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Assessing global potential output growth and the US neutral rate: April 2023

by Salma Ahmed, Aviel Avshalumov, Tania Chaar, Eshini Ekanayake, Helen Lao, Louis Poirier, Jenna Rolland-Mills, Argyn Toktamyssov and Lin Xiang

International Economic Analysis Department
Bank of Canada
SalmaAhmed@bankofcanada.ca, aavshalumov@bankofcanada.ca, tchaar@bankofcanada.ca, eekanayake@bankofcanada.ca, hylao@bankofcanada.ca, lpoirier@bankofcanada.ca, jrolland-mills@bankofcanada.ca, atoktamyssov@bankofcanada.ca, lxiang@bankofcanada.ca

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Summary

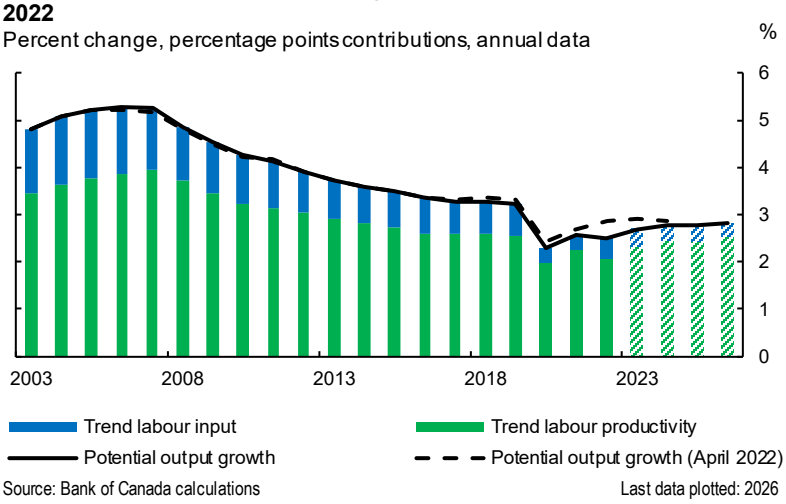
We present the annual update of Bank of Canada staff estimates for global potential output growth and the US neutral rate of interest. Both estimates serve as key inputs to the analysis in the April 2023 *Monetary Policy Report*.

Global potential output growth

We expect growth in global potential output to increase from 2.5% in 2022 to 2.8% by 2026 (**Chart 1**). This increase is due mainly to a pickup in the growth of trend labour productivity (TLP) as firms adopt more efficient organizational and management practices and implement new and previously developed technologies. In addition, TLP growth is expected to return to more normal levels in the euro area and rest-of-world region (RoW) after having been disrupted by Russia's invasion of Ukraine.

Chart 1: Global potential output growth expected to pick up after 2022

Percent change, percentage points contributions, annual data



Source: Bank of Canada calculations

Last data plotted: 2026

In contrast, the growth rate of trend labour input (TLI) is projected to fall modestly between 2022 and 2026. Population aging is expected to reduce growth in the global workforce, particularly in China. TLI growth rises moderately in only two regions over this period: the United States and emerging-market economies (EMEs). This growth is due, respectively, to an expected pickup in net immigration and to a population that is young and growing.

Overall, our estimates of growth in global potential output have been revised down slightly compared with the April 2022 assessment. Larger effects of the war on the economies of the euro area and RoW and less robust growth in trend total factor productivity (TFP) in China account for the change. By contrast, stronger-than-expected net immigration led to an upward revision to potential output growth in the United States.

US neutral rate

The US neutral rate is our proxy for the global conditions that affect the Canadian neutral rate. Our conclusion is that the April 2022 assessment—which estimated a range for the US neutral rate of interest between 2% and 3%—remains appropriate.

We organize the remainder of this note as follows. First, we provide a detailed regional breakdown of estimates for potential output (**Table 1**). Then we shed some light on the risks to these estimates. Finally, we elaborate on Bank staff's assessment of the US neutral rate.

Table 1: Projection for potential output growth

	Share of real global gross domestic product* (%)	Projected growth† (%)					
		2021	2022	2023	2024	2025	2026
United States	16	1.2 (1.3)	1.7 (1.6)	1.8 (1.7)	1.8	1.8	1.7
Euro area‡	12	1.2	0.8 (1.4)	1.3	1.2 (1.1)	1.1	1.1
Japan	4	0.6	0.6 (0.7)	0.6 (0.8)	0.7 (0.8)	0.8	0.7
China	19	5.2 (5.5)	4.8 (5.2)	4.7 (5.1)	4.5 (4.9)	4.3	4.2
Oil-importing EMEs§	33	3.0 (3.1)	3.3 (3.4)	3.5 (3.7)	3.7	3.7	3.9
Rest of the world◊	17	1.6 (1.7)	0.7 (1.9)	1.3 (1.8)	1.7 (1.8)	1.7	1.8
World	100	2.6 (2.7)	2.5 (2.9)	2.7 (2.9)	2.8 (2.9)	2.8	2.8

* Gross domestic product (GDP) shares are based on International Monetary Fund (IMF) estimates of the purchasing-power-parity valuation of country GDPs for 2021 from the IMF's October 2022 World Economic Outlook. The individual shares may not add up to 100 due to rounding.

† Numbers in parentheses are projections used in the April 2022 *Monetary Policy Report* and are reported only when different from the current projection.

‡ Croatia joined the euro area on January 1, 2023. The current projection and historical data do not include the change in membership.

§ The oil-importing emerging-market economies (EMEs) group excludes China. It is composed of large EMEs from Asia, Latin America, the Middle East, Europe and Africa (such as India, Brazil and South Africa) as well as newly industrialized economies (such as South Korea).

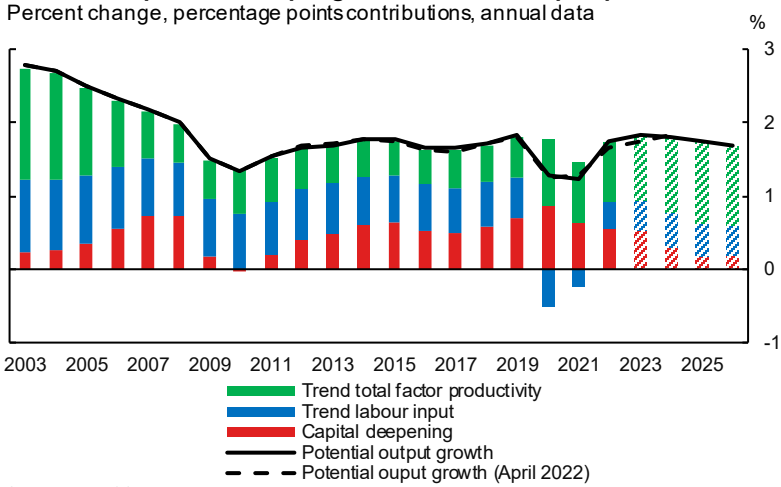
◊ "Rest of the world" is a grouping of other economies not included in the first five regions. It is composed of oil-exporting EMEs (such as Russia, Nigeria and Saudi Arabia) and other advanced economies (such as Canada, the United Kingdom and Australia).

Regional estimates for potential output growth

United States

In 2020 and 2021, US potential output growth slowed as population aging and the COVID-19 crisis negatively affected TLI growth (Chen et al. 2020). These negative effects were partly offset by increases in TLP growth—linked mainly to investment in information and communications technology driven by the pandemic (Boutilier et al. 2022). As the economy recovered in 2022, TLI growth rose and TLP growth returned to a level close to that estimated in 2019. These developments pushed potential output growth closer to its pre-pandemic average (2015 to 2019) of 1.7%.

Chart 2: **US potential output growth to return to pre-pandemic rate**
Percent change, percentage points contributions, annual data



Source: Bank of Canada calculations
Last data plotted: 2026

Potential output is expected to continue to grow at a rate close to its pre-pandemic average between 2023 and 2026 (**Chart 2**). TFP is expected to be the largest source of growth over the projection. The end of the disruptive effects of the pandemic drives TFP growth, as does firms' adoption of digital technologies and other new ways of operating. TLI is also expected to contribute positively to potential output growth, on average, over this period, as net immigration continues to rebound from the effects of the pandemic (**Box 1**). This is partly offset by a modest decrease in the trend labour force participation rate due to the aging of the US workforce.

Relative to the April 2022 assessment, potential output growth is revised down by 0.1 percentage point (pp) in 2021 and up by 0.1 pp in 2022 and 2023. The downward revision in 2021 is due mainly to a rise in excess retirements that led to a lower trend participation rate than previously expected. The upward revisions in 2022 and 2023 reflect slightly higher population growth. This is partly offset by lower trend labour force participation due to a higher retirement rate among older workers.[1] As a result, the level of potential output is 0.1% higher by 2024 compared with the April 2022 assessment.

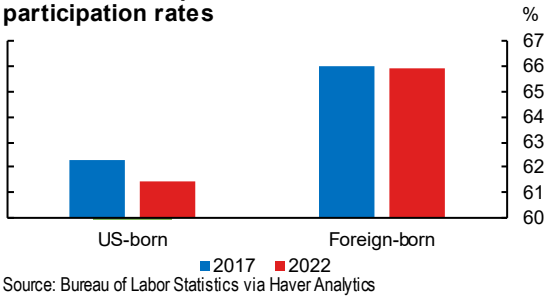
[1] The stronger profile for net immigration is from the most recent demographic outlook published by the Congressional Budget Office. The downward revision of the trend labour force participation rate mainly reflects the assumption that retirement rates among the population age 55 and over remain elevated over 2023–26.

Box 1: The role of immigration in explaining US potential output

Immigration influences potential output in the United States by:

- raising population growth
- increasing the participation rate, since foreign-born individuals tend to have higher participation rates than workers born in the United States (**Chart 1-A**)
- reducing the natural rate of unemployment by improving matching efficiency in the labour market (Orrenius, Zavodny and Gullo 2020)
- increasing trend labour productivity by contributing to innovation [2]

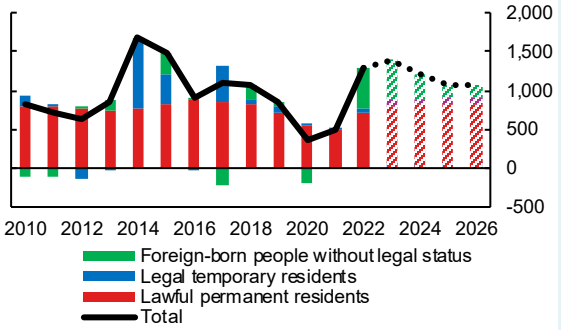
Chart 1-A: Comparison of labour force participation rates



Source: Bureau of Labor Statistics via Haver Analytics

Chart 1-B: Net immigration rebounded in 2022

Annual data — Thousands of people



Source: Congressional Budget Office — Last data plotted: 2026

In this box, we present estimates of the impact of immigration on potential output growth from the first two of these channels for the period 2022–26.

Net immigration in the United States averaged around 1 million people per year from 2010 to 2019. The COVID-19 pandemic led to sharp declines in immigration in 2020 and 2021 (to about 400,000 people annually, on average) due to border closures and challenges in processing visas. In 2022, the Congressional Budget Office estimated that net immigration rebounded to close to 1.3 million, largely because of an increase in foreign-born people without legal status (**Chart 1-B**). If net immigration had been zero in 2022, population growth, the participation rate and potential output growth would be 0.5 pps, 0.3 pps and 0.7 pps lower in 2022, respectively.

Between 2023 and 2026, strong net immigration is expected to support population growth and the participation rate, offsetting downward pressures from population aging and a declining birth rate. In our base-case projection, population growth averages 0.8% annually and the average participation rate is 61.6% from 2023 to 2026. To highlight the importance of immigration in our base case, we present an alternative scenario in **Table 1-A** where net immigration is zero over 2023–26. In this scenario, population growth averages about 0.4% annually—roughly half the average growth rate in the base case. Moreover, the trend participation rate is about 0.1 pp lower, on average. As a result, average potential output growth is 1.3% in the alternative scenario—0.5 pps lower than in the base case.

Table 1-A: Components influenced by immigration (base case versus alternative scenario)

	Population growth		Participation rate		Potential output growth	
	Base case	Alternative scenario	Base case	Alternative scenario	Base case	Alternative scenario
2023–2026	0.8%	0.4%	61.6%	61.5%	1.8%	1.3%

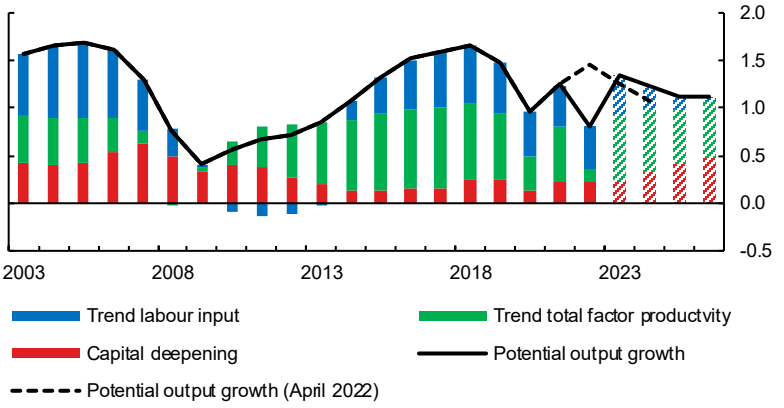
[2] According to Bernstein et al. (2022), immigrants are important contributors to US innovation. They represent 16% of all US inventors but produced nearly 25% of total innovation output from 1990 to 2016.

Euro area

After a brief bounce-back to near pre-pandemic rates in 2021, potential output growth in the euro area is estimated to have slowed sharply in 2022 because of Russia's invasion of Ukraine (**Chart 3**). The surge in domestic energy prices was a significant supply shock to the euro area economy (**Box 2**). In 2023, potential output growth should recover as the drag from high energy prices on trend TFP growth abates.

Chart 3: High energy prices weighed on euro area potential output

Percent change, percentage points contributions, annual data



Source: Bank of Canada calculations

Last data plotted: 2026

Over 2024–26, potential output growth is estimated to grow around 1.1%. Capital deepening is expected to accelerate as private investment strengthens and public investment increases. The latter is due to the continued implementation of recovery and resilience plans—a key part of NextGenerationEU funding.[3] In contrast, TLI growth is expected to slow due to population aging.

Compared with the April 2022 assessment, our estimate of potential output growth is 0.5 pps lower in 2022. The negative impact of high energy prices on trend TFP growth—which disproportionately affected activity in highly productive industrial sectors—largely explains the revision. The level of potential output is 0.4% lower by 2024, as trend energy prices remain above their pre-invasion levels.

[3] NextGenerationEU is an €800 billion fiscal package launched in 2021 to support the recovery of European Union member states from the COVID-19 pandemic (European Commission 2021).

Box 2: The impact of higher energy prices on potential output in the euro area

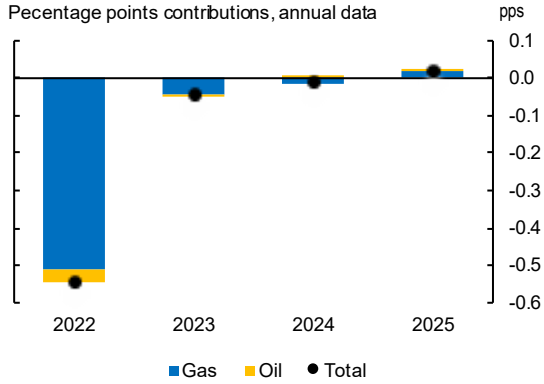
Energy prices rose sharply in the euro area in 2022—particularly for natural gas—because of Russia's invasion of Ukraine and related sanctions targeting the Russian economy. Energy is an important input to the production process in the euro area. A sustained hike in energy prices due to the reduced availability of natural gas supplies lowers potential output in the euro area. This box presents a methodology to estimate the impact of higher energy prices on the euro area's potential output.

We assess the implications of high and sustained energy prices for potential output by expanding a standard Cobb–Douglas production function to include oil (O) and natural gas (G) as inputs into the production process.[4] Equation (1) shows the modified production function:

$$Y^{pot} = AK^{\alpha}L^{1-\alpha-\mu-\tau}O^{\mu}G^{\tau}, where\ \alpha = 0.31, \mu = 0.025\ and\ \tau = 0.019. \quad (1)$$

All else equal, decreases in the availability of oil and natural gas will lower potential output in the euro area.[5] The decrease of each input (O and G) can be estimated by multiplying its price elasticity of demand by the expected change in its price due to Russia's invasion of Ukraine. Empirical estimates suggest a price elasticity of oil and natural gas demand of -0.13 and -0.15, respectively.[6] Moreover, the projected trends of oil and natural gas prices, measured against pre-invasion counterfactuals, yield higher oil and natural gas prices (8% and 220%, respectively, over 2022–25).[7] This means that the amount of oil and gas used in production should be about 1% and 33% lower over 2022–25, respectively. Finally, we use the factor shares μ and τ to calculate the impact on potential output of the decline in each factor. On average, these factor shares and the estimated declines of oil and natural gas imply that potential output is about 0.15% lower over 2022–25. The same calculations can be done for each year. We estimate that higher trend energy prices reduce potential output growth by about 0.5 pps in 2022 (**Chart 2-A**) and total a 0.6% reduction in the level of potential output by 2024.

Chart 2- A: Change to potential output growth in the euro area from high energy prices



[4] Some studies propose other methods of modelling energy as a productive input—including constant elasticity of substitution (CES) and a nested CES function for the substitution of capital, labour and energy inputs—that allow for technological change. See Dissou, Karnizova and Sun (2015), Klump, McAdam and Willman (2012) and Schubert and Turnovsky (2011). An exercise using an alternative nested CES production function, however, suggests the results are not very sensitive to the structure of the production function.

[5] Assuming perfect competition, flexible wages and a limited impact on the capital stock, the effect on output from a shift in the relative price of energy can be approximated by the factor share of energy multiplied by its price elasticity of demand (Hamilton 2012).

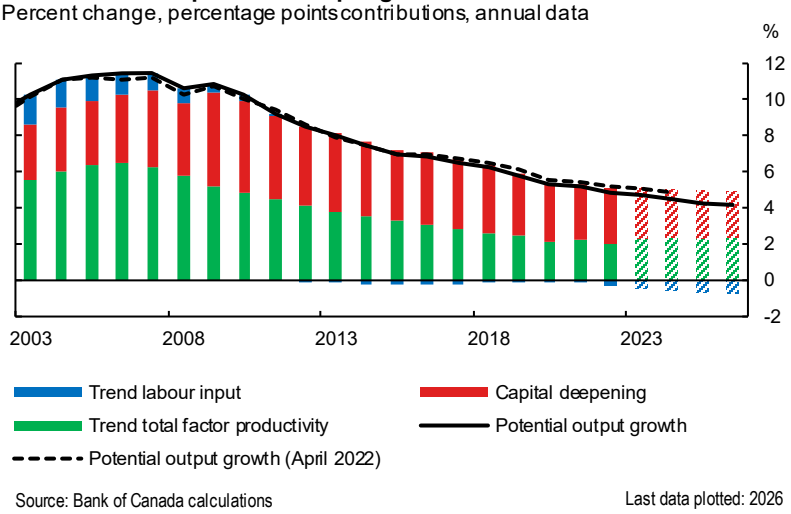
[6] Estimates of the short-run demand elasticity of crude oil range from -0.9 to -0.03, with the median of -0.13. Meanwhile, empirical studies find short-term demand elasticity of natural gas in Europe ranges from -0.24 and 0.02. See Caldara, Cavallo and Iacoviello (2019), Di Bella et al. (2022) and Erias and Iglesias (2022).

[7] We convert both oil and natural gas prices into euros and adjust them using the projected GDP deflator for the euro area.

China

China's potential output growth is expected to fall gradually over the projection horizon, as the growth of both TLI and TLP decline (**Chart 4**).

Chart 4: China's potential output growth to slow further
Percent change, percentage points contributions, annual data



Source: Bank of Canada calculations

Last data plotted: 2026

TLI growth is expected to fall from -0.3% in 2022 to -0.7% in 2026. The fall mainly reflects the decline in the size of the workforce due to population aging. In addition, TLP growth falls over 2023–26, as declining contributions to growth from capital deepening are only partly offset by rising contributions from trend TFP. Spillovers from the correction in the property market drive the expected evolution of capital deepening. Trend TFP growth increases in 2023 due to the lifting of the government's "zero-COVID" strategy. Going forward, the intensification of decoupling from the United States and other advanced economies on the trade and technology fronts is expected to constrain inflows of foreign direct investment (FDI) and weigh on trend TFP growth.

Compared with the April 2022 assessment, our estimate of potential output growth is revised down over history and is 0.4 pps weaker, on average, over 2022–24. Overall, the level of potential output is 2.3% lower by 2024. Downward revisions over 2022–24 mostly reflect a reduction in trend TFP growth linked to policy uncertainty that has intensified over the past year. In addition, FDI flows in 2022 came in weaker than previously forecasted. We expect that weakness to persist over the projection due to Western-imposed restrictions on imports of advanced technology, which slow the pace of technological adoption in China. Updated UN population projections led to a small upward revision to China's TLI growth. However, this is offset by a downward revision to our estimate of the contribution of capital deepening to potential output.[8,9]

[8] Our assessment of TLI is expected to evolve in line with the latest UN medium fertility scenario for population growth assuming that the average retirement age of 60 remains constant over the projection.

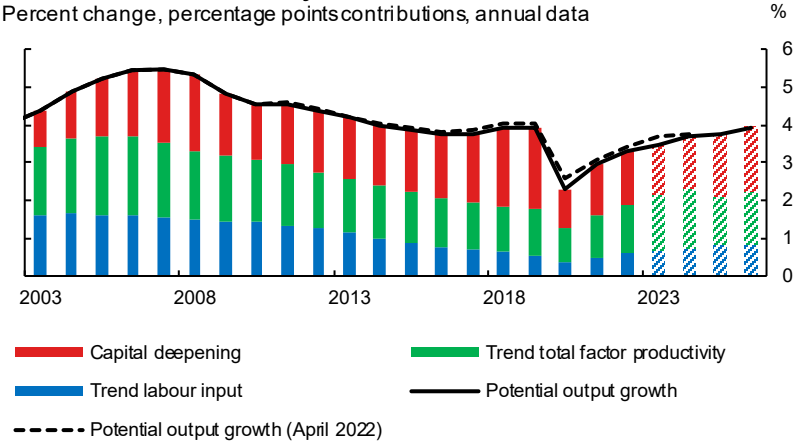
[9] We have reduced our assumption of the capital income share (α) from 50% to 40%, in line with the recent literature (Marie, Cristina and Cyril 2015; IMF 2023).

Oil-importing emerging-market economies

Potential output growth in oil-importing EMEs is estimated to recover steadily between 2022 and 2026. This is mainly because of a recovery in capital deepening and TLI growth as scarring effects from early in the COVID-19 pandemic dissipate (**Chart 5**). Additionally, trend TFP growth is projected to improve modestly due to firms in this region gradually catching up to the technological frontier.

Chart 5: Potential output growth of emerging-market economies to recover slowly

Percent change, percentage points contributions, annual data



Source: Bank of Canada calculations

Last data plotted: 2026

Compared with the April 2022 assessment, potential output growth is revised down on average by 0.1 pp over 2022–24. The limited changes to potential output growth are the result of competing factors. We expect the weakness in capital deepening observed in 2022 to persist through 2024 as EMEs face slower growth, tighter financial conditions and higher levels of debt than previously forecasted. Weaker capital deepening is also expected to constrain TFP growth over the same horizon (World Bank 2023). These negative effects are largely offset by stronger-than-projected trend labour force participation, which has shown less evidence of scarring from the pandemic than previously anticipated.

Other regions

Potential output growth in Japan is expected to remain tepid, averaging 0.7% over 2023–26, as a rapidly aging population continues to weigh heavily on TLI growth. The main driver of potential growth continues to be TFP, reflecting advances in digitalization. Potential output growth is little changed compared with the April 2022 assessment.

Potential output growth in the RoW region is expected to recover gradually but to remain below its pre-pandemic average of 2% over 2017–19. RoW potential output growth is expected to have slowed to 0.7% in 2022. This is due to the heavy impact of international sanctions on potential output in Russia after its invasion of Ukraine. Russia's drag on RoW potential output growth is expected to decline gradually over the projection horizon. Compared with the April 2022 assessment, our estimate of potential output growth has been revised down by 0.6 pps, on average, over 2022–24, based on our updated assessment of the impact of the war on the region. As a result, the level of potential output in 2024 is 3.1% weaker than in the April 2022 assessment.

Uncertainties around the outlook for global potential output growth

Our assessment is subject to several uncertainties.

On the downside, the future shape of global supply chains has become less certain following the trade war between China and the United States, the COVID-19 pandemic and Russia's invasion of Ukraine. Climate change could also help reconfigure supply chains as more frequent extreme weather events could cause substantial disruptions to international trade.[10] In response to these events, firms are adjusting their supply chain practices and governments are considering policies to relocate strategic industries closer to home. In the long term, near-shoring or re-shoring could lower TFP growth by substantially increasing consumer prices, lowering business profits, and reducing hiring and capital spending.[11]

The upside risks to potential output remain the same as in our last assessment. Increased investments in new digital technologies and remote work—both prominent outcomes of the pandemic—could increase labour productivity. For example, firms could find it easier to hire workers that otherwise may not have wanted to relocate for jobs. Renewable energy investment could also be stronger than expected given recent public incentives, particularly in Europe and the United States. Geopolitical considerations could also drive new energy investments, particularly in Europe following Russia's invasion of Ukraine.

[10] For more, see Dunbar, Steingress and Tomlin (2023).

[11] For instance, when asked by a journalist about the difference in production costs between the two jurisdictions, an executive with the Taiwan Semiconductor Manufacturing Company Limited noted that construction costs in Arizona can be four to five times greater than in Taiwan (see Xu 2023).

US neutral rate

Our assessment suggests that the US nominal neutral rate—our proxy for the global neutral rate—lies within a range of 2% to 3%. This is unchanged from the April 2022 assessment (Boutilier et al. 2022). As in 2022, our assessment is informed by a suite of structural models capturing different drivers of the neutral rate. The neutral rate of interest is unobservable and inferred from the evolution of the factors that influence it. Therefore, our estimate is subject to considerable uncertainty.

This latest assessment accounts for two factors affecting the US neutral rate:

- mild upward pressure from an updated profile for US potential output growth
- a downward revision to the Congressional Budget Office's projected profile for the US government's debt-to-GDP ratio between 2023 and 2026[12]

Given that these changes are largely offsetting and that other factors influencing the US neutral rate are roughly unchanged, our estimate of the US neutral rate is the same as in the April 2022 assessment.[13]

[12] All else being equal, a lower ratio of government debt to GDP reduces the supply of safe assets and puts downward pressure on the neutral rate.

[13] Other factors include inequality and the demand for safe assets.

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