chapter/CRE/22.htm?inforce=20230101&published=20201126)  
[https://www.bis.org/basel\\_framework/chapter/CRE/56.htm?inforce=20230101&published=20210701](https://www.bis.org/basel_framework/chapter/CRE/56.htm?inforce=20230101&published=20210701)

<sup>22</sup> OSFI Liquidity Adequacy Requirements Chapter 2 [https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gld/Pages/LAR22\\_chpt2.aspx](https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gld/Pages/LAR22_chpt2.aspx)

<sup>23</sup> Latham & Watkins US vs EU/UK Margin Rules Comparative Summary  
<https://www.lw.com/admin/upload/SiteAttachments/US-EU-UK-margin-rules-reference-guide.pdf>

<sup>24</sup> SEC File S7-24-15 Risk Adjustment and Haircut Schedules <https://www.sec.gov/comments/s7-24-15/s72415-260.pdf>

<sup>25</sup> ISDA Eligible Collateral Comparison <https://www.isda.org/a/EqxxgE/Eligible-Collateral-Comparison-010523.pdf>

sterling monetary framework<sup>26</sup> and the Bank of Canada's collateral asset eligibility and margin requirements<sup>27</sup>.

In addition to haircuts mandated by regulators, certain industry associations and self-regulatory bodies provide guidance for haircuts. For instance, the Investment Industry Regulatory Organization of Canada (IIROC) has published guidance on margin requirements for securities financing<sup>28</sup> and Canadian banks charge haircuts on securities collateral against margin loans<sup>29</sup>. Central counterparties and clearinghouses also publish their requirements for collateral haircuts for clearing members. For instance, the Canadian Derivatives Clearing Corporation (CDCC) maintains published margin requirements including haircut levels which rise from 0.25% for eligible Canadian Government and Provincial securities with maturities of 3 months or less to 6.5% for such securities with maturities of 35 years or more<sup>30</sup>. For instance, LCH also maintains a list of required collateral haircuts<sup>31</sup>, as does ICE Clear US<sup>32</sup> and FICC<sup>33</sup>.

Notwithstanding the preponderance of guidance for regulatory supervisory haircuts (both for credit and liquidity risk purposes) together with industry guidance, central bank collateral haircut requirements, and central counterparty / clearinghouse margin haircut requirements, market participants in the major North American and European bilateral repo markets are generally free to negotiate contractual haircuts with their counterparts, and haircuts for high-quality government securities with well-regarded counterparties are generally zero in North America – and even across a broader spectrum of UK transactions the BIS has reported that a substantial minority of transactions have a zero haircut<sup>34</sup>.

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<sup>26</sup> Bank of England Sterling Monetary Framework <https://www.bankofengland.co.uk/-/media/boe/files/markets/eligible-collateral/summary-tables-of-haircuts-for-bank-lending-operations.pdf>

<sup>27</sup> Bank of Canada Current Collateral Policy <https://www.bankofcanada.ca/2021/07/assets-eligible-collateral-standing-liquidity-facility-200721/>

<sup>28</sup> IIROC Margin requirements for certain cash and security borrowing and lending arrangements — Amendments to Schedules 1, 7 and 7A of Dealer Member Form 1 <https://www.iiroc.ca/news-and-publications/notices-and-guidance/margin-requirements-certain-cash-and-security-borrowing-and-lending-arrangements-amendments>

<sup>29</sup> The Financial Industry Regulatory Authority (FINRA) maintains guidance for US broker-dealer margin requirements <https://www.finra.org/rules-guidance/key-topics/margin-accounts#overview>

<sup>30</sup> CDCC Margin Requirements [https://www.cdcc.ca/risk\\_collateral\\_en](https://www.cdcc.ca/risk_collateral_en)

<sup>31</sup> LCH Ltd Securities Collateral Haircuts

<https://www.lch.com/sites/default/files/media/files/Acceptable%20Collateral%20Haircuts%20LCH%20Ltd%20Securities%20Area%2023112022%20%28inc%20FX%20HC%29.pdf>

<sup>32</sup> ICE Clear US Acceptable Collateral and Haircuts

[https://www.theice.com/publicdocs/clear\\_us/ICUS\\_Collateral\\_Information.pdf](https://www.theice.com/publicdocs/clear_us/ICUS_Collateral_Information.pdf)

<sup>33</sup> FICC MBS Rules [https://www.dtcc.com/~media/Files/Downloads/legal/rules/ficc\\_mbsd\\_rules.pdf](https://www.dtcc.com/~media/Files/Downloads/legal/rules/ficc_mbsd_rules.pdf)

<sup>34</sup> BIS Working Papers No 1027: What drives repo haircuts? Evidence from the UK market <https://www.bis.org/publ/work1027.pdf>



## Section 4: Collateral Value-at-Risk and Stress Testing

Given the repo market participants generally consist of financial institutions, it is not unreasonable to assume that a counterparty default may be linked to an event or period of stress within the broader financial markets. As such, it is logical to examine potential tail events and stress scenarios to benchmark the efficacy of haircuts to the extent that haircuts are present in repo transactions.

From a historical perspective, calendar 2022 experienced renewed interest rate volatility on a global scale after a period of low and generally stable interest rates, and as such presents a useful period of analysis. Charts depicting the increased interest rate volatility (as expressed over a rolling weekly basis) for Canadian Government bond yields over a recent 10-year period are contained in Appendix 2. The w/w yield change charts consistently show rate moves increased into the +/-40bp range for 2022 (with some larger tail moves during 2022) across most tenors. The relatively consistent magnitude of yield volatility translates into significantly different price changes across different bond tenors, as depicted by the price change charts for Canadian Government bonds issued in 2021 also shown in Appendix 2. The consistent scale of these price change charts illustrates the increasing magnitude of price volatility that occurs as bonds become more and more long-dated.

Value-at-Risk (VaR) is a useful loss measure to examine the behavior of government bonds under tail events with certain modeling specifications and over specific historical periods. By examining a confidence interval of a distribution of price movements or returns over a specific period, one can make predictions about the magnitude of a potential loss with a certain level of confidence.

Trading portfolio risk is often measured with a 99% confidence interval 1-day VaR calculation, but for the purposes of collateral movement over a liquidation period it is more appropriate to use a 1-week or 2-week calculation, and in certain extreme cases, one may want to extend this observation period even further. The need to examine a time interval longer than a single trading day is due to the margin period of risk observed in relation to collateral liquidation and trade re-hedging should a counterparty default. Regulators generally require a minimum margin period of risk of 1 week for securities financing transactions with extensions required for illiquid transactions or collateral<sup>35</sup>.

The table below provides an indication of 99% confidence interval returns for portfolios of Canadian Government and Provincial bonds over a 1-week interval – a time period that could reasonably be required to liquidate collateral held by a reverse repo lender should the borrower default. These calculations are based on a portfolio valuation date of December 30th, 2022 and use two Bloomberg portfolio VaR calculation approaches – a Monte-Carlo simulation approach (“MC”) and a historical simulation approach using three look-back periods of 1 year, 2 years, and 3 years.

Table: 99% Confidence Interval 1-week VaR Portfolio Loss Returns (%)

	<b>0-2yr</b>	<b>2-5yr</b>	<b>5-10yr</b>	<b>10-20yr</b>	<b>20-30yr</b>	<b>+30yr</b>
MC	1.05%	1.55%	2.27%	3.32%	4.54%	5.05%
Hist 1Y	0.99%	1.37%	2.43%	3.84%	5.42%	6.12%

<sup>35</sup> See for instance OSFI Capital Adequacy Requirements Chapter 4 paragraphs 246 & 247 [Capital Adequacy Requirements \(CAR\) Chapter 4 – Credit Risk – Standardized Approach \(osfi-bsif.gc.ca\)](https://www.osfi-bsif.gc.ca/en/capital-adequacy-requirements-car)

Hist 2Y	1.02%	1.33%	1.95%	3.08%	4.38%	5.89%
Hist 3Y	1.04%	1.33%	1.93%	3.09%	4.42%	5.96%

The table indicates that adverse price movement generally increases as the residual term to maturity of the bond portfolio increases, as would be expected using duration intuition. The 1-year historical VaR also generally produces more severe losses than its 2-year and 3-year peers given the greater interest rate volatility experienced during calendar 2022, with the +30-year portfolio experiencing a predicted loss of -6.12%.

For comparison, if the 1-week “close-out” interval<sup>36</sup> is increased to 2 weeks, the 99% confidence interval VaR loss returns increase, with the +30-year portfolio experiencing a -8.66% loss under the 1-year historical VaR simulation. These results increase further for a 1-month close-out interval. More complete VaR results for these portfolios over 1-day, 1-week, 2-week, and 1-month close-out intervals and at 95.0%, 97.5%, and 99.0% confidence intervals are in Appendix 3.

Expected shortfall (otherwise known as conditional VaR) is a measure related to VaR. It measures the expected loss of a portfolio beyond a specific confidence level and so provides a measure of insight into the tail beyond the VaR loss. Bloomberg provides the expected shortfall calculation for its Monte-Carlo simulation option and the results at 99% confidence level for 1-day, 1-week, 2-week, and 1-month close-out periods are displayed below.

Table: 99% Expected Shortfall 1d/1w/2w/1m Portfolio Loss Returns (%)

	<b>0-2yr</b>	<b>2-5yr</b>	<b>5-10yr</b>	<b>10-20yr</b>	<b>20-30yr</b>	<b>+30yr</b>
MC – 1d	0.58%	0.87%	1.26%	1.83%	2.57%	2.89%
MC – 1w	1.35%	1.95%	2.82%	4.10%	5.75%	6.47%
MC – 2w	1.84%	2.76%	3.99%	5.80%	8.13%	9.15%
MC – 1m	2.67%	4.00%	5.79%	8.40%	11.78%	13.26%

A comparison of the 1-week loss returns for the expected shortfall vs the VaR measure indicates the relative increased severity of this measure – the +30-year portfolio loss increases from -5.05% to -6.47% when the losses beyond the 99% confidence interval are averaged. The expected shortfall loss returns for the 1-day, 2-week, and 1-month closeout intervals can be compared to the VaR results in Appendix 3.

Stress testing is another useful risk tool – namely, creating specific stress scenarios against which the performance of a security or portfolio of securities can be measured. For reverse repo lenders of high-quality Canadian Government and Provincial bonds the consistent risk factor to stress is the underlying interest rate. Though Provincial bonds will carry a credit spread against the underlying Canadian Government curve, in the interest of simplicity the credit-specific risk factor is not explicitly singled out in

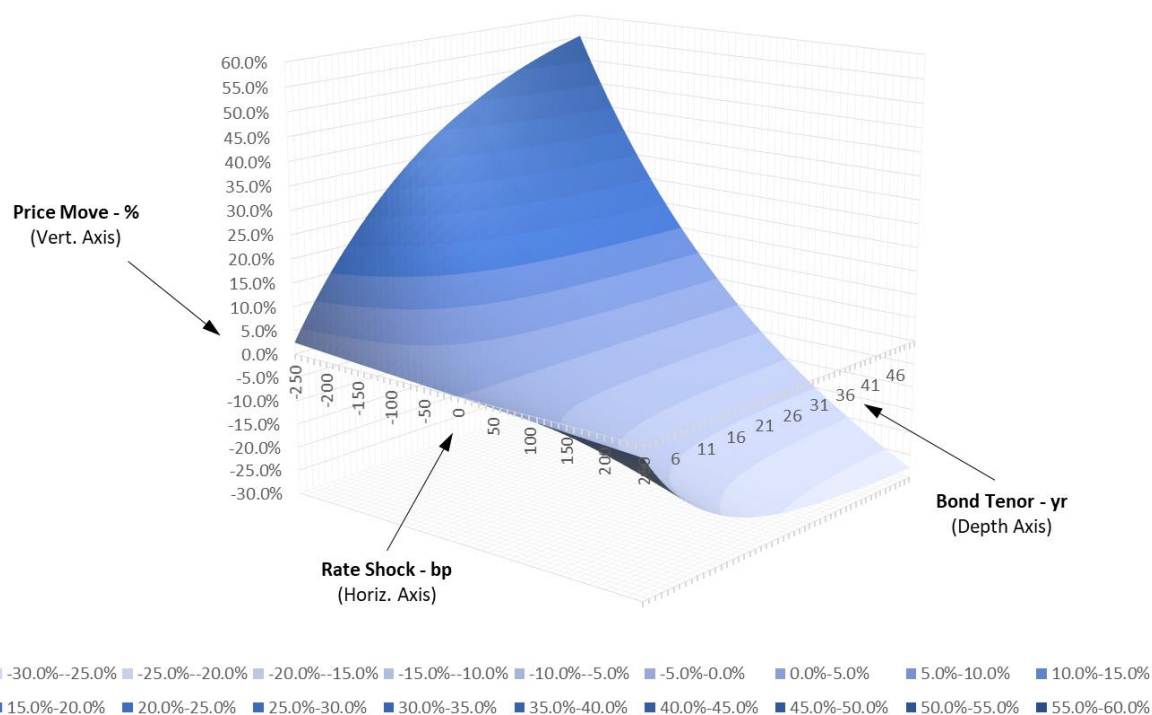
<sup>36</sup> As discussed earlier in this section, it is not unreasonable to expect a close-out interval of at least 1 week to ascertain default of a counterpart, establish legal certainty, and begin to liquidate collateral in line with regulatory margin period of risk requirements

this analysis. It should also be noted that for fixed-income securities a stress to the underlying interest rate will generally induce a price outcome like that derived from a corresponding shock to the credit spread of the bond.

A wide variety of interest rate movements are possible across various stress scenarios – these can include parallel movements up and down, bull and bear steepeners and flatteners, etc. However, for simplicity only parallel up and down curve movements are considered in the following analysis. This is because a wide variety of bond tenors and curve move increments can be examined on a parallel basis without significant loss of analytical insight.

The following chart depicts the range of relative price moves in percentage terms for a variety of par bonds ranging from 1 year to 50 years in residual term to maturity after the application of rate shocks ranging from parallel -250bp to parallel +250bp underlying base interest rate curve movements. As expected, shorter-tenor bonds experience a lower level of price volatility than do longer-dated bonds for the same level of interest rate movement. Especially at the long end, bond prices are skewed towards greater price increases under the largest levels of rate compression versus the price decreases observed under the largest levels of rate expansion. That said, the long-dated bonds nevertheless experience significant price declines as low as approx. -28% under the +250bp rate rise stress scenario for the longest-dated 50-year maturity bonds.

Bond Price Movement by Rate Shock & Tenor



The following table condenses the most significant bond returns for specific maturity buckets and interest rate shock buckets from the chart above to provide a numerical depiction of the results. Shorter-dated bonds experience comparatively less severe price movements as noted above, and the most severe interest rate moves dominate bond tenor to produce the most severe price moves (e.g. an interest rate

shock of +250bp to a 10-year bond induces a -17% price decline versus a +50bp interest rate shock to a 50-year bond which induces a -7% price decline). As noted above, the large interest rate rally scenarios exhibit correspondingly larger positive price returns than do the large rate sell-off shocks. These scenarios correspond to the situations where borrowers engaged on the cash demand (repo) side could be exposed should a lender default.

Table: Maximal Bond Returns by Tenor and by Interest Rate Shock Buckets (%)

	1-2yr	3-5yr	6-10yr	11-15yr	16-20yr	21-25yr	26-30yr	31-40yr	41-50yr
-250bp to -200bp	2%	9%	19%	27%	34%	39%	43%	50%	55%
-200bp to -150bp	2%	7%	15%	21%	26%	30%	33%	37%	40%
-150bp to -100bp	1%	6%	11%	15%	19%	21%	23%	26%	28%
-100bp to -50bp	1%	4%	7%	10%	12%	14%	15%	16%	17%
-50bp to 0bp	0%	2%	4%	5%	6%	6%	7%	8%	8%
0bp to 50bp	-1%	-2%	-4%	-5%	-5%	-6%	-6%	-7%	-7%
50bp to 100bp	-2%	-4%	-7%	-9%	-10%	-11%	-12%	-13%	-13%
100bp to 150bp	-3%	-6%	-10%	-13%	-15%	-16%	-17%	-18%	-19%
150bp to 200bp	-4%	-8%	-13%	-17%	-19%	-21%	-22%	-23%	-24%
200bp to 250bp	-5%	-10%	-17%	-21%	-23%	-25%	-26%	-27%	-28%

The increased severity of the most extreme interest rate scenarios must be considered relative to the probability of such scenarios occurring over a likely short close-out window. Though Canadian interest rates rose dramatically through periods of 2022 with accompanying price declines for long-dated Government and Provincial bonds, a +250bp parallel increase in interest rates is incredibly unlikely within a 1-week or 2-week interval. In fact, a comparison of the stress scenario results against the VaR and expected shortfall output indicates that at a high level a +50bp interest rate increase generally corresponds to a 99% confidence VaR or perhaps expected shortfall result. A more severe interest rate shock could always occur, but, notwithstanding the unprecedented 6 day +150bp rise in UK Gilt yields in September 2022, the probability of a rate rise decreases as the magnitude of the shock increases above the +50-100bp range.

## Section 5: Conclusion

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Since early 2022, the fixed income markets for high quality long-dated “risk-free” sovereign bonds have exhibited a higher degree of volatility than at any other period for at least the last 40 years. Central banks around the globe have tightened financial conditions to combat severe inflation by raising overnight lending rates significantly – and interest rates have correspondingly increased across the curve. Many “risk-free” sovereign bonds with long-dated maturities have thus been subject to price declines greater than 25% over this period. This extreme price movement has led to important consequences for repo markets – such as the UK Gilt Crisis discussed in Section 2.

Even over much shorter time intervals, high-quality assets such as Canadian Government and Provincial bonds are susceptible to large price movements, as illustrated in Section 4. Under these market conditions, leveraged repo borrowers may have difficulty meeting margin calls from their financing providers, who themselves could be exposed to losses should their counterparts default. Though the Canadian Government repo market does not typically trade with a high degree of haircuts, cash providers are exposed to risks inherent to the volatility of the collateral and the credit quality of the counterparty. Notable to the Canadian repo market is the duration risk on many of the securities being financed – these long-dated securities will experience the most severe price declines as interest rate rise. Regulated banks are expected to conduct their intermediation activities with appropriate judiciousness by not only the Canadian financial system and its relevant regulatory bodies, but also by the broader public.

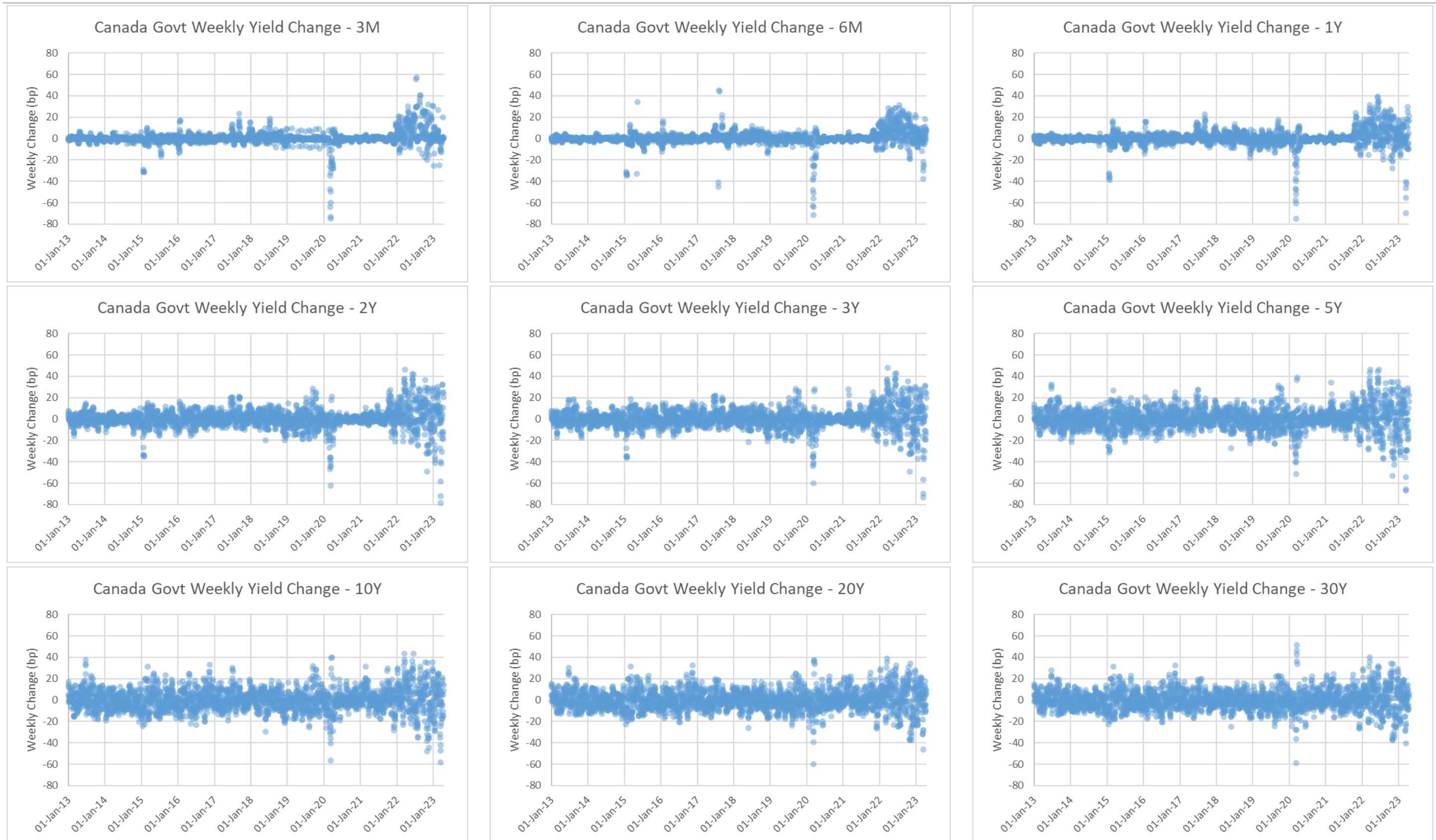
It is, however, also important to recall the generally high creditworthiness of participants within the Canadian securities financing markets and the relative lack of counterparty credit events in the Canadian context relative to recent global events. The benefits of counterparty credit risk mitigation from the over-collateralization provided by haircuts should also be weighed against the relatively lower leverage borne by market participants versus some other developed markets, as well as the liquidity considerations that could develop from an increased volume of encumbered collateral. To the extent that mandated bilateral haircut requirements could increase structural pro-cyclicality and decrease liquidity or market depth, intermediaries will continue to need to adjudge counterparty riskiness, especially in relation to longer-dated financing transactions and/or less liquid or more volatile collateral when choosing to negotiate haircuts. Reflecting on how liquidity stress materialized through the dimension of duration over the past 12 months, having a balanced focus on managing these exposures in the Canadian market, including the promotion of haircuts as a key risk mitigant, should be a priority for all participants.

## Appendix 1: Repo Market Features by Jurisdiction\*

	European Economic Area	UK	US	Canada
Average repo cash value, weekly	EUR € 11 Tn	GBP £ 8 Tn	USD \$ 21 Tn	CAD \$ 1.2 Tn (IIROC 2022)
Clearing distribution type	Direct Bilateral: 55.5% Direct Centrally Cleared: 9.0% Voice-brokered: 8.1% Automated Transaction System: 27.4%	Bilateral: 49.9% Centrally Cleared: 49.1% (est. 2012)	Bilateral: 24.6% Centrally Cleared & Triparty: 75.4% (est. 2022)	Bilateral: 66.3% Centrally Cleared: 33.7% (2017)
Triparty Agents & Central Counterparties	LCH SA in France Eurex Clearing in Germany CC&G in Italy BME Clearing in Spain	LCH Ltd.	FICC Bank of New York Mellon	CDCC
Regulatory institutions	Various European financial authorities	Bank of England	US Federal Reserve, SEC	OSFI, IIROC, CSA
Regulatory frameworks	EU Financial Collateral Directive Short Selling Regulation Securities Financing Transaction Regulation (SFTR) Basel III implementations	UK Securities Financing Transaction Regulation (UK SFTR) Basel III implementations	CFR Basel III implementations	Basel III Implementations
Tenor Distribution	Open _____ 1.8% 1d _____ 17.3% 2d-1w _____ 22.8% 1w-1m _____ 14.8% 1-3m _____ 9.5% 3-6m _____ 7.4% 6-12m _____ 2.4% 12m+ _____ 2.2% Forward _____ 15.3%	Overnight _____ 14.3% 1d-3m _____ 48.9% 3m-1y _____ 29.2% 1y-5y _____ 6.9% 5y+ _____ 0.6%	Overnight _____ 97.3% 1d-1m _____ 2.0% 1m+ _____ 0.6%	Overnight _____ 24.6% 2d-1w _____ 36.5% 1w-1m _____ 23.0% 1m-3m _____ 12.1% 3m+ _____ 3.8% (2014)
Mandatory Haircut	Proposed under Basel III	Proposed under Basel III	Proposed under Basel III	Proposed under Basel III
Haircut pricing	Government securities _____ 1.8% Public agencies / sub-national governments _____ 3.0% Supranational agencies _____ 2.4% Corporate bonds (financial) _____ 3.7% Corporate bonds (non-financial) _____ 4.9% Covered bonds _____ 1.3% Residential mortgage-backed _____ 2.6% Commercial mortgage-backed _____ 3.4% Other asset-backed _____ 6.4% CDO, CLN, CLO, etc _____ 4.0% Convertible bonds _____ 7.5% Equity _____ 6.7% Other _____ 3.1% (weighted averages)	HM Government securities _____ 0.5% Public agencies _____ 3% Foreign government bonds _____ 3% Corporate bonds _____ 20% Residential mortgage-backed _____ 12% Commercial mortgage-backed _____ 25% Covered bonds _____ 12% ABS _____ 15% US Residential mortgage-backed _____ 25% (Floating term, tripartite)  Described in a file: <a href="https://www.bankofengland.co.uk/-/media/boe/files/markets/eligible-collateral/summary-tables-of-haircuts-for-bank-lending-operations.pdf">https://www.bankofengland.co.uk/-/media/boe/files/markets/eligible-collateral/summary-tables-of-haircuts-for-bank-lending-operations.pdf</a>	U.S. Government securities _____ 2% Public agencies _____ 2% Agency CMOs _____ 3% Agency MBS _____ 2% Municipal bonds _____ 7.5% Corporates Investment Grade _____ 5% Corporates Non-Investment Grade _____ 8% Residential mortgage-backed _____ 5% ABS Investment Grade _____ 6% ABS Non-Investment Grade _____ 8% Money Market _____ 5% Equity _____ 7.4% International Securities _____ 3% (weighted median, tripartite)	Government of Canada issued securities _____ 0.25% Government of Canada Guaranteed securities _____ 1.25% Provincial issued securities _____ 1.5% Provincial guaranteed securities _____ 1.75% Agency MBS _____ 2.25% Municipal bonds _____ 2% Corporate bonds _____ 2.25% Covered bonds _____ 2.25% ABS _____ 3.75% U.S. Government securities _____ 1% (margins for short-term collateral)  Described on the BoC website: <a href="https://www.bankofcanada.ca/2021/07/assets-eligible-collateral-standing-liquidity-facility-200721/">https://www.bankofcanada.ca/2021/07/assets-eligible-collateral-standing-liquidity-facility-200721/</a>
Recent Challenges	Sovereign debt crisis, 2008-2012	Gilt yield spike, 2022	SOFR spike, 2019 US regional bank defaults, 2022	

\*Unless otherwise indicated, these data are commonly sourced from July 1, 2022

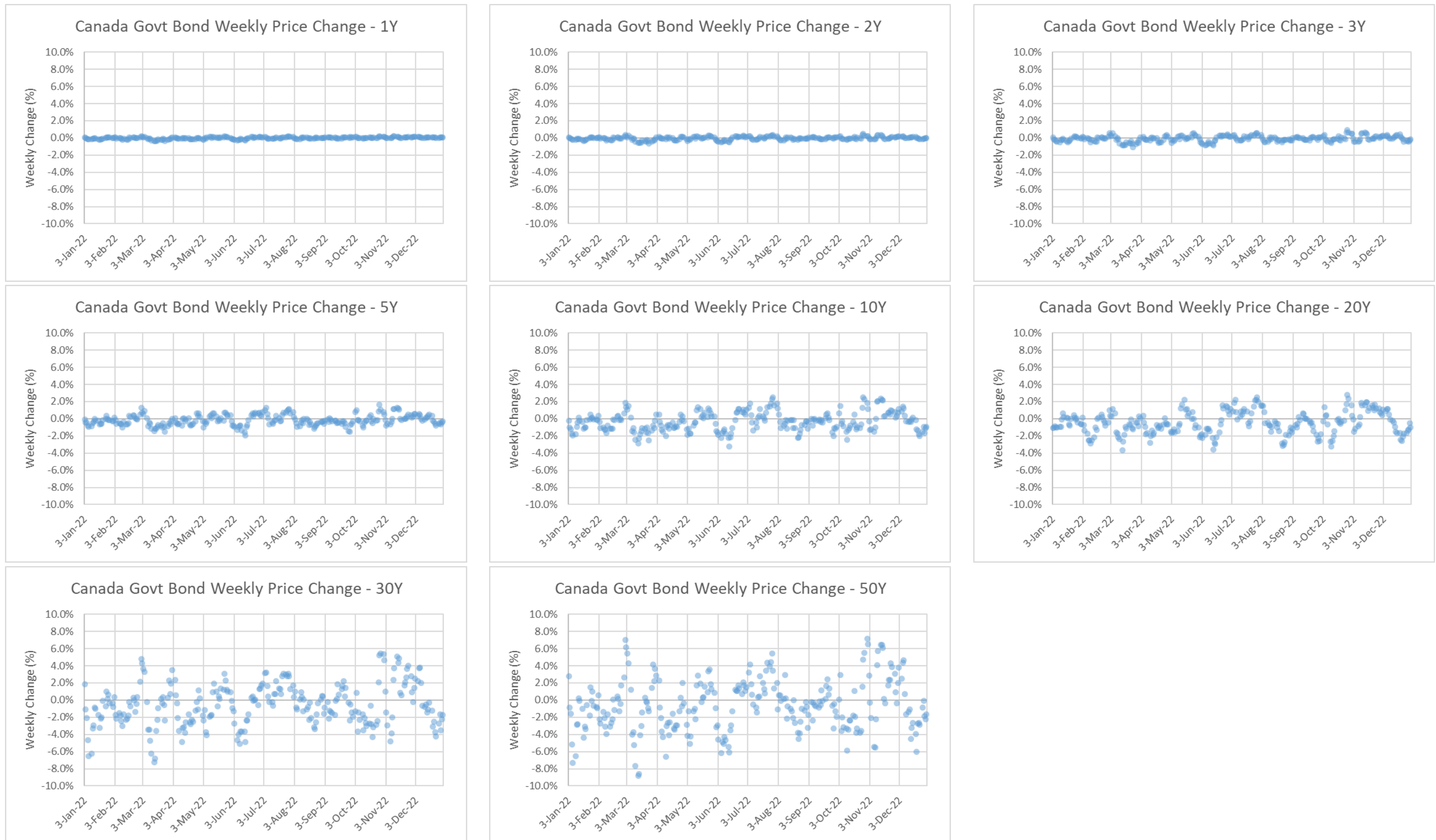
**Appendix 2: Government of Canada Yield Changes - Selected Bond Tenors\***



\*Source: Bloomberg. Historical Canadian Government yield changes on a w/w basis for the 10-year period January 1<sup>st</sup>, 2013 to December 31<sup>st</sup>, 2023.



Appendix 2 (cont'd): Government of Canada Price Changes - Selected Bond Tenors\*



\*Source: Bloomberg. Historical w/w price changes for Canadian Government bonds issued in 2021 for the 1-year period January 1<sup>st</sup>, 2022 to December 31<sup>st</sup>, 2022.



## Appendix 3: Canadian Government &amp; Provincial Bond Portfolios - Value-at-Risk (VaR) Analysis\*

## Notes:

1. All data and results are from Bloomberg
2. The universe of Canadian Government & Provincial bonds (ex. strips/residuals) was divided into 6 equal-weight portfolios by remaining term to maturity: 0-2yr, 2-5yr, 5-10yr, 10-20yr, 20-30yr, & +30yr
3. Each of the 6 portfolios was subjected to VaR calculations through Bloomberg's portfolio analytics
4. The calculation date was December 30<sup>th</sup>, 2022 and 3 confidence levels were used (99.0%, 97.5%, & 95.0%)
5. Four scaling periods were used to observe results over different observation lengths: 1 day ("1d"), 1 week ("1w"), 2 weeks ("2w"), and 1 month ("1m")
6. Results are based on Bloomberg's four standard VaR methodologies; Monte-Carlo simulation using Bloomberg's MAC3 methodology ("MC"), Historical 1-year simulation ("Hist 1Y"), Historical 2-year simulation ("Hist 2Y"), & Historical 3-year simulation ("Hist 3Y")

## 99.0% Confidence Interval

1d	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	0.47%	0.69%	1.02%	1.48%	2.03%	2.26%
Hist 1Y	0.44%	0.61%	1.09%	1.72%	2.42%	2.74%
Hist 2Y	0.45%	0.59%	0.87%	1.38%	1.96%	2.63%
Hist 3Y	0.47%	0.59%	0.86%	1.38%	1.98%	2.67%

1w	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	1.05%	1.55%	2.27%	3.32%	4.54%	5.05%
Hist 1Y	0.99%	1.37%	2.43%	3.84%	5.42%	6.12%
Hist 2Y	1.02%	1.33%	1.95%	3.08%	4.38%	5.89%
Hist 3Y	1.04%	1.33%	1.93%	3.09%	4.42%	5.96%

2w	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	1.48%	2.19%	3.22%	4.70%	6.42%	7.14%
Hist 1Y	1.39%	1.94%	3.44%	5.43%	7.67%	8.66%
Hist 2Y	1.44%	1.88%	2.76%	4.35%	6.19%	8.32%
Hist 3Y	1.48%	1.88%	2.73%	4.37%	6.26%	8.43%

1m	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	2.14%	3.17%	4.66%	6.80%	9.30%	10.35%
Hist 1Y	2.02%	2.81%	4.99%	7.87%	11.11%	12.55%
Hist 2Y	2.08%	2.72%	3.99%	6.31%	8.97%	12.06%
Hist 3Y	2.14%	2.72%	3.96%	6.33%	9.07%	12.21%

## 97.5% Confidence Interval

1d	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	0.37%	0.54%	0.82%	1.19%	1.63%	1.81%
Hist 1Y	0.33%	0.53%	0.81%	1.34%	1.84%	2.42%
Hist 2Y	0.36%	0.51%	0.75%	1.11%	1.68%	2.10%
Hist 3Y	0.37%	0.48%	0.71%	1.09%	1.61%	2.08%

1w	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	0.83%	1.20%	1.84%	2.66%	3.64%	4.05%
Hist 1Y	0.73%	1.19%	1.81%	3.00%	4.11%	5.40%
Hist 2Y	0.80%	1.13%	1.67%	2.49%	3.75%	4.69%
Hist 3Y	0.83%	1.08%	1.59%	2.43%	3.60%	4.64%

2w	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	1.17%	1.70%	2.61%	3.76%	5.14%	5.73%
Hist 1Y	1.04%	1.68%	2.56%	4.24%	5.81%	7.64%
Hist 2Y	1.13%	1.60%	2.37%	3.52%	5.30%	6.63%
Hist 3Y	1.18%	1.53%	2.25%	3.44%	5.09%	6.57%

1m	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	1.69%	2.46%	3.78%	5.45%	7.46%	8.30%
Hist 1Y	1.50%	2.44%	3.71%	6.14%	8.42%	11.07%
Hist 2Y	1.64%	2.32%	3.43%	5.10%	7.68%	9.61%
Hist 3Y	1.71%	2.21%	3.26%	4.99%	7.38%	9.52%

## 95.0% Confidence Interval

1d	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	0.29%	0.43%	0.66%	0.95%	1.32%	1.48%
Hist 1Y	0.29%	0.46%	0.72%	1.10%	1.65%	2.09%
Hist 2Y	0.29%	0.43%	0.66%	1.00%	1.36%	1.67%
Hist 3Y	0.29%	0.41%	0.64%	0.92%	1.32%	1.55%

1w	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	0.66%	0.96%	1.47%	2.12%	2.95%	3.30%
Hist 1Y	0.65%	1.03%	1.61%	2.45%	3.68%	4.67%
Hist 2Y	0.66%	0.97%	1.48%	2.23%	3.05%	3.77%
Hist 3Y	0.65%	0.91%	1.42%	2.07%	2.95%	3.47%

2w	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	0.93%	1.36%	2.08%	3.00%	4.17%	4.67%
Hist 1Y	0.92%	1.45%	2.27%	3.46%	5.21%	6.61%
Hist 2Y	0.93%	1.37%	2.10%	3.15%	4.31%	5.37%
Hist 3Y	0.93%	1.28%	2.01%	2.92%	4.17%	4.91%

1m	0-2yr	2-5yr	5-10yr	10-20yr	20-30yr	+30yr
MC	1.35%	1.97%	3.02%	4.35%	6.04%	6.77%
Hist 1Y	1.34%	2.10%	3.29%	5.02%	7.55%	9.58%
Hist 2Y	1.35%	1.99%	3.04%	4.56%	6.25%	7.73%
Hist 3Y	1.34%	1.86%	2.91%	4.23%	6.05%	7.12%

\*Source: Bloomberg