A STOCHASTIC DEBT SUSTAINABILITY ANALYSIS OF BUDGET 2022

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Summary

This report provides a stochastic debt sustainability analysis of the medium-term outlook presented in Budget 2022. We assess the prospects of maintaining a declining debt-to-GDP ratio and of meeting the Government's medium-term deficit target of 1 per cent of GDP. In addition, based on historical experience, our analysis assesses the balance of risks to the budget outlook and highlights potential fiscal stress over the medium term.

In this report, we adopt the International Monetary Fund's new stochastic simulation approach and apply it to the federal government, generating a distribution of paths of the Government's debt-to-GDP ratio over the medium term. These paths are based on future outcomes of the fundamental debt drivers: the effective interest rate on government debt and GDP growth rate differential; and the operating balance (that is, revenues less program spending) relative to GDP. The debt drivers are drawn from historical data observed over 1990-91 to 2019-20.

Given our approach to randomly drawing future debt drivers from a historical sample, our projected distributions for debt, deficit and debt service ratios should not be regarded as true density forecasts. Rather, our approach should be seen as providing a "stress" test of the Government's financial position over the medium term. Consistent with the International Monetary Fund's debt sustainability analysis framework, we use federal interest-bearing debt as the measure of "gross" debt.
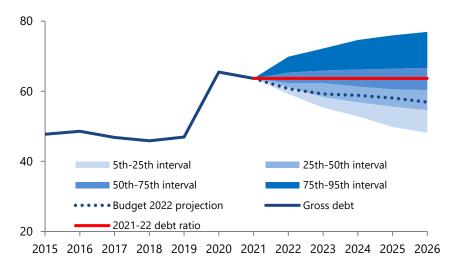
Main results

- We estimate that there is a 65 per cent chance that the Government's gross debt-to-GDP ratio in 2026-27 will be below its 2021-22 value of 63.7 per cent (Summary Figure 1). In other words, most future debt paths would result in a lower gross debt ratio after five years.

- Based on past experience, the Government could maintain debt sustainability over the medium term. Moreover, it is likely that the Government will meet its objective of maintaining a declining federal debt-to-GDP ratio over the medium term.

- However, our results also suggest that, on balance, there is upside risk to the Budget 2022 projection of gross debt as a share of GDP. We estimate there is a 65 per cent chance that the gross debt-to-GDP ratio in 2026-27 will exceed the Budget 2022 projection.

- Based on past experience, it is highly likely that the gross debt-to-GDP ratio will not return to its 2019-20 pre-pandemic level of 46.9 per cent by the end of the medium-term planning horizon in 2026-27.

Summary Figure 1 Gross debt, 2015-16 to 2026-27

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer

Note: Gross debt is measured as interest-bearing debt. The series are presented on a fiscal-year basis where 2015 refers to 2015-16. The projection period covers fiscal years 2022-23 to 2026-27.

As an indicator to "demonstrate the government's commitment to its fiscal anchors" the December 2021 Economic and Fiscal Update highlighted the deficit-to-GDP ratio falling to less than 1 per cent over the planning horizon (2021-22 to 2026-27).

- We estimate that there is effectively an even chance that the budgetary deficit in 2026-27 will be lower than the Government's 1 per cent of GDP medium-term deficit target (Summary Figure 2).

- Our results suggest that, on balance, there is upside risk to the Budget 2022 projection of the deficit as a share of GDP. Based on historical experience, we estimate that there is a 69 per cent chance that the budgetary deficit-to-GDP ratio in 2026-27 will exceed the level (of 0.3 per cent) projected in Budget 2022.

We also include the debt service ratio (that is, public debt charges relative to revenues) as a metric in our debt sustainability analysis.

- Our results suggest there is significant upside risk to the Budget 2022 projection of the debt service ratio. Indeed, based on historical experience, the projected debt service ratio is below, or very close to, the 5th percentile of (lowest) outcomes in each year over the medium term.

This reflects the significantly higher effective interest rate, on average, from our sample compared to the effective rate projected in Budget 2022, as well as the higher gross debt-to-GDP ratio, on average, in our simulations.

Summary Figure 2 **Budgetary balance, 2015-16 to 2026-27**

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer

Note: The series are presented on a fiscal-year basis where 2015 refers to 2015-16. The projection period covers fiscal years 2022-23 to 2026-27.

1.   Introduction

This report provides a stochastic debt sustainability analysis of the medium-term outlook presented in Budget 2022. We assess the prospects of maintaining a declining debt-to-GDP ratio and of meeting the Government's medium-term deficit target of 1 per cent of GDP.[1] In addition, based on historical experience, our analysis highlights and assesses potential fiscal stress over the medium term.

In 2020, the International Monetary Fund (IMF) completed a review of its public debt sustainability framework for market access countries, which is used both for its country surveillance and lending programs.[2] The review put forth a new framework for the IMF's debt sustainability analysis (DSA). The new framework was approved by the IMF Executive Board in 2021.

The IMF's framework is based on a broad definition of sustainability.

> In general terms, public debt can be regarded as sustainable when the primary balance needed to at least stabilize debt under both the baseline and realistic shock scenarios is economically and politically feasible, such that the level of debt is consistent with an acceptably low rollover risk and with preserving potential growth at a satisfactory level. *IMF Policy Paper*, January 2021.

This definition is more expansive than that used in PBO's Fiscal Sustainability Reports (FSRs), which focuses exclusively on debt-to-GDP stabilization over a long-term horizon.[3] That said, the stability of a government's debt-to-GDP ratio figures prominently in both definitions.

One of the improvements to the IMF's tools for medium-term risk analysis in the new DSA framework is a revised stochastic simulation approach for assessing prospects for public debt-to-GDP stabilization.[4]

The IMF's new approach uses stochastic simulations of debt drivers (that is, revenues, program spending, interest and GDP growth rates) based on historical experience to generate a distribution of future debt-to-GDP paths over a medium-term horizon. The simulation results can be used to assess probabilities of debt-to-GDP stabilization and to illustrate potential fiscal stress over the medium term through "fan charts".[5] Recent research on fiscal rules and discussion of "safe" debt levels also point to this type of stochastic debt sustainability analysis tool.[6]

In this report, we adopt the IMF's new stochastic simulation approach and apply it to the federal government rather than the total government sector as a whole, which is typically assessed in IMF debt sustainability analyses.[7] We also use the more familiar Public Accounts basis instead of the IMF-based (Government Finance Statistics) accounting framework. Further, we enhance the analysis by introducing the debt service ratio (that is, debt charges relative to revenues) as another key DSA metric.

2. Data and methodology

The methodology used in this report is based on the IMF's new stochastic simulation approach proposed in its 2020 DSA review.[8]

A stochastic debt sustainability analysis generates a distribution of paths of a government's debt-to-GDP ratio over the medium term based on future outcomes of the fundamental debt drivers: the difference between the effective interest rate on government debt and the growth rate of nominal GDP; and the government's operating balance (that is, revenues less program spending) relative to GDP.

Debt drivers are drawn from historical experience and are then used to extrapolate the current debt-to-GDP ratio forward, typically over five or six years. The distribution of debt paths is used to construct fan charts, which provide a visual representation of risks to the baseline projection. Moreover, the distributions can be used to estimate the probability of a specific outcome based on historical experience. For example, the probability that the debt-to-GDP ratio does not stabilize in the medium term.

2.1. Debt-to-GDP accounting

The evolution of a government's debt-to-GDP ratio can be expressed as:

$$\frac{D_t}{Y_t} = \frac{D_{t-1}}{Y_{t-1}} + \frac{i_t - g_t}{(1 + g_t)} \times \frac{D_{t-1}}{Y_{t-1}} - \frac{OB_t}{Y_t} + \epsilon_t$$

$$OB_t \equiv R_t - PS_t$$

The above equation highlights the fundamental debt-to-GDP drivers: the effective interest rate (*i*) and nominal GDP growth rate (*g*) differential; and the operating balance *OB* relative to nominal GDP. The operating balance is defined as revenue *R* less program spending *PS*. The effective interest rate is calculated as public debt charges divided by the previous year's interest-bearing debt *D*. To ensure that the stock-flow accounting relationship holds, a residual term ϵ is required.

Following the Government's accounting framework, the budgetary balance *BB* is defined as the operating balance less public debt charges:

$$\frac{BB_t}{Y_t} = \frac{R_t - PS_t}{Y_t} - \frac{i_t \times D_{t-1}}{Y_t}$$

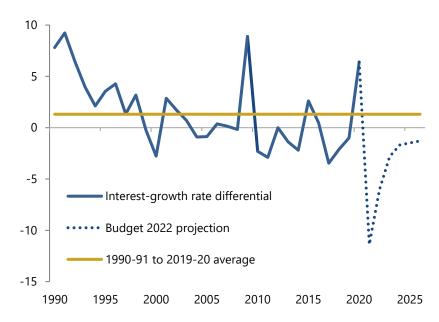The debt service ratio *DSR* is defined as public debt charges divided by revenue:

$$DSR_t \equiv \frac{i_t \times D_{t-1}}{R_t}$$

2.2. Data

Our analysis is based on the fiscal outlook presented in Budget 2022, which serves as the baseline projection. Consistent with the IMF's DSA framework, which adopts gross debt as its core measure, we use federal interest-bearing debt as our measure of gross debt.[9] Our use of interest-bearing debt also ensures consistency with public debt charges.

Over the historical period, the residual is calculated given data on interest-bearing debt, public debt charges, revenue and program spending from the Fiscal Reference Tables, and nominal GDP from Statistics Canada.[10] Consistent with the IMF approach, our historical sample begins in 1990-91, and we limit the sample to 2019-20 to exclude the recent pandemic years.[11] The future realizations of the debt drivers in our stochastic simulations are drawn from this historical sample.

Figure 2-1 highlights the historical sample of the effective interest rate and nominal GDP growth rate differential used in our simulations. Our sample includes the early- to mid-1990s, which captures the impact of higher interest rates following the Bank of Canada's efforts to reduce inflation beginning in the late 1980s, combined with the 1990-1991 recession. Our sample also includes the sharp downturn during the global financial crisis that resulted in an interest-growth rate differential of almost 9 percentage points in 2009-10, just slightly below the previous peak observed in 1991-92.

Figure 2-1   **Effective interest rate and GDP growth rate differential**

Percentage points

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer
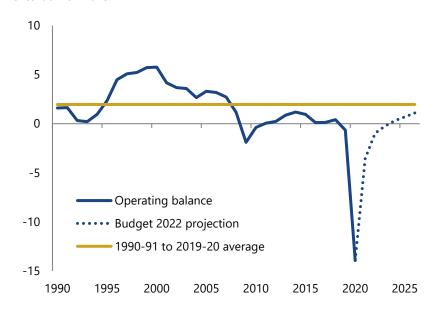
Note: The series are presented on a fiscal-year basis where 1990 refers to 1990-91. The projection period covers fiscal years 2021-22 to 2026-27.

In terms of the operating balance, our sample includes the period of fiscal consolidation over 1995-96 to 2000-01 and the subsequent period during which budgetary surpluses were maintained until 2008-09 (Figure 2-2).

Figure 2-2   **Operating balance**

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer

Note: The series are presented on a fiscal-year basis where 1990 refers to 1990-91. The projection period covers fiscal years 2021-22 to 2026-27.

2.3.   Stochastic simulation

We assume that the initial fiscal year, 2021-22, is given (non-stochastic). Stochastic realizations of the debt drivers are then randomly drawn using a "block-bootstrap" approach, in which draws from the historical sample are taken for consecutive two-year "blocks". As the IMF notes, this approach helps to capture the correlations across debt drivers and the intertemporal dependence in the data.

The stochastic realizations of the debt drivers are then substituted into the above accounting framework to generate future debt-to-GDP, budgetary balance-to-GDP and debt service ratios for each year over the medium-term horizon 2022-23 to 2026-27. This simulation generates one path, and the process is repeated 10,000 times. Following the IMF, we construct fan charts for our sustainability metrics using the 5th-25th, 25th-50th, 50th-75th and 75th-95th percentile intervals of the distributions generated by our simulations.

Similar to the IMF's approach, we assume that there is no feedback between the debt drivers and the level of debt relative to GDP. Consequently, as the IMF notes, the fan charts understate the true uncertainty.[12]

3.   Results

Based on our simulations drawn from historical data, we first assess risks to the Budget 2022 projection of the debt drivers and estimate the probability of exceeding the baseline at the end of the medium-term horizon in 2026-27. Next, we assess the prospects of maintaining a declining debt-to-GDP ratio and of meeting the Government's medium-term deficit target of 1 per cent of GDP. In addition, based on historical experience, our analysis assesses the balance of risks to the budget outlook and highlights potential fiscal stress over the medium term.

Given our approach to randomly drawing future debt drivers from a historical sample, our projected distributions for debt, deficit and debt service ratios should not be regarded as true density forecasts. Rather, our approach should be seen as providing a "stress" test of the Government's financial position over the medium term.
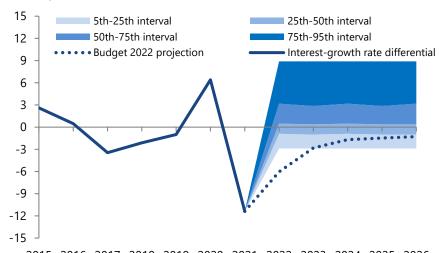
3.1.   Debt-to-GDP drivers

Based on our simulations drawn from historical data, our results suggest that there is upside risk to the Budget 2022 projection of the effective interest rate and nominal GDP growth rate differential (Figure 3-1). In 2026-27, the interest-growth rate differential exceeds the Budget 2022 projection in 77 per cent of the stochastic simulations. The interest-growth rate differential in 2026-27 averages 1.36 percentage points in our simulations, which is approximately 265 basis points higher than the Budget 2022 projection (-1.29 percentage points).

This result is not surprising given that, despite the Budget 2022 forecast of rising government bond yields over the medium term, the effective interest rate on government debt is projected to remain close to, or below, its historical low (of 2.2 per cent registered in 2017-18), while nominal GDP is forecast to grow more closely in line, on average, with historical experience.

Figure 3-1   Effective interest rate and GDP growth rate differential

Percentage points

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget
            Officer.

Note: The effective interest rate is calculated as public debt charges divided by the
            previous period's stock of interest-bearing debt. The series are presented on a
            fiscal-year basis where 2015 refers to 2015-16. The projection period covers
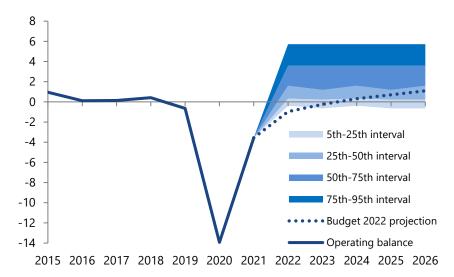   fiscal years 2022-23 to 2026-27.

In terms of the operating balance, our results suggest that there is upside
risk to the Budget 2022 projection (Figure 3-2). The operating balance-to-
GDP ratio in 2026-27 exceeds the Budget 2022 projection in 57 per cent of
the stochastic simulations. The operating balance ratio in 2026-27 averages
1.95 per cent of GDP in our simulations, which is 0.86 percentage points
higher than the Budget 2022 projection (1.09 per cent of GDP).

The upside risk to the operating balance in Budget 2022 reflects both upside
risks from revenues and downside risks from program spending, based on
historical experience.

Figure 3-2   Operating balance

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget
            Officer

Note: The operating balance is calculated as revenue less program spending. The
            series are presented on a fiscal-year basis where 2015 refers to 2015-16. The
            projection period covers fiscal years 2022-23 to 2026-27.

Relative to the Budget 2022 baseline, both the interest-growth rate
differential and the operating balance-to-GDP ratio in our stochastic
simulations exceed, on average, their baseline projection. However, all else
equal, these debt drivers have offsetting implications (directionally speaking)
for debt-to-GDP accumulation over the medium term. The higher interest-
growth rate differential puts upward pressure on the debt-to-GDP ratio while
the higher operating balance ratio puts downward pressure on the debt
ratio.[13]

3.2.   Stochastic debt sustainability metrics
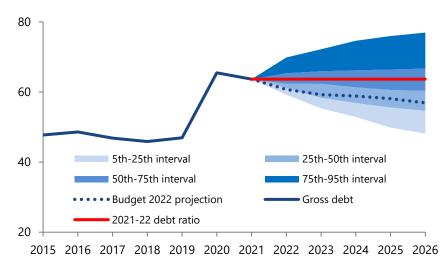
Gross debt relative to GDP

Based on stochastic draws of debt drivers from our historical sample, we
estimate that there is a 65 per cent chance that the gross debt-to-GDP ratio
in 2026-27 will be below its 2021-22 value of 63.7 per cent. In other words,
most future debt paths would result in a lower gross debt-to-GDP ratio after
five years relative to the current level, as the operating balance generally
dominates the interest-growth rate differential (Figure 3-3).

This result suggests that, based on past experience, the Government could
maintain debt sustainability over the medium term. Moreover, it is likely that
the Government will meet its objective of maintaining a declining federal
debt-to-GDP ratio over the medium term.[14]

However, our results also suggest that, on balance, there is upside risk to the Budget 2022 projection of gross debt as a share of GDP. Based on our simulation results, we estimate that there is a 65 per cent chance that the gross debt-to-GDP ratio in 2026-27 will exceed the level (of 56.9 per cent) projected in Budget 2022. The gross debt ratio in 2026-27 averages 61.1 per cent of GDP in our simulations, which is 4.2 percentage points higher than projected in Budget 2022.

Figure 3-3   Gross debt, 2015-16 to 2026-27

Per cent of nominal GDP

5th-25th interval	25th-50th interval
50th-75th interval	75th-95th interval
Budget 2022 projection	Gross debt
2021-22 debt ratio	

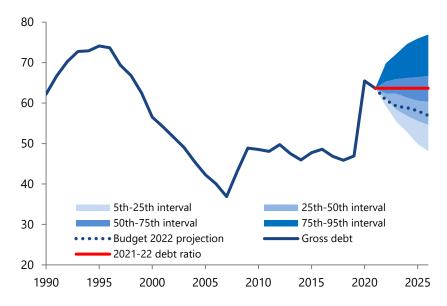Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer

Note: Gross debt is measured as interest-bearing debt. The series are presented on a fiscal-year basis where 2015 refers to 2015-16. The projection period covers fiscal years 2022-23 to 2026-27.

Based on past experience, it is highly likely that the gross debt-to-GDP ratio will not return to its 2019-20 pre-pandemic level of 46.9 per cent by the end of the medium-term planning horizon. That said, based on historical experience, it is highly likely that the gross debt-to-GDP ratio will remain below the peak level of 74.1 per cent observed in 1995-96 (Figure 3-4). The width of the 90 per cent interval (that is, 90 per cent of all outcomes) of the gross debt-to-GDP ratio in 2026-27 is 28.8 percentage points. That is, 90 per cent of all outcomes for the gross debt-to-GDP ratio fall within the range of 48.1 per cent to 76.9 per cent.[15]

Figure 3-4   Gross debt, 1990-91 to 2026-27

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget
Officer

Note: Gross debt is measured as interest-bearing debt. The series are presented on
a fiscal-year basis where 1990 refers to 1990-91. The projection period covers
fiscal years 2022-23 to 2026-27.

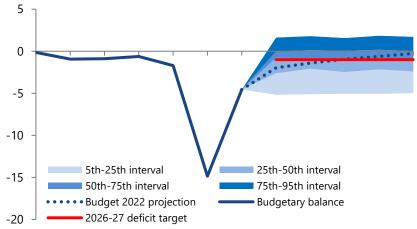**Budgetary balance relative to GDP**

Based on stochastic draws of debt drivers from our historical sample, we
estimate that there is effectively an even chance that the budgetary deficit in
2026-27 will be lower than the Government's 1 per cent of GDP medium-
term deficit target (Figure 3-5).

Our results suggest that, on balance, there is upside risk to the Budget 2022
projection of the budgetary deficit as a share of GDP. Based on historical
experience, we estimate that there is a 69 per cent chance that the deficit-to-
GDP ratio in 2026-27 will exceed the level (of 0.3 per cent) under the Budget
2022 projection. The budgetary deficit ratio in 2026-27 averages 1.3 per
cent of GDP in our simulations, which is one full percentage point higher
than the Budget 2022 projection, but in line with the post-financial
crisis/pre-pandemic average (Figure 3-6).

In addition, our results suggest that it is highly unlikely that the budgetary
deficit-to-GDP ratio over the medium term will reach the highs observed
over the pre-fiscal consolidation period, 1990-91 to 1994-95. The width of
the 90 per cent interval of the budgetary balance-to-GDP ratio in 2026-27 is
6.7 percentage points. That is, 90 per cent of all outcomes for the budget
balance-to-GDP ratio fall within the range from a deficit of 5.0 per cent to a
surplus of 1.7 per cent.

Figure 3-5   **Budgetary balance, 2015-16 to 2026-27**

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer

Note: The series are presented on a fiscal-year basis where 2015 refers to 2015-16. The projection period covers fiscal years 2022-23 to 2026-27.

Figure 3-6   **Budgetary balance, 1990-91 to 2026-27**

Per cent of nominal GDP

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Office
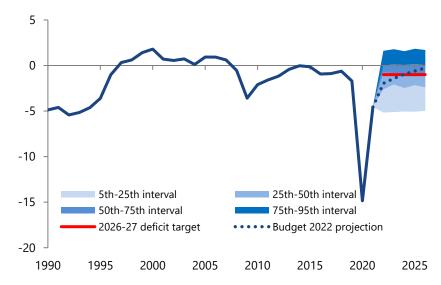
Note: The series are presented on a fiscal-year basis where 1990 refers to 1990-91. The projection period covers fiscal years 2022-23 to 2026-27.
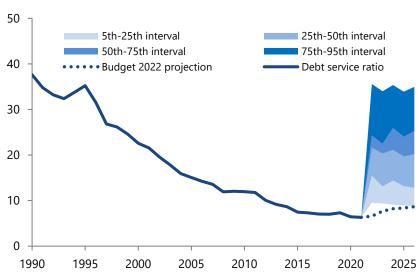
Debt service ratio

We also include the debt service ratio (that is, public debt charges relative to revenues) as a metric in our debt sustainability analysis. The debt service ratio provides a more meaningful metric of a government's debt-servicing capacity.[16]

Based on stochastic draws of debt drivers from our historical sample, our results suggest that there is significant upside risk to the Budget 2022 projection of the debt service ratio (Figure 3-7). Indeed, the projected debt service ratio is below (or very close to) the 5th percentile of outcomes in each year of the projection horizon. This reflects the significantly higher effective interest rate, on average, from our sample compared to the effective rate projected in Budget 2022 (for example, 5.6 per cent compared to 2.4 per cent in 2026-27), as well as the higher, on average, gross debt-to-GDP ratio in our simulations.

Based on historical debt drivers, the debt service ratio could rise significantly above projected levels in the 2022 Budget, stretching the Government's debt-servicing capacity and increasing fiscal stress. In our simulations, the debt service ratio averages between 19.8 and 21.3 per cent over the projection horizon, in line with debt service ratios observed in the early-2000s, but well in excess of the high of 8.6 per cent in 2026-27 projected in Budget 2022.

Figure 3-7   **Debt service ratio, 1990-91 to 2026-27**

Public debt charges as a percentage of revenues

Sources: Finance Canada, Statistics Canada and Office of the Parliamentary Budget Officer

Note: The debt service ratio is defined as public debt charges relative to revenues. The series are presented on a fiscal-year basis where 1990 refers to 1990-91. The projection period covers fiscal years 2022-23 to 2026-27.

Notes

1. The Government's December 2021 Economic and Fiscal Update highlighted indicators to "demonstrate the government's commitment to its fiscal anchors": the deficit-to-GDP ratio falling to less than 1 per cent over the planning horizon (2021-22 to 2026-27); and the federal debt-to-GDP ratio returning to a downward track. See: https://www.budget.gc.ca/efu-meb/2021/report-rapport/chap3-en.html#preserving-canada-s-low-debt-advantage. Budget 2022 reiterated these indicators and added public debt charges.

2. See the IMF Policy Paper (January 2021), "Review of The Debt Sustainability Framework For Market Access Countries". Available at: https://www.imf.org/en/Publications/Policy-Papers/Issues/2021/02/03/Review-of-The-Debt-Sustainability-Framework-For-Market-Access-Countries-50060.

   Market access countries refer to countries that "principally receive financing through market-based instruments and on non-concessional terms".

3. See PBO's 2021 Fiscal Sustainability Report. Available at: https://www.pbo-dpb.ca/en/publications/RP-2122-010-S--fiscal-sustainability-report-2021--rapport-viabilite-financiere-2021.

4. The IMF's new stochastic simulation approach (that is, using a "block-bootstrap" approach to draw from historical data), is used in the first step of a two-step procedure to impose, if necessary, in the second step a "realism adjustment", which re-orients the distribution of stochastic outcomes relative to the baseline projection.

   In this report, we adopt only the stochastic simulation approach used in the first step of this procedure and do not incorporate a realism adjustment. See Annex VI in the IMF's January 2021 Policy Paper for additional detail on the IMF's two-step procedure.

5. PBO has used stochastic simulations to generate fan charts for the federal debt-to-GDP ratio and budgetary balance in past analyses. For example, see our January 2022 report on the Economic and Fiscal Update. Available at: https://www.pbo-dpb.ca/en/publications/RP-2122-027-S--economic-fiscal-update-2021-issues-parliamentarians--mise-jour-economique-budgetaire-2021-enjeux-parlementaires.

   However, these fan charts reflect only the uncertainty surrounding the economic outlook (based on historical forecast performance) and, by construction, are symmetric and centred on a baseline projection. Based on this approach, and similar to the IMF's previous fan chart methodology, risks to the baseline debt-to-GDP projection (arising from economic shocks) are "balanced".

   Moreover, the IMF's DSA review noted that the major shortcoming of its earlier methodology was that the fan chart depended entirely on the baseline projection and assumed a normal (symmetric) distribution of outcomes. The IMF's new approach severs the links with the baseline

projection (using historical outcomes) and normal distribution (generally asymmetric).

6. For example, see the February 2021 Peterson Institute for International Economics Working Paper, "Redesigning EU Fiscal Rules: From Rules to Standards" (available at: https://www.piie.com/sites/default/files/documents/wp21-1.pdf) and the March 2022 IMF Finance & Development article by Olivier Blanchard, "Deciding When Debt Becomes Unsafe" (available at: https://www.imf.org/en/Publications/fandd/issues/2022/03/Deciding-when-debt-becomes-unsafe-Blanchard).

7. Future work may extend this approach to assess provincial governments.

8. See Note 4.

9. The Budget 2022 projection of interest-bearing debt was provided by Finance Canada.

   The IMF January 2021 Policy Paper notes that gross debt will remain the core concept in its DSA framework, but that there will be an enhanced role for liquid assets that, "particularly when liquid and foreign currency denominated, can have important implications for both solvency and liquidity".

   We adopt the Government's measure of interest-bearing debt, which includes "unmatured debt and pensions, other future benefits and other liabilities". For additional detail, see Section 6 Interest-bearing debt in Volume I of the 2021 Public Accounts (available at: https://www.tpsgc-pwgsc.gc.ca/recgen/cpc-pac/2021/vol1/intro-eng.html).

   In the Public Accounts, gross debt (that is, total liabilities) is comprised of interest-bearing debt, accounts payable and accrued liabilities. In 2020-21, interest-bearing debt amounted to $1,444.8 billion, representing 87.4 per cent of the Government's total liabilities.

   Future work may consider alternative measures, such as net debt and unmatured debt.

10. Available at: https://www.canada.ca/en/department-finance/services/publications/fiscal-reference-tables/2021.html and https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610010401.

    Nominal GDP growth is calculated as the percentage change in calendar-year values. Ratios expressed relative to nominal GDP are based on calendar-year GDP values.

11. In its 2020 DSA review, the IMF used the historical sample period 1990-2018.

    In addition to the four debt drivers (the effective interest rate, GDP growth, revenue and program spending) our stochastic simulations also include the residual drawn from the historical sample. This differs from the IMF approach, which does not include a residual drawn from the historical sample.

    We believe that excluding the residual in the stochastic simulations would not be consistent with the accounting framework and potentially bias the results given that the residual over the historical period may be

non-zero. The residual in our historical sample is relatively small but averages 0.7 percentage points of GDP over 1990-91 to 2019-20.

12. The IMF notes that "a proper modeling of the feedback between debt and interest rates is beyond the present research frontier. While DSAs at the Fund and elsewhere have sometimes used simple linear feedback rules, these offer only a modest improvement over ignoring the feedback altogether, as they do not capture the sharply non-linear rises in borrowing spreads when markets begin to view debt as unsustainably high."

13. Based on our historical sample, 1990-91 to 2019-20, there is very little correlation (r = –0.06) between the interest-growth differential and the operating balance-to-GDP ratio.

14. Budget 2022 re-iterates the Government's fiscal anchor, which is defined in terms of *federal* debt, committing to "reducing the federal debt-to-GDP ratio over the medium term" in addition to unwinding COVID-19-related deficits.

    Federal debt consists of gross liabilities (that is, interest-bearing debt, accounts payable and accrued liabilities) less financial and non-financial assets. In 2020-21, federal debt amounted to $1,048.7 billion, which is $396.1 billion (27 per cent) lower than the stock of interest-bearing debt (which our analysis uses as a measure of gross debt) in the same year.

    Given the size of interest-bearing debt relative to federal debt, a decline in the interest-bearing debt-to-GDP ratio in our simulations would likely be reflected as a decline in the federal debt-to-GDP ratio. Annual changes in interest-bearing debt and federal debt ratios (relative to GDP) over 1990-91 to 2020-21 are highly correlated (r = 0.95).

15. The 2020 IMF DSA review notes that the width of the 90 per cent interval in the final year of the medium-term projection, "captures the volatility of the country's debt drivers, and the potential for highly adverse debt realizations in the future, even if starting from a low level".

16. In his March 2022 IMF article, Blanchard notes that the ratio of debt service to GDP would be an improvement over the debt-to-GDP ratio since, "lower rates imply much more favorable debt dynamics. A debt ratio that may have been unsafe in the early 1990s is much less likely to be unsafe now".