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INTERNATIONAL MONETARY FUND

CANADA

SELECTED ISSUES

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Approved By
Western Hemisphere Department

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INCOME INEQUALITY: WHERE DO WE STAND?[1]

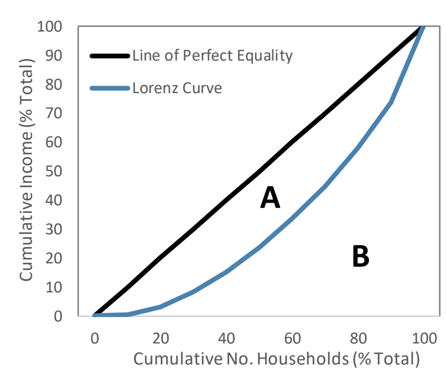
The economic lockdown triggered by COVID-19 led to a sharp decline in employment in Canada, with lower-paid workers being particularly hard hit. The government's fiscal response to the crisis included a range of programs that provided significant income support to low-income workers, with many households receiving emergency transfers exceeding their pre-crisis income levels. While the long-term impact of the crisis on income inequality is uncertain, it will need to be closely monitored and assessed against the government's policy objectives. To help inform this policy discussion, this chapter describes recent (pre-COVID-19) trends in income inequality across Canada.

A. Introduction

1. **There has been a well-documented upward trend in income inequality in advanced economies over recent decades.** Addressing this trend has moved towards the top of the policy agenda in many countries. Concerns about high inequality relate to fears that persistently unbalanced income growth can result in rising social tensions that could fuel populist and protectionist sentiment, potentially leading to political instability. These concerns are not unfounded, as was recently seen in Chile—the paragon of macroeconomic stability in Latin America—where high level of income inequality helped to serve as a catalyst for widespread protests and riots, sparked by a small (4 percent) increase in public transport fares in Santiago. There is also evidence that high levels of income inequality can hamper economic growth (see, for example, Ostry and Others, 2018). Indeed, inequality can affect growth by undermining education opportunities for children from poor socio-economic backgrounds, lowering social mobility, and hampering skill development. But when is inequality excessive? As noted by IMF Fiscal Monitor (October 2017), there is no easy answer, but it will depend on country-specific factors, including the growth context in which inequality arises and with societal preferences.

2. **How is income inequality typically measured?** The Gini coefficient is the most widely cited measure of income inequality and will be used as the measure income inequality throughout this chapter. The Gini coefficient measures the extent to which the income distribution within an economy deviates from a perfectly equal income distribution. Specifically, the coefficient is computed as the ratio of the area between two curves (the Lorenz curve and the line of perfect equality), i.e. area A divided by areas A and B in figure 1. The Gini coefficient ranges between 0 for perfect equality to 1 for perfect inequality.

Figure 1. Gini Coefficient



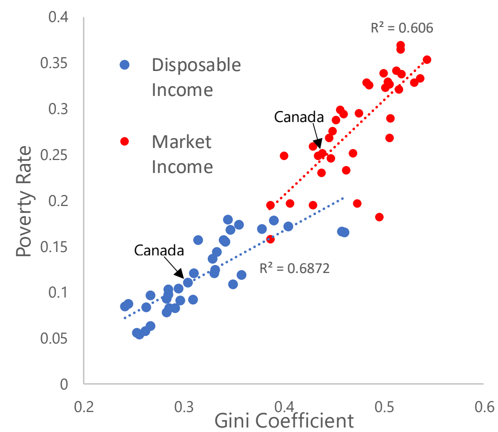
3. **The definition of income matters.** There are three definitions of household income that can be used to compute Gini coefficients: market income (income received from market sources,

[1] Prepared by Troy Matheson and Dan Pan (WHD).

such as wages and interest income); total income (market income plus government transfers); and disposable income (total income less taxes paid). Gini coefficients computed based on market income reflect inequality in incomes derived from market sources and Gini coefficients computed based on disposable incomes reflect inequality in disposable incomes, which are incomes after government taxes and transfers. Thus, the difference between Gini coefficients based on market incomes and disposable incomes reflects the impact that government redistributive polices (through transfers and taxes) has on income inequality.

4. Poverty and inequality are linked. As shown from figure 2, there is strong correlation between poverty rates and income inequality across the OECD countries using Gini coefficients measured in both market incomes and disposable incomes. Recognizing this, the Government of Canada released its poverty reduction strategy in August 2018, which targeted a 20 percent reduction in poverty by 2020 and a 50 percent reduction in poverty by 2030.[2] More generally, the current administration has placed significant emphasis on supporting the middle class in its annual budget in an effort to reduce income inequality since it came to power in 2015.

Figure 2. Inequality and Poverty Rates

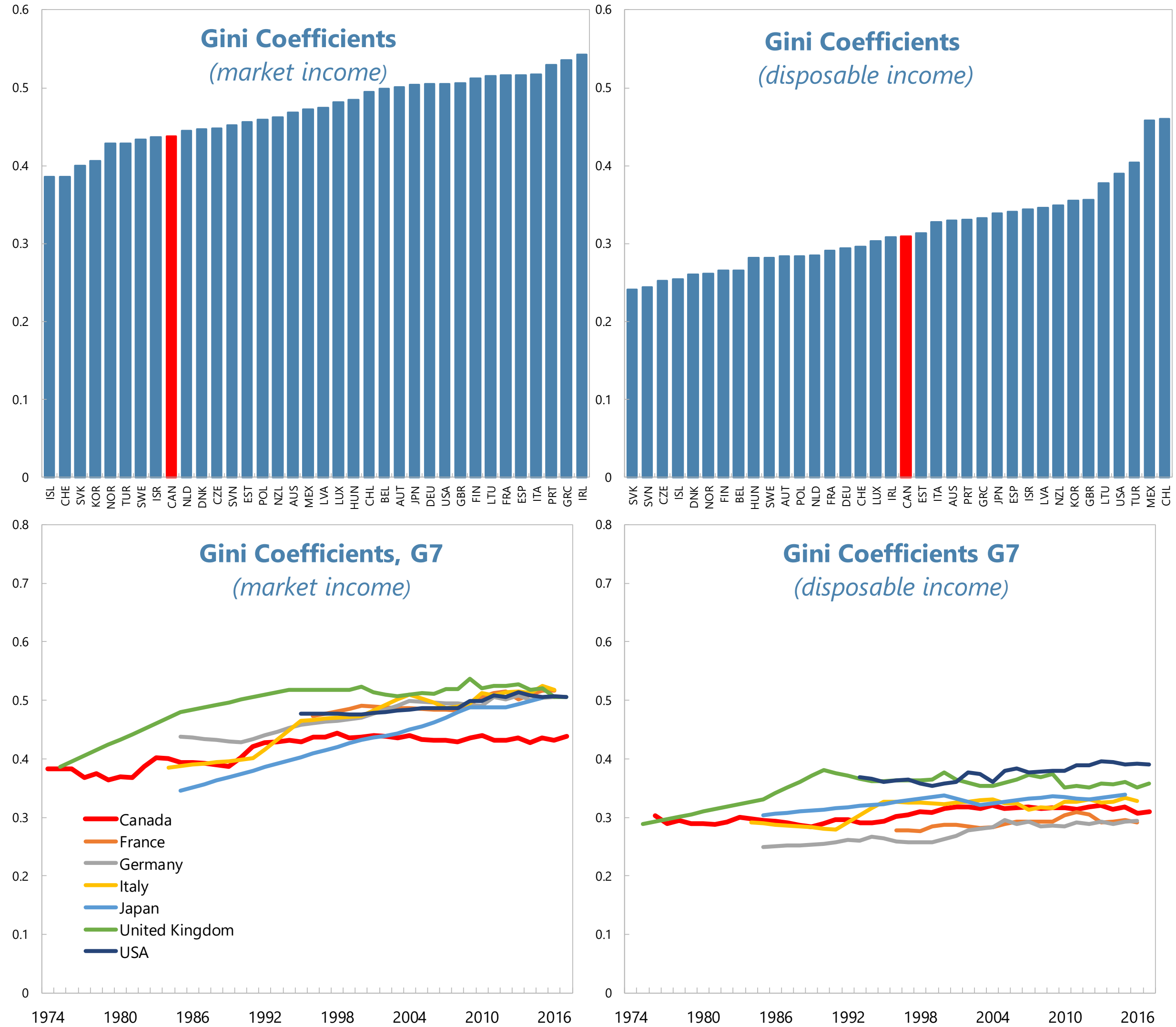


Source: OECD and staff estimates.

5. How do inequality levels in Canada compare with other advanced economies? According to OECD data, Canada has the 9th lowest Gini coefficient in the OECD countries and the lowest Gini coefficient among G7 countries based on market incomes (figure 3).Inequality in Canada ranks towards the middle of OECD countries when considering disposable income distributions, after accounting for governments' redistributive policies. While the tax and transfer systems act to reduce income inequality across all OECD countries, Canada's redistribution polices appear to reduce inequality by less than many European countries, largely because these countries have stronger social safety nets and more progressive tax systems (OECD, 2012). As noted above, figure 3 also shows that income inequality has generally risen across the G7 over the past several decades. More recently, Canada's inequality has been relatively stable, while upward trends have largely continued unabated in other G7 countries. This raises the question: How has inequality evolved across Canadian provinces?

[2] The targets were set relative to the 2015 level of poverty. See https://www.canada.ca/en/employment-social-development/programs/poverty-reduction/reports/strategy.html

Figure 3. Inequality Across the OECD and the G7



Source: OECD and staff estimates.

6. **This chapter examines income inequality across Canadian provinces along several dimensions.** The chapter proceeds as follows. Section B takes a closer look at income inequality across Canadian provinces and section C assesses the relationship between inequality and growth within Canada. Section D examines why income inequality has risen in Canada by exploring changes in inequality in market incomes and redistribution policies. Section E concludes with a summary of the findings and policy messages.

B. A Closer Look at Inequality Across Canadian Provinces

7. **There is not much diversity in market income inequality across provinces.** Market income inequality is highest in Quebec, Ontario, and Newfoundland and Labrador, and lowest in

Alberta, British Columbia, and Prince Edward Island (figure 4). Not surprisingly, market income inequality tends to be higher at national level than provincial level, with only Ontario and Newfoundland and Labrador having higher levels of market income inequality than Canada as a whole.

8. Redistributive polices reduce inequality within provinces. Disposable income inequality is lower than market income inequality for all provinces, suggesting government redistributive policies play crucial roles in reducing inequality within provinces.

9. Trends in inequality across Canadian provinces have been remarkably similar. After remaining broadly stable since the mid-1970s, disposable income inequality rose across Canada in the second half of the 1990s and settled at a higher level in the 2000s. Underlying these overall trends were increases in market income inequality starting in the 1980s, which were broadly offset by increases in redistribution through taxes and transfers from government until about 1995. Between 1995 to 2000 the redistributive effect of government programs fell, market income inequality remained high, and disposable income inequality rose as a result. Since around the time the current federal administration came into power in 2015, redistributive policies have had a greater impact on lowering disposable income inequality, particularly in Alberta and Newfoundland and Labrador, but overall levels of inequality remain high from an historical standpoint. [3]

C. Does Inequality Reduce Growth in Canada?

10. To assess the impact of inequality on growth, different variants of the following panel regression equation are estimated using provincial data:

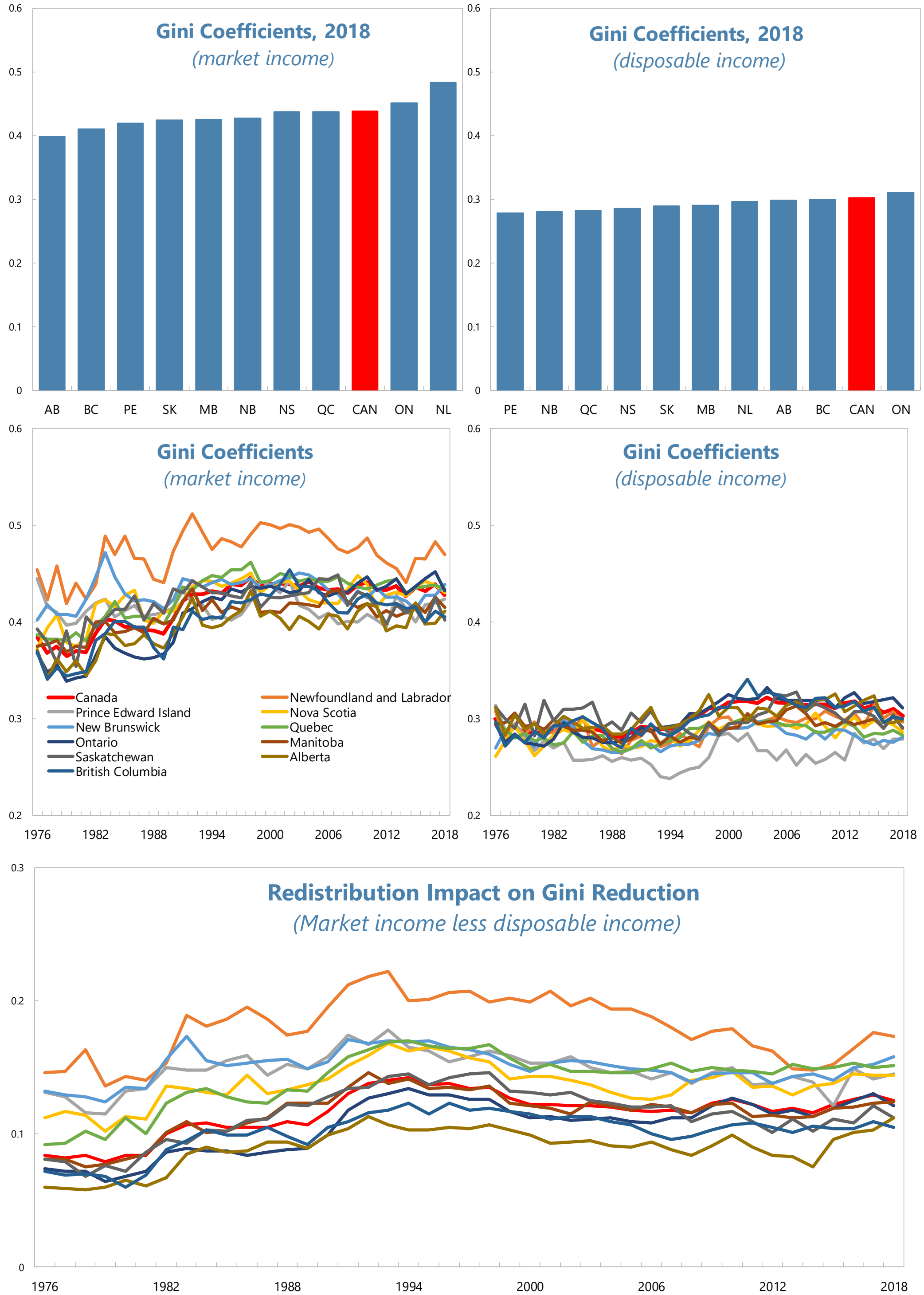
$$lnY_{i,t} - lnY_{i,t-\tau} = \alpha lnY_{i,t-\tau} + \beta X_{i,t-\tau} + \gamma Z_{i,t-\tau} + u_i + v_t + \varepsilon_{i,t}$$

where $Y_{i,t}$ denotes real GDP per capita in province i and year t, $X_{i,t-\tau}$ consists of proxies for inequality, and $Z_{i,t-\tau}$ contains a number of control variables that have been used in previous studies, including trade openness, investment, education, terms of trade, and government expenditure. $t - \tau$ denotes non-overlapping 5-year periods (i.e. $\tau = 5$).

11. Four different specifications are estimated. The models examined are based on specifications used in several previous cross-country empirical studies and include different proxies for inequality in $X_{i,t-\tau}$. Summaries of these studies and the data used to estimate the models in this chapter are provided in tables A1 and A2 in the appendix. The models are estimated using both fixed effects and system GMM panel regressions.

[3] The greater impact of redistributive policies on lowering disposable income inequality in Alberta and Newfoundland & Labrador (and the national average) after 2015 is likely to partly reflect that many lost their jobs and received employment insurance benefits during the oil supply shock that began in 2014.

Figure 4. Provincial Inequality



Source: Statistics Canada and staff estimates.

Model 1

In line with Berg and others (2018), Model 1 focuses on identifying the relationship between disposable income inequality, redistribution, and economic growth. Model 1 is:

$$lnY_{i,t} - lnY_{i,t-\tau} = \alpha lnY_{i,t-\tau} + \beta_1 G_{i,t-\tau} + \beta_2 R_{i,t-\tau} + \gamma Z_{i,t-\tau} + u_i + v_t + \varepsilon_{i,t}$$

where $G_{i,t}$, is disposable income inequality defined as Gini coefficient measured by after taxes and transfers income, and $R_{i,t}$ is redistribution defined to be the difference between the Gini coefficient for market income $GM_{i,t}$ and the Gini coefficient for disposable income $G_{i,t}$,i.e., $R_{i,t} = GM_{i,t} - G_{i,t}$.

Model 2

To further explore the potential for a non-linearity in the relationship between inequality and growth, Model 2 incorporates squared Gini coefficient following Aiyar and Ebeke (2019). Model 2 is:

$$lnY_{i,t} - lnY_{i,t-\tau} = \alpha lnY_{i,t-\tau} + \beta_3 G_{i,t-\tau} + \beta_4 G^2_{i,t-\tau} + \gamma Z_{i,t-\tau} + u_i + v_t + \varepsilon_{i,t}$$

Model 3

Aiyar and Ebeke (2019) also showed that inequality is likely to have a larger negative impact on growth when intergenerational mobility is lower (i.e. parents with lower income can only afford lower quality education so that their children have more limited potential earnings). The relative income mobility index IM_i for each province is drawn from Corak (2017) and is an estimate of the intergenerational income elasticity (the percent change in child income for a one percent change in parent income), where a lower elasticity means a society has more intergenerational mobility. Since there is no time variation in the income mobility index, it enters Model 3 as an interaction term with the Gini coefficient:

$$lnY_{i,t} - lnY_{i,t-\tau} = \alpha lnY_{i,t-\tau} + \beta_5 G_{i,t-\tau} + \beta_6 (G_{i,t-\tau} \times IM_i) + \gamma Z_{i,t-\tau} + u_i + v_t + \varepsilon_{i,t}$$

Model 4

In Halter and others (2013), a Gini coefficient that is lagged 10 years is added to the specification, allowing for a separation of the long-term impact of income inequality on growth from the short-term impact.[4] Model 4 is:

$$lnY_{i,t} - lnY_{i,t-\tau} = \alpha lnY_{i,t-\tau} + \beta_7 G_{i,t-\tau} + \beta_8 G_{i,t-2\tau} + \gamma Z_{i,t-\tau} + u_i + v_t + \varepsilon_{i,t}$$

[4] Halter and others (2013) developed a model in which high income inequality boosts economic growth in the short term and reduces growth over the long term. The authors argue that most of the positive effects on growth from income inequality in the short to medium run (e.g., those operating through market imperfections or incentives to invest) rely on purely economic mechanisms. Most of the negative effects, on the other hand, involve disruptions in political processes, the rise of socio-political movements, or they operate through changes in educational attainment of the population, all which take some time to materialize.

Estimation Results

12. **The results show mixed evidence on the impact of inequality on growth among Canadian provinces.**[5] The results can be summarized as follows:

- *Model 1*. The results show a negative relationship between inequality and growth when the model is estimated using system GMM, but this relationship is not statistically significant. Likewise, the joint coefficient of income inequality and redistribution (market income inequality) is also estimated to be both positive and insignificant.

- *Model 2*. The results show a negative relationship between inequality and growth when estimated using system GMM, but this effect is not statistically significant. This specification also shows no evidence that higher levels of income inequality have a disproportionately large negative impact on growth.

- *Model 3*. Consistent with the findings of Aiyar and Ebeke (2019), the system GMM results suggest a negative relationship between inequality and growth and that this effect is mitigated when intergenerational income mobility is higher. However, both effects are not statistically significant.

- *Model 4*. Consistent with the findings from Halter and others (2013), there is some evidence suggesting that higher income inequality can boost growth in the short term but hamper it over the long term. However, as with the results described above, these relationships are not found to be statistically significant.

13. **Why is the evidence mixed?** While recent cross-country empirical studies have tended to find a negative relationship between inequality and growth (see, for example, the studies described in table A2 in the appendix), a broader examination of the numerous empirical studies on the topic that have been conducted over the past 50 years suggests the evidence can best be described as mixed. Why? As noted in Barro (2000): "Many nice theories exist for assessing the effects of inequality on investment and economic growth. The problem is that these theories tend to have offsetting effects and that the net effects of inequality on investment and growth are ambiguous". Theories related to the negative effects of inequality on growth also tend to involve disruptions in political processes and rising social tensions, factors that likely present themselves in empirically unpredictable and non-linear ways. As such, in a sense, empirical ambiguities broadly accord with the findings in the theoretical literature and thus are not surprising.[6]

[5] In addition to the baseline specifications, a large number of alternative specifications were also investigated, including models with different lag lengths, different instruments, and with no controls. The qualitative findings are broadly similar to those described below. These results can be obtained from the authors on request.

[6] This broad assessment has also been shared by Ostry and Berg (2017), who note that relationship between income inequality and growth is complex and the evidence mixed.

Table 1. Canada: Estimation Results 1/

Dependent variable:	Fixed Effects				System GMM			
Real GDP per capita growth	Model 1	Model 2	Model 3	Model 4 2/	Model 1	Model 2	Model 3	Model 4 2/
Inequality *(t-5)*	0.0015	0.0009	-0.0055	0.0008	-0.0001	-0.0624	-0.0020	0.0078
	(0.0011)	(0.0162)	(0.0042)	(0.0005)	(0.0024)	(0.1042)	(0.0069)	(0.0278)
Redistribution *(t-5)*	0.0010				0.0009			
	(0.0007)				(0.0008)			
Inequality squared *(t-5)*		0.0000				0.0001		
		(0.0000)				(0.0002)		
Inequality *(t-5)* * Relative income mobility			0.0303				0.0055	
			(0.0188)				(0.0136)	
Inequality *(t-10)*				-0.0014**				-0.0144
				(0.0005)				(0.0169)
Real GDP per capita *(t-5)*	-0.5667***	-0.6663***	-0.7670***	-0.7327***	-0.5182	-0.3213	-0.5223	0.4936
	(0.0909)	(0.0770)	(0.0889)	(0.0770)	(0.3268)	(0.2702)	(0.5858)	(1.0847)
Trade openess *(t-5)*	0.0023*	0.0022	0.0017	0.0015	0.0032**	0.0034	0.0030	-0.0095
	(0.0012)	(0.0014)	(0.0013)	(0.0011)	(0.0014)	(0.0031)	(0.0030)	(0.0160)
Investment *(t-5)*	-0.0027	-0.0046	-0.0045	-0.0078***	0.0041	0.0036	0.0057	0.0110
	(0.0026)	(0.0027)	(0.0028)	(0.0023)	(0.0074)	(0.0070)	(0.0175)	(0.0456)
Education *(t-5)*	0.1860***	0.2494***	0.2992***	0.3502***	0.2152	0.1216	0.2298	0.1269
	(0.0512)	(0.0409)	(0.0539)	(0.0274)	(0.1662)	(0.1400)	(0.2883)	(0.4404)
Terms of trade *(t-5)*	-0.0012**	-0.0014***	-0.0013***	-0.0003	-0.0065***	-0.0075*	-0.0079	-0.0041
	(0.0004)	(0.0004)	(0.0003)	(0.0009)	(0.0019)	(0.0035)	(0.0045)	(0.0048)
Government expenditure *(t-5)*	-0.0093**	-0.0094**	-0.0110***	-0.0024	-0.0226**	-0.0128**	-0.0268	0.0050
	(0.0034)	(0.0033)	(0.0032)	(0.0031)	(0.0078)	(0.0046)	(0.0235)	(0.0598)
Constant	-2.5959***	-2.7397	-3.3235***	-2.7690***	-1.4801	8.3257	-1.0291	4.2891
	(0.2276)	(2.4325)	(0.3437)	(0.3908)	(1.5782)	(16.2161)	(3.1806)	(4.8010)
Observations	70	70	70	60	70	70	70	60
Sargan (p-value)					0.6032	0.5415	0.1550	0.6606
Hansen (p-value)					0.6148	0.4818	0.3447	0.5931
AR1 (p-value)					0.1064	0.2699	0.2145	0.4682
AR2 (p-value)					0.4602	0.5581	0.5025	0.4769
Instrument Number					10	10	10	10

Note: Robust standard errors in brackets; *, **, and *** denote statistical significance at the 10%, 5% and 1% levels, respectively; Hansen (Difference-in-Hansen) denotes the p -value on the test for the validity of the full instrument set.

1/ In addition to the baseline specifications, a large number of alternative specifications were also investigated, including models with different lag lengths, different instruments, and with no controls. The qualitative findings are broadly similar to those described below. These results can be obtained from the authors on request.

2/ Consistent with Halter and others (2013), in model 4, control variables are the original levels with a 5-year lag. For example, inequality (t-5) is Gini coefficient at t-5. Consistent with Berg others (2018) and Aiyar and Ebeke (2019), control variables in all equations except model 4 are averaged over each five-year period and enter the model with a one period (5-year) lag. For example, net inequality (t-5) is average of net inequality from t-5 to t-1.

14. **Inequality is still important, irrespective of its impact on growth.** Most academics agree that some level of inequality is desirable to incentivize investment and growth in a market economy, and that levels that are too high can lead to social disruptions that can lower growth. But how much inequality is too much? The empirical findings for Canada suggest that, over this sample, inequality has not had a significant impact on growth in either direction—it has been neither too high nor too low. However, this does not diminish the importance of policymakers' efforts to reduce inequality based on societal preferences and social justice grounds, which have long been emphasized by the Government of Canada.

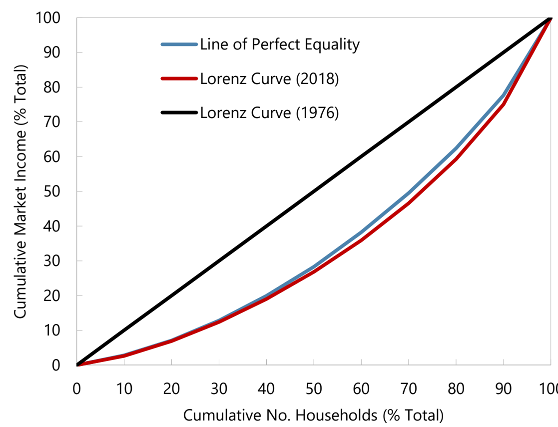
D. Why Has Inequality Risen Across Canada?

Inequality in disposable incomes can be impacted by the distribution of market incomes and redistribution policies. This section discusses each of these drivers of inequality in Canada in turn.

Market Income

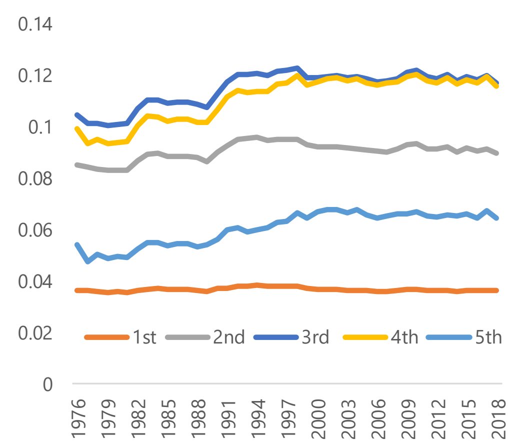
15. Market income inequality has been rising since the 1970s (figure 5). This is largely the result of a hollowing out of the middle class and a rising share of income going to the richer Canadians. Figure 6 shows the contributions to the increase in the Gini from the bottom 2 quintiles of the income distribution (representing the bottom 40 percent of the provincial income distribution) has been broadly stable over the past 40 years. On the other hand, the middle quintile and the top 2 quintiles have contributed more to the rise in income inequality (caused by a larger share of income going to the rich and a smaller share going to the middle class). These trends are also reflected in the provincial data (see figure A1 in the appendix).

Figure 5. Lorenz Curves (Market Income)



Source: Statistics Canada and staff estimates.

Figure 6. Contributions to Market Income Gini Coefficient by Quintile



Source: Statistics Canada and staff estimates.

16. What are the forces driving the rise in market inequality? As noted in section 1, the rising market inequality seen across Canadian provinces appears to be a global phenomenon. Researchers have argued that several important factors have contributed to the rise in global inequality, factors that are also at work in Canada (Green and others, 2016):

- ***Globalization and skill-biased technical change***. Technological improvements raise incomes unevenly, with rewards going disproportionately to highly educated workers. Skill-Biased Technical Change refers to a shift in the production technology that favors skilled over unskilled labor by increasing its relative productivity (Card and DiNardo, 2002). Essentially, technological improvements raise demand for educated workers, thus allowing them to demand higher wages, which in turn increases inequality.

- ***Immigration.*** Importing low-skilled workers tends to raise income inequality by increasing labor supply in sectors with wages that are already low. Card (2009), for example, found that immigration accounted for 5 percent of the increase in wage inequality between 1980 and 2000 in the United States. The evidence on this is not as clear cut in the case of Canada (see, for example, Picot and Hou, 2016, and Warman and Worswick, 2016).

- ***Decline of labor unions.*** Labor unions reduce inequality both by raising wages at the low end of the distribution and constraining them at the high end, so a decline in unionization rates goes hand in hand with a rise in income inequality. Indeed, Western and Rosenfeld (2011) found the decline in labor unions is responsible for 20 to 33 percent of the overall rise in inequality in the United States. As noted by Legree and others (2016), the literature on income inequality in Canada also shows that an important part of rising wage inequality is the result of declining unionization rates.

- ***Intergenerational income mobility.*** Equality of opportunity in society is strongly related to intergenerational mobility—the extent to which children are afforded the same life chances regardless of their parents' income status. Chorak (2013) argues that a country's income inequality and the level of intergenerational income mobility are correlated, with more unequal societies being less mobile. As noted by Heisz (2016), evidence that income mobility among individuals has declined in Canada in recent years raises concerns that inequalities might become more permanent.

Redistributive Policies

17. Disposable income inequality rose across Canadian provinces in the second half of the 1990s (see section B). Across Canada, rising market income inequality in the 1980s and early 1990s was largely offset by the redistributive effects of government programs. However, as market inequality settled at a higher level in the 2000s, the redistributive impact of government programs also began to decline, causing a rise in disposable income inequality.

18. Redistribution can be achieved through tax and transfer policies. As discussed in section C, total redistribution R is defined to be the difference between Gini coefficients computed using market income GM and disposable income G:

$$R = GM - G$$

Defining total income as market income plus transfers (before taxes) and its associated Gini coefficient GT, separate redistribution indices for transfers (subscript *b*) and taxes (subscript *t*) are defined to be:

$$R_b = GM - GT$$

for transfers, and:

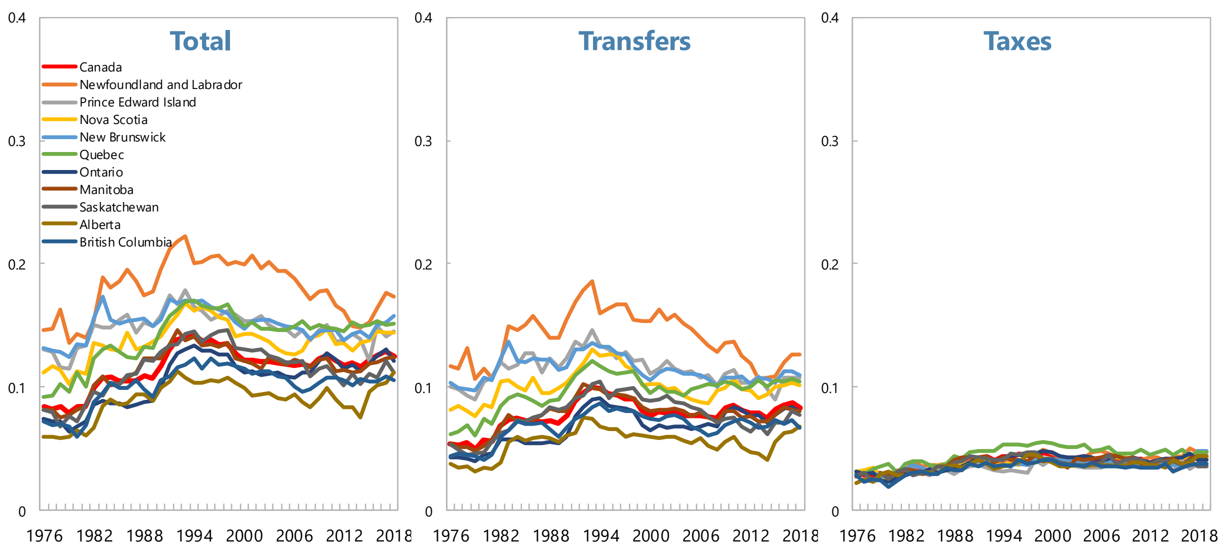
$$R_t = GT - G$$

for taxes, where:

$$R = R_b + R_t$$

19. Redistribution through transfers has a much larger impact on inequality across provinces than taxes (figure 7).[7] Indeed, the declining redistributive effects of transfers is the key reason why the overall effect of redistributive government policies across all provinces fell from the middle of the 1990s until 2014, with the redistributive effects of taxes remaining broadly stable over this period. The redistributive impact of transfers has been rising across all provinces since the current federal administration came into power in 2015.

Figure 7. Redistribution's Impact on Improvements in Gini Coefficients



Source: Statistics Canada and staff estimates.

20. Have redistributive polices become more "progressive" over time? As discussed in Heisz and Murphy (2016), the amount of redistribution generated by transfers and taxes depends on both their size (as measured by average benefit and tax rates) and their progressivity. Progressive transfer systems provide more benefits to households at the lower end of the income distribution, while progressive tax policies charge higher tax rates on households at the upper end of the income distribution. Following Kakwani (1984), progressivity indices and indices reflecting the size of transfers and taxes can be related to the redistribution indices. For transfers:

$$R_b \sim \frac{b}{1+b} P_b$$

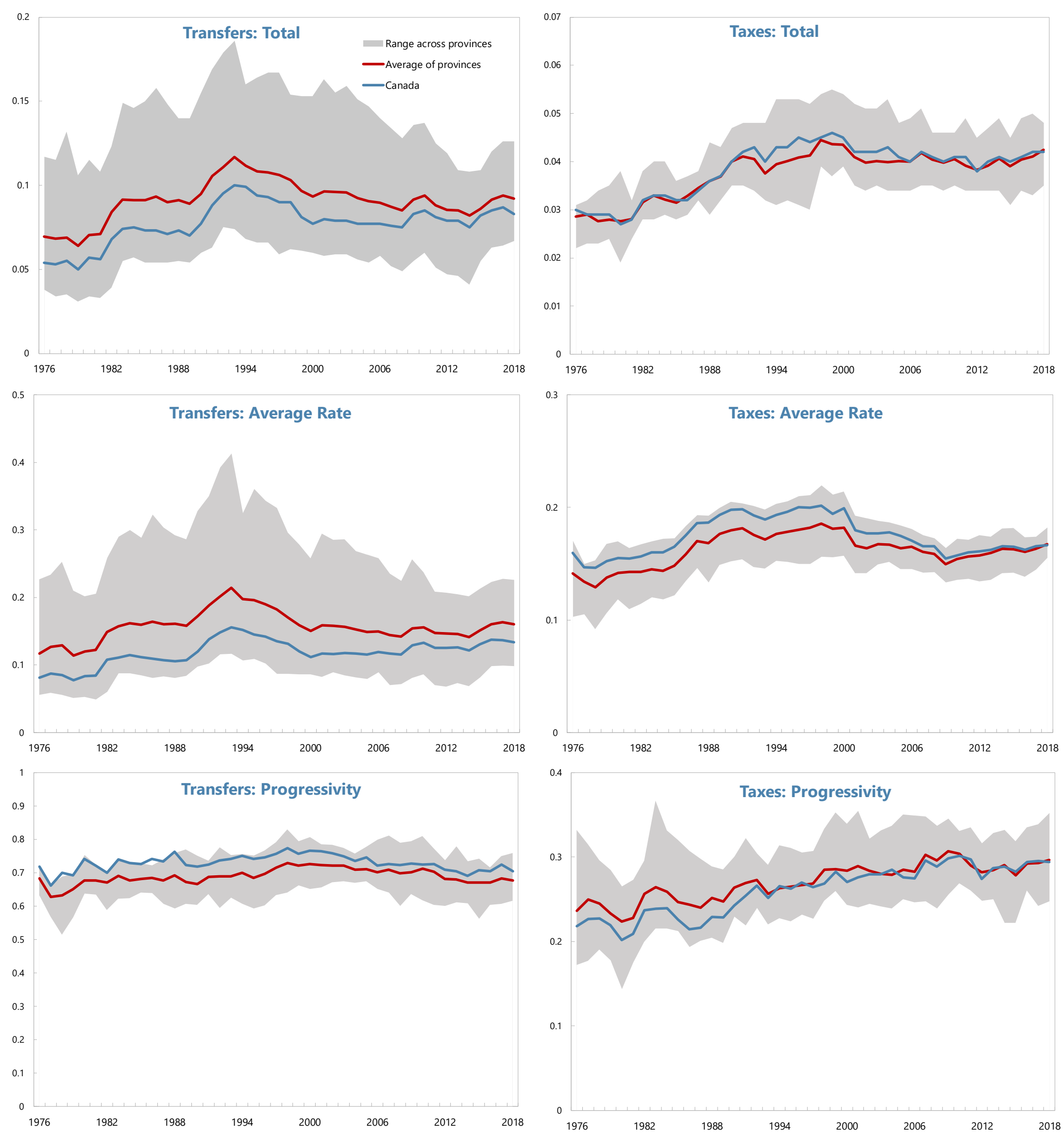
[7] This also applies when looking at the impact of government redistributive policies across all OECD countries.

where P_b is the Kakwani progressivity index for transfers and b is the average benefit rate, defined to be total transfers received divided by total market income. Likewise, for taxes:

$$R_t \sim \frac{t}{1-t} P_t$$

where P_t is the Kakwani progressivity index for taxes and t is the average tax rate, defined to be total taxes paid divided by total income. Figure 8 displays total redistribution indexes for Canada, the range of estimates across provinces and the provincial average. The figure also displays the average transfer and tax rates and the progressivity indices for transfers and taxes.

Figure 8. Decompositions of Redistribution

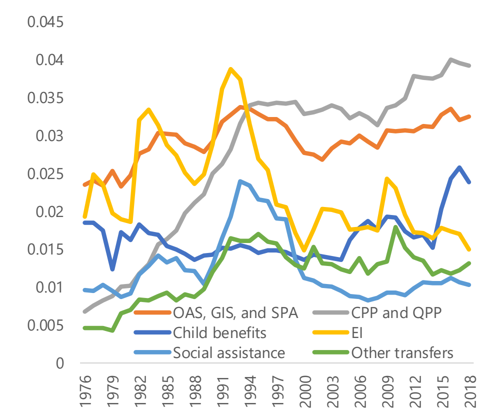


Source: Statistics Canada and staff estimates.

21. Transfers largely contributed to the decline in the impact of redistribution since the middle of the 1990s, while taxes appear to have become more progressive.[8] Figure 8 clearly shows that the impact of transfers and rose from the 1970s to the middle of the 1990s when it began to fall. The impact of taxes, on the other hand, rose from the 1970s and has remained broadly stable since 2000. Looking across all provinces, the principal factor driving redistribution through transfers appears to be average benefit rate, which closely mirrors developments in total redistribution through transfers. Nevertheless, there are still some minor changes in the progressivity of transfers, which increased in impact from the 1970s to 2000 and then began to fall. In contrast, while average tax rates rose between the 1970s and 2000 and then began to fall, the progressiveness of taxes has been steadily increasing over time. This shows that governments have been able to achieve the same total redistributive impact from taxes since 2000 while maintaining lower average tax rates.

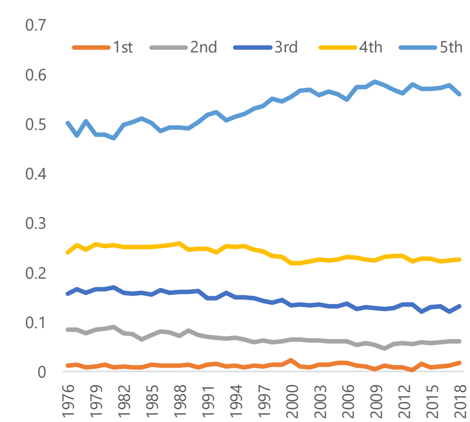
22. Why have overall transfer rates declined? Figure 9 displays shares of different types government transfers in total income for Canada (the same shares for each province are displayed in figure A2, in the appendix). The transfers are: Old Age Security (OAS) and Guaranteed Income Supplement (GIS), Spouse's Allowance (SPA); Canada Pension Plan (CPP) and Quebec Pension Plan (QPP) benefits; Child benefits; Employment Insurance (EI) benefits; Social assistance; and Other government transfers. The decline in transfers since the middle of the 1990s can largely be attributed to a reduction in EI benefits and social assistance, which more than offsets rising childcare and pension benefits. More recently, the rise in the redistributive impact of transfers since 2014 can be attributed to an increase in childcare benefits that the current federal government announced in 2015. The same trends can also be seen across each province (see figure A1).

Figure 9. Transfers: Average Rate



Source: Statistics Canada and staff estimates.

Figure 10. Taxes: Shares of Total Paid by Income Quintiles



Source: Statistics Canada and staff estimates.

23. How have taxes become more progressive? As discussed in Heisz and Murphy (2016), both federal and provincial taxes have shared similar levels of progressivity over time, and average tax rates have fallen since 2000

[8] For a detailed summary of changes to the transfer and tax programs since 1976 can be found in the appendix of Heisz and Murphy (2016).

across both levels of government.[9] Unsurprisingly, as can be seen in figure 10, the increase in the progressivity of taxes over time can be attributed to a rise in the share of taxes paid by high income households and falling shares paid by households in the middle of the income distribution. Meanwhile, the share of taxes paid by households at the lower end of the income distribution has remained broadly stable since the 1970s.

E. Summary and Policy Conclusions

24. There has been a well-documented upward trend in income inequality in advanced economies over the past several decades. More recently, Canada's inequality has been relatively stable, while upward trends have largely continued unabated in other G7 countries. Tax and transfer systems act to reduce income inequality across all OECD countries, but Canada's redistribution polices appear to reduce inequality by less than many European countries. Overall, Canada ranks towards the middle of OECD countries when considering disposable income inequality, after accounting for the impacts of government redistributive policies.

25. There is not much diversity in market income inequality across provinces, and trends in inequality are remarkably similar over time. After remaining broadly stable since the mid-1970s, disposable income inequality rose across Canada in the second half of the 1990s and settled at a higher level in the 2000s. Underlying these overall trends were increases in market income inequality starting in the 1980s. This was broadly offset by redistributive policies (transfers and taxes) until about 1995. However, between 1995 to 2000 the redistributive effect of government programs fell while market inequality remained higher, increasing disposable income inequality. Since the current federal administration came into power in 2015, redistributive policies have been having a greater impact on lowering disposable income inequality, particularly in Alberta and Newfoundland and Labrador. However, the overall levels of inequality remain high from an historical standpoint.

26. While recent cross-country empirical studies tend to find a negative relationship between inequality and growth, this chapter finds mixed evidence for Canada. Theories related to the negative effects of inequality on growth tend to involve disruptions in political processes and rising social tensions, factors that likely present themselves in empirically unpredictable and non-linear ways. This may be one reason why this chapter finds mixed evidence for Canada.

27. Inequality remains important, irrespective of its impact on growth. Over the sample period examined, inequality in Canada has not had a significant impact on growth in either direction—suggesting it has been neither too high nor too low. However, this does not diminish the importance of policymakers' efforts to reduce inequality on the basis of societal preferences and social justice grounds, something the Canadian governments have long emphasized.

28. Rising market income inequality in Canada can be attributed to several factors, many of which are also present in other advanced economies. These factors include globalization and

[9] The evolution of tax redistribution and progressiveness for different taxes cannot be evaluated due to data limitations.

skills-bias technical change, immigration, the decline unionization rates, and intergenerational mobility.

29. A decline in the impact of redistributive policies between the mid-1990s and 2014 also contributed to the rise income inequality. The decline in the impact of redistributive policies was most pronounced for transfers, particularly those associated with reductions in benefit rates for employment insurance and social assistance. The redistributive impact of taxes, on the other hand, has remained broadly stable since 2000, despite a decline average tax rates across all income groups, reflecting an increase in the progressivity of taxes—a rise in the share of taxes paid by high income households and a concurrent fall in the share paid by middle-income households. Since the current federal government came into power in 2015, redistribution has lessened inequality largely through a rise in childcare benefits.

30. The economic lockdown triggered by COVID-19 led to a sharp decline in employment in Canada, with lower-paid workers being particularly hard hit. While the long-term impact of the crisis on income inequality is uncertain, it will need to be closely monitored and assessed against the government's policy objectives. To help inform this policy discussion, this chapter has described recent (pre-COVID-19) trends in income inequality across Canada.

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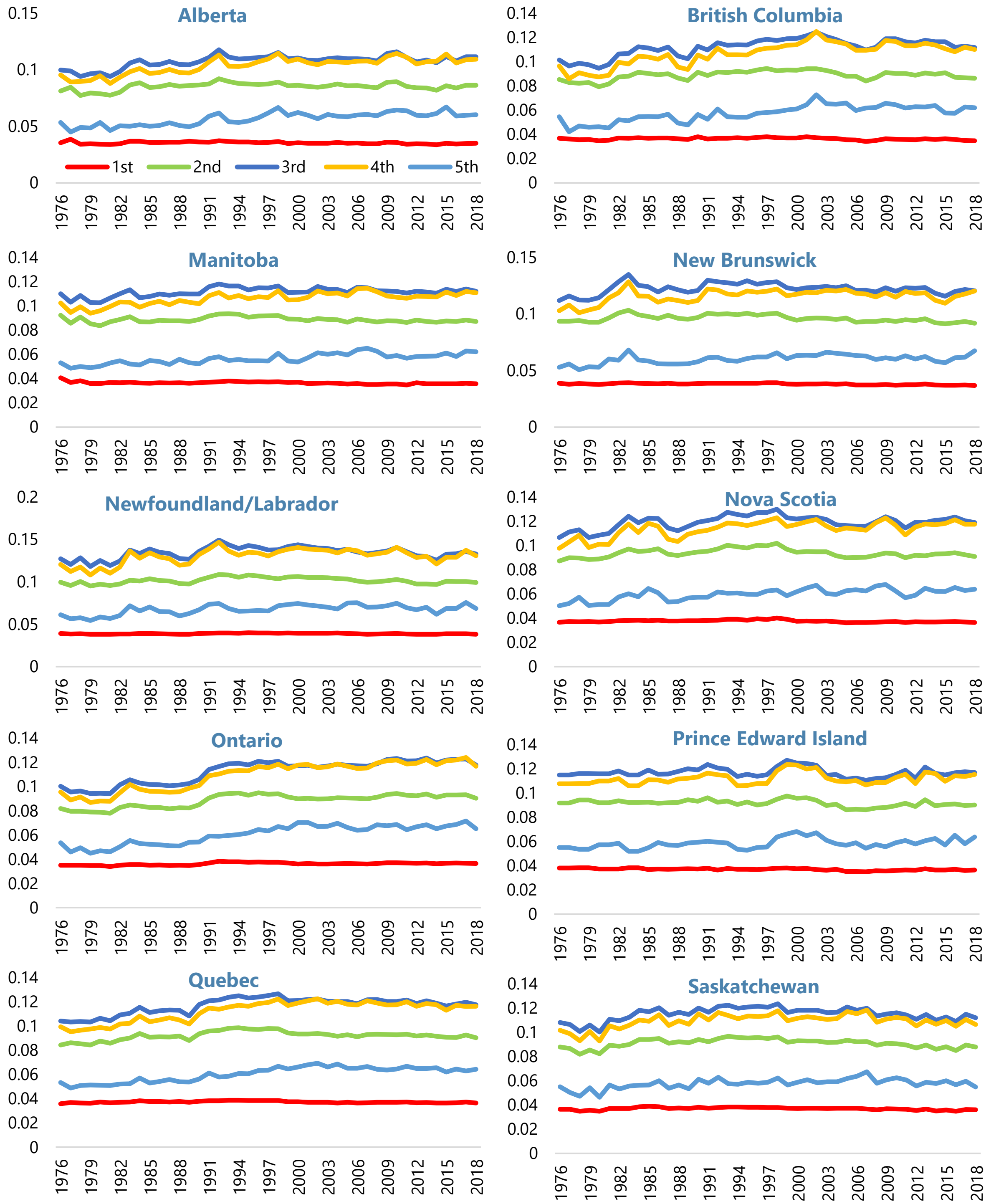
Appendix I. Background

Table A1. Summary of Empirical Studies				
Paper	**GINI Specification**	**Timing Specification**	**Results**	**Controls**
Berg and others (2018)	The Gini coefficient for disposable income and redistribution (the difference between the Gini coefficients for market income and disposable income). Gini coefficients come from SWIID 3.1	**Dependent variable**: (log) real GDP per capita, difference between current and 5-year lagged period **Inequality variables:** averaged over each five-year period and enter the model with a one period (5-year) lag **Other control variables:** unclear	Lower inequality is strongly correlated with faster economic growth. Redistribution is generally benign in terms of its impact on growth (slightly positive but insignificant).	Real GDP per capita (5-year lag, in logs). Investment (percent of GDP, in logs). Population (in logs). Large negative terms of trade shocks (dummy). Political institutions. Trade openness. Debt liabilities.
Aiyar and Ebeke (2019)	The definition of the Gini coefficient differs across the sample (between the coefficient for market income and disposable income). The Gini coefficients comes from Branko Milanovic's dataset, *All the Ginis*.	**Dependent variable:** real GDP per capita growth averaged over the 5-year period; **Inequality variables:** averaged over each five-year period and enter the model with a one period (5-year) lag **Other control variables:** unclear	The negative relationship between inequality and growth can be mitigated by the equality of opportunity. Inequality has a more negative impact on growth when the intergenerational mobility is lower.	Real GDP per capita (5-year lag, in logs). Investment (percent of GDP). Trade openness. Average years of secondary schooling (in logs). Two estimates of intergenerational elasticity of earnings and two estimates of the intergenerational elasticity of education.
Halter and others (2013)	The definition of the Gini coefficient differs across the sample (between the coefficient for market income and disposable income). The primary data source is the Deininger and Squire (1996) database, and the secondary source is the World Income Inequality Database (WIID2c).	**Dependent variable:** (log) real GDP per capita, difference between current and 5-year lagged period; **Inequality variables:** 5-year lag and 10-year lag **Other control variables:** 5-year lag	Higher inequality has positive impact on growth in the short term, but the impact tends to be negative over the long term.	Real GDP per capita (5-year lag, in logs). Investment (percent of GDP). Average years of secondary schooling. Price of investment.

Table A2. Canada: Data and Sources

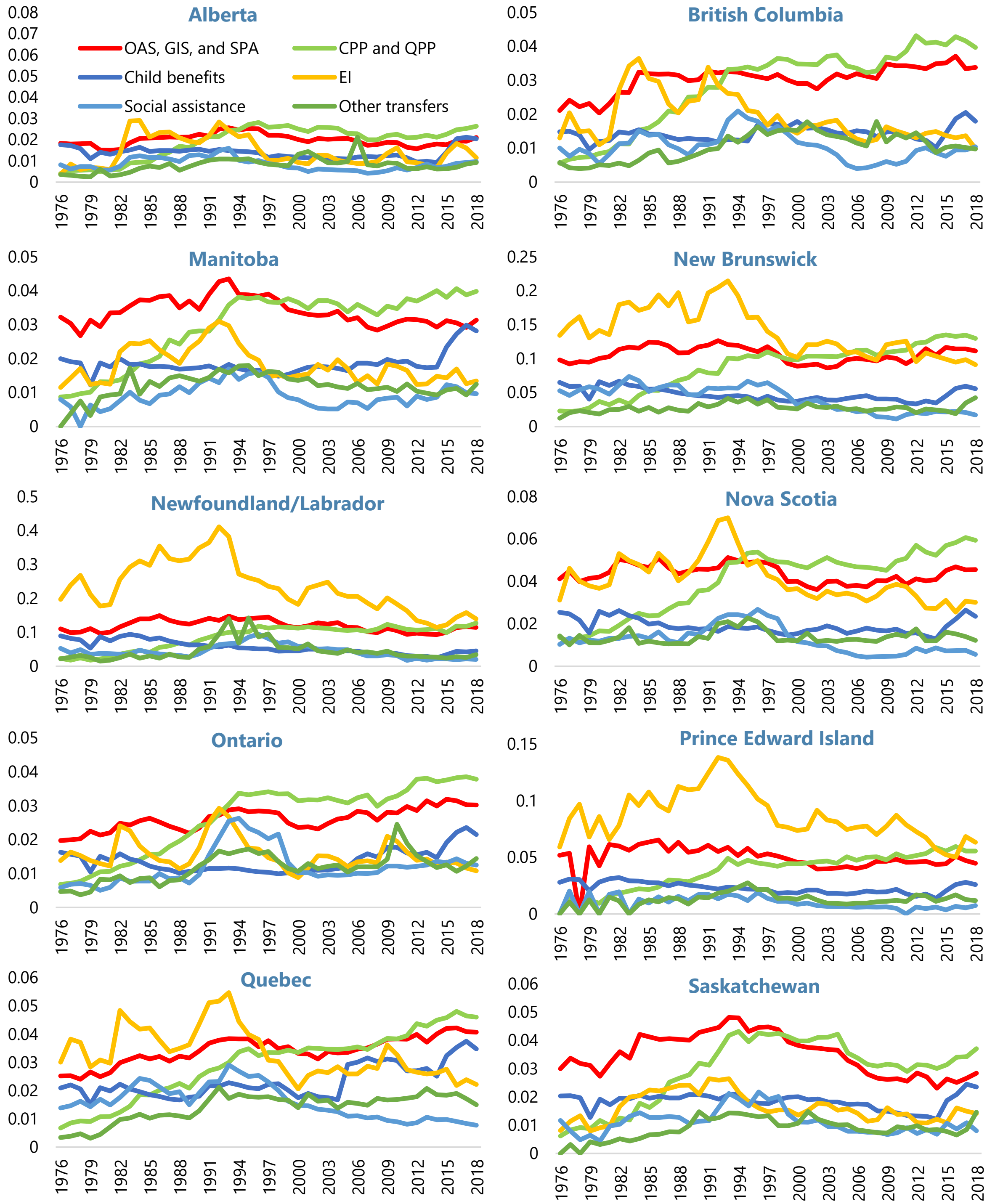
Variable	**Description**	**Sources**
Gini coefficients	Disposable income inequality measured after taxes and transfers (*G*). Market income inequality measured before taxes and transfers (*GM*).	Statistics Canada, table 11-10-0134
Redistribution	$R = GM - G$	
Relative income mobility index	Estimated as the percent change in child income for a one percent change in parent income (intergenerational income elasticity)	Corak (2017)
Real GDP per capita (log)	Real GDP (measured at chained 2012 Canadian dollars) divided by population.	Real GDP: Statistics Canada, table 36-10-0222 Population: Statistics Canada, table 17-10-0009
Trade openness	Nominal trade volume divided by nominal GDP.	Statistics Canada, table 36-10-0222
Investment	Nominal investment as share of nominal GDP.	Statistics Canada, table 36-10-0222
Education	Share of population with university certificate, diploma or degree at bachelor level or above. Data between census years are calculated based on linear interpolation.	Statistics Canada, Census Programs (1976, 1981, 1986, 1991, 1996, 2001, 2006, 2016)
Terms of trade	Export price index divided by import price index.	Statistics Canada, table 36-10-0223
Government expenditure	Government expenditure as share of nominal GDP.	Canada Department of Finance, Fiscal Reference Tables

Figure A1. Contributions to Market Gini Coefficients by Income Quintiles



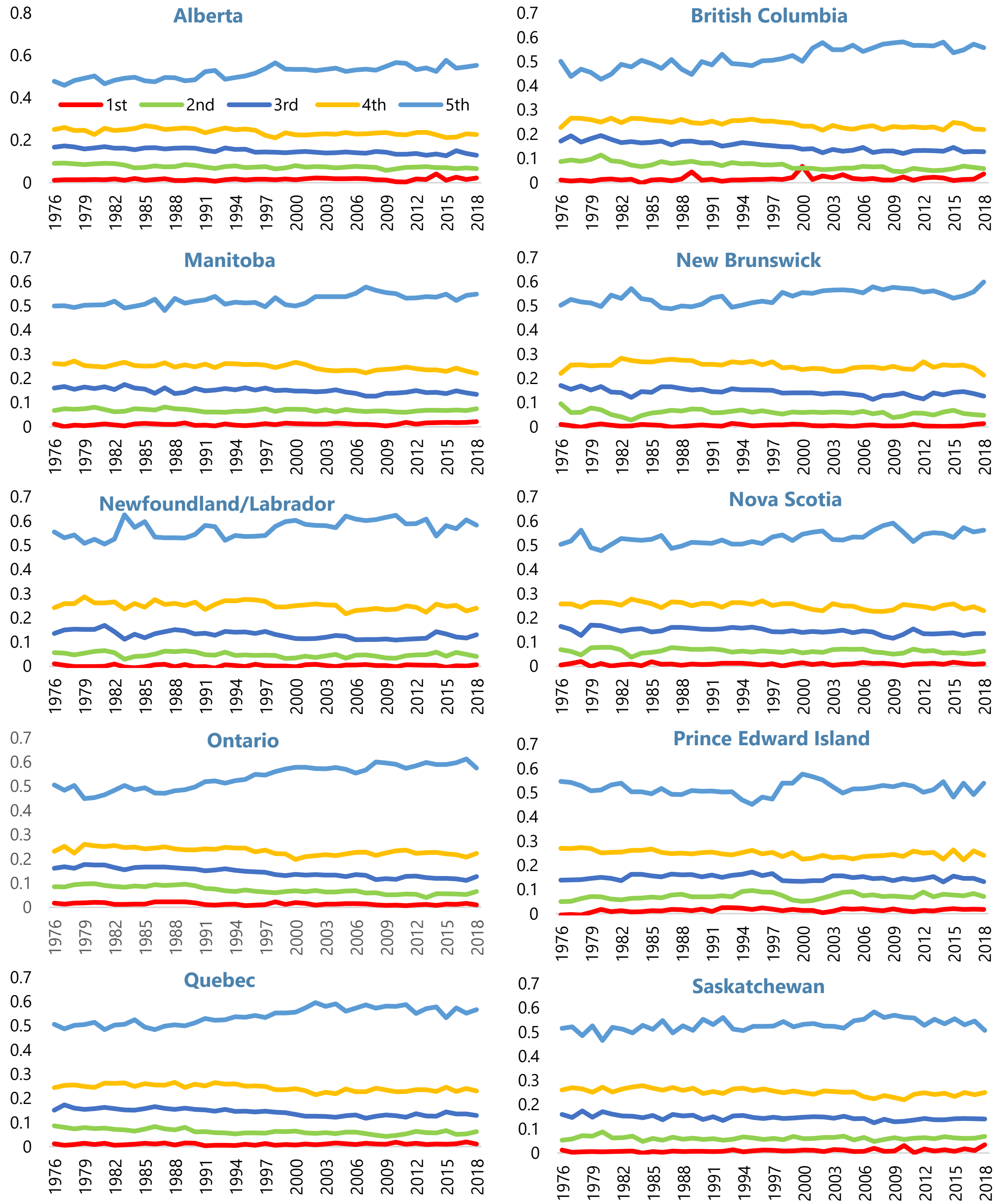
Source: Statistics Canada and staff estimates.

Figure A2. Transfers: Average Rate



Source: Statistics Canada and staff estimates.

Figure A3. Taxes: Shares of Total Paid by Income Quintiles



Source: Statistics Canada and staff estimates.

CANADA: CORPORATE SECTOR RISK ANALYSIS, COVID-19 POLICY COUNTERFACTUALS, AND LINK TO BANK BALANCE SHEETS[1]

A. Introduction

1. **The analysis presented in this chapter aims to quantify the extent to which monetary easing in Canada during the COVID-19 pandemic contributed to circumventing firm defaults and adverse macroeconomic feedback.** This is useful to inform the support policies' benefit. An integrated micro-macro simulation model for the non-financial sector was built, involving balance sheet and P&L data for 850 firms and the seven largest Canadian banks. It allows analyzing the differences across firm sectors regarding various risk and vulnerability metrics—including interest coverage ratios (ICRs), probabilities of default (PDs), loss given default (LGDs), and others.

2. **The counterfactual simulation results suggest that firms would have been notably worse off had monetary policy support not been that significant**.[2] In a scenario with policy rates assumed to be 150 bps higher than observed since March 2020 for the remainder of the year, the industry-aggregate debt-weighted PD could have moved to about 5.5 percent at the peak when considering second-round feedback effects, compared to an observed 3.2 percent on average in 2020. The corporate loan pool's LGD could have moved beyond 30 percent across industries, from a realized, approximate 20 percent. Combined with the assumed base rate shift, the counterfactual scenario entailed a debt cost increase for firms of close to 300 basis points. Real GDP growth could have been 3.4 ppts lower and the unemployment rate 1 ppt higher (year average). The counterfactual impact on banks ranges between -25 bps and -240 bps (min-max) for the seven largest banks' regulatory capital ratios.

3. **Indebtedness and debt-related risk metrics suggest a notable heterogeneity across firm sectors**. Most notably, the energy segment (oil and gas) is plagued by low profitability, low cash to debt ratios, and consequently comparably high probabilities of default already before the COVID-19 pandemic. Continued downward pressure on oil prices as a result of the pandemic, as well as an ongoing trend toward greening the economy more structurally—both domestically in Canada and world-wide—imply further consolidation pressure on the energy segment in Canada.

4. **Notwithstanding the measurable benefit, the risks and vulnerabilities implied by the sizable policy support beyond the short-term should be anticipated and inform policy makers in their strategy to unwind the support measures once warranted**. The risk pertains to

[1] Prepared by Marco Gross (MCM) and Dan Pan (WHD).

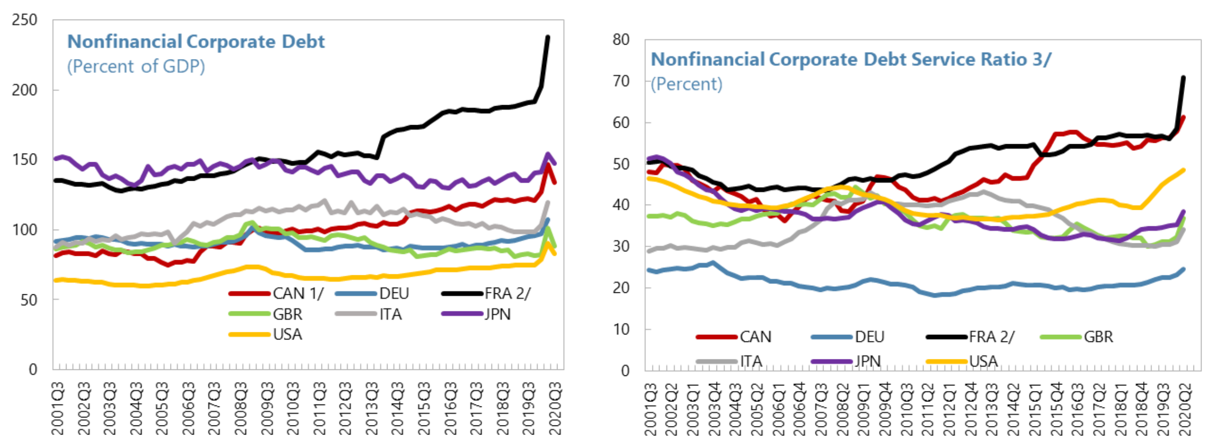
[2] Three caveats apply to the analysis. First, the policy counterfactual is defined in a "broad" manner in the sense of reflecting a general debt cost increase, and not accounting for specific corporate support policies such as wage subsidies. Second, the analysis entails the assumption of no additional debt accumulation of firms. Third, the estimates are generally surrounded by non-negligible model and parameter uncertainty.

overleveraging, incentivized through low interest rates, which careful lending practices by banks (encouraged by the supervisor) should aim to preempt and counteract to prevent macro-financial imbalances from building up.

B. Objective, Data, and Model Framework

5. The objective of this analysis is to assess how the Bank of Canada's broad monetary policy support during the Covid-19 pandemic has helped to contain non-financial corporates' (NFCs) defaults and their implied adverse macro-financial feedback. The analysis aims to quantify how the NFCs and macroeconomic dynamics would have behaved during the pandemic in the assumed absence of the significant monetary policy support in broad term; being reflective of the significant policy interest rate cut as well as its corporate and sovereign bond purchase activities. Canadian NFCs entered the Covid-19 pandemic with stretched levels of leverage and debt service ratios compared to other G7 countries (Figure 1). Preventing firms' debt service costs from further rising seemed therefore particularly warranted in Canada.

Figure 1. Corporate Sector Leverage and Debt Service Burden in G7 Countries

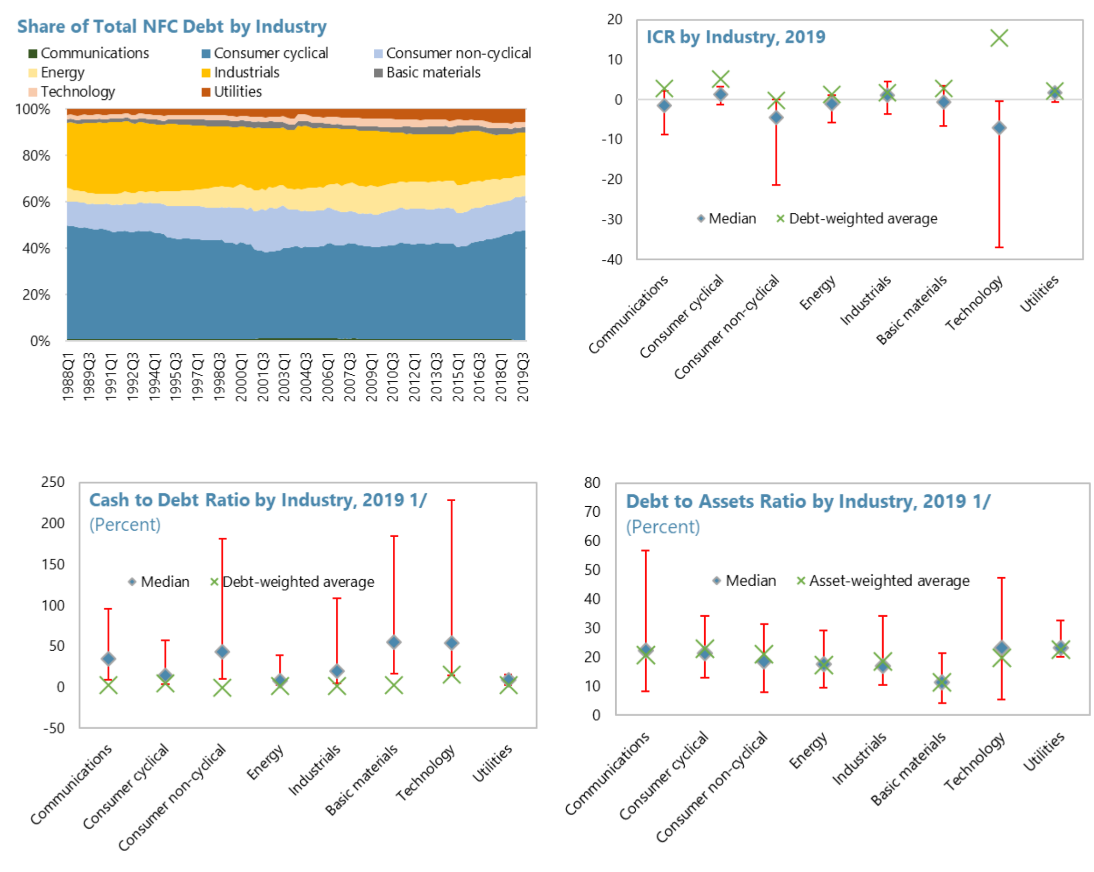


Sources: Haver Analytics, Statistics Canada, Bank for International Settlements, IMF World Economic Outlook, and IMF staff calculations.
1/ Corporate debt in Canada includes intercompany lending and therefore is not fully comparable to that of other G7 countries. Canada's non-financial corporate debt-to-GDP ratio for 2020Q3 would be 45 percentage points lower if intercompany lending (e.g., a foreign parent company lending to its Canadian subsidiary) was excluded from the analysis.
2/ Corporate debt in France is reported on an unconsolidated basis and therefore not comparable to that of other G7 countries.
3/ The BIS uses an internal methodology to estimate the principal repayment flow component of the annuity in the numerator of the debt service ratio for firms.

6. An integrated micro-macro simulation model based on firm-level micro data, coupled with a macro-financial feedback mechanism as well as an impact channel on bank solvency has been set up. The model's micro simulation component rests on historical P&L and balance sheet data for 843 listed and non-listed nonfinancial firms from eight industry segments. As of end-2019, the most sizable debt stock pertained to the consumer cyclical and the industrial segments (Figure 2). ICRs are comparably small for firms in the consumer noncyclical and technology segment;

in the technology segment, they are particularly dispersed. Median cash to debt ratios are the lowest for firms in the consumer cyclical, energy, and utilities segments; while debt-weighted cash debt ratios appear more even across industries. Debt stock to asset ratios, where debt is defined as short-term debt plus half long-term debt, is also rather comparable across industries. Cross-firm heterogeneity, however, is visible in the communications and technology segment. The micro-level data sample from Capital IQ captures 75 percent[3] of the total non-financial corporate debt. Appendix Figure 1 compares various ratios (for example, cash to debt, debt to assets, etc.) from the firm micro data (Capital IQ) with sector aggregate data (Statistics Canada). They suggest a broad correspondence between the averages of such ratios across industries. An exception is the debt to asset ratios for which STATCAN aggregates are lower across all industry segments compared to Capital IQ micro data. This suggests that smaller firms which the micro data does not cover may be characterized by lower indebtedness than larger firms.

Figure 2. Firm Industry-Level Risk Metrics

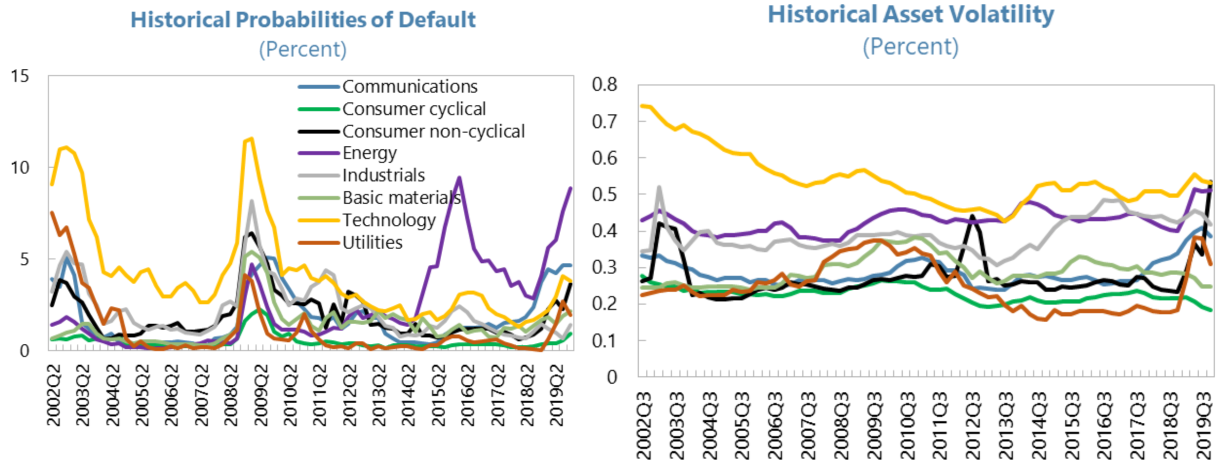


Sources: Capital IQ, Haver Analytics, and IMF staff calculations.
1/ Debt in the debt to asset ratios is defined as short-term plus half long-term debt. Debt in the cash to debt ratios comprises total debt. The red whiskers denote the interquartile ranges.

[3] This share is an approximation and should be interpreted with some caution because of differences in the scope of its components, which reflect, respectively, firms' consolidated debt inclusive of subsidiaries' debt abroad in its numerator, as opposed to a domestic perspective of the firms' debt data from Statistics Canada in the denominator.

7. PDs and asset volatilities are heterogenous in terms of levels and volatility across firm segments historically and at the end-sample position (Figure 3). Firms in the technology segment experienced higher default rates most of the time historically. Since 2014, PDs of firms in the energy segment started trending up, to an average three-fold level of the average observed in the years before 2014. This trend reflects the notable consolidation pressure on the segment over the past few years.

Figure 3. Historical Probabilities of Default and Asset Volatility by Industry Segments



Sources: Moody's Analytics and IMF staff calculations. The PDs and asset volatility are medians of the underlying firm data at any point in time historically.

8. The policy counterfactual analysis will assume that firms' debt cost would have been higher had monetary policy easing through various means not been considered. The model's underlying rationale is summarized in Figure 4. Expansionary monetary policy support compresses firms' debt cost (A in Figure 4), implying fewer firm defaults than otherwise (B). Employment and aggregate demand are thereby supported (C), which in turn helps bolstering firms' income through stronger sales revenues (D). This as a result feeds back to less firm defaults (B), in addition to the relief through lower debt financing costs at the outset. Tagged on to this macro feedback circle is a bank solvency impact module (E). Fewer firm defaults imply for banks to face less material loan losses and more interest income. The feedback from more solid bank solvency to supporting aggregate demand is implicit in the model framework (not explicit). Table 1 summarizes the framework's sub-components and how they are modeled.

9. Firms' gross revenue was related to GDP growth, while firms' cost of goods sold were related to firms' revenue. Gross revenue (*REV*) growth was linked to nominal GDP growth; firms' costs of goods sold (*CGS*) growth was linked to gross revenues growth. Both sets of industry-specific models are firm-level fixed effects panel regressions whose slope coefficient estimates suggest some cross-industry heterogeneity (Table 2).

10. Other firm-level P&L and balance sheet variables were projected following basic accounting relationships. Other operating expenses (OOE) was held constant, and along with sales revenues and the costs of goods sold imply the firms' earnings before interest and taxes (EBIT):

(1) $$EBIT_{f,t} = REV_{f,t} - CGS_{f,t} - OOE_{f,t}$$

Figure 4. Impact Channels Captured by the Corporate Sector Model Framework

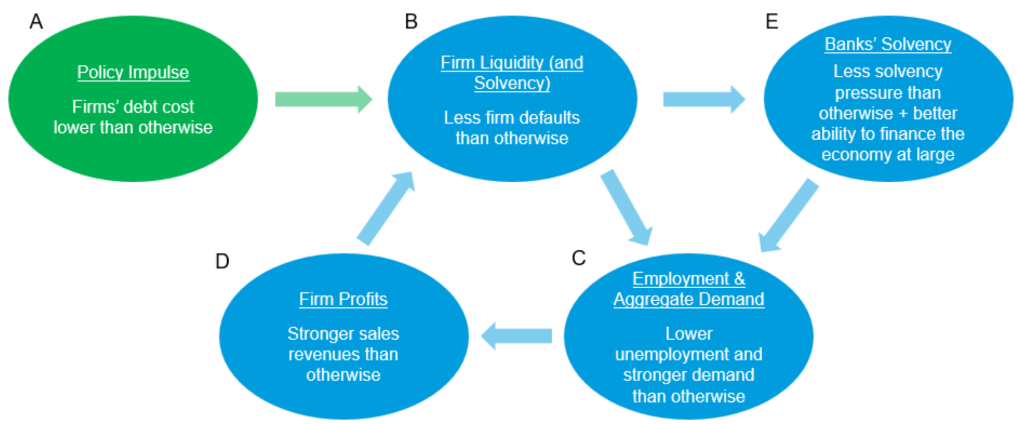


Table 1. Canada: Model Framework – Components

Model Component	Model Approach	Data
Gross revenue	Fixed effects panel regressions for each industry, i.e., eight panel models, linking firms' gross revenue growth to nominal GDP growth; annual freq.	Capital IQ, IMF WEO
Costs of goods sold	Linked to gross revenue via fixed effects panel regressions for each industry, i.e., eight panel models, linking firms' cost of goods sold growth to gross revenue growth; annual freq.	Capital IQ
Other operating expenses	Assumed to be constant	Capital IQ
Interest expenses	Synthetic firm-level interest rate (annual interest expense in 2019 over average debt in 2019 and 2018) as starting point, aligned with scenario paths (apply absolute shift from av. 2019 CBY to average 2020 CBY under two scenarios to the av. 2019 synthetic firm-level interest rate start pt.); assuming variable rate debt is predominant; assumptions on debt stock dynamics/rollover: constant, except for firms whose cash stock would turn negative during the simulation, in which case debt stocks filled up accordingly to keep cash at 0	Capital IQ
Tax expenses	Implicit tax rates (tax expense over EBIT) held constant as of 2020Q1 (median per industry segment)	Capital IQ
Probability of Default (PD)	Econometric bridge equations at industry-level reflecting a combined stock and flow-based Merton model-type rationale, i.e. relating logit(industry PD) to leverage (debt/TA), asset volatility, cash/debt ratios, and risk premiums.	MKMV, Statcan
Asset volatility	Industry-specific bridge equations linking the volatilities to macro environment	Bloomberg, MKMV, Statcan
Link to bank balance sheets	Bank-level data and link to corporate credit portfolios, accounting for loan loss through PDs and LGDs, default-implied foregone interest income flows for banks, and risk weight impact through (1) STA portion of corporate credit portfolios via changing loan loss reserve stock, (2) IRB portion via pass-through from PiT to regulatory risk parameters. LGD treatment: Markdown assumptions on firms' recovery values, applied at banks' corporate portfolio PiT LGDs.	Fitch, Banks' Annual Reports

11. The PD bridge equations were estimated at the industry-level, capturing a stock and flow-oriented Merton-type model rationale in an econometric manner. They had the following structure:

(2) $$\text{logit}(PD_{i,t}) = \alpha_{1,i} + \alpha_{2,i}CD_{i,t} + \alpha_{3,i}DTA_{i,t} + \alpha_{4,i}AV_{i,t} + \alpha_{5,i}EBITR_{i,t} + \alpha_{6,i}RS_{i,t} + \cdots (\text{RHS lags}) \ldots + \varepsilon_{i,t}$$

The RHS variables include a cash to debt ratio (*CD*), a debt to asset ratio (*DTA*, where debt in this ratio is defined as short-term debt plus half long-term debt), asset volatility (*AV*, industry median from the MKMV model), an EBIT to total asset ratios (*EBITR*), and a risk spread (*RS*). The latter was defined as the sectoral aggregate interest expense (4-quarter trailing sum) over debt ratios minus a 2-year sovereign bond yield. The inclusion of *DTA* and *AV* reflects a stock-oriented Merton model philosophy and hence a solvency perspective, relating PDs to leverage and asset volatility. The *CD* and *EBITR* variables have more of a flow (liquidity) perspective.

Table 2. Canada: Bridge Equations (Semi-Elasticities) For Revenue Growth and Costs of Goods Sold Growth

	Revenue growth to nominal GDP growth	CGS growth to Revenue growth
Communications	0.75	0.96
Consumer cyclical	1.19	1.00
Consumer non-cyclical	1.36	0.95
Energy	5.21	0.97
Industrials	1.60	0.98
Basic materials	3.15	0.81
Technology	0.83	0.95
Utilities	1.09	1.00

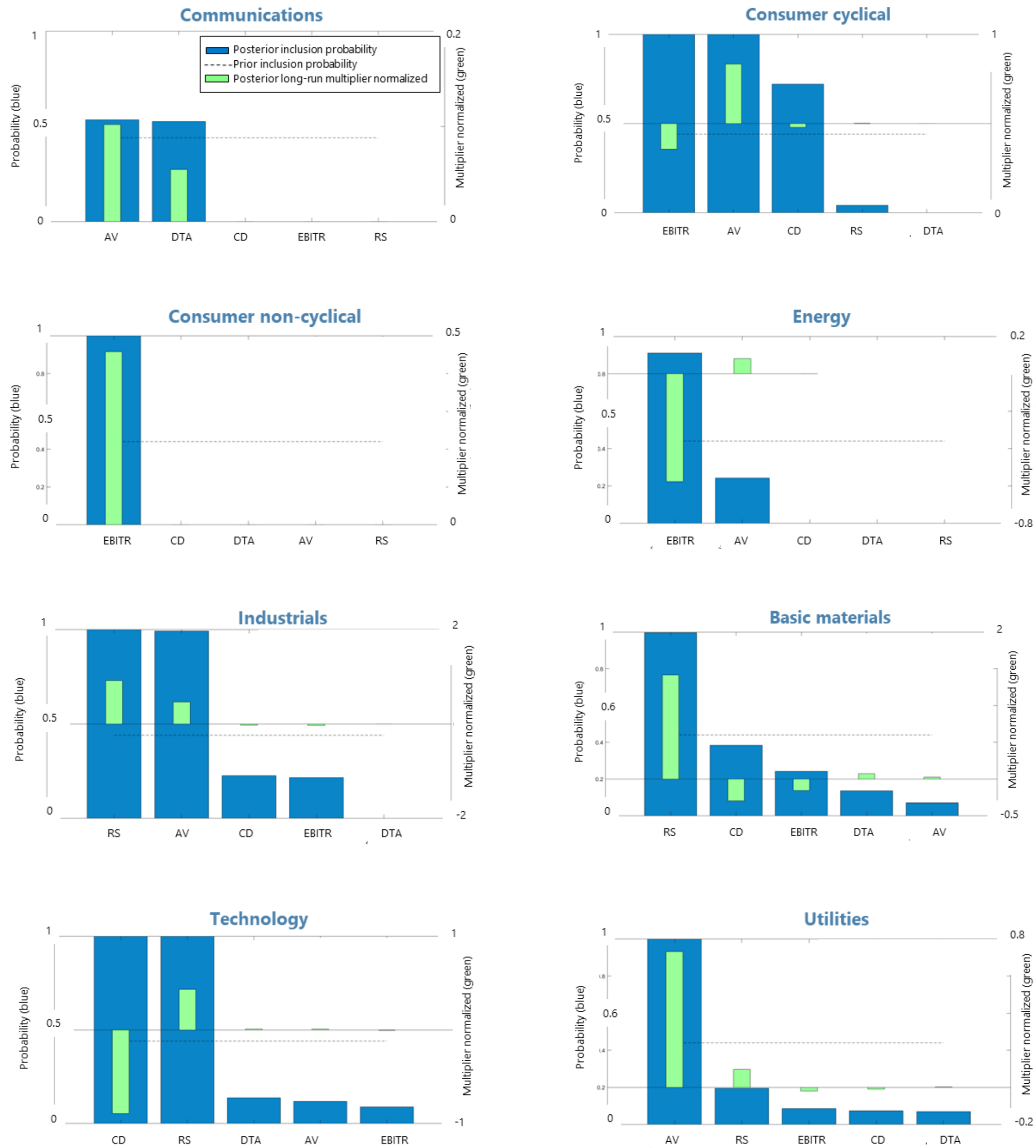
Sources: Capital IQ, IMF World Economic Outlook, and IMF staff calculations. The coefficients are semi-elasticities resulting from regressing log growth on log growth of the respective variables in the bank fixed effects panels for each industry segment. The CGS elasticities for the consumer cyclical and utilities segment were capped at 1. The sample period covered the 1995-2019 period (annual frequency).

12. A long-run multiplier (LRM) sign-constrained Bayesian model averaging (BMA) methodology was used to estimate this equation structure. The BMA estimation routine considers all conceivable combinations of the potential RHS variables as depicted in eq. (2). The resulting "model space" for a given LHS variable is thereby obtained. For each individual equation in that model space, the RHS lag structure is optimized via an additional permutation search (up to two lags of the RHS variables beyond their contemporaneous inclusion were allowed). Each equation in the model space is then assigned a weight conditional on its predictive performance, measured here through a Bayesian Information Criterion. This weight is set to zero if it is not conform with at least one LRM sign constraint. Finally, a posterior, weighted average model is obtained using the weights.[4] The LRM constraints for the PD equations were set to positive for the RS, AV, and DTA variable; negative ones were set for the remaining variables. The model estimates (Figure 5) suggest a role for asset volatility, leverage, and EBIT to total asset ratios, with some heterogeneity in terms of which drivers were found to be relevant across industries. The firm-level balance sheet variables on the right side (debt to assets, cash to debt, and EBIT to assets ratios) are endogenized through the micro simulation part of the model, calculated by aggregating the firm-level estimation results to

[4] For details see Gross, M. and Población, J. (2017), "Implications of Model Uncertainty for Bank Stress Testing." Journal of Financial Services Research, Vol. 55(1), pp. 31-58.

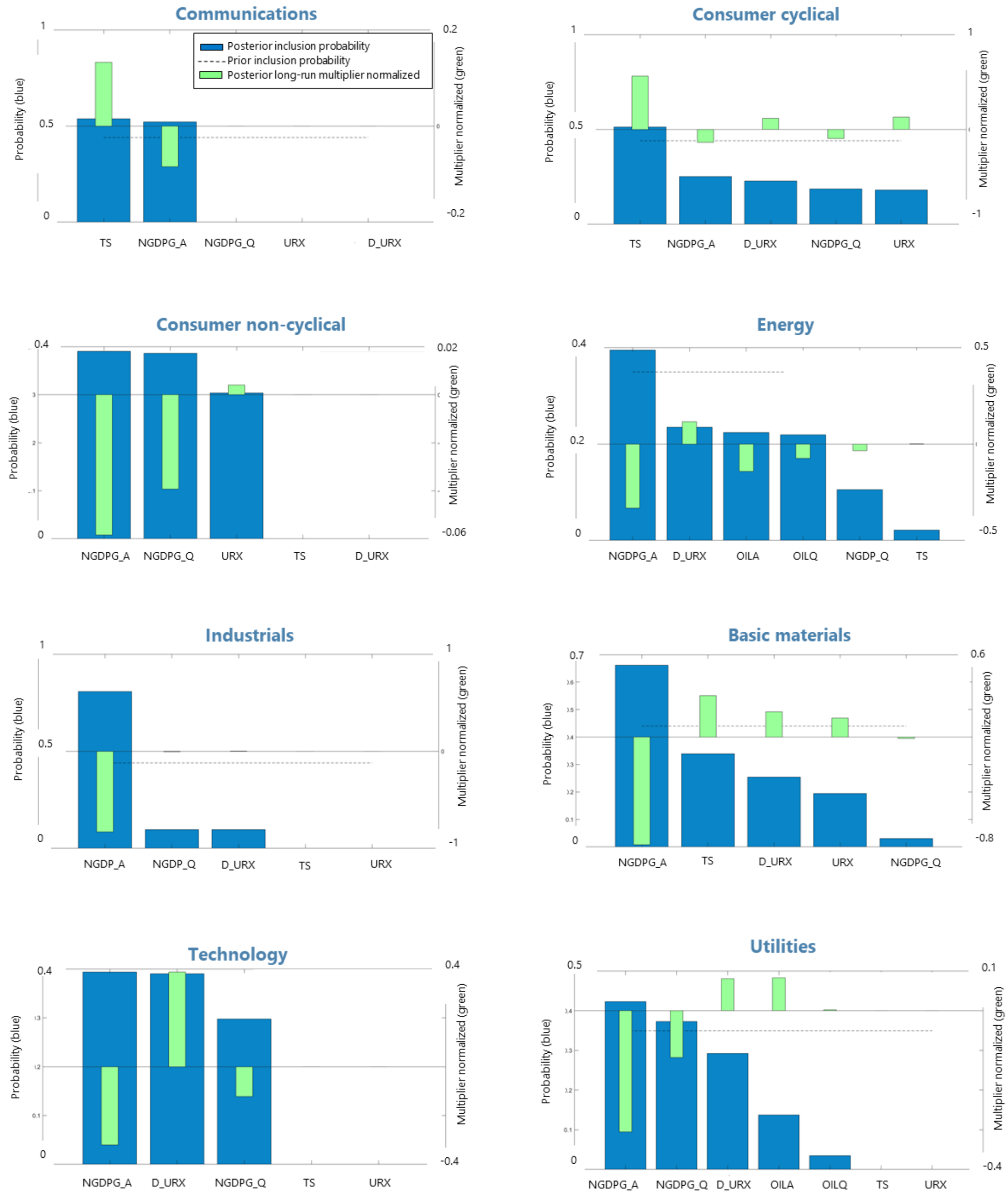
industry-level before feeding into the eight industry-level equations. Asset volatilities are endogenized through econometric bridge equations, described next.

Figure 5. PD Bridge Equations: Long-Run Multipliers and Inclusion Probabilities



Sources: Statistics Canada, Capital IQ, Datastream, and IMF staff calculations.
Note: The normalized long-run multipliers (right axis, green bars) reflect the effect of a RHS variable through their time contemporaneous and possibly lagged inclusion in the underlying models. They were normalized by multipliying them with the ratio of the standard deviation of the respective RHS and LHS variables. They are therefore comparable across drivers and models. When a RHS variable's posterior inclusion probability (left axis, blue bars) exceeds the prior inclusion probability (dashed line), a variable is deemed to be significant from a Bayesian perspective. For variable abbreviations used in these plots, see the text.

Figure 6. Asset Volatility Bridge Equations: LRMs and Inclusion Probabilities



Sources: Statistics Canada, Capital IQ, Moody's Analytics, IMF World Economic Outlook, and IMF staff calculations. See notes to Figure 5.

13. The asset volatility bridge equations establish the volatility's link to the firms' macro-financial, operating environment. These bridge equations were also estimated using the BMA methodology for each industry, based on the following structure:

(3) $$\ln(AV_{i,t}) = \beta_{1,i} + \beta_{2,i}NGDPG_t + \beta_{3,i}TS_t + \beta_{4,i}URX_t + \beta_{5,i}\Delta URX_t + \beta_{6,i}\mathrm{OIL}_t \ldots (\mathrm{RHS\ lags}) \ldots + \varepsilon_{i,t}$$

The RHS variables here include nominal GDP growth (NGDPG, considering QoQ and YoY growth separately), the term spread (TS), unemployment rates (URX) in levels and first differences. For the energy and utilities sectors, the inclusion of an oil price growth variable (OIL, in QoQ and YoY growth) was allowed as well. Positive LRM sign constraints were set for the TS and URX; negative ones for the remaining variables. The oil price growth variable was assigned a negative and positive LRM sign constraint for the energy and utilities segment, respectively. In numerous of the models, the asset volatility is found to be driven primarily by GDP growth and employment conditions (Figure 6).

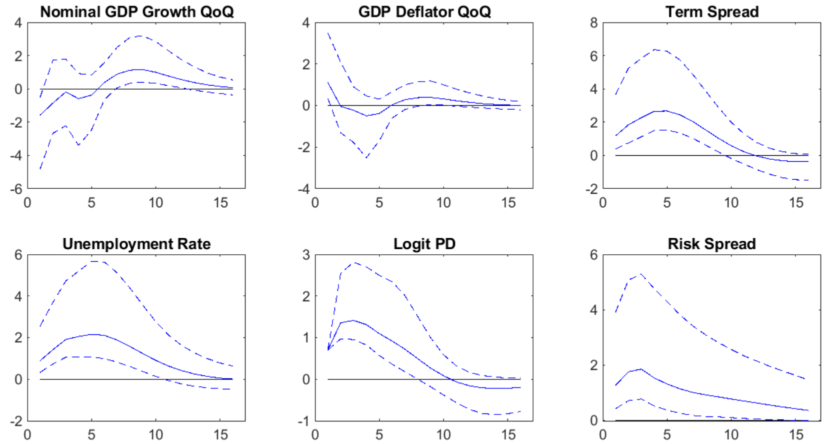
14. A Structural VAR (SVAR) model serves as the macro-financial feedback engine. It contains six variables: nominal GDP (ln QoQ), GDP deflator (ln QoQ), a term spread (10Y sovereign minus 3-month treasury bill rate), the unemployment rate, a risk spread (the difference between the firms' historical implicit interest rate, which is calculated based on industrial total interest expenses over total debt, minus a 2-year sovereign bond yield), and a logit-transformed aggregate NFC sector annual default rate. It was estimated based on quarterly data covering the 2000Q4-2019Q4 period (77 obs.). It is structural in the sense of operating with sign-restricted impulse responses for identifying an initial shock to firm PDs as a supply shock, constraining nominal GDP to fall, GDP deflator inflation to be non-negative, and the unemployment rate to not rise, all on impact. The simulated impulse responses for a +1 pp PD shock (about +0.7 in logit space) is shown in Figure 7. This quarterly impulse response profile was used throughout the second round "looping", scaling the initial PD impulse until convergence of the overall system.

15. The structural bank impact module links the impact of industry-level PDs and LGDs (aggregated to the NFC sector total) to banks' loan losses and RWAs. Starting point risk parameter data as of 2019 for the corporate loan portfolios of the seven largest Canadian banks were collected (Appendix Figure 2). These parameters specifically for the banks' corporate loan books included: their risk weight densities, IRB portfolio shares, PiT and regulatory TTC PDs, and PiT and regulatory downturn LGDs; they were all sourced primarily from the banks' financial reports and Pillar 3 reports as of 2020Q1, thereby being reflective by and large of 2019 conditions.

16. The bank-level PD projections for 2020 are obtained by linking them to the firm sector aggregate PD projections from the micro-macro simulation engine, while another structural extension links PDs to LGDs for the banks. To let also corporate loan portfolio LGDs move under the scenario counterfactual simulation, they are structurally linked to the evolution of PDs based on the Frye-Jacobs method.[5] The LGD formula applied at the banks' corporate portfolio-level is:

[5] See Frye, J. and Jacobs, M. (2012), Credit Loss and Systematic Loss Given Default, The Journal of Credit Risk, 8(1):109–140.

Figure 7. Initial Impulse Response to a Corporate Default Rate Shock of +1pp



Sources: Statistics Canada, Capital IQ, Moody's Analytics, IMF World Economic Outlook, and IMF staff calculations.
Note: The error bounds mark the 20th and 80th percentiles of the impulse response distribution. The impulse response profile as shown here is not as such related in quantitative terms yet to the policy counterfactual simulation and results shown later in this section. See text for details.

(4) $$LGD_{b,t} = \frac{\Phi[\Phi^{-1}[PD_{b,t}] - k_b]}{PD_{b,t}}$$

The parameter *k* was computed based on the risk parameters for the corporate loan book of each bank, assuming an asset correlation (ρ) of 10 percent:

(5) $$k_b = \frac{\phi^{-1}[PD_b^{TTC}] - \phi^{-1}[PD_b^{TTC} \times LGD_b]}{\sqrt{1-\rho}}$$

Long-term average LGDs for feeding eq. (5) were not available; the corporate loan books' point-in-time LGDs as of 2019 as reported by the banks were used instead. Appendix Figure 3 reports the estimated values of *k* according to eq. (5). The RWA impact was obtained by employing the Basel risk weight formula for the IRB portion of the banks' corporate portfolios. The TTC PD input to the equation was a smooth function of the point-in-time PD impact under simulations, with a smoothing parameter (λ) set judgmentally to 0.3 for the base set of results.

(6) $$PD_{b,t+h}^{TTC} = logit^{-1}\left(logit\left(PD_{b,t}^{TTC}\right) + \lambda\left(logit\left(PD_{b,t+h}^{PiT}\right) - logit\left(PD_{b,t}^{PiT}\right)\right)\right)$$

Banks' regulatory downturn LGDs were held constant at their reported value during the simulations. One caveat which applies in the context of the LGD model component is that the "anchor" values for LGDs were sourced from banks, i.e. they pertain to the corporate *loan* portfolios of banks; while the micro simulation component of the model operates on the firms' overall debt inclusive of corporate debt. The underlying assumption is therefore that the loan portfolios' LGDs are a reasonable proxy for corporate bond LGDs.[6]

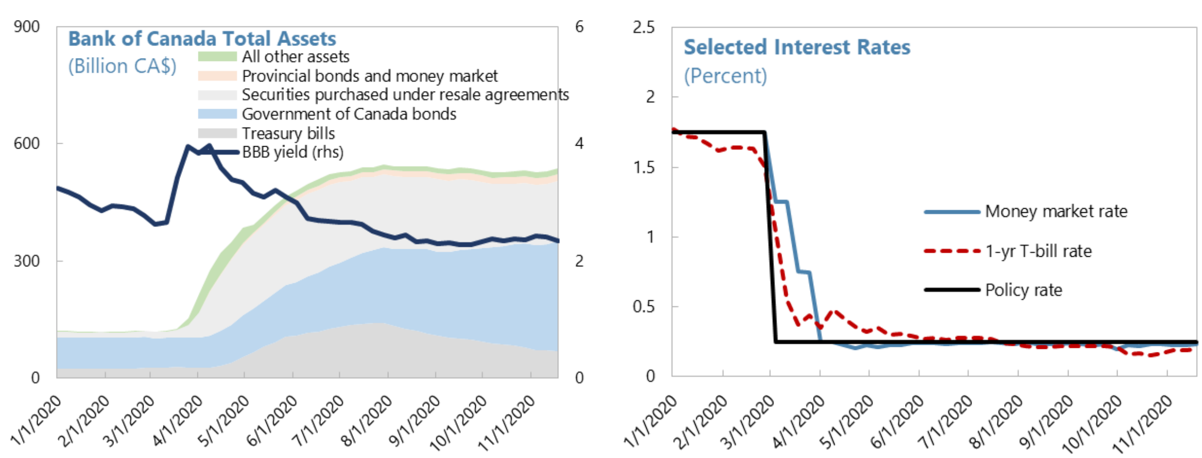
[6] According to data by the Bank of Canada, corporate debt is composed of about 60 percent (40 percent) by loans (bonds).

C. Policy Counterfactual Simulation Results

17. The generic policy counterfactual assumption has been informed judgmentally. It was set to +150bps, being reflective of the move of policy rates and short-term money market rates after the onset of the pandemic in spring 2020 and throughout the year (Figure 8).

18. The firm-level impact results suggest their broad-based susceptibility to variation in debt costs across all industries, as visible through rising PDs, rising LGDs, and falling ICRs and cash to debt ratios (Figure 9). The cross-industry debt-weighted aggregate PD could have moved to about 6 percent, or beyond 9 percent at the peak throughout the year 2020 when considering second-round feedback effects; instead of a measured 3.2 percent in 2020 on average. The LGDs for all industries combined move from the 2020 measured 21 percent to 32 percent under the counterfactual scenario inclusive of feedback, representing an LGD increase by a factor of about 1.5. The shares of firms with ICRs less than 1 increases more visibly than for other segments in particular for the consumer cyclical and non-cyclical, and the utilities sector. Cash to asset and cash to debt ratios tend to fall in a comparable manner across all industries. Debt to asset ratios do not move much, which reflects the assumption of no additional debt being assumed by the firms throughout the simulation (only in case cash stocks would have turned negative was debt increased accordingly).

Figure 8. Policy and Market Interest Rate Dynamics Central Bank Balance Sheet



Sources: Haver Analytics, Datastream, Bank of Canada, and IMF staff calculations.

Figure 9. First and Second Round Counterfactual Simulation Results

Sources: Capital IQ, Statistics Canada, and IMF staff calculations.

1/ Debt in the debt to asset ratios is defined as short-term plus half long-term debt. Debt in the cash to debt ratios comprises total debt. The red whiskers denote the interquartile ranges.

19. The counterfactual estimates for the real economy response suggest sizable effects through the support of nonfinancial corporates. The macro feedback effects estimates (Table 3) suggest that absent the broad-based monetary support, real GDP growth could have been lower by 3.3 ppts, the unemployment rate higher by 1 ppt (year average), and risk spreads pertaining to corporate debt yet wider by about 120 bps, in 2020. The counterfactual scenario therefore entailed a debt cost increase for firms amounting to a combined 270 bps. An assessment of the model responses to the dynamics of GDP growth, employment dynamics, and risk premia during the Global Financial Crisis period suggests that their responses in relative terms across such variables is comparable indeed to their past behavior under stressful conditions.

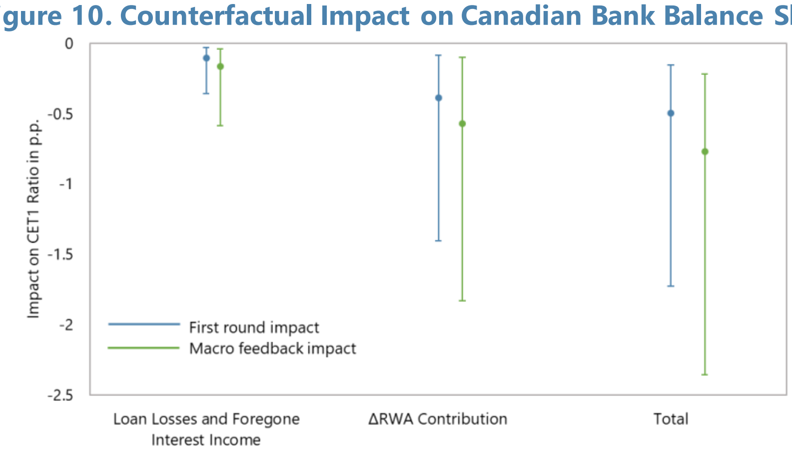
Table 3. Canada: Macroeconomic Feedback Estimates from Corporate Sector Debt Cost Counterfactual

Variable	Real GDP, YoY growth in 2020	Unemployment rate	Risk premium, 2020Q1-4
Counterfactual deviation from baseline	-3.4pp	1.0pp	1.2pp

Sources: IMF staff calculations.

20. The impact on banks' capitalization, too, is notable. Assuming that deferral and restructuring would not be considered by banks as a behavioral reaction for the purpose of the analysis here, the impact on banks' capitalization ranges between -25 bps and -240 bps (min-max) for the seven largest banks' CET1 capital ratios (Figure 10). The RWA-weighted banking system-wide impact stands at about -70 bps inclusive of second-round feedback. The banks' capital ratios and underlying drivers react differently across banks due to various reasons, including, most notably, differences regarding their corporate loan portfolio shares as well as structural differences in terms of risk parameters at the outset.

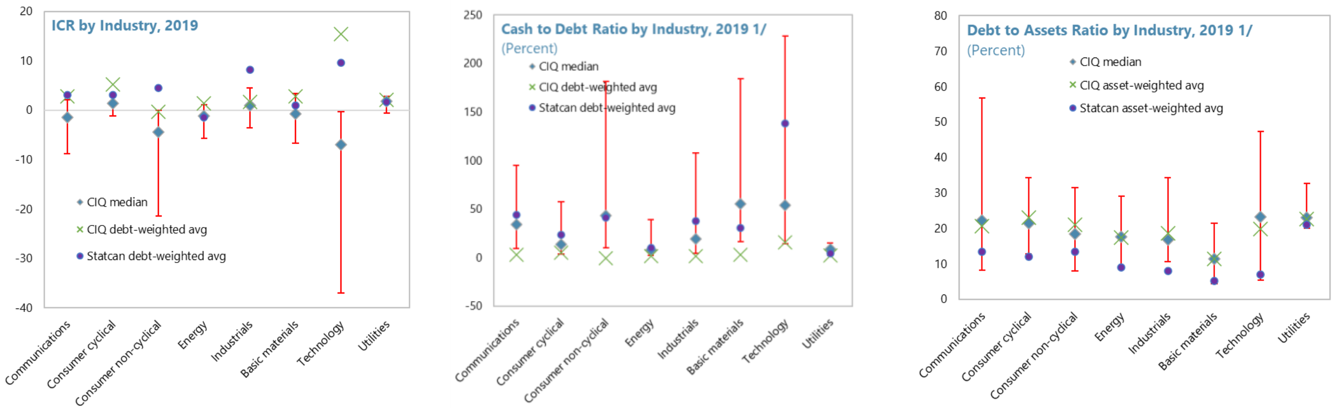
Figure 10. Counterfactual Impact on Canadian Bank Balance Sheets



Sources: IMF staff calculations, involving data from banks' financial and Pillar III reports and through the underlying model framework the data from corporates sourced through Capital IQ. The dots reflect median impacts across the underlying seven banks; the whiskers cover the min-max ranges.

Appendix I. Micro Data Characteristics

Figure A1. Data Comparison between Statistics Canada and Capital IQ

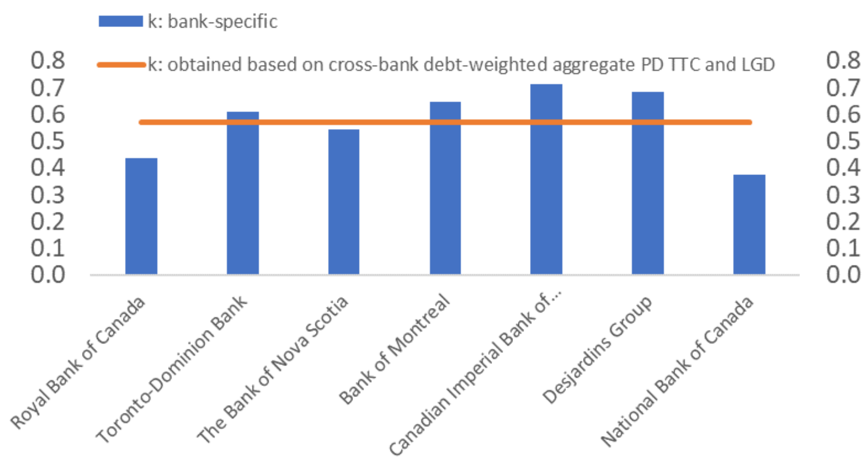


Sources: S&P Capital IQ, Statistics Canada, and IMF staff calculations.
1/ Debt in the debt to asset ratios is defined as short-term plus half long-term debt. Debt in the cash to debt ratios comprises total debt. The red whiskers denote the interquartile ranges.

Figure A2. Canadian Bank Capitalization and Corporate Loan Book Conditions at the Outset

Sources: Fitch connect, banks' financial and Pillar III reports, and IMF staff calculations.

Figure A3. Estimates of "k"



Sources: IMF staff calculations based on data from banks' financial and Pillar III reports.

CLIMATE MITIGATION POLICY IN CANADA: A PROTOTYPE FOR OTHER COUNTRIES[1]

A. Introduction

1. **Canada has set an ambitious target to achieve net zero greenhouse gas (GHG) emissions by 2050 (pending legislation would make this legally binding), has an intermediate target for 2030 aligned with this long-term commitment, and there are federal-level targets for the sales shares of zero-emission vehicles (ZEVs), phaseout of coal generation, and forest carbon sequestration.** Requirements for carbon pricing at the provincial/territorial level are progressively scaling up. Carbon pricing is the most (cost)-effective instrument for promoting reductions in energy use, shifting to clean fuels, and establishing the critical price signal for redirecting new investment towards clean technologies. The pricing requirement of CAN $40 per ton ($CO_2$) for 2021 will make Canada, along with the EU, the frontrunner on carbon pricing, while planned price increases over the next decade put it on track to meet its 2030 emissions targets. Canada's mitigation strategy therefore provides a valuable model for others to follow at the national level and its approach shows how a price floor arrangement among large-emitting countries could work to effectively deliver emissions reductions at the global level that are urgently needed over the next decade.

2. **Canada's mitigation strategy has several key elements:**

- Most importantly, a proposed requirement that provinces and territories phase in an explicit carbon price floor, or an equivalently scaled emissions trading system (ETS), with a proposed price progressively rising to CAN $170 by 2030;
- A federally imposed carbon pricing backstop, where sub-national carbon pricing falls short, consisting of (i) a fuel charge and (ii) an output-based performance standard (OBPS) for energy-intensive, trade exposed (EITE) industries;
- Reinforcing federal incentives at the sectoral level, including tax credits for ZEVs, emission rate standards for vehicles and power generators, and building retrofit programs;
- Public funding to support low-carbon investments and transitional assistance; as well as
- Equitable and transparent recycling of carbon pricing revenues to households and (where revenues substitute for distortionary taxes) incentives for work effort and investment.

3. **Although modelling suggests the carbon price floor trajectory is aligned with the 2030 emissions target, there is some uncertainty over the emissions impacts, and political acceptability, of high carbon prices.** Additionally, some sectors (e.g., transportation, forestry,

[1] Prepared by Ian Parry, Simon Black, Danielle Minnett, and Victor Mylonas.

agriculture) are difficult to decarbonize through pricing alone or are not currently covered by pricing. Federal policies at the sectoral level, combined with the planned carbon pricing, could help enhance the overall effectiveness and acceptability of Canada's mitigation strategy.

4. **This chapter recommends policymakers consider the use of federal-level feebates to reinforce private mitigation incentives at the sectoral level.** Feebates apply a revenue-neutral, sliding scale of fees on products or activities with above-average emission rates and a sliding scale of rebates on products or activities with below-average emission rates. They do not impose a fiscal cost to the government (which is important given current budgetary pressures induced by the pandemic) and they can help with acceptability because (unlike carbon pricing) they avoid the burden of higher energy prices on the average household and firm. Feebates are more flexible and cost-effective than regulations and can provide powerful mitigation incentives. While feebates have most appeal for the transportation sector, they could also be used alongside existing policies in the power, industry, building, and forestry sectors. Variants of pricing schemes might also be applied to fugitive emissions, logging on public forestland, and agriculture (in the latter case supported by consumer-level incentives to encourage plant-based diets).

5. **The chapter also discusses strategies for enhancing the acceptability of carbon pricing.** The pricing scheme by itself would impose an average burden on households of 2 percent of consumption in 2030 with burdens evenly distributed across household income groups. Returning carbon pricing revenues to households (as already common at the provincial level) offsets about 80 percent of this burden, however. For the most part, burdens at the provincial level are broadly representative of those at the national level.

6. **Policymakers might also consider, over the medium term, a transition away from the OBPS to a border carbon adjustment (BCA), which is slated for introduction in the EU and is under consideration elsewhere (e.g., UK, US).** With deeper decarbonization of industry, the BCA could address competitiveness and emissions leakage concerns more effectively than the OBPS, by applying carbon charges to imports with high embodied carbon (exempting trading partners with adequate carbon pricing). A BCA applied to EITE industries would limit administrative burdens and perhaps legal risks while raising revenues of 0.7 percent of GDP in 2030 with 35 percent from charges on imports from China and 28 percent from the US. An international carbon price floor (ICPF) arrangement, based on the Canadian model is, however, a potentially far more effective mechanism (than unilateral BCAs) for achieving the mitigation among large-emitting countries that is needed over the next decade to stay on track with climate stabilization goals.

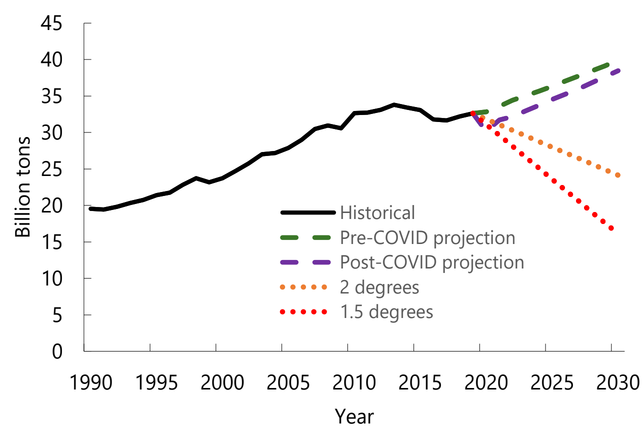
Table 1 (below) summarizes the main policy recommendations of the chapter.

Table 1. Canada: Summary of Recommended Federal Policy Actions

Sector	Policy
Road transport	Introduce feebates for passenger vehicles: a sliding scale of fees/rebates applied to vehicles with above/below average CO_2/mile to complement emissions regulations. Incentives can be set aggressively to promote ZEVs without a new tax burden on the average motorist or fiscal cost to the government.
Power	Introduce a feebate: a sliding scale of fees/rebates on generators with above/below average CO_2/kWh to reinforce incentives for zero carbon fuels, without a new tax burden on the average generator.
Industry	Introduce feebates: a sliding scale of fees/rebates on firms with emission rates above/below the average for their industry. Feebates can provide powerful incentives for cleaner production processes without a large tax burden on the average firm which lessens concerns about competitiveness and emissions leakage.
Buildings	Supplement energy efficiency programs with: (i) tax-subsidy scheme promoting shifting from natural gas/oil heating systems to electric or other clean fuel systems; (ii) feebates to promote adoption of more efficient appliances and lighting.
Forestry	Consider a carbon tax on logging from public forestland. Introduce a nationwide feebate applied to private landowners equal to an (annualized) CO_2 price times the difference between forest carbon storage on their land in a baseline period and carbon storage in the current period. The feebate promotes the full range of mitigation responses with no burden on the average landowner or fiscal cost to the government.
Agriculture	Introduce a charge on farm-level emissions with revenues returned in proportion to the value of output to improve acceptability. Emissions can be estimated based on farm-level inputs and default emissions factors. A shift from beef and dairy to crop-based production could be reinforced by fiscal incentives at the consumer level.
Fugitive	Tax methane emissions from extractives based on a default leakage rate with rebates for firms validating their emission rates are lower than the default.
Trade	Following future EU experience, consider a BCA and full carbon pricng for EITE industries to substitute for OBPSs.
International	Promote dialogue on an ICPF for scaling up action among large emitting countries using Canada's carbon pricing scheme as a potential prototype.

B. Background on Emissions, Targets, and Policies

Figure 1. Global Fossil Fuel CO2 Emissions Trends



Source: IEA (2020), Fund staff estimates, IPCC (2018).

The window of opportunity for containing global climate change to manageable levels is closing rapidly. Global carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions must be cut 25–50 percent below 2018 levels by 2030 to be on track with containing projected warming to 1.5º–2ºC above preindustrial levels (on a linear reduction pathway) with rapid reductions to emissions neutrality thereafter. Due to the pandemic-induced crisis, global emissions projections for 2020 are about 8 percent below 2019 levels. However, without strong mitigation policies, global emissions are likely to start rising again in 2021 as economies recover (Figure 1). With governments bringing forward investment plans to boost their economies, the pandemic has added to the urgency of ensuring this new investment is efficiently allocated to low-carbon technologies. This, in turn, requires strengthening carbon pricing or equivalent measures to level the playing field for clean technologies.

7. Canada has set aggressive targets to reduce carbon dioxide (CO_2) and other GHGs. Key targets include:

- A goal (made legally binding by the tabled Canadian Net-Zero Emissions Accountability Act, if passed by Parliament) of zero net GHG emissions by 2050.[2] Other large emitters including the EU, Japan, Korea, UK and the US have also set carbon or GHG neutrality targets for 2050, while China has announced a carbon neutrality target for 2060.[3] On a linear emissions reduction pathway, emissions neutrality in 2050 would require cutting 2030 emissions by one-third below current levels and 2040 emissions by two-thirds.

- An intermediate goal—from Canada's Nationally Determined Contribution (NDC) submitted for the 2015 Paris Agreement—to reduce GHG emissions to 511 million tons of CO_2 equivalent in 2030 or 30 percent below the 2005 level and 15 percent below the 1990 level.[4] Since Canada's 2020 emissions are approximately the same as in 2005 (see below), the NDC target is aligned with a linear pathway to emissions neutrality.

- Increasing the sales shares of ZEVs (for passenger vehicles) to 10 percent by 2025, 30 percent by 2030, and 100 percent by 2040.

- Phasing out coal-based power generation by 2030.

- Sequestering a net 7-46 million tons of CO_2 in forests (depending on harvest rates) in 2030.[5]

8. GHG emissions in Canada were 729 million tons in 2018, with 74 percent of emissions from fossil fuel energy (see Figure 2). Another 8 percent of GHGs were from industrial processes like metal and cement production and fluorinated (F-) gases, 8 percent were fugitive emissions (leaks from extraction, storage, processing, and distribution of oil and gas), 8 percent from agricultural sources, and 2 percent from waste (e.g., methane leaks at landfills). By sector, energy (i.e., power and district heating) accounted for 36 percent of fossil fuel CO_2 emissions in 2018, industry and construction 12 percent, transport 34 percent, and other sources (principally buildings)

[2] See https://mcmillan.ca/Canada-Legally-Commits-to-Net-Zero-Emissions-by-2050. Emissions in some sectors (e.g., transportation) may be positive so long as they are offset elsewhere by negative emissions (e.g., from reforestation, using biomass with carbon capture and storage technologies in power generation, deploying air filter technologies to directly remove CO_2 from the atmosphere).

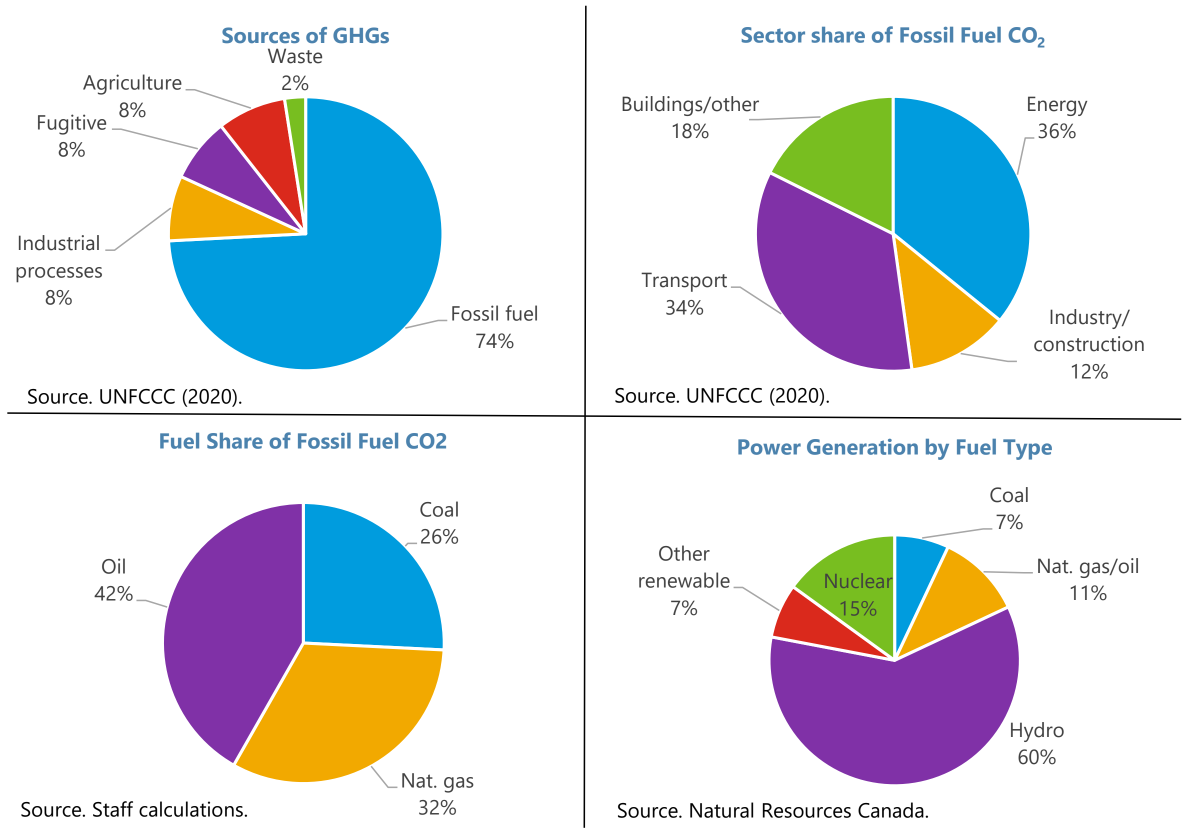
[3] See www.iea.org/reports/world-energy-outlook-2020/achieving-net-zero-emissions-by-2050.

[4] See Government of Canada (2015) and CAT (2020a). All 190 parties to the 2015 Paris Agreement are submitting revised climate strategies for the November 2020 UN climate meeting in Glasgow.

[5] ECCC (2018).

18 percent. By fuel type, coal accounted for 26 percent of fossil fuel CO_2 emissions in 2018, oil 42 percent, and natural gas 32 percent. Land use, land use change, and forestry (LULUCF) emissions were negative 13 million tons in 2018.[6]

Figure 2. Breakdown of GHG Emissions, 2018



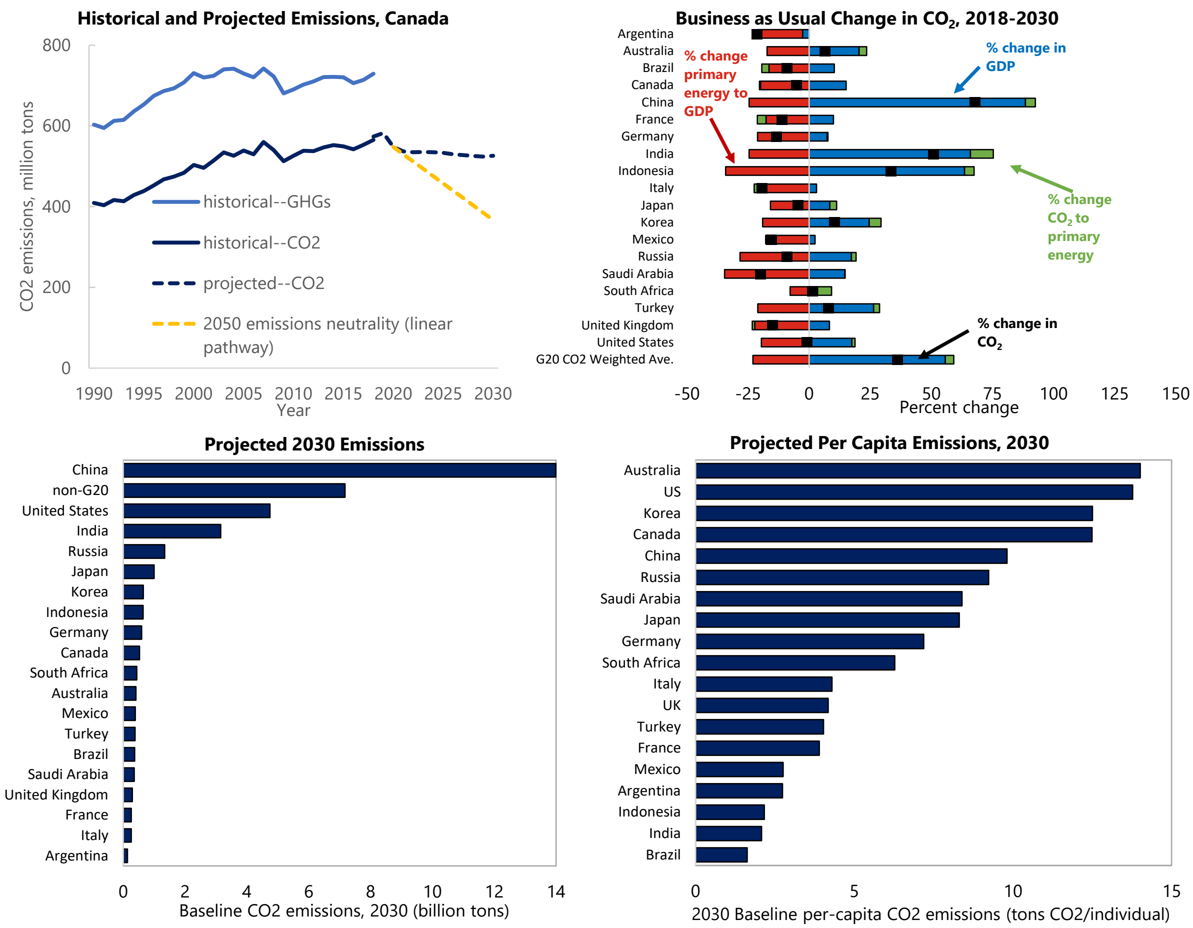
9. **GHG emissions peaked at 744 million tons in 2007, or 24 percent above the 1990 level**. Emissions were 2 percent below this peak in 2018. In a business-as-usual (BAU) scenario (i.e., with no new, or tightening of existing, mitigation policies) IMF staff[7] project fossil fuel CO_2 emissions to be 7 percent lower in 2030 than in 2018—although projected GDP is 15 percent higher this is more

[6] UNFCCC (2020).

[7] Staff analysis is based on an IMF model parameterized to individual countries. Use of fossil and other fuels in the power generation, road transport, industry, and household/commercial sectors are first projected forward in a BAU scenario using assumptions about: (i) GDP growth; (ii) income elasticities (i.e., the responsiveness of energy demand to higher GDP); (iii) autonomous rates of technological change (e.g., that improve energy efficiency and the productivity of renewables); (iv) future international energy prices; and (v) the price responsiveness of fossil fuels in different sectors. The responsiveness of fuel use to carbon pricing and other policies depends on: (i) the proportionate change in energy prices in different sectors and (ii) various price elasticities for electricity and fuels. Parameter values are based on mid-range assumptions from the modelling and econometric literature. The analysis of nationwide policies below is based on the IMF staff model.

than offset by a decline in the energy intensity of GDP.[8] In contrast, in large emerging market economies, BAU emissions expand rapidly. Nonetheless, without its planned mitigation policies, Canada would be the third largest per-capita emitter among G20 countries in 2030, and the tenth largest emitter in absolute terms. See Figure 3.

Figure 3. Fossil Fuel CO_2 Emission Trends



Source: Fund staff estimates.

10. The Pan-Canadian Framework on Clean Growth and Climate, adopted in 2016, ensures that carbon pricing applies throughout Canada with increasing stringency up to 2022, and the 2020 Climate Plan proposes to extend the horizon of escalating carbon prices to 2030.[9] The framework covers all emissions sources except those from forestry, agriculture, and waste. Canadian provinces and territories have the flexibility to either implement an explicit price-based system—a carbon tax as in British Colombia or levy (i.e., where revenues are earmarked) as (initially) in

[8] Reflecting gradually improving energy efficiency and an assumption that the demand for energy increases by less than in proportion to GDP.

[9] ECCC (2020).

Alberta—or an ETS. Jurisdictions with an explicit price-based system need a minimum price rising by CAN$10[10] per ton of CO_2 equivalent per year to reach $50 per ton by 2022. The Climate Plan proposes raising the annual increase in the carbon price to $15 per ton from 2023, implying a 2030 carbon price of $170 per ton. Jurisdictions with ETSs should have: (i) a 2030 emissions reduction target equal to or greater than Canada's 30 percent reduction target; and (ii) declining annual caps corresponding, at a minimum, to the projected emissions reductions that would otherwise result in that year from a price-based system. The federal approach evolved from earlier provincial carbon pricing schemes which led federal policy to provide flexibility for provinces to maintain control over their carbon pricing systems.

11. Under Canada's Greenhouse Gas Pollution Pricing Act, a federal 'carbon pricing backstop system' imposes pricing of fossil fuel GHGs in any province or territory that requests it or that does not have carbon pricing systems aligned with federal criteria (or, if needed, will supplement sub-national schemes with a 'top-up').[11] The backstop has two components:

- a tax-like component that is a regulatory charge on fuels; and
- a tradable performance standard for EITE facilities called the Output-Based Pricing System (OBPS). Facilities with annual emission rates per unit of output above industry standards (which, to varying degrees, are set below the industry average) can meet their compliance through purchasing credits from facilities with emission rates below the standard. They can also use banked credits, pay a fee (equal to the carbon price), or buy offsets from provincial offset schemes (generated from projects in sectors not covered by pricing).[12] Emitters registered for the OBPS are exempt from regulatory fuel charges. Most provincial carbon pricing systems meeting federal requirements have a version of the OBPS. See Annex 1 for further details.

12. Carbon pricing systems that fully meet or exceed federal requirements are in place across the country though there is a risk this could change due to pending legal actions in jurisdictions where it was more difficult to gain public acceptance of pricing. Carbon pricing systems in British Columbia, the Northwest Territories, Nova Scotia, and Quebec are fully meeting federal requirements. Systems in place in Alberta, New Brunswick, Prince Edward Island, and Saskatchewan also meet them for the emission sources they cover while the federal backstop supplements these systems for other sources. The federal backstop is in place in Manitoba, Nunavut, Ontario, and Yukon. See Annex 1 for more detail on provincial schemes. Alberta, Ontario, and Saskatchewan have taken the pricing requirement to the supreme court claiming it is not constitutional as it steps on provincial jurisdiction while Manitoba, New Brunswick, and Quebec also argued the law should be struck down.[13]

[10] Unless otherwise indicated, monetary figures below are in current CAN $.

[11] See ECCC (2016).

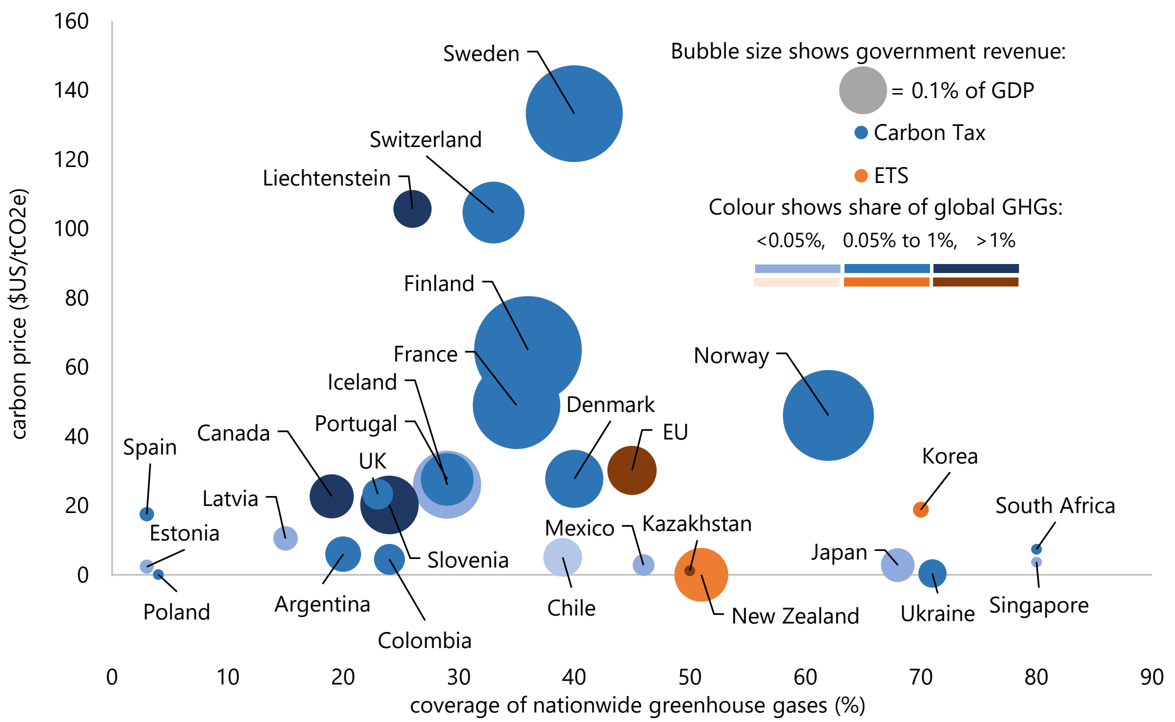
[12] A federal offset program is currently under development.

[13] The hearing concluded on September 23, 2020 but a decision could take several months.

13. Proceeds from the federal carbon pricing backstop remain, by law, in the jurisdiction of origin. Provincial and territorial governments with systems meeting the federal benchmark, or who have voluntarily adopted the federal system, retain revenues. For provinces that have not committed to carbon pricing, the federal government returns approximately 90 percent of revenues from the backstop directly to households in the form of tax-free Climate Action Incentive payments.[14]

14. The price floor establishes Canada as one of the most aggressive emission pricing countries. Current prices in most carbon tax and ETS schemes are around US$5-25 per ton, though the EU's ETS price has risen to $35 per ton, and some countries (e.g., in Scandinavia) have much higher prices (Figure 4). By 2022 and 2030, Canada's price floor would reach the equivalent of US$36 and $133 per ton respectively.

Figure 4. Selected Carbon Pricing Schemes, 2020



Source: World Bank, Climate Watch, Fund Staff Estimates.
Note. Updated as of Nov. 2020. GHGs from 2017. EU includes Norway, Iceland, Liechtenstein. Revenues less than 0.005 percent of GDP are of equal size for illustrative purposes.

[14] The remaining 10 percent is also directed back to the jurisdiction of origin through funding for schools, hospitals, small- and medium-sized businesses, colleges and universities, municipalities, not-for-profits, and indigenous communities in the province. Payment amounts for 2021 are available at https://www.canada.ca/en/department-finance/news/2020/12/climate-action-incentive-payment-amounts-for-2021.htm. Individuals can claim these amounts through their personal income tax and benefits returns. In Nunavut, Yukon, and Prince Edward Island, direct proceeds are returned to the provincial or territorial government.

15. The federal government is pursuing complementary actions to reduce emissions and meet sectoral targets. These include:

- emission rate standards on coal and natural gas-fired power stations (adopted in 2018);
- federal rebates of $5,000 ZEVs and long-range plug-in hybrid vehicles and rebates of $2,500 for short-range plug-in hybrid electric vehicles;[15]
- standards for the average emission rate of vehicle manufacturers sales fleets that are progressively declining from 210-275 grams CO2 per mile in 2016 to 130-175 grams CO2 per mile in 2025, depending on the vehicle footprint;[16]
- building retrofit programs to improve energy efficiency;
- incentives for reducing hydrofluorocarbons (HFCs) (the major F-gas) and methane leaks from the upstream oil and gas sector and a Clean Fuel Standard (CFS) to lower the carbon intensity of all fossil fuels.[17]

16. Public funding for green projects. This includes:[18]

- *Buildings*: $2.6 billion over seven years starting in 2020-21 for residential energy efficiency improvements through grants for upgrades and energy audits; $1.5 million over three years for refurbishment of community and municipal buildings; $2 billion for retrofitting commercial and large-scale buildings.
- *Power*: $964 million over four years for renewable energy and grid modernization projects (e.g., power storage); $300 million in clean power projects for remote and Indigenous communities.
- *Transport*: $150 million over three years for charging/refueling stations for ZEVs; $1.5 billion for adoption of zero emission buses.
- *Industry*: $3 billion over five years for a Strategic Innovation Fund that expedites decarbonization projects with large emitters.

[15] See www.tc.gc.ca/en/services/road/innovative-technologies/zero-emission-vehicles.html.

[16] See https://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-201/index.html. 130 and 275 grams of CO_2 per mile are equivalent to about 70 and 33 miles per gallon respectively. Canadian standards have traditionally been aligned with fuel economy standards in the US and, therefore, may be tightened if the Biden Administration adopts stricter standards than the Obama Administration.

[17] The CFS sets standards, starting in 2022 and increasing annually until 2030, to reduce the lifecycle carbon intensity of gasoline, diesel, kerosene and other liquid fuels (e.g., through blending biofuels, improving the energy efficiency of refineries, adopting carbon capture and storage technologies, investing in hydrogen and renewables). Suppliers failing to meet the standards will be required to purchase credits in the CFS market.

[18] ECCC (2020).

- *Agriculture: $165.7 million over seven years for clean technology development and deployment.*
- *Forestry: Up to $3.16 billion to partner with local actors to plant two billion trees by 2030.*
- *Clean fuels: $1.5 billion for production and use of low-carbon fuels (e.g., hydrogen, biocrude, renewable natural gas and diesel, cellulosic ethanol).*
- *Just Transition: $35 million fund supporting skills development and economic diversification in Canada's coal regions; $150 million infrastructure fund for projects in impacted communities.*
- *Net-Zero Advisory Body: $15.4 million over three years, starting in 2020-21 providing guidance on net zero emission pathways.*

17. Although road fuels are subject to tax, fuel prices in Canada prior to carbon pricing (as in other countries) undercharge for supply costs and non-carbon environmental costs (Figure 5). That is, the existence of fuel taxes does not undermine the case for carbon pricing. In fact, accounting for unpriced, non-carbon environmental costs (e.g., local air pollution and, for road fuels, congestion, accident, and road damage externalities) enhances the economic case for carbon pricing—at least for coal and road fuels.[19]

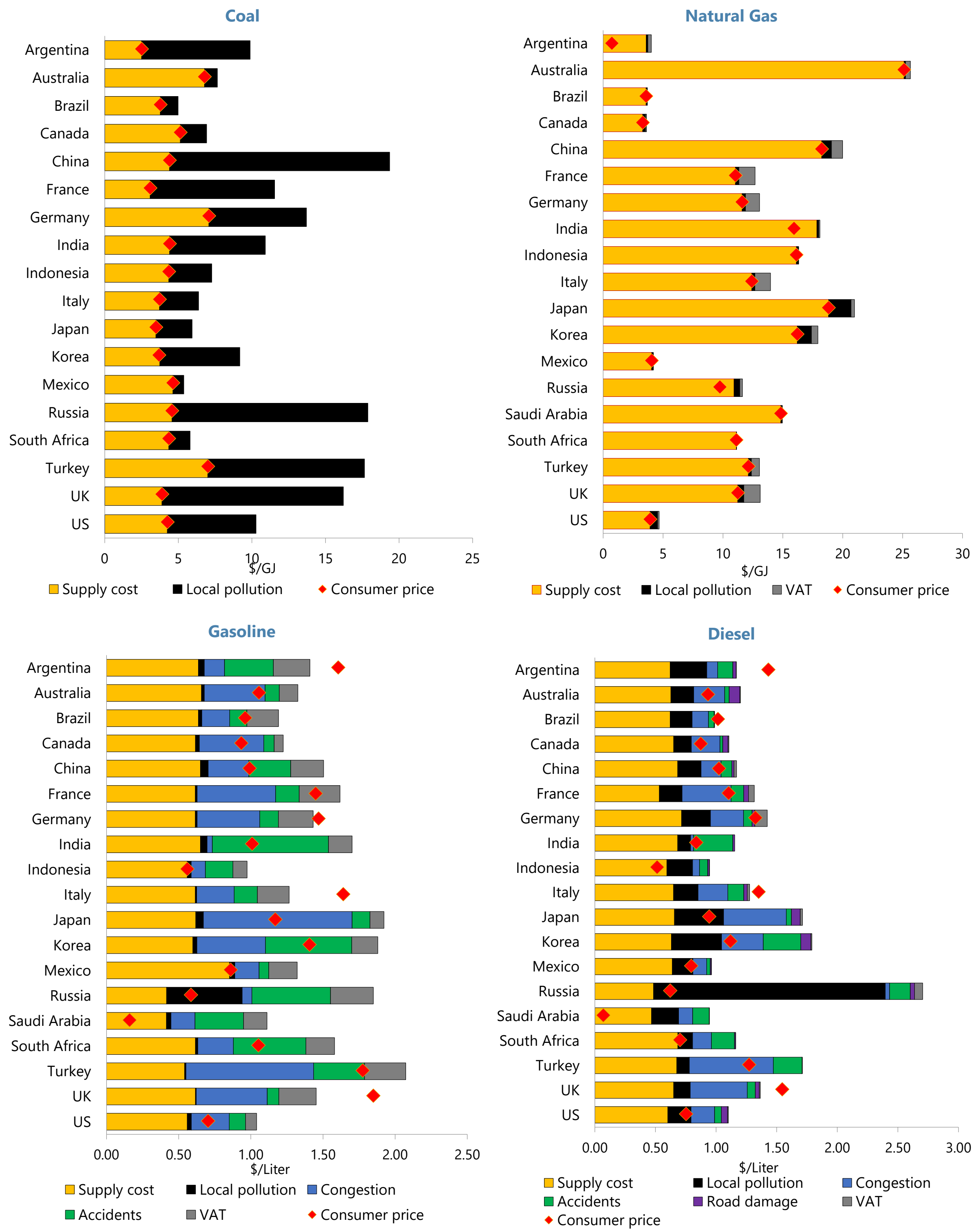
18. Canada is in the vanguard of climate mitigation policy, though a variety of reinforcing fiscal measures at the federal level could help enhance the effectiveness and acceptability of the mitigation strategy. This paper first assesses Canada's mitigation strategy. It then discusses reinforcing federal fiscal policy options for the **transport, power, industry, building, extractive, forestry, and agricultural sectors. The paper also addresses the incidence of carbon pricing and strategies for addressing burdens on households and EITE industries. It also discusses an ICPF to scale up near-term action among large emitters using Canada's approach as a prototype.**

C. Assessing Canada's Mitigation Strategy

19. For most countries, carbon pricing should be the centerpiece of climate mitigation strategy. Pricing: (i) provides across-the-board incentives to reduce energy use and shift towards cleaner fuels; (ii) automatically minimizes emissions mitigation costs (regardless of future energy prices or availability of carbon-saving technologies) by equalizing the cost of the last ton reduced across fuels and sectors; (iii) provides a robust price signal for redirecting private investment to clean technologies; (iv) mobilizes government revenue; and (v) generates domestic environmental benefits, like reductions in local air pollution mortality. It can also be straightforward administratively if, for example, it builds off existing fuel tax collection.

[19] Some level of fuel taxation is efficient to reflect local external costs of driving, including traffic congestion, accidents, and air pollution—at least until more efficient instruments like mileage-based charging systems are widely applied. Parry and others (2014) provide an extensive discussion of second-best efficient fuel taxes, methods for quantifying them in different countries, and more efficient policies.

Figure 5. Comparison of Efficient and Actual Fuel Prices, G20 Countries, 2015



Source: Coady and others (2018).

20. The pan-Canadian carbon pricing scheme is well designed. The scheme:

- *Comprehensively applies to all provinces and territories* and all fossil fuel and industrial process emissions within those jurisdictions.

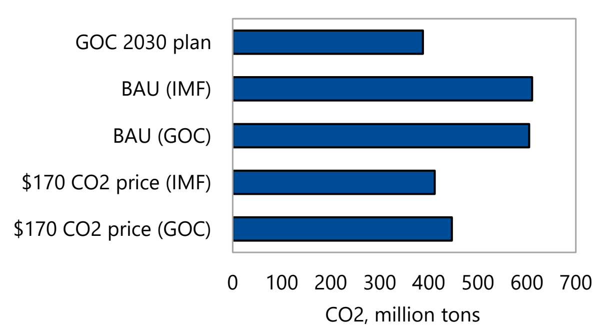
- *Has a clearly specified trajectory of robust and rising prices*—recently proposed to be extended to 2030—which provides the critical price signal for redirecting investment towards low-emission technologies.

- *Allows flexibility in the use of revenues*. Using revenues to increase economic efficiency is important for containing the overall costs of carbon pricing for the economy—efficient uses include, for example, lowering distortionary taxes on work effort and investment, or increasing socially efficient investments, whereas lump-sum transfers to households do not increase economic efficiency. In fact, combinations of policies like feebates can have significantly lower costs than (equivalently scaled) carbon pricing schemes where revenues are not used efficiently. See Annex 2 for further discussion.

- *Is compatible with overlapping instruments at the federal or sub-national level*. In other words, other instruments reduce emissions without affecting price floors at the provincial and territorial levels. In contrast, if nationwide emissions were subject to a pure ETS, overlapping instruments at the federal or sub-national level would have no effect on emissions and instead would lower the ETS allowance price.

21. According to government and IMF projections, the carbon price is approximately in line with the 2030 emissions target (Figure 6), though estimates are subject to uncertainty. IMF staff estimates suggest the price would cut nationwide CO_2 emissions about 33 percent below BAU levels which result in emissions slightly above the 2030 target. This projection however is sensitive to BAU emissions growth, which depends, for example, on GDP projections, and on the responsiveness of emissions to pricing, the latter of which relies on the future cost and availability of clean technologies, among other elements. Significant uncertainties surround all these factors, and uncertainties on the price responsiveness of emissions rise with the level of pricing. Political resistance to pricing, at the jurisdictional, industry, or household level may also intensify with the level of pricing.[20]

Figure 6. 2030 CO_2 Projections



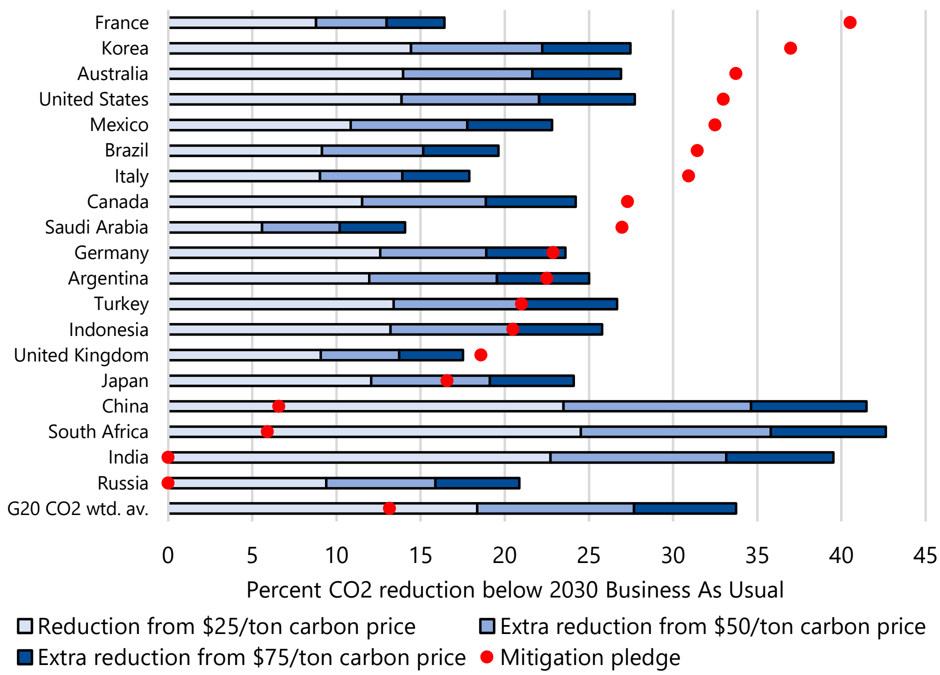
Source: Fund staff estimates, GOC (2019).
Note. Target assumes CO2 is reduced in proportion to GHGs. GOC targets are BR2 for BAU and BR5 for $170 CO2 price.

22. The acceptability of pricing in Canada will partially depend on progress with pricing elsewhere - and implicit

[20] For example, France's attempt to rapidly increase a carbon tax for non-ETS emissions was suspended in 2018, due to public opposition, when the price reached US$49 per ton.

prices in some G20 countries' 2030 targets are much lower than Canada's. This reflects both less stringent targets, and greater responsiveness of emissions to pricing, in these countries. For example, carbon prices implicit in 2030 current mitigation pledges in China, India, Russia, and South Africa are all well below US$25 per ton (Figure 7).

Figure 7. CO_2 Reductions for Pledges/from Pricing



Source: Updated from IMF (2019a).
Note. Pledge is from Paris Agreement or subsequent pledge. Price is additional to any existing pricing.

23. Complementary federal instruments to promote mitigation at the sectoral level that avoid (i) a fiscal cost and (ii) the burden of higher energy prices on households and firms can enhance the effectiveness and acceptability of the mitigation strategy. Sectoral measures promote a somewhat narrower range of behavioral responses to reduce emissions than carbon pricing. However, these measures have an important reinforcing role if carbon pricing becomes constrained from opposition to higher energy prices.

24. Existing Federal measures play a valuable role but have limitations. For example, meeting the coal generation phaseout and sales share requirement for ZEVs would reduce nationwide emissions by 3 and 1.5 percent respectively in 2030.[21] Emission rate standards for power generators designed to phase out coal may not strike the cost-effective balance of emissions reductions across shifting from coal to gas, from these fuels to natural gas combined cycle (NGCC)

[21] IMF staff calculations.

with carbon capture and storage, and from all these fuels to zero-carbon fuels.[22] Tax incentives for ZEVs do not promote shifting among conventional vehicles to reduce emissions and impose a fiscal cost on the government.

D. Fiscal Policy Options for Enhancing the Effectiveness and Acceptability of Canada's Mitigation Strategy Without a Revenue Loss

Road Transportation

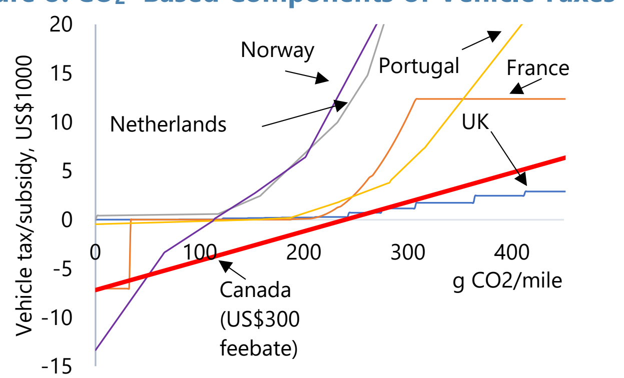
25. Generalizing ZEV tax credits with a more comprehensive feebate would strengthen incentives for progressively and cost-effectively decarbonizing the vehicle fleet, while avoiding a fiscal cost to the government. A feebate would provide a sliding scale of fees on vehicles with above-average emission rates and a sliding scale of rebates for vehicles with below-average emission rates. That is, each new vehicle would be subject to a fee given by:

$$\begin{gathered}CO_2 \text{ price} \\ \times \{CO_2\text{/mile} - CO_2\text{/mile of the new vehicle fleet}\} \\ \times \{\text{average lifetime vehicle mileage}\}\end{gathered}$$

Certified CO_2 per mile by model type (currently used to administer the vehicle emissions program) provides the data needed to assess the fees and rebates for each vehicle. The feebate cost-effectively promotes the full range of behavioral responses for reducing emission rates, as there is always a continuous reward (lower taxes or higher subsidies) from switching from any vehicle with a higher emission rate to one with a lower emission rate.[23] In addition, the feebate maintains (approximate) revenue neutrality: by definition, fees offset rebates as the average emission rate in the formula is updated over time.

26. For illustration, a feebate with a price of US$300 per ton CO_2 would apply a subsidy of US$7,500 for ZEVs and a tax of US$1,800 for a vehicle with a CO_2 emission rate of 300 grams per mile (Figure 8).[24] Other countries in Europe with elements of feebates generally impose much higher taxes on high emission vehicles

Figure 8. CO_2-Based Components of Vehicle Taxes



Source: ACEA (2018) and Fund staff estimates.
Note. Assumes discounted lifetime driving of 62,000 miles.

[22] NGCC generators with fast ramp up speeds can be used as a complement to intermittent renewable generators (e.g., Verdolini and others 2018).

[23] Vehicle manufactures are, therefore, rewarded for going beyond prevailing emission rate standards (and penalized for not meeting them). In this way, the feebate reinforces existing regulations.

[24] For comparison, a 2015 Honda Fit, Toyota Camry XV70, and Ford ranger T6 currently have mpgs of 49, 41, and 31 respectively or CO_2 emission rates of 181, 217, and 287 g CO_2 per mile respectively.

than this illustrative feebate though the sales shares for these vehicles is smaller than in Canada. Subsidies for ZEVs would decline over time as the average fleet emission rate declines, which is appropriate as the cost differential between clean vehicles and their gasoline counterparts falls over time (e.g., with improvements in battery technologies). The feebate price can be scaled up if needed to keep on track with ZEV targets.

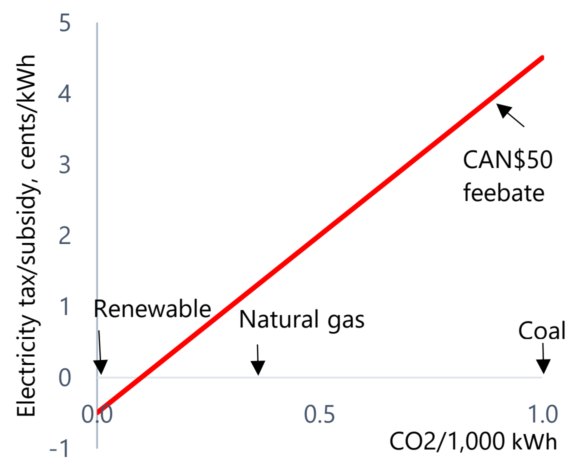
Power Generation

27. Incentives for de-carbonizing the power sector could be strengthened with a federal level feebate. Under this scheme, power generators would be subject to a fee given by:

$$CO_2 \text{ price} \times \{CO_2/kWh - \text{industry-wide average } CO_2/kWh\} \times \text{electricity generation}$$

The feebate cost-effectively, and in a revenue-neutral way, promotes the full range of responses for reducing emission rates per kWh—improving generation efficiency and shifting the mix of fuels from coal to gas and from these fuels to nuclear, fossil plants with carbon capture, and renewables. The feebate avoids the increase in electricity prices under carbon pricing which might be politically challenging, though it does not generate the same reduction in electricity demand. For illustration, a feebate with a price of CAN$50 per ton would currently apply a subsidy of 0.5 cents per kWh for zero-carbon generation plants and fees of 1.2 and 4.5 cents per kWh for natural gas and coal plants respectively (Figure 9).

Figure 9. Illustrative Feebate for Power Sector



Source: Fund staff estimates.

Industry

28. Carbon pricing for industry (for both emissions from fuel combustion and process emissions) may be constrained in practice by concerns about competitive and leakage impacts. The burden of carbon pricing on industry would consist of the costs of cutting emissions (e.g., from switching to cleaner but more expensive technologies) and the, typically much larger, tax or allowance purchase payments for remaining emissions (Annex 3). The leakage rate for carbon pricing—the offsetting increase in emissions in other countries in response to comprehensive domestic carbon pricing—has been estimated at 19 percent for Canada.[25] To date, competitiveness

[25] IMF (2021).

concerns have been, in part, addressed in Canada through OBPSs that, for the average firm, do not charge for most infra-marginal emissions.

29. Feebate schemes for industries could reinforce incentives for reducing emissions intensity but with a smaller burden on the industries than from higher carbon pricing (Annex 3). Under a feebate firms would pay a fee given by:

$$\begin{gathered} CO_2 \text{ price} \\ \times \{CO_2/\text{production} - \text{industry-wide average } CO_2/\text{production}\} \\ \times \text{ production} \end{gathered}$$

Feebates are essentially the fiscal analog of OBPSs, but they avoid the need for trading markets and provide more certainty over emissions prices—prices would be easily harmonized with carbon prices applied to fossil fuels to promote cost effectiveness across the EITE sector and the rest of the economy. Annex 3 provides illustrative comparisons of the impacts of carbon pricing and feebates on production costs in the steel and cement industries.

Buildings

30. Improvements in the energy efficiency of new and existing buildings, and appliances used in buildings, reduce both direct emissions and (through lowering electricity demand) indirect emissions. These improvements may, however, be hindered by possible market failures (e.g., liquidity constraints, cost-benefit mismatches between owners and renters, unawareness or uncertainty of energy savings from renovation). These would warrant some policy intervention, even if nationwide emissions were adequately priced.[26] Codes for the design, construction, alteration, and maintenance of buildings are implemented at the state level.

31. Various feebate schemes could strengthen incentives for energy-efficient and low-carbon appliances and equipment. For example, sales of refrigerators, air conditioners, and other energy-consuming products could incur a fee given by:

$$\begin{gathered} CO_2 \text{ price} \\ \times\ CO_2 \text{ per unit of energy} \\ \times \{\text{energy consumption per unit} - \text{industry-wide energy consumption per unit}\} \\ \times \text{ number of units} \end{gathered}$$

For refrigerators, for example, the energy consumption rate would be kWh per cubic foot cooled (and the number of units would be cubic feet). A similar scheme applying taxes to gas- and oil-based heating systems, and a subsidy for electric heat pumps, could accelerate the transition to zero-carbon heating systems. Again, feebate schemes avoid a fiscal cost to the government and the

[26] See, for example, Arregui and others (2020).

carbon prices in feebate programs across different product categories are easily harmonized to promote cost effectiveness.

Fugitive Emissions from Extractive Industries

32. Venting accounted for 55 percent of fugitive emissions in Canada in 2018 (two-thirds from oil, one-third from gas), flaring 13 percent (mostly from oil) and other leaks 30 percent (the majority from gas). 70 percent of the CO_2 equivalent emissions were from methane releases and 30 percent from CO_2.[27] Possibilities for mitigating fugitive emissions include: (i) reinjecting gas for enhanced oil recovery or storage; (ii) using methane for on-site or regional power generation; (iii) compressing the gas, or liquifying it, for sale; and (iv) improved maintenance of infrastructure for gas processing and distribution. Canada has adopted a target of reducing fugitive methane emissions by 40-45 percent below 2012 levels by 2025 and 60-75 percent below by 2030 in line with international best practices. Current regulations take the form of targeted interventions (e.g., routing emissions to vents, replacing or controlling individual high-emitting components, inspecting equipment for methane leaks).[28]

33. Pricing schemes for fugitive emissions would promote the full range of responses for reducing emission rates and are administratively feasible using default emission rates with rebating for firms demonstrating lower emission rates.[29] Emissions monitoring technologies[30] generally provide only discrete measurements at a limited number of sites, though technologies are improving, and CO_2 emissions from flaring are measurable. Fuel suppliers might be taxed based on a default leakage rate with rebates to firms demonstrating lower leakage/venting rates than the default rate through mitigation and installing their own continuous emission monitoring systems. Fugitive emissions are released within Canadian borders, and therefore should be priced regardless of whether the fuel is for domestic or overseas markets. Pricing approaches can be more flexible and cost-effective than regulatory approaches—under the latter approach, there is no automatic mechanism for equating the cost of the last ton reduced across different mitigation opportunities.

34. For illustration, an emissions tax of $25 per ton of CO_2 equivalent on fugitive emissions would apply charges equivalent (prior to mitigation) of approximately $0.5 per barrel of oil and $0.1 per thousand cubic feet of natural gas. These charges are equivalent to

[27] From https://di.unfccc.int/detailed_data_by_party. One ton of methane is equivalent to about 25 tons of CO_2 in terms of warming equivalents over a 100-year horizon (IPCC 2007).

[28] See https://laws-lois.justice.gc.ca/PDF/SOR-2018-66.pdf. The federal government has also announced a $675 million Emissions Reduction Fund for reducing onshore methane emissions and establishing a leak detection and repair program to reduce fugitive emissions (see www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/current-funding-opportunities/new-oil-gas-sector-emissions-red/emissions-reduction-fund-onshore-program/23050).

[29] Norway, for example, imposes a tax on methane emissions. See www.norskpetroleum.no/en/environment-and-technology/emissions-to-air.

[30] Including satellites, aircraft, drones, and remote sensing from vehicles.

about 0.6 and 2 percent of current supply prices.[31] Studies suggest however, that this modest level of pricing could lower emission rates by around 20 percent.[32]

Forestry

35. Ideally, federal forestry policies should cost-effectively promote, nationwide, the three channels for increasing forest carbon storage. These include: (i) afforestation; (ii) reducing deforestation; and (iii) enhanced management of tree farms (e.g., planting larger trees, longer rotations, fertilizing, tree thinning). Most forestland is publicly owned, and measured changes in forest area have been very modest.[33] Nonetheless, marginal land use change at the forestry/agriculture border, and reduced logging (which is not classified as deforestation) on public lands, could usefully complement public tree planting programs.[34] Forest carbon inventories can be measured, albeit in a rudimentary way, through a combination of satellite monitoring, aerial photography, and on-the-ground tree sampling.

36. A national feebate program could cost-effectively promote responses for increasing carbon storage on private land without a fiscal cost to the government. The policy would apply fees to landowners at the agricultural/forestry boundary that reduce stored carbon relative to a baseline level and rebates to landowners that increase stored carbon. That is, the fee is given by:

$$\{CO_2 \text{ rental price}\}$$

$$\times \{\text{carbon storage in a baseline year} - \text{stored carbon in the current year}\}$$

The scheme would reward all three channels for enhancing carbon storage, either through reduced fees or increased subsidies. Feebates can be designed—through appropriate scaling of the baseline over time[35]—to be revenue-neutral in expected terms. Feebates should involve rental payments—on an annualized basis, a CO_2 price times the interest rate[36]—rather than large one-off payments for tree planting, given carbon storage may not be permanent (e.g., due to subsequent harvesting or loss through fires, pests, windstorms). For illustration, fully stocking a hectare that previously had no

[31] Calculations using data from https://di.unfccc.int/detailed_data_by_party and www.eia.gov.

[32] US EPA (2019).

[33] 90 percent of forestland is owned by provinces and territories, 4 percent by the federal government, and 6 percent by private landholders. Over the last 30 years, less than 0.5 percent of Canada's forestlands have been converted to a non-forest land use. See www.nrcan.gc.ca/our-natural-resources/forests-forestry/sustainable-forest-management/forest-land-ownership/17495 and www.nrcan.gc.ca/our-natural-resources/forests-forestry/state-canadas-forests-report/how-much-forest-does-canada-have/indicator-forest-area/16397.

[34] Temperate forests can sequester up to about 3 tons of CO_2 per hectare a year during the growth cycle (Domke and others 2020). In 2018, logging in Canada's managed forests accounted for removals of about 8 million tons of CO_2 (see www.nrcan.gc.ca/our-natural-resources/forests-forestry/state-canadas-forests-report/how-does-disturbance-shape-canad/indicator-carbon-emissions-removals/16552).

[35] See Parry (2020) for details.

[36] Periods might be defined as averages over multiple years given that carbon storage might be lumpy during years when harvesting occurs.

trees would increase the land value by about $2,000 under a $50 feebate (or 25 percent of average agricultural land values in Canada in 2019).[37] Fees and rebates could be administered based on the registry of landowners used for business tax collection.[38]

37. Logging taxes are common around the world, but generally in the form of sales or income taxes.[39] Technically, however, it would be straightforward to modify logging taxes to link them to carbon. Partial exemptions from fees may be warranted for timber harvested for wood products (e.g., furniture, houses) because the carbon emissions (released at the end of the product life) will be delayed, perhaps by several decades or more.

Agriculture

38. Agricultural GHGs can be reduced through several channels. Reducing livestock herds (particularly beef and dairy cattle) reduces methane releases from enteric fermentation (41 percent of Canadian agricultural GHGs) and nitrous oxide emissions from manure (14 percent), while reducing crops for human and animal consumption (42 percent) reduces nitrous oxide emissions from soils, especially where there is intensive chemical fertilizer use.[40]

39. Pricing could be based on proxy estimates of emissions but a compensation scheme for the farm sector may be needed to enhance acceptability and limit emissions leakage. Direct monitoring of farm-level emissions is not currently practical, but emissions can be estimated indirectly using farm-level data (on livestock herds, feed, crop production, fertilizer use, and acreage), as well as default emissions factors.[41] Emissions taxes might face strong political opposition and could cause significant emissions leakage as the tax burden reduces the international competitiveness of Canadian farmers. A feebate approach is worth studying, perhaps based on GHG-equivalent emission rates per hectare, nutritional value, or per $ of output.[42] Alternatively, an emissions fee could be combined with the revenues recycled to the agricultural sector in the form a rebate proportional to the value of farm output (this would be operationally equivalent to a feebate based on emissions per $ of output). These approaches promote behavioral responses for reducing the emissions intensity of farming and, from an administrative perspective, the fees and rebates could be integrated into collection procedures for farmer business tax regimes.

[37] Calculation assumes the planting sequesters an additional 3 tons of CO_2 each year over a 20-year growth cycle with payments discounted at 5 percent. Land values are from www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210004701.

[38] See Mendelsohn and others (2012), Parry (2020) for further discussion of design issues for forestry feebates.

[39] See WBG (2021) for further discussion of logging taxes.

[40] Figure from UNFCCC (2020).

[41] IPCC (2019).

[42] Basing the feebate on emission rates per hectare could be problematic because livestock is land intensive but the emissions per hectare could be smaller than for crops. The feebate could be disaggregated with higher pivot points for beef producers and lower pivot points for crop producers—this might enhance acceptability (by lowering fees for the former) though it would lower incentives to switch from livestock to crop operations.

Demand responses at the household level might be promoted through taxes on meat and dairy products (from both domestic and overseas suppliers).[43]

E. Addressing the Burden of Carbon Pricing on Households and Firms

Household Incidence

40. A $170 carbon price in 2030 would, on average, increase retail electricity prices in Canada 20 percent above BAU levels, road fuel prices 30 percent, and natural gas prices 200 percent. Absolute and proportionate price increases for natural gas and road fuels would be similar across provinces and territories but absolute and proportionate price increases for electricity differ to the extent power grids are not integrated.[44] In proportionate terms, carbon pricing has larger impacts on natural gas prices in Canada than in most other G20 countries, but smaller (nationwide) impacts on electricity prices—see Table 2 comparing impacts of a US$75 carbon price. In most other G20 countries, the proportionate increase in natural gas prices is lower due to higher BAU prices, while the proportionate increase in electricity prices is larger due to more emission-intensive generation.

Table 2. Energy Price Impacts of US$75/ton CO_2 Price, Selected Countries, 2030

Country	Coal		Natural gas		Electricity		Gasoline	
	BAU price, $/GJ	% increase	BAU price, $/GJ	% increase	BAU price, $/kWh	% increase	BAU price, $/liter	% increase
Australia	2.9	222	8.5	50	0.10	79	1.2	17
Canada	2.9	259	2.6	141	0.10	12	0.9	19
China	2.9	238	8.5	48	0.09	76	1.1	14
Germany	5.2	136	7.9	52	0.13	22	1.7	9
India	2.9	239	8.5	31	0.09	97	1.2	15
Indonesia	2.9	247	8.5	40	0.11	80	0.5	39
Japan	2.9	237	8.5	50	0.11	48	1.3	12
Mexico	2.9	235	2.6	165	0.09	83	0.9	20
UK	5.7	151	7.9	53	0.13	15	1.6	9
US	2.9	255	2.6	154	0.08	59	0.7	23

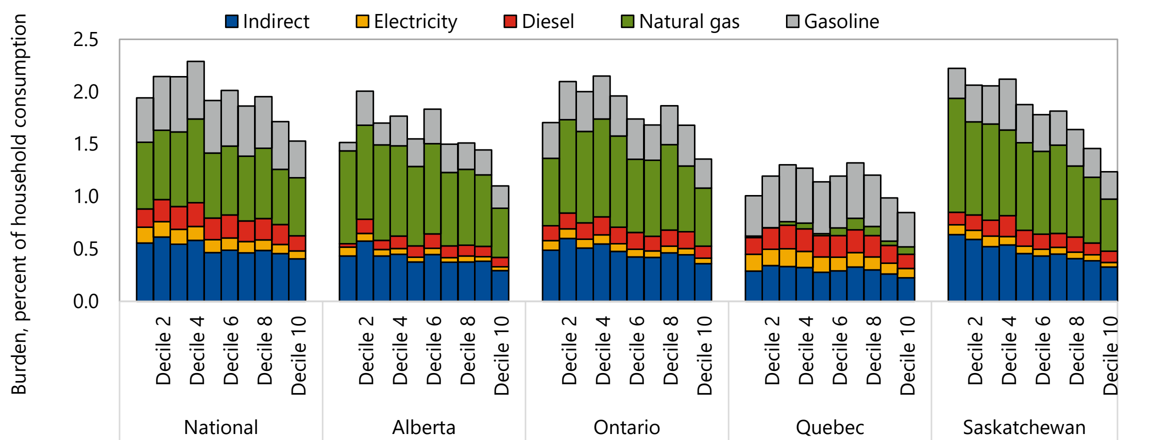
Source: Updated from IMF (2019a).
Note. BAU prices are retail prices from Coady and others (2019), including preexisting energy taxes, and adjusted for projected changes in international reference prices. Coal and natural gas prices are based on regional reference prices while electricity and gasoline prices are from cross-country databases. Price increases are proportional to carbon emissions factors which are exogenous for coal, gas, and road fuels and endogenous for electricity. GJ = gigajoule; kWh = kilowatt-hour.

[43] Batini and Pointereau (2021).

[44] The Canadian grid consists of the Western, Eastern, and Quebec grids.

41. On average, the burden on Canadian households from increasing the carbon price to $170 carbon price in 2030 (relative to the 2020 price of $30) is 2 percent of consumption prior to revenue use. See Figure 10. Burdens are evenly distributed across (population-weighted) household per-capita consumption deciles at the national level. About 35 percent of the burden comes from higher road fuel prices, 33 percent from higher natural gas prices, 6 percent from higher electricity prices, and 25 percent comes indirectly from the impact of higher energy costs on the general consumer price level. Burdens for most provinces are broadly representative of the national average, though burdens are noticeably lower in Quebec where natural gas consumption is limited. About 80 percent of the average household burden in 2030 is offset (at least for the near-to-medium term) when revenues are recycled back into the economy (e.g., in the form of broad income tax reductions or general investments).

Figure 10. Burden from Increasing the CO_2 Price to $170 per ton by Household Income Decile and Region Prior to Revenue Recycling, 2030

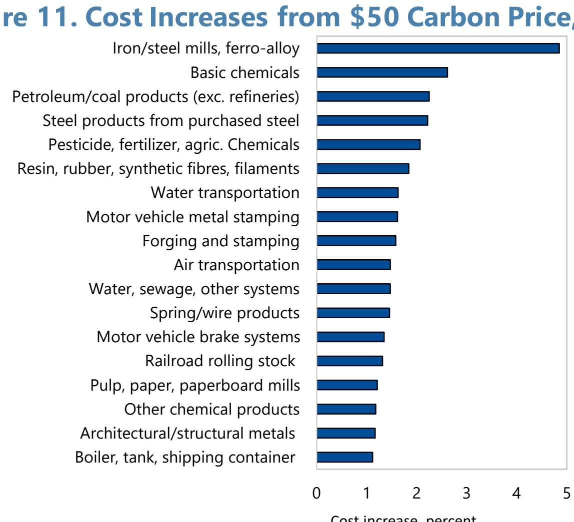


Source. Fund staff estimates updating from IMF (2019b).
Note. Deciles are ordered poorest to weathiest.

Firm Incidence

42. Iron and steel mills and other ferrous alloys stand out as the most vulnerable industries to carbon pricing. Other vulnerable industries include chemicals; petroleum and coal production; steel production (from purchased steel); pesticide, fertilizer and other agricultural chemicals; as well as resin, synthetic rubber, and artificial fibers and filaments manufacturing. See Figure 11.

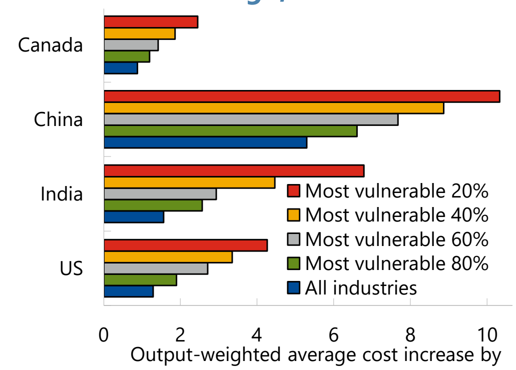
Figure 11. Cost Increases from $50 Carbon Price, 2030



Source: IMF (2019).
Note. Estimates account for behavioral responses by firms.

43. Competitiveness impacts of a given level of carbon pricing would be less severe at the national level in Canada than in some other large emitters (due, in part, to Canada's high share of renewables in electricity). Averaged across the 20 percent of most vulnerable industries, cost increases from the same level of carbon pricing (US$50) in 2030 (prior to any pass-through into consumer prices) would be 1.7 times as large in the United States as in Canada, 2.7 times in India, and a striking 4.1 times in China. See Figure 12.

Figure 12. Burden of a US$50/Ton Carbon Price on Industries in 2030 Before Pass Through, Selected Countries



Source: IMF (2019a).

44. There is debate about the possibility of a border carbon adjustment (BCA) for Canada imposing charges for the embodied carbon in imports. The EU intends to announce a proposal for a BCA in June 2021 that would come into force in 2023[45] and the Biden Administration's climate plan[46] contains a BCA proposal.

45. BCAs have three main rationales.[47] First, they help address the competitiveness impacts of carbon-price-induced increases in energy prices, which can be critical for enhancing the political viability of high carbon prices. Second, they reduce the risk of 'emissions leakage', that is, partially offsetting increases in emissions in overseas countries induced by domestic mitigation policy. Third, at an international level, they might encourage (through BCA exemptions for those with adequate pricing) stronger carbon pricing in other countries. The last rationale has little relevance for Canada, unless it were acting in coordination with other large emitters.

Table 3. BCAs Versus Other Instruments

Metric	BCAs	EITE industry exemptions from pricing	OBPS	Free allowances under ETS
Protecting competitiveness of EITE industries	Yes or mostly	Yes	Mostly	Mostly
Limiting leakage	Yes	Yes	Yes	Yes
Promoting carbon pricing in other countries	Partial	No	No	No
Reducing EITE industry emissions	Maintains all incentives	Removes all incentives	Reduces emissions per unit of output	Maintains all incentives
Raising revenue	Yes (though export rebates lose revenue)	Forgoes revenue	Forgoes revenue	Forgoes revenue
Administrative burden	Significant if coverage beyond EITE products	Modest	Modest	Modest
Risk of legal challenge under WTO	Significant with certain design features	No challenges to date	No challenges to date	No challenges to date

Source: Fund staff.

[45] Worldwide, only one BCA has been implemented to date, applying to the embodied carbon in imported electricity under California's ETS (e.g., Pauer 2018).

[46] See https://joebiden.com/climate-plan.

[47] For example, Morris (2018).

46. BCAs would be at least as effective as other approaches for addressing competitiveness and leakage, encouraging pricing elsewhere, maintaining mitigation incentives for industry, as well as mobilizing revenue (see Table 3). For example, a BCA can be more effective at assisting EITE industries on competitiveness than OBPSs. More precisely, the latter do not compensate for the costs of reducing emission rates, which increase rapidly with the level of abatement (see Annex 3).

47. Concerns about BCAs revolve around administrative complexities and legal risks and both might be lessened by limiting the BCA to EITE industries. A BCA would be administratively burdensome if it applied to imports of every manufacturing product from all Canada's trading partners. In contrast, administration is much simpler if it is limited to EITE industries—reliable data on embodied carbon in trade flows for these industries is publicly available at an aggregated level.[48] Moreover, EITE industries account for nearly 90 percent of the emission from manufacturing in Canada.[49] Another concern is the possibility of legal challenges at the World Trade Organization (WTO), or retaliation by trading partners. Limiting the BCA to EITE industries, however, may enhance the prospects for legality under trade law—reducing carbon leakage is a potential legal justification for trade measures like BCAs under GATT Article 20[50] which has credibility for industries with substantial embodied carbon.

48. There are various other design issues, but they should be administratively practical and EU experience should provide useful guidance. Other design issues include, for example, whether to allow rebates for individual overseas exporters that are less carbon intensive than the industry average, how to adjust charges for carbon pricing or mitigation measures in trading partners, whether to rebate charges for embodied carbon in exports, and whether to set lower BCA rates for developing country trading partners. See Annex 4 for further discussion. The authorities should consider whether a BCA might be an appropriate instrument for

Table 4. G20 CO2 Outcomes Under Alternative ICPF Scenarios

% reduction in G20 CO2 emissions below baseline, 2030

Required for 2° (1.5) target[a]	28 (55)
Only China, India, and US implement their Paris pledges	4.1
All G20 countries implement their Paris pledges and[b]	
none join an ICPF	10.4
China, India, US join a $50/25 price floor	22.6
All G20 countries join a $50/25 price floor	23.4
China, India, US join a $50 price floor	28.6
All G20 countries join a $50 price floor	29.9
China, India, US join a $75/50 price floor	29.5
All G20 countries join a $75/50 price floor	31.1
China, India, US join a $75/50/25 price floor	28.4
All G20 countries join a $75/50/25 price floor	29.8

Source: Fund staff estimates.

Note. [a]Assumes CO_2 reduced in proportion to total GHGs.

[b]Higher/lower price for advanced/emerging market economies or higher/middle/lower price for advanced/high income emerging market/low income emerging market economies.

48 OECD (2021).

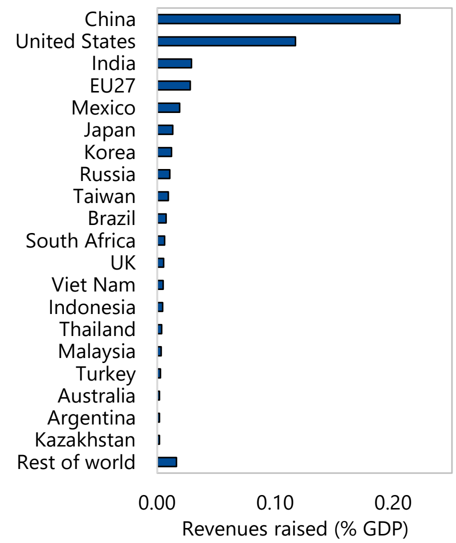
49 From OECD (2021).

50 See Flannery and others (2020).

Canada and, at least to some degree, design features that might be harmonized with those adopted by the EU.

49. A Canadian BCA with a carbon charge of $170 applied to EITE industry imports would have raised revenues of 0.5 percent of GDP in 2015. 41 percent of the revenue would have come from imports from China, 23 percent from the United States, and 6 percent each from India and the EU (Figure 13). Using revenues for assisting the domestic clean energy transition (e.g., clean technology infrastructure investments, assistance for vulnerable workers and regions), international climate finance, or rebates to governments of developing country trading partners may enhance the likelihood the BCA is viewed as an environmental measure (and compatible with the WTO) rather than a protectionist measure.

Figure 13. Revenue from $170 BCA, 2015



Source: OECD (2021).

F. Global Mitigation: Canada's Price Floor as a Prototype for an ICPF

50. Even if countries achieved their current mitigation commitments for the Paris Agreement, worldwide GHG emissions in 2030 would be reduced less than one-third of the amount consistent with containing projected global warming to 2°C or below.[51] The main issue is that the bulk of low-cost mitigation opportunities is in large emerging market economies, but these countries have relatively lax commitments at present, at least in part because they have differentiated responsibilities or a lower valuation of the insurance properties of mitigation policy[52] than advanced countries. Acting unilaterally, countries lack incentives to scale up carbon mitigation due, for example, to concerns about competitiveness impacts. IMF staff[53] recommend an ICPF arrangement to complement and reinforce the Paris Agreement with the principal aim of increasing near-term mitigation effort in large emerging market economies.

51. Canada's carbon pricing scheme provides a valuable prototype for how an ICPF arrangement among large emitting countries might work to scale up global mitigation action. An ICPF arrangement would be the most efficient approach for addressing countries' concerns about the competitiveness impacts of carbon mitigation. The arrangement need only include a small number of large emitting countries facilitating negotiation. It could be designed equitably with lower requirements for non-advanced economies, and/or transparent transfers, to reflect their lower per-capita income and small contribution to the historical stock of atmospheric GHGs. The floor

[51] UNEP (2020).

[52] Becker and others (2011)

[53] IMF (2019a), Parry (2020).

could also be designed flexibly to accommodate different approaches at the national level including carbon taxes, ETSs, and combinations of pricing, feebates and regulations that achieve the equivalent emissions outcome as implementing the price floor.

52. A carbon price floor could be highly effective in scaling up global mitigation. For illustration, if the United States, China, and India were subject to price floors of $75, $50, and $25 per ton respectively in 2030, this would cut G20 emissions about 28 percent below baseline levels, which is just consistent with the 2ºC target. Including all G20 countries would increase G20 emissions reductions, but only moderately, to about 30 percent. Emissions reductions under the $75/$50/$25 price floor would, broadly speaking, be evenly distributed—about 20 percent below baseline levels in the EU and India, about 28 percent in the US, and somewhat over 30 percent in China.[54]

53. Implementation issues would need to be fleshed out. For example, the focus could initially be on emissions from the power and industry sectors as: (i) these emissions are generally the most responsive to pricing and, therefore, play a key role in the early stages of clean energy transitions; (ii) most ETSs currently in place are limited to these sectors; and (iii) historically, fuels in these sectors were largely untaxed (or subject to minimal taxation, in terms of CO_2 equivalent taxes) making for a clean comparison to a baseline without carbon pricing. Over time, as the arrangement transitions to broader coverage of fossil fuel emissions, and measuring conventions are developed, the focus might move to countries' 'effective' carbon prices which take into account potentially incomplete coverage of formal carbon pricing schemes and changes in pre-existing energy taxes (which are typically large for transport fuels). In relation to this, participants could agree to increase their effective carbon prices by a given absolute amount over time, relative to effective prices in a baseline year.[55]

G. Summary of Policy Recommendations

- Introduce a system of revenue-neutral federal feebates to provide strong, reinforcing incentives for reducing emission rates in the transport sector.
- Apply feebates to reinforce decarbonization in power generation and industry.
- Use feebates to promote adoption of energy-efficient appliances and clean heating systems for buildings.
- Apply a fee to fugitive emissions from extractive industries with rebates for firms demonstrating their emission rates are below default rates.
- Consider feebates and a logging tax to promote forest carbon sequestration.

[54] Parry (2020).

[55] See Parry (2020) for further discussion.

- Consider feebates or emissions pricing schemes (with within-sector revenue recycling) to promote shifting to less emissions-intensive farming practices, reinforced with fiscal incentives at the consumer level to encourage plant and poultry-based diets.
- Consider a medium-term transition from the OBPS to a border carbon adjustment applied to EITE industries.
- Promote dialogue on an ICPF arrangement among large emitters to complement the Paris Agreement using Canada's model as a prototype.

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Appendix I. Further Details on the OBPS and Provincial/Territorial Carbon Pricing Schemes

1. Facilities covered by the federal OBPS include those that emitted 50,000 tons of CO_2 equivalent in 2014 or any subsequent year in the following industries: oil/gas production, minerals, chemicals, pharmaceuticals, iron/steel/metal tubes, mining/ore processing, nitrogen fertilizers, food processing, pulp/paper, automotive and electricity. Facilities emitting 10,000 tons or more in certain sectors can also apply to participate voluntarily in the OBPS. Most provincial carbon pricing systems have a version of the OBPS including Alberta, Newfoundland and Labrador, Nova Scotia, Quebec, and Saskatchewan. Standards for sectors assessed to be at low or medium risk of competitiveness impacts are set at 80 percent of the sector's average emissions intensity; those assessed to be at high risk are set at 90 or 95 percent of the average. Effectively, carbon pricing applies to 100 percent of emissions but there is an offsetting output subsidy valued at 80-95 percent of the industry average.[1]

Table A1 provides detail on sub-national pricing schemes.

Table A1. Canada: State of Provincial Emissions Pricing Initiatives, 2021

Province	Policy					Federal backstop integration
	Instrument	Year introduced	GHG coverage, percent	Emissions price, CAN$/ton CO_2	Revenue use	
Alberta	ETS on large industrial emitters (carbon tax abolished 2019)	2020	48	30	Household rebates, green infrastructure, renewable energy, community assistance, small	Fuel charge
Br. Columbia	Carbon tax, ETS on LNG	2008	70	40*	Reductions in household and business taxation	
Manitoba	Federal backstop	2019		30	Rebates to households	Fuel charge; OBPS (proposed provincial OBPS and carbon tax under consideration)
New Brunswick	Carbon tax	2020	39	30	Climate Change Fund	Fuel charge removed; OBPS in operation (proposed provincial OBPS under consideration)
Newfoundland and Labrador	Carbon tax, ETS on large industrial emitters and electricity generation	2019	47	20*		
Northwest Territories	Carbon tax	2019	79	30	Cost of Living Offset, reductions in reduce GHG emissions	
Nova Scotia	ETS	2019	80	20 (floor price)	Green Fund	

[1] For further discussion see www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/industry/pricing-carbon-pollution.html.

Table A1. Canada: State of Provincial Emissions Pricing Initiatives, 2021 (concluded)

Province	Policy					Federal backstop integration
	Instrument	Year introduced	GHG coverage, percent	Emissions price, CAN$/ton CO_2	Revenue use	
Nunavut	Federal backstop	2019		30	Rebates to households	Fuel charge; OBPS
Ontario	Federal backstop	2019		30	Reductions in household taxation, community assistance, SME support, and GHG reduction.	Fuel charge; OBPS (provincial OBPS approved and awaiting transition)
Pr. Edward Is.	Carbon tax	2019	44	30	Reduction in excise tax, transit fees, vechicle registration	OBPS
Quebec	Provincial ETS (linked to WCI)	2008	85	22 (floor price)	Green fund	
Saskatchewan	ETS for large industrial emitters	2019	12	30	Rebates to households	Fuel charge; partial OBPS (for electricity generation and gas
Yukon	Federal backstop	2019		30	Rebates to households and businesses	Fuel charge; OBPS

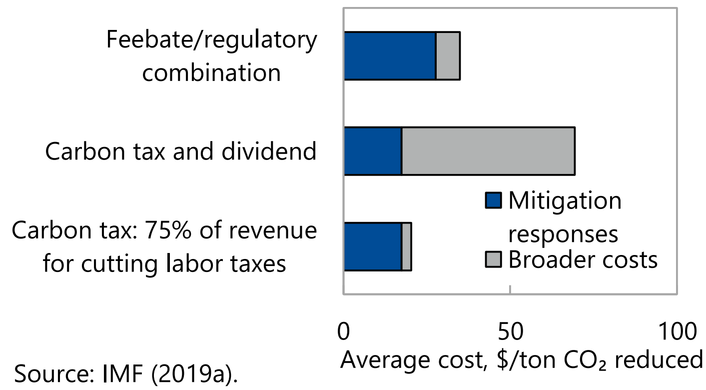
Sources: WBG (2021). WBG (2020). Canadian Energy Research Institute (2020). International Carbon Action Partnership (2021). New Brunswick Gov (2018). NWT Gov (2019). PEI Gov (2018). Ontario Gov (2021).

Notes. LNG is liquefied natural gas operations. WCI is the Western Climate Initiative including the California ETS. *Increases delayed due to COVID-19.

Appendix II. The Economic Importance of Using Carbon Pricing Revenues Productively

1. **Carbon pricing imposes two sources of costs on the economy. First is the cost of the mitigation responses themselves.** For example, firms producing with cleaner (but more expensive) technologies or households using less fuel than they would otherwise prefer. Second are broader macroeconomic costs. Higher energy prices tend to slightly contract overall economic activity as they increase the general price level, which in turn reduces the real returns to work effort and investment and causes compounding of distortions in factor markets created by taxes on labor and capital income. These costs can be largely offset (or perhaps more than offset, in some cases) from using carbon pricing revenues to increase economic efficiency, for example for lowering taxes on work effort or funding investments warranted on cost-benefit grounds.[1]

Figure A2. United States: Economic Efficiency Costs of Alternative Mitigation Instruments ($50/Ton Carbon Tax), 2030



Source: IMF (2019a).
Note. Policies reduce economywide CO_2 emissions 22 percent below BAU.

2. **An assessment for the United States (Figure A2) suggests that an ETS with free allowance allocation** and emissions price of $50 per ton (or the equivalent carbon tax with revenues returned in lump-sum dividends to households[2]) is about twice as costly—for a given nationwide emissions reduction—as a combination of feebates exploiting the major opportunities across the economy for reducing emission rates. This is because feebates have smaller impacts on energy prices and, therefore, smaller macroeconomic costs. The most cost-effective policy, however, is an ETS with allowance auctions, or a carbon tax, with the bulk of revenues used to cut distortionary taxes on labor and business income, or otherwise increase economic efficiency.

[1] A substantial analytical literature has explored these interactions. See, for example, Goulder and others (1999), Parry and Williams (2012).

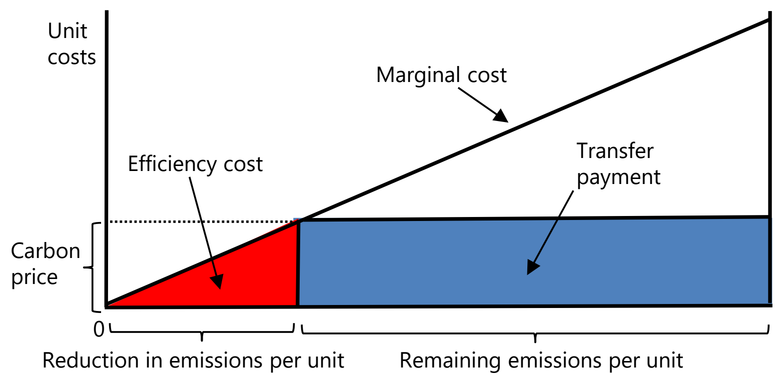
[2] Dividends have no efficiency benefits as they do not increase the real return to work effort or investment.

Appendix III. Burden of Carbon Pricing on Industries

Conceptual Analysis

1. **The increase in unit production costs for an industry subject to carbon pricing has two components (Figure A3).** First is the efficiency (or resource) cost of the induced changes in production methods (e.g., the cost of switching to cleaner technologies and fuels), indicated by the area under the marginal abatement cost schedule. Second is the transfer payment, equal to the carbon price times the remaining emissions per unit of output, which is a private rather than social cost (it reflects a tax payment to the government or a payment to allowance sellers). Schemes that avoid (for an average firm) the transfer payment, are effective at offsetting most of the increase in unit production costs for modest levels of abatement, but they become progressively less effective at higher levels of abatement. For example, they offset about 95 percent of costs when emissions reductions are 10 percent but only 45 percent of costs when emissions reductions are 70 percent.[1] This in part explains the growing interest in a BCA as the EU moves to deeper de-carbonization of industry.

Figure A3. Unit Cost Increases for Industry from Carbon Pricing



Illustrative Impacts of Carbon Pricing and Feebates on Production Costs for Steel and Cement

Steel

2. **Traditionally, steel is produced using an integrated process involving heating coal to form coke, feeding coke and iron ore into a blast furnace, and using an oxygen furnace to purify the molten metal.** This process produces about two tons of CO_2 per ton of steel.[2] Alternatives include an electrified process using scrap metal, and emerging technologies—for example, applying CCS, or feeding an electric furnace with iron made by direct reduction (e.g., using natural gas). These alternatives produce CO_2 emissions of about 0.3–0.4 tons per ton of steel.

3. **A carbon price of CAN$50/ton of CO2 would increase the cost of integrated production by about CAN$100/ton of steel through the first-order transfer payment, about**

[1] From a simple comparison of the triangle and rectangle in Figure A3, assuming a linear marginal cost curve.

[2] Unless otherwise noted, all data in this Annex is taken from van Reijven and others (2016).

one seventh of recent steel prices.[3] t would also increase the cost under alternative technologies by about CAN$20/ton of steel.[4] In contrast, under a feebate, the cost increase for integrated production (given an assumed industry average emission rate of 1 ton of CO_2 per ton of steel) would increase costs by CAN$50 per ton of output, while alternative technologies would receive a subsidy of about CAN$30 per ton of output.

Cement

4. Most cement is produced using traditional kilns to decompose calcium carbonate into clinker and CO_2 and then using mills to mix clinker with other minerals (e.g., limestone) and grind it. This process produces about 1 ton of CO_2 per one ton of cement, with process emissions contributing about 70 percent of these emissions. Alternatives include state-of-the-art plants in terms of energy efficiency, currently about 10 percent of production, and CCS—either post-combustion (where CO_2 is extracted from exhaust gases) or oxy-combustion (where fuel is burned with a mixture of pure oxygen and exhaust gases). State-of-the-art plants largely eliminate non-process emissions. Post- and oxy-combustion reduce emissions about 55 and 85 percent respectively, while increasing capital costs by about 25 and 100 percent respectively.

5. A carbon price of CAN$50/ton of CO_2 would increase the cost of traditional production by about CAN$50 per ton of cement, or about 30 percent,[5] while also increasing the price of more efficient and CCS-fitted plants by CAN$30, and CAN$8–25 per ton of output respectively through the first-order transfer payment. In contrast, a feebate with price CAN$50/ton of CO_2 would only increase the cost of traditional production by CAN$5 per ton of cement, while providing a subsidy to more efficient and CCS-fitted plants of CAN$10 and CAN$18–35 per ton of output.

[3] See www.focus-economics.com/commodities/base-metals/steel-usa.

[4] Technology switching is more likely to take the reform of retrofitting existing plants, rather than scrapping plants and building new ones, given that existing steel factories can potentially produce for several decades. Incentives will vary across plants, for example with local fuel and electricity prices.

[5]Cement prices are currently around US$125 per ton of cement (www.ibisworld.com/us/bed/price-of-cement/190).

Appendix IV. Design Issues for BCAs

Design issues include the following.

Sectoral coverage

1. **Limiting the BCA to EITE industries may make sense on competitiveness, targeted leakage, administrative, and legal grounds.** Competitiveness and leakage concerns are less severe for industries with relatively low energy intensity and trade exposure. The narrow focus also limits administrative burdens, as only a few key products from trading partners need to be tracked and there is publicly available data on carbon content for these products. It may also limit legal risks because: (i) the BCA would be replacing the OBPS which has not been subject to legal challenge; and (ii) the motivation based on leakage is more transparent for EITE products than for other manufactured products with low embodied carbon (relative to output) value.

2. **Applying a broader BCA to all manufactured products more comprehensively addresses leakage and provides a larger incentive for carbon pricing overseas but these effects are modest, and administration is more complex.** As noted above, the difference between emissions from EITE and all manufacturing industries is generally not that large. Administrative burdens rise rapidly with broader coverage due to the need to track more products. In addition, calculating embodied carbon for non-EITE products is more difficult. Indeed, charges on these products may need to be at a high level (e.g., taxing the value of all electronic products at the same rate). Moreover, a broader BCA might involve higher legal risks. If WTO compatibility is met through the leakage rationale, this might be more open to question, as leakage risks for an individual non-EITE product (with low carbon relative to value product) are generally small.

Measuring embodied carbon

3. **The first issue here is whether to assess BCAs on imports using country-specific or domestic measures of embodied carbon.** Using country-specific data has appeal on economic efficiency grounds, as domestic consumers will face the right set of relative prices across imported products with different carbon intensities. Administration is more complex however, as a different BCA rate needs to be calculated for each overseas exporter and there are uncertainties over whether objective criteria for applying differentiated rates across countries would breach WTO rules. A pragmatic approach may be to use domestic embodied carbon (initially to limit legal risks while the BCA is being established, with a view to progressively transitioning to country-specific BCAs at a later stage).

4. **The second issue is whether to use industry-wide, or firm-level, measures of embodied carbon.** Where BCAs are based on country data, it may seem appropriate to use firm-level data because of the heterogeneity of production methods used in many EITE industries. This would add further administrative complexity, however, and, at present, measures of embodied carbon in trade flows are publicly available by country and product only for broad product classifications. Using industry average benchmarks may, therefore, be the more practical approach. However, a

'rebuttability' provision allowing individual firms in trading partners to claim rebates, subject to third-party verification that their production is lower than this average, may help with WTO compatibility. There could be a risk of gaming, however, if the BCA induces firms to switch production from their cleaner plants for export to Canada while redirecting products from dirtier plants to other countries. To avoid this issue, the BCA rebate could be based on embodied carbon for an exporter averaged over all their production.

Rebates for domestic exporters

5. **From a competitiveness perspective, including a symmetric rebate on exports reflecting the difference between domestic and foreign carbon prices levels the playing field in international markets.** However, the subsidy element of a BCA reduces domestic mitigation incentives, making it harder to meet national mitigation targets, and forgoes government revenues.

Adjusting import charges for carbon pricing or other mitigation policy overseas

6. **Lowering the BCA rate for an overseas exporting country with carbon pricing is consistent with the motivation to reduce carbon leakage and avoids double taxation of overseas emissions.** If the primary motivation for a BCA is maintaining competitiveness for EITE industries or reducing carbon leakage, the BCA might be linked to pricing just for the power generation and industrial sectors (as emission pricing for residential and transport fuels has little impact on production costs for EITE industries). In principle, adjusting the BCA for formal carbon pricing elsewhere would be straightforward from a measurement perspective, as up-to-date details on the scope and price levels in carbon pricing schemes around the world is available.[1] One complication is that formal carbon pricing may be partially offset by reductions in pre-existing fuel taxes. Furthermore, if the BCA is linked to economy-wide pricing, schemes with partial coverage would need converting to economy-wide equivalents. In principle, these complications could be addressed through linking the BCA to changes in 'effective' carbon pricing in overseas countries, but this would complicate administration. Some practical compromise should be feasible, however. One example would be to simply weigh formal pricing schemes by the fraction of emissions covered, at least until widely accepted measures of effective carbon prices are developed.

Differentiating charges by country income

7. **Applying a lower BCA rate for exporters in low-income countries (LICs) would partially undermine the ability of the BCA to address competitiveness and leakage (but only moderately so given their modest shares in trade with Canada).** Excluding LICs would, in a blunt way, be consistent with the principle of common but differentiated responsibilities and it may be consistent with the WTO's Enabling Clause, if the exemption criteria are based on objective development indicators. Country-based exemptions would need to be designed to prevent the trans-shipment of goods from covered countries through exempted countries, but this challenge should be manageable.

[1] See WBG (2020).