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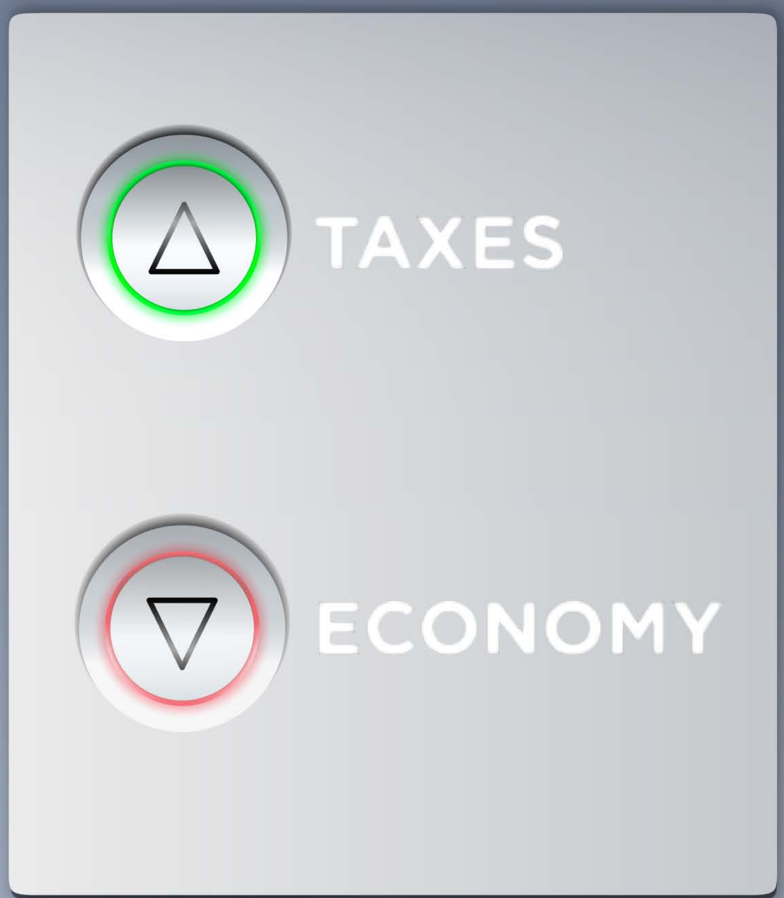
WHAT ARE THE ECONOMIC COSTS OF RAISING REVENUE BY THE CANADIAN FEDERAL GOVERNMENT?



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Executive Summary

Personal and corporate income taxes are important sources of revenue for the Canadian federal government, accounting for 72 percent of its total tax revenue in 2020–2021. This study investigates the economic costs of raising revenue through the federal personal income tax (PIT) and corporate income tax (CIT). We begin by estimating a measure of the tax sensitivities of the CIT and PIT bases based on data from 1972 to 2019. The econometric model indicates that a one percentage point increase in the federal CIT rate is associated with a 3.36 percent reduction in the CIT base, and a one percentage point increase in the top federal marginal PIT rate is associated with a 1.97 percent decline in the PIT base in the long run. Our estimates of the tax sensitivity of the tax bases are generally consistent with the findings of previous studies, and in particular that the CIT base is more responsive to tax rate changes than the PIT base. We also compare our estimates of the tax sensitivity of the federal PIT and CIT bases with the estimates of the tax sensitivities of the provincial tax bases in Dahlby and Ferede (2018). As anticipated, the federal tax bases are much less tax sensitive than the provincial bases, especially in the case of the CIT, because it is easier to shift taxable income or re-allocate investments across provincial boundaries than across international boundaries.

Taxes impose a cost on the economy if they alter taxpayers' consumption, production, and investment decisions, leading to a less efficient allocation of resources. Raising an additional dollar of tax revenue costs the private sector more than a dollar if the allocation of land, labour, and capital becomes more distorted. The marginal cost of public funds (MCF) is a measure of the cost imposed on the private sector in raising an additional dollar of tax revenue. These measures of the cost of raising revenues at the federal level can be used in cost-benefit analysis of expenditures programs, evaluating tax reforms, and designing federal transfers to the provinces.

We use our estimates of the tax sensitivity of the tax bases to compute the MCFs for the federal CIT and PIT. Our analysis shows that MCF for the federal CIT was much higher than the MCF for the federal PIT prior to 2012. However, in 2012 the federal government cut the CIT rate to 15 percent, which lowered the MCF to approximately 2.02, which was below the MCF for the federal PIT of 2.33. In 2016, the federal government raised the top marginal PIT rate to 33 percent. The MCF for the federal PIT increased to 2.86 and has exceeded the MCF for the federal CIT since then. In summary, our computations indicate that in 2021, an additional dollar of tax revenue raised through the federal CIT costs Canadian society $2.02 while an additional dollar raised through the federal PIT costs $2.86.

We also compare the MCFs for the federal PIT and CIT with the MCFs for provincial MCFs for these taxes. Even though the federal PIT base is less tax sensitive than the provincial PIT bases, the MCFs for the PIT for five provinces were lower than the federal MCF for the PIT in 2020. This arises mainly because the top provincial marginal

tax rates are lower than the top federal marginal tax rate. Regarding the CITs, our analysis indicates that the six smallest provinces were on the downward sloping sections of their Laffer curves in 2020. In these provinces, a lower CIT rate would increase total tax revenues to the province in the long run. The four largest provinces are on the positively sloped sections of their CIT Laffer curves and their MCFs bracket the federal MCF.

We illustrate how the MCFs can be used for policy analysis by showing how the federal and provincial MCFs affect the optimal matching grant rate for federal funding of provincial infrastructure. Infrastructure projects which improve labour productivity not only confer benefits to a province's residents, but they also increase federal revenues which benefit Canadians in all provinces through higher spending on federal programs. However, provinces will tend to underinvest in infrastructure projects from a national perspective because they will not consider the benefit to the residents of other provinces from higher federal tax revenues when they conduct a cost-benefit analysis of their spending on infrastructure. This is a rationale for the federal government to provide an incentive for the provinces to spend more on the infrastructure project than they otherwise would through a matching grant. We show that the matching rates should be higher in a province's MCFs and the ratio of a province's MCF and to the federal MCF.

The model indicates that the matching rates are higher for the provinces with higher MCFs and when the differential between provincial and federal MCFs is greater.

1. Introduction

Governments use the tax system to finance various public services and infrastructure. When governments want to raise more revenue, they often raise tax rates. However, tax rate increases adversely impact the incentive to save, invest, and work. Thus, taxpayers' behavioural responses to tax rate hikes generally distort the economy. In Canada, both the federal and provincial governments rely on personal income tax (PIT) and corporate income tax (CIT). For instance, in 2020–21, about 72 percent of the federal government's revenue came from these two essential tax sources. Therefore, when the federal government faces budgetary pressures, it may raise the PIT and CIT rates. However, such efforts to increase revenue impose a cost on the economy if taxpayers alter their consumption, production, and investment decisions, leading to a less efficient allocation of resources. This implies that tax rate increases cost society above and beyond what the government collects in revenue.

Therefore, measuring the social cost imposed on Canadians when the federal government attempts to raise more tax revenue is crucial to encourage public discussion and enhance informed policymaking. In the literature, the social cost of raising tax revenue is measured with the Marginal Cost of Public Funds (MCF)—a measure of the social cost of raising an additional dollar of tax revenue. MCF is a crucial parameter in cost-benefit analyses of expenditures programs, evaluations of tax reforms, and designing federal transfers to the provinces. See Dahlby (2008) for the theoretical foundation of the MCF and Dahlby (2020) on its use in policy analysis.

Assessing the social cost of tax rate changes using the MCF requires primarily measuring the taxpayers' behavioural responses to the tax rate changes. This is relevant because the additional revenue that governments can raise and the distortion in the allocation of resources associated with tax rate increases depend on the behavioural responses of taxpayers.

Tax rate increases encourage tax avoidance and evasion activities, which will adversely impact the tax base. If the tax bases shrink following tax rate increases, the government may collect much less revenue than anticipated. Accordingly, the sensitivity of tax bases to changes in tax rates plays a vital role in assessing the efficiency cost of tax policies and governments' capacity to raise more revenue. Consequently, several previous studies focus on examining the sensitivity of tax bases to tax rate changes.

Previous studies have investigated the sensitivity of personal taxable income with respect to the PIT rate using individual-based data. This strand of the literature commonly focuses on estimating the taxable income elasticity with respect to the net-of-tax rate (i.e., one minus the marginal tax rate) and a wide range of estimates have been obtained. Early studies by Lindsey (1987) and Feldstein (1995) reported a very high taxable income elasticity estimate, while more recent US studies such as Goolsbee (1999, 2000), Gruber and Saez (2002) and Giertz (2007) have found somewhat lower elasticity estimates. See

Saez et al. (2012) for a survey of earlier studies of taxable income elasticities. Canadian studies by Sillamaa and Veall (2001) and Milligan and Smart (2015) obtained high taxable income elasticity estimates for the self-employed and high-income earners.

Other empirical studies utilize aggregate Canadian data to estimate tax base elasticities. Using an empirical methodology that is similar to that adopted in this study, Dahlby and Ferede (2012, 2018) and Milligan and Smart (2019) employed Canadian provincial data to estimate the sensitivity of personal taxable income with respect to provincial marginal top PIT rate. These studies found very high responsiveness of PIT base to changes in provincial PIT rates.

Another strand of the literature has focused on taxpayers' responses to changes in business taxes. See Gruber and Rauh (2007) for the United States, Huizinga and Laeven (2008) for European Countries, Riedl and Rocha-Akis (2009) for OECD countries, and Mintz and Smart (2004) and Dahlby and Ferede (2012, 2018, 2021) for Canadian provinces. The international studies have revealed very high responsiveness of the CIT base to changes in the CIT rate. The Canadian studies have also shown that the CIT base is very sensitive to changes in provincial CIT rates.

While the above Canadian studies have enhanced provincial tax policy discussions by providing estimates of taxable income elasticity and the MCFs for provincial taxes, few studies have focused on taxes imposed by the federal government. An exception is Ferede (2019) which provided an estimate of the tax sensitivity of the federal PIT base. However, Ferede (2019) only provided an estimate of the short-term sensitivity of taxable income to tax rate changes and ignored the long-term economic distortions associated with PIT rate increases.

The objective of this paper is to estimate the tax sensitivity of the CIT and PIT bases to federal tax rate increases and to compute the MCFs for these taxes. First, we estimate the long-run tax base semi-elasticities—measures of the shrinkage of the CIT and PIT bases associated with a one percentage point increase in the tax rates—based on data for the period 1972–2019. The econometric analysis indicates that the long-run semi-elasticity of PIT base is about -1.97. This indicates that in the long run, a one percentage point increase in the top federal marginal PIT rate is associated with a reduction of taxable income by about 1.97 percent. Similarly, we find that a one percentage point increase in the federal CIT rate is associated with a 3.36 percent decrease in the CIT base. These tax base semi-elasticity estimates are broadly consistent with those of previous studies and indicate that tax rate increases cause shrinkage of the tax bases because of taxpayers' behavioural responses to the higher tax.

Second, we use the estimated tax base semi-elasticities to compute the MCFs for the federal CIT and PIT in order to assess the economic cost of raising revenue through these two key tax bases. Our calculations show that the MCF for the federal CIT was higher than the MCF for the federal PIT prior to 2012. This is consistent with the finding of previous studies that show business tax bases are generally more sensitive to tax rate changes and have higher economic costs than the personal income tax base. However, the federal CIT rate reduction that was introduced in 2012, as well as the PIT rate hike on high-income earners of 2016, changed the ranking of the costs of these two taxes. Consequently, in 2021, the MCF for PIT is 2.86 while the MCF for CIT is 2.02. This implies that society incurs costs of $2.86 and $2.02 when the federal government attempts to raise one dollar of revenue from PIT and the CIT, respectively.

The remainder of this study is organized as follows. Section 2 provides background information about federal income taxes. Section 3 starts with a primer on the MCF concept. We then compute the MCFs for the federal CIT and PIT, show how they have varied over time, and show how the federal MCFs compare with the provincial governments MCFs. We then provide an example of how the MCFs can be used in a policy evaluation by computing the optimal matching rates for federal infrastructure grants. The final section summarizes the key results in the study.

2. Background

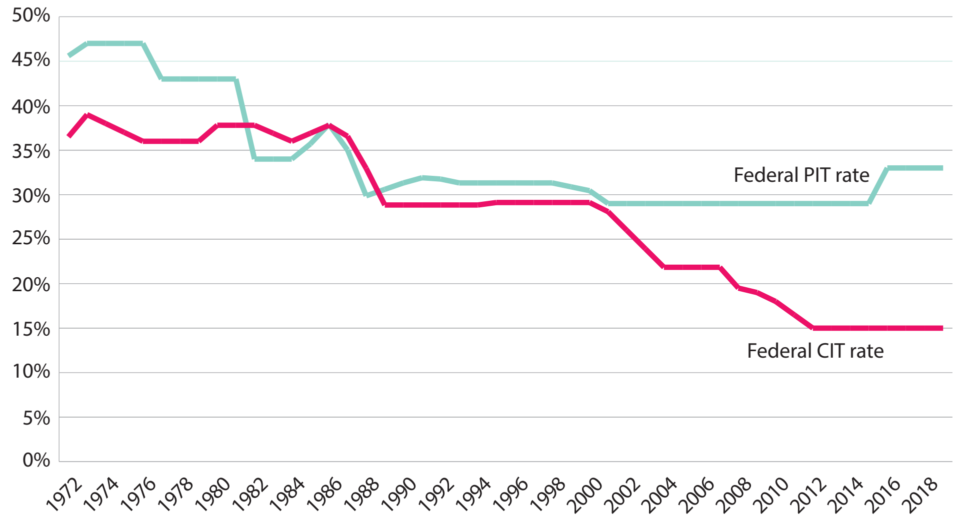
In Canada, the personal and corporate income taxes are important revenue sources for both the federal and provincial governments. On average, during the period under investigation, these two tax sources account for about 58 per cent of the federal government's total revenue. In the fiscal year 2020–21, the last year for which complete revenue data is available, the federal government collected about 72 percent of total revenue from these two main tax sources. The corresponding revenue share for the GST was about 10 percent. These stylized facts indicate the significance of the personal income and corporate income taxes in the federal government's budget. Consequently, this study focuses on these two main taxes. [1]

The amount of revenue that the federal government collects crucially depends on the statutory tax rates and the tax bases. While the tax bases and revenues can fluctuate due to various factors that influence the economic development of the country, often the federal government's decision to change the tax rates impact economic activities and tax revenue. In this section, we provide a brief background information about income taxes in Canada, with a focus on the federal government. We limit our discussion to the period 1972 to 2019, which is the sample period for our main empirical analysis. The Federal PIT and CIT rates exhibit significant variations during the sample period under investigation. The federal top marginal statutory PIT rate averaged about 34 percent and ranges between 29 percent to 47 percent. Similarly, the average federal general CIT rate during the sample period was about 27.7 percent and it varies between 15 percent and 39 percent. Figures 1 and 2 show the federal PIT and CIT rates to visualize how these rates evolve during the sample period.

Figure 1 shows the evolution of the statutory federal CIT rate and top marginal PIT rate from 1972 to 2019. The figure displays that the CIT rate trends downwards over the period under consideration, and it ranges between 15 percent and 39 percent. The current CIT rate of 15 percent has been in place since 2012, following the government's decision to cut the rate. Similarly, the federal top PIT rate exhibits a downward trend during most of the period under consideration. However, this changed in 2016 when the federal government decided to increase the tax rate on high-income earners, which raised the top marginal rate from 29 percent to 33 percent.

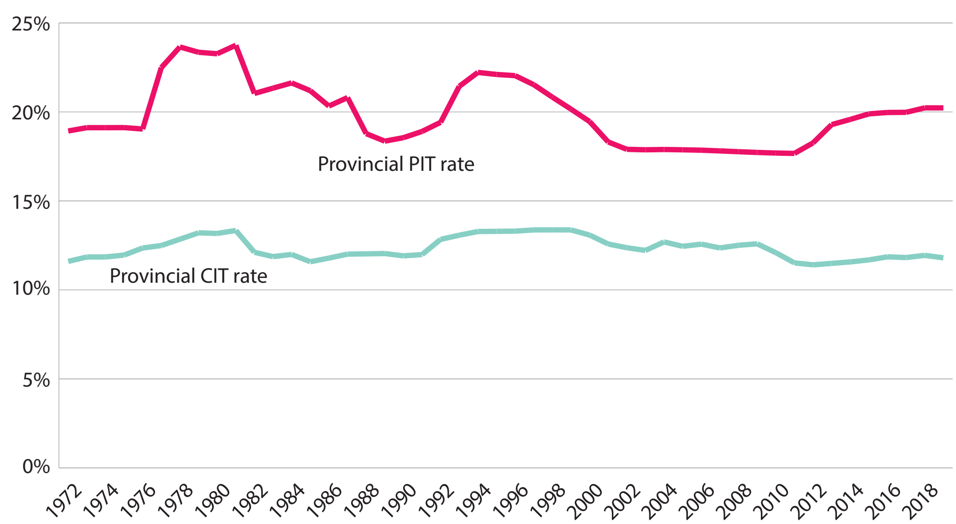
[1] We do not estimate the tax base sensitivity of another major source of federal tax revenues, Goods and Services Tax (GST), due to the lack of variability in GST rate during the period under investigation. The federal government introduced the GST in 1991 at the rate of 7 percent. Since then, the tax rate was changed only twice (once in 2006 to 6 percent, with a further reduction to 5 percent in 2008). This lack of variability in the GST rate makes empirical analysis infeasible. Thus, the empirical analysis of this study focuses only on personal income and corporate income taxes, which are the primary revenue sources for the federal government. The federal government used to levy the Manufacturers' Sales Tax (MST) at the rate of 13.5 percent prior to the introduction of the GST. However, the MST was mainly hidden from the public and the tax base was very different than that of GST.

Figure 1: Federal CIT and PIT rates, 1972 to 2019



Source: Finances of the Nation, 2022.

Figure 2: Provincial CIT and PIT rates, 1972 to 2019



Source: Finances of the Nation, 2022; authors' calculations.

Figure 2 shows the provincial average statutory CIT and top marginal PIT rates from 1972 to 2019. The provincial tax rates are weighted by population. While using provincial tax bases or GDP provide somewhat similar results, we choose population as it is more appropriate from an empirical methodology perspective. [2] Thus, larger provinces such as Ontario and Quebec have a more significant impact on the average tax rates. Note that this is generally true whether one uses GDP or tax bases as weights. Unlike the federal PIT and CIT rates, the provincial tax rates do not exhibit a clear trend. The provincial PIT rate shows significant fluctuation during the sample period. The figure shows that the provincial PIT rate trends upwards beginning 2012. This was partly due to the tax rate hike on high-income earners that Ontario introduced in 2012. Alberta and Quebec also raised their top marginal PIT rates in 2015 and 2013, respectively. When we look at the provincial CIT rate, there is less variation during the period under investigation.

[2] The reason is that in our empirical estimation of the tax base elasticities, population is less correlated with the tax base (which is the dependent variable) than GDP. This alleviates some of the concerns associated with endogeneity problems in empirical studies such as ours.

3. Tax Base Responsiveness and Computation of MCFs

3.1 Tax Base Responsiveness

As previously noted, the main objective of this study is to quantify the long-term responses of the federal personal and corporate income tax bases to tax rate changes and use such estimates to compute the economic cost of raising revenue from these sources. The study focuses only on personal income tax and corporate income tax. On average, during the period under investigation, these two tax sources account for about 58 per cent of the federal government's total revenue. In the fiscal year 2020–21, the last year for which complete revenue data is available, the government collected about 72 percent of total revenue from these two main tax sources. The corresponding revenue share for the GST was about 10 percent.

To this end, following the approach of previous studies such as Dahlby and Ferede (2012, 2018), Milligan and Smart (2019), and others, we estimate an empirical model of the personal income tax and corporate income tax bases. We present and discuss the estimated regression results in **Appendix 1**. Our main empirical model of column 2 of table A1 shows that the federal PIT base's long-run own semi-elasticity estimate is about -1.97. This suggests that a one percentage point increase in the federal statutory top marginal PIT rate is associated with a 1.97 per cent reduction in the tax base. To put this semi-elasticity estimate in perspective, it is equivalent to an elasticity of taxable income with respect to the net-of-tax rate of 1.3, calculated at the period average federal top PIT rate of 34 percent. [3] This elasticity of taxable income estimate is well within the range of values that previous similar studies obtained. The implication of statistically significant PIT base responsiveness is that when the federal government raises the PIT rate on high-income individuals, the government is likely to collect less revenue than anticipated due to the negative behavioural responses associated with the tax hike.

We also provide an empirical estimation of the responsiveness of the CIT base to changes in the CIT rate. Our main CIT base semi-elasticity estimation result is shown in column 4 of table A1 in Appendix 1. The results indicate that the coefficient of the CIT rate is, as expected, negative and statistically significant. According to this main model, the CIT base long-run own semi-elasticity estimate is about -3.36. This suggests that a

[3] Many of the previous individual data-based studies focus on estimating the elasticity of taxable income with respect to the net-of-tax rate (i.e., one minus the tax rate). See Gruber and Saez (2002) and Saez et al. (2012) for an excellent survey of the literature. One can easily obtain the implied elasticity of total taxable income with respect to net-of-tax rate by multi¬plying the long-run own semi-elasticity estimate by -(1-PIT rate) using the mean PIT rate of the sample period, which is 0.34. Note also that our semi-elasticity estimate implies a federal government revenue maximizing PIT rate of about 51 percent.

one percentage point increase in the federal CIT rate is associated with a 3.36 percent reduction in the CIT base. We use this long-run own semi-elasticity estimate to compute the federal government's MCF for the corporate income tax.

How do our long-run PIT and CIT base semi-elasticity estimates compare with those of previous similar studies? Generally, it is very difficult to make a direct comparison with results of previous empirical studies due to differences in estimation methodology, the focus of the studies, or the type of tax rates used in the analyses. Further, there is a paucity of empirical studies that exclusively focus on the Canadian federal personal and corporate income tax systems. Nonetheless, we focus below on some of those studies that utilize aggregate data and provide tax base semi-elasticity estimates to place our empirical results in the context of the wider relevant literature.

There is a lot of variation in the empirical approaches of previous studies that focus on investigating taxpayers' behavioural responses to changes in the personal income tax rate. [4] In a related study, using Canadian provincial data, Milligan and Smart (2019) found a long-run personal income tax own semi-elasticity of about -2.40, which is slightly higher than our estimate. [5] Again, this is expected as taxpayers' behavioural responses are generally greater for the provincial tax rates than for the federal government. Ferede (2019) also investigated the short-run taxpayers' behavioural responses to changes in the federal statutory top marginal PIT rate. He found a short-run PIT base own semi-elasticity of about – 0.50. This implies that, based on Ferede's (2019) estimate, it takes about four years for our long-run PIT base semi-elasticity estimate to be attained. Therefore, our result is comparable to that of Ferede (2019). In sum, the tax base semi-elasticity estimates of this study are broadly consistent with those of previous studies.

Our long-run corporate income tax base own semi-elasticity estimate is well within the range of taxable income elasticity values obtained by Mintz and Smart (2004), but they used combined federal and provincial tax rates. On the other hand, our semi-elasticity estimate is slightly higher than the range of values that Huizinga and Laeven (2008) found for European countries. Similarly, our CIT base own semi-elasticity estimate is higher than the long-run tax base semi-elasticity estimate that Riedl and Rocha-Akis (2012) obtained for OECD countries (including Canada), although they used effective average tax rates rather than statutory tax rates.

[4] Many of the previous studies on taxable income elasticity such as Sillamaa and Veall (2001) and Milligan and Smart (2015) relied on using individual based data and focused on estimating taxable income elasticity with respect to the net-of-tax rate (one minus the tax rate) in the short term. Thus, it is difficult to make direct comparison with this body of the literature.

[5] Milligan and Smart (2019)'s own semi-elasticity estimates of taxable income with respect to provincial top PIT rate are: -0.61 (for the top 10% earners), -1.53 (for the top 5% earners), -2.4 (for the top 1% earners), and -3.08 (for the top 0.1% earners).

Table 1 compares our estimate of the semi-elasticities of the federal PIT and CIT bases with the semi-elasticities for the provincial tax bases in Dahlby and Ferede (2018). [6] As expected the semi-elasticities for federal tax bases are substantially lower (in absolute value) than the provincial bases, especially in the case of the CIT, because it is easier to shift taxable income or re-allocate investments across provincial boundaries than across international boundaries.

Table 1: Comparison of Federal and Provincial Tax Base Semi-Elasticities

	PIT	CIT
Federal	-1.97	-3.36
Newfoundland and Labrador	-4.03	-15.32
Prince Edward Island	-3.50	-15.46
Nova Scotia	-3.22	-10.99
New Brunswick	-2.96	-17.56
Quebec	-2.62	-6.08
Ontario	-4.15	-13.00
Manitoba	-3.37	-17.03
Saskatchewan	-3.86	-17.40
Alberta	-2.89	-13.10
British Columbia	-4.42	-15.24

Source: The provincial semi-elasticities are from Dahlby and Ferede (2018). See Appendix 1 for the estimation of federal semi-elasticities.

3.2 A Primer on the Marginal Cost of Public Funds

The amount of tax revenue that a government collects depends on the size of the tax base, the tax rate, and how tax sensitive the tax base is. When a government raises a tax rate in an attempt to collect more revenue, the tax base in most cases shrinks because of tax avoidance and tax evasion activity. As a result, there is both a direct and indirect burden on the private sector from a tax rate increase. [7] The direct burden is revenue collected by the government. The indirect burden is the decline in the economy's ability to generate income and consumption opportunities in the private sector because a tax increase

[6] A related study by Dahlby and Ferede (2012) used annual panel data from the ten Canadian provinces to estimate the short-run and long-run tax base semi-elasticities. In their preferred regression, they found that for the Canadian provinces, the own long-run semi-elasticity for the provincial CIT base was -13.60.

[7] Raising tax revenues also involves administration cost for the government and compliance costs for the private sector. While these costs are significant, we abstract from them because our focus in on the cost of raising an additional dollar of revenue, while the administrative and compliance costs are largely fixed and do not vary with the amount of revenue raised.

changes the economic incentives that workers and firms face, and they generally respond in ways that cause the tax bases to shrink. As a result, there is a less efficient allocation of labour, capital, and land in the economy, and the production potential of the economy declines. The direct and indirect cost of raising an additional dollar of tax revenue is measured by the Marginal Cost of Public Funds (MCF). See Dahlby (2008) for the theoretical foundation of the MCF and Dahlby (2020) for its uses in policy analysis. The following section draws heavily from Dahlby (2020).

The intuition behind the MCF can be explained using the familiar demand and supply model. Figure 3 shows the market demand curve, D, and the market supply curve, S, for a commodity x. In the absence of taxation, x^0 units of the good would be produced and consumed, and the price of the good would be q^0. If a tax of t^1 dollars per unit of x is imposed on the producers of this commodity, the consumer price would increase to q^1, the price that producers receive would decline to $p^1 = q^1 - t^1$. The quantity of x produced would decline to x^1. The total tax revenue collected by the government would be $R^1 = t^1 \cdot x^1$ or area q^1agp^1. The increase in the price paid by consumers would cause a reduction in consumer surplus equal to the area q^1abq^0, and the decline in the producer price would cause a loss of producer surplus equal to area q^0bgp^1. The loss of consumer and producer surplus exceeds the revenue raised by the tax by the area of the triangle abg, which is a measure of the excess burden of the tax.

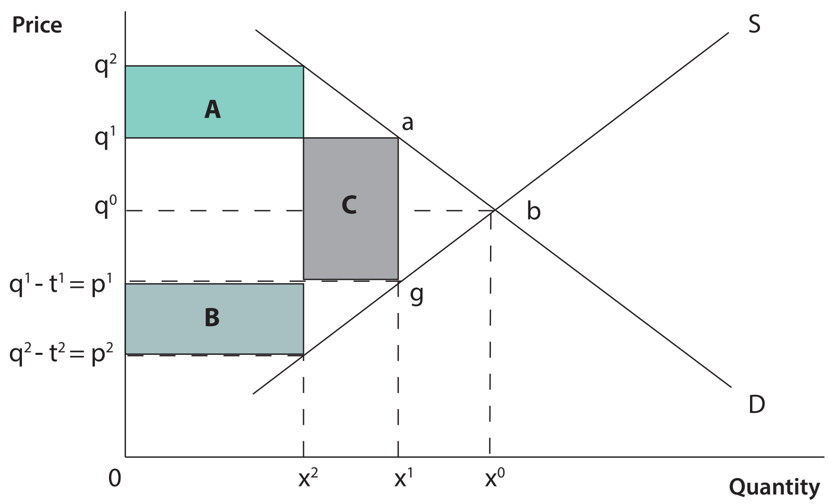
Now consider the cost of raising additional tax revenue by increasing the tax rate to t^2. The consumer price increases to q^2, the producer price declines to p^2, and output declines to x^2. The change in total tax revenue, $\Delta R = t^2x^2 - t^1x^1$, would be equal to shaded areas A + B - C. The reduction in the net output of the economy (the value of the lost output to consumers less the opportunity cost of the resources to producers) is given by the area between the demand and supply curves over the output range $x^1 - x^2$. This net output loss can be approximated by the area C.

The MCF is equal to one plus the reduction in the value of the net output of the economy per dollar of additional tax revenue, or:

$$MCF = 1 + \frac{C}{A+B-C} = \frac{A+B}{A+B-C} \qquad (1)$$

Since A + B is the loss of consumer and producer surplus for a very small tax rate increase, the MCF can also be interpreted as loss of consumer and producer surplus per dollar of additional tax revenue. This formula indicates that the MCF is greater than one if the output of x declines. As figure 3 indicates, area C will be larger (and therefore the MCF will tend to be larger) when the reduction in output is larger or when the size of the initial tax distortion is larger.

Figure 3: The MCF from an Excise Tax Rate Increase

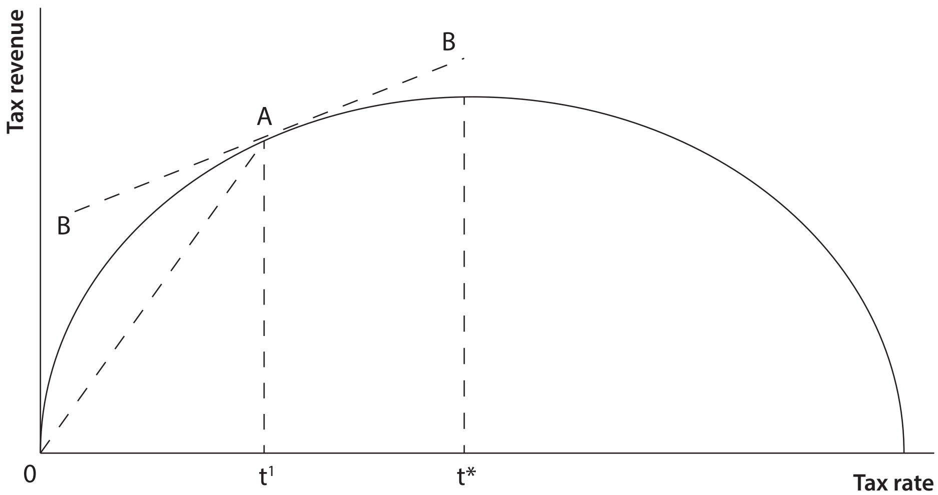


The MCF will also be larger when demand and supply of the taxed commodity are more sensitive to price changes and when the existing tax rate is higher. For example, if the elasticity of supply is 4, the elasticity of demand is -2, and the ad valorem tax rate is 0.333, the MCF is 2. Therefore, raising $1 of tax revenue costs the private sector $2. The MCF is the sum of the taxpayers' direct loss of $1 from the increase in taxes, and the indirect loss of $1 from the reduction in the value of output. If demand were more price sensitive, with a price elasticity of -4, the MCF would be 5.

While the loss of income and consumption opportunities is the true cost of raising tax revenues, governments are often only focused on the how tax increases affect total tax revenue, a relationship which is popularly known as the Laffer curve, named after Arthur Laffer who drew a curve illustrating this relationship on a napkin for Ford Administration officials in 1974. The Laffer curve is commonly portrayed as inverted U shaped, as in **figure 4**. When the tax rate is initially relatively low, as at t^1, governments can raise more revenue by raising the tax rate, although at a less than proportionate rate to the tax rate increase because the tax base shrinks from tax avoidance and evasion. We can interpret the MCF from a small increase in the tax rate at t^1 as the slope of a line from the origin to point A on the Laffer curve divided by the slope of the tangent line at point A. Since the slope of OA is greater than the slope of BB, the MCF will be greater than one.

In most situations there is a critical rate of taxation, such as t* in figure 4, which maximizes tax revenues. Tax rate increases beyond that rate beyond actually reduce tax revenue collected. This has two important implications. At the revenue maximizing tax rate, the MCF is infinite because a small tax rate increase generates no additional revenues but still imposes an additional burden on taxpayers. Second, if the tax rate exceeds this critical rate, a tax rate cut will increase tax revenues. In such cases, we say that the government is on the "wrong side" of the Laffer curve and the MCF is not defined because the government can increase revenues by lower the tax rate. In that situation, raising

Figure 4: The MCF and the Laffer curve



revenues does not impose a "cost" on the private sector, but provides a net benefit. This implies that a government should set tax rates so that it is on the upward sloping section of the Laffer curve.

This introduction to the MCF concept has focused a simple case with a tax on one commodity or service which distorts the allocation of resources in the economy. Of course, taxes can help to improve the allocation of resources by reducing activities that generate harmful externalities—that is, where the private cost to an individual or firm of engaging in an activity is less than its full social cost because part of the cost is borne by a third party. It is even possible for the MCF of a tax to be less than 1.00 if it reduces the production and consumption of products with harmful externalities, or if a tax rate increase on one base causes other tax bases to expand as taxpayers shift their activities to the lower-taxed bases. In the next section, we are concerned with two broad taxes—personal income tax and corporate income taxes—whose primary function is to raise revenue and which play only a minor role in offsetting externalities because they do not focus on a narrow range of externality-producing activities.

3.3 Computations of the Federal Marginal Cost of Public Funds

In this section, we compute the MCF for the federal government using our tax base semi-elasticity estimates, reported in the previous section, and the federal statutory PIT and CIT rates. Appendix 2 explains the analytical framework that enables us to compute the MCF using tax base semi-elasticity estimates. Although the tax base semi-elasticity estimates are assumed to be the same during the period under consideration, the computed MCF estimates can vary over time due to changes in the statutory tax rates. Thus, we calculated the MCF estimates for all years during the sample period using the formula indicated in equation (1.5) in **Appendix 2**. However, we present and discuss the MCFs of selected years for the sake of brevity.

In general, the loss of economic efficiency increases at an increasing rate as the tax rate increases. Accordingly, given the tax base semi-elasticity estimate, the MCF increases with the tax rate. Thus, in **table 2** below, we report the computed MCF values for the personal and corporate income taxes for selected years.

Table 2: Marginal Cost of Public Funds (MCF) Estimates

	PIT	CIT
1980	6.54	***
1985	3.37	***
1990	2.61	32.28
1995	2.61	46.36
2000	2.50	46.36
2005	2.33	3.76
2010	2.33	2.53
2015	2.33	2.02
2020	2.86	2.02
2021	2.86	2.02

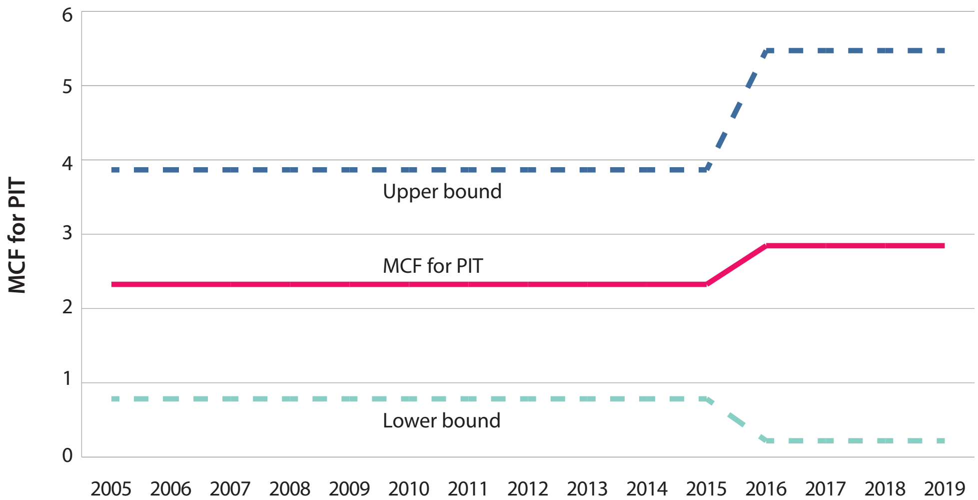
Note: *** indicates that a tax rate increase would reduce the government's tax revenue in the long run. In such cases, a tax cut would increase revenues as well as benefit producers and consumers and raising additional revenue does not impose a cost on the society.

Source: Authors' computation based on the coefficient estimates of Table A1 and the data on statutory tax rates obtained from Finances of the Nation.

Table 2 indicates that prior to 1990 the federal corporate income tax rate was on the "wrong side" of its Laffer curve and a federal CIT rate cut would have increased tax revenues. The high MCF for the CIT in the 1990s provides empirical support for the Technical Committee on Business Tax's recommendation that the federal government lower its CIT rate in its 1998 report. Following the CIT rate reduction in 2000, the MCF for the CIT was still twice as high as the MCF for the PIT. However, this changed in 2012 when the federal government cut the statutory CIT rate from 16.5 percent to 15 percent while the top statutory marginal PIT rate was maintained at 29 percent. The federal statutory marginal PIT rate hike of 2016, which raised the top tax rate from 29 percent to 33 percent, further widened the gap in the MCF for PIT and CIT. Consequently, in 2021, the PIT has a higher MCF than the CIT. More specifically, in 2021, the MCF for PIT implies that society incurs a cost of $2.86 when the government raises an additional dollar of revenue from PIT. On the other hand, the MCF for CIT in 2021 indicates that when the federal government attempts to raise a dollar of revenue from this tax source, the cost to society is about $2.02.

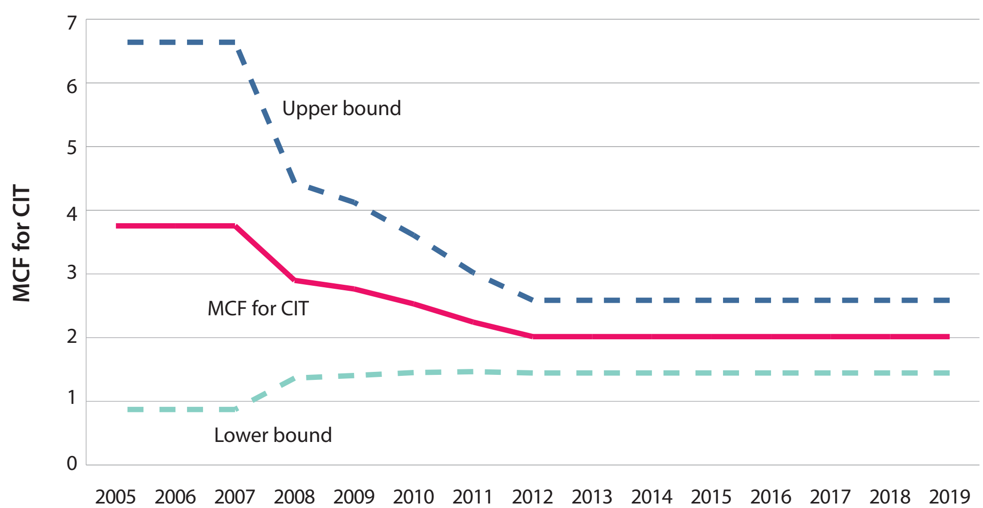
One may be interested to know whether the MCF values are precisely estimated. To shed light on this we show the MCFs along with their 95 percent confidence interval in **figure 5a** and **figure 5b**. [8]

Figure 5a: MCF for PIT and 95 percent confidence intervals, 2005 to 2019



Source: Table 2; authors' calculations.

Figure 5b: MCF for CIT and 95 percent confidence intervals, 2005 to 2019



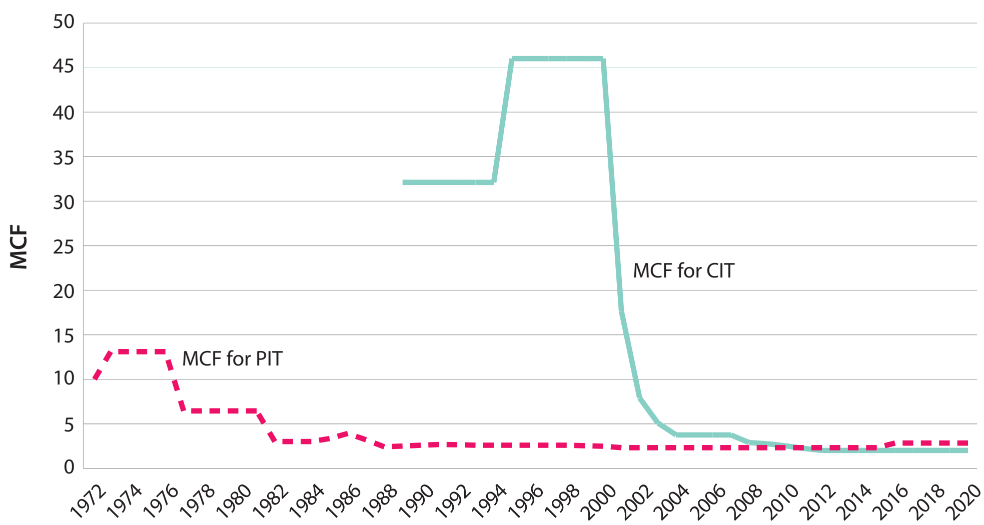
Source: Table 2; authors' calculations.

[8] As shown in equation (1.5) in the appendix, the MCF is a non-linear function of both the tax base semi-elasticity estimates and the tax rates. Thus, the confidence intervals for the MCF depend on the tax rates, the tax base-elasticity estimates, and their standard deviations. Thus, as the tax rates change, the confidence intervals also change.

Both figures 5a and 5b show that the confidence intervals are broader when the tax rates are higher. For example, the 95 percent confidence interval for the MCF of the PIT expands in 2015 when the top federal marginal tax rate increase to 33 percent. This occurs because the confidence intervals depend not only on the standard errors of the estimated semi-elasticities of the PIT and CIT tax bases, but also on the tax rates. Thus, the MCF estimates are statistically significant. Note that we show the MCF estimates and their confidence intervals only for the period 2005–2019 for the sake of brevity, but the story is the same throughout the sample period. **Figure 6** exhibits the computed MCFs for every year during the sample period.

Figure 6 shows the MCF for the personal income tax with the dotted line and the MCF for the corporate income tax with the unbroken line. As Figure 6 indicates, the MCF for personal income tax has been trending downwards during most of the sample period. The reason for this decline in the MCF is the decrease in the top statutory marginal PIT rate. Similarly, the MCF for the corporate income tax varies over time due to changes in the statutory marginal tax rate. As noted above, a reduction in the corporate income tax would have increased corporate income tax revenue prior to 1989. Figure 6 shows the MCF only over the period 1989 to 2021, in which the MCF for corporate income tax had positive values.

Figure 6: The MCF for PIT and CIT, 1972 to 2020



Source: Finances of the Nation, 2022; Table 2; authors' calculations.

Table 3 compares the MCFs for the federal PIT and CIT with the MCFs for provincial PIT and CIT based on the Dahlby and Ferede (2018) estimates of the semi-elasticities of the provincial tax bases as shown in table 1. [9] First, consider the MCFs for the PIT. Even though table 3 indicates that the federal PIT base is less tax sensitive than the provincial PIT bases, the MCFs for the PIT for five provinces were lower than the federal MCF for the PIT in 2020. This arises mainly because the top provincial marginal tax rates are lower than the top federal marginal tax rate. It is also interesting to note that the MCF for the PIT in Ontario is substantially higher than the federal PIT MCF because of Ontario's relatively higher top marginal tax rate, 20.53 percent, and its high semi-elasticity -4.15.

Table 3: Comparison of the Federal and Provincial MCFs for the PIT and CIT in 2020

	PIT	CIT
Federal	2.86	2.02
Newfoundland and Labrador	3.81	***
Prince Edward Island	2.80	***
Nova Scotia	---	***
New Brunswick	2.51	***
Quebec	3.06	3.32
Ontario	6.76	2.62
Manitoba	2.42	***
Saskatchewan	2.27	***
Alberta	1.77	1.89
British Columbia	3.88	2.19

Notes: Calculations based on 2020 tax rates as of July 1, 2020, average revenue shares 1972–2013, and estimates of the semi-elasticities of the provincial tax bases based on data from 1972 to 2013 in Dahlby and Ferede (2018).

*** indicates that a tax rate increase would reduce total tax revenues in the long-run.

--- indicates that the MCF could not be computed because the tax rates were stationary and the semi-elasticities could not be estimated.

Sources: Dahlby and Ferede (2018); calculations by authors.

Regarding the CITs, table 3 indicates that the six smallest provinces were on the downward sloping sections of their Laffer curves in 2020. In these provinces, a lower CIT rate would increase total tax revenues to the province in the long run. See Dahlby and Ferede (2018) for more details on the provincial CIT Laffer curves. The four largest

[9] The estimates of the MCFs of the federal and provincial governments do not consider the vertical tax externality that may occur when a tax rate increase by one level of government adversely affects the tax bases on the other level of government. Incorporating these interaction effects would result in substantially larger estimates of the MCFs for both levels of government. However, our econometric model does not permit us to accurately estimate the total MCF because as noted above, the coefficient of the average provincial tax rates was not statistically significant for either the PIT or the CIT.

provinces are on the positively sloped sections of their CIT Laffer curves and their MCFs bracket the federal MCF. It is important to note that the MCFs for the CIT in Ontario, Alberta, and British Columbia are relatively low, in spite of having relatively high own semi-elasticities for their CIT bases, because the Dahlby and Ferede (2018) study found that higher CIT rates in these provinces increased the provincial PIT base. These positive cross semi-elasticities substantially reduce the computed values of MCFs for the CIT for these provinces. Recall that the cross semi-elasticities were not statistically significant in the regressions for the federal CIT and PIT and therefore this tax base shifting effect is not incorporated in the computation of the MCF for the federal CIT.

3.4 Using the MCF in Policy Analysis

These measures of the cost of raising revenues at the federal and provincial levels can be used in cost-benefit analysis of public expenditure programs and in evaluating tax reforms. Examples of these applications include a cost-benefit analysis of fiscal stimulus by OECD countries in Dahlby (2009) and an evaluation of the net gains to Manitobans from reductions to the Manitoba land transfer tax in Dahlby and Mintz (2021). Here we will provide an example of how estimates of the MCFs for the federal and provincial governments can be used to determine the optimal matching grant rate for federal funding of provincial infrastructure.

General models of optimal matching grant are contained in Dahlby and Jackson (2015) and Dahlby (2020). Here we will focus on a specific case that illustrates one of the rationales for federal funding of provincial infrastructure through match grants and why the matching rate should vary from province to province, depending on their MCF as well as on the federal MCF. We focus on a simple case in which provincial government expenditures on infrastructure improve labour productivity, leading to higher wages and salaries for the residents of the province. These are the direct benefits from the project which we assume only accrue to the residents of the province, i.e., the incomes of the residents of other provinces are not affected by the infrastructure investment in a given province. However, there is an indirect benefit to the residents of other provinces in the form of higher federal tax revenues. These higher federal revenues will benefit Canadians in all provinces through higher spending on federal programs. However, the provinces will tend to under-investment in the infrastructure project from a national perspective because they will not consider the benefit of higher federal tax revenues when they conduct a cost-benefit analysis of their spending on infrastructure. There is, therefore, a case for the federal government to provide an incentive for the provinces to spend more on the infrastructure project than they otherwise would. A second issue is that the amount that provinces spend on the project will depend on their MCF, with those provinces that have a higher MCF spending less on the project than those with a lower MCF because a project has to generate a higher return in a province where the cost of raising revenues is higher.

The details of the application of the model are omitted here but can be related to the general model that is described in Dahlby (2020). We assume that the infrastructure projects are financed by provincial governments with a small personal income tax increase and the infrastructure grants are financed by a small federal personal income tax rate increase. We therefore use the MCFs for the federal and provincial personal income tax to calculate the matching rates for federal infrastructure grants which are shown in **table 4.** [10]

Table 4: Optimal Matching Rates for Federal Infrastructure Grant

Newfoundland and Labrador	0.60
Prince Edward Island	0.46
Nova Scotia	0.41
New Brunswick	0.37
Quebec	0.47
Ontario	0.63
Manitoba	0.35
Saskatchewan	0.30
Alberta	0.00
British Columbia	0.62

Note that the matching rates are generally higher for the provinces with higher MCFs. For example, Ontario has the highest matching rate because it has the highest MCF for the personal income tax and would otherwise spend less on the infrastructure project than the other provinces. Conversely, no matching rate would be provided to Alberta because its MCF from the personal income tax is less than the federal MCF. While this model is very simple, it highlights the importance of taking into account the variation in the provincial governments' cost of financing infrastructure through personal income tax increases in setting the matching rates for federal infrastructure grants.

[10] In the case of Nova Scotia, we assume that its MCF is the average of the MCFs of PEI and NB, 2.65.

4. Conclusions

The Canadian federal government relies on the PIT and CIT as principal revenue sources. However, many commentators and analysts express their concerns that any attempt to collect more revenue from these sources by raising the relevant tax rates impacts the country's overall tax competitiveness adversely and causes significant distortion in economic activities. Since tax increases adversely affect the private sector's decisions related to saving, labour supply, and investment, society loses more than what the government collects in tax revenue. In this regard, the cost of raising one dollar of tax revenue, measured by the MCF, plays a crucial role in evaluating a wide range of fiscal tax policies.

Therefore, the main objective of this study is to investigate the economic cost of raising revenue through the corporate and personal income taxes by the federal government. To this end, we compute the MCF of the two tax sources to shed light on this critical public policy issue. Since MCF depends on how tax bases respond to changes in the applicable tax rates, we first obtain empirical estimates of the magnitude of the sensitivity of the PIT and CIT bases to tax rate changes. These estimates suggest that a one percentage point increase in the CIT and PIT are associated with a 3.36 percent and 1.97 percent reduction in the two tax bases, respectively. The estimates are consistent with the findings of similar previous studies, which indicate that business income tax bases are generally more responsive to tax rate changes.

We then use tax base semi-elasticity estimates to compute the MCF and measure the marginal cost of raising revenue by the federal government. The empirical analysis of this paper shows, in broad terms, the federal corporate income tax has a higher MCF than the personal income tax during most of the sample period. However, this has changed in most recent years due to the reduction in the corporate income tax that occurred in 2012 and the PIT tax rate hike instituted in 2016. Thus, in 2021, the MCF of the personal income tax is higher than the MCF of the corporate income tax. These measures of the cost of raising revenues by the federal government can be used in cost-benefit analysis of public expenditure programs, evaluating tax reforms, and designing federal transfers to the provinces.

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Appendix 1: Estimation of Federal Tax Base Semi-Elasticities

Methodology

We obtain the key tax base semi-elasticities for the federal corporate and personal income taxes, by estimating tax base regressions using an empirical model commonly employed in similar previous studies such as Dahlby and Ferede (2012, 2018), Milligan and Smart (2019), and others. More specifically, we estimate the log of the real per-capita federal PIT and CIT bases, on their respective statutory tax rates and other relevant control variables. In the PIT base regression, the main variable of interest is the federal statutory top marginal personal income tax rate including all applicable surtaxes. Similarly, in the CIT base regression, we are mainly interested in the federal statutory general CIT rate. Due to our semi-log specification, the coefficient of the federal statutory top marginal PIT rate in the PIT base regression is the semi-elasticity estimate, and it shows the response of the personal income tax base associated with a one percentage point change in the PIT rate. Similarly, the coefficient of the federal CIT rate in the CIT base regression provides the long-run semi-elasticity estimate for the tax base.

Previous studies employed various estimation methodologies to investigate long-term relationships between economic variables using time series data such as ours. [11] One of these methods, which is widely used to estimate long-term relationships, is the Dynamic Ordinary Least Square (DOLS) estimation method suggested by Stock and Watson (1993). The DOLS empirical approach simply involves the inclusion of the lagged, contemporaneous, and leads of the first differences of the non-stationary explanatory variables in the model and estimating the equation by OLS. Stock and Watson (1993) show that such an estimation of a cointegrated relationship provides super-consistent coefficient estimates and valid statistical inferences are possible if one uses heteroskedasticity and autocorrelation robust standard errors. Thus, our empirical model is estimated using the DOLS estimation method. This empirical approach requires us to first check the time series properties of the various variables of interest and check if they have statistically valid long-run relationships. Therefore, in this study, we employ the DOLS to obtain the long-run tax base semi-elasticity estimates. This empirical methodology was also widely employed in previous similar studies such as Bruce et al. (2006), Schaller (2006), Wolswijk (2007), Havranek et al. (2016), and Dahlby and Ferede (2018).

[11] Time series analysis requires that one needs first to check the time series properties of the variables of interest and investigate whether there is a long-term relationship between variable using various cointegration tests. In this regard, our analysis, which is available from the authors upon request, show that all the variables of interest are non-stationary in levels, but they are stationary in first differences.

The empirical analysis of this study is based on aggregate annual time series data for the period 1972 to 2019. We obtain our data from various sources. Statutory provincial and federal CIT and the top marginal PIT rates come from the Finances of the Nation (2022). Further, the data on population and the Consumer Price Index (CPI) come from the Statistics Canada database CANSIM. The commodities price index is also obtained from the Bank of Canada. Data on personal taxable income, which is used as the PIT base, is obtained from various issues of *Income Statistics* (formerly *Tax Statistics on Individuals*) from the Canada Revenue Agency. The sum of the personal taxable income of the ten provinces is used as the national taxable income. Similarly, the CIT base is measured by the administrative data of the business income tax base obtained from Finance Canada. [12] This business income tax base data is the one that is used by the federal government in the equalizations payments allocations to the provinces. Again, the sum of the business income tax bases of the ten provinces is used as the national CIT base.

Tax Base Semi-Elasticity Estimates

We report our long-run PIT and CIT base semi-elasticity estimates in **Table A1**. As explained before, the estimates are obtained using the DOLS estimation method. [13] Columns 1 and 2 present the PIT base regressions, while Columns 3 and 4 show the CIT base regressions. Our main explanatory variables are the federal statutory marginal top PIT rate and the federal statutory CIT rate. To account for the possible effects of vertical tax externality, we include the population weighted-average statutory top marginal PIT rate of the ten provinces in the PIT base regression. Similarly, we include the population weighted-average statutory CIT rate of the ten provinces in the CIT base regression. [14] The justification for the inclusion of such explanatory variables in tax base regressions is widely discussed in previous studies such as Dahlby and Ferede (2012, 2018), Milligan and Smart (2019), and others. Thus, for the sake of brevity, we limit our discussion to the key variables of interest. Also note that, as required in the DOLS estimation method, in each regression we include one period lagged, present, and lead values of the first difference (or change) of the tax rates.

In column 1, we estimate the PIT base on the federal PIT rate, federal CIT rate and the weighted average provincial PIT rate. Further, in column 2, we include a dummy variable for the 1988 major federal PIT reform. Column 2 is our main regression model. The regression results show that the coefficient of the federal PIT rate is, as expected, negative and statistically significant at the one percent significance level. Thus, the estimation result indicates that the PIT base long-run own-semi elasticity estimate is about -1.97. This suggests that a one percentage point increase in the federal statutory top marginal

[12] Data obtained from the Department of Finance, Canada, workbooks used in the calculation of equalization entitlements, provided at the authors' request for data.

[13] Alternative estimation methods yield somewhat similar tax base semi-elasticity estimates. These estimates are available from the authors upon request.

[14] Using the combined federal and provincial rates as the key variable rather than entering the federal and provincial rates separately in the regressions provides somewhat similar results.

Table A1: Long-Run Tax Base Semi-Elasticity Estimates, 1972 to 2019

	PIT base regressions		CIT base regressions	
Variables	(1)	(2)	(3)	(4)
Federal PIT rate	-2.076***	-1.965***	4.317	1.569
	(0.546)	(0.501)	(2.710)	(1.790)
Federal CIT rate	-3.008	-2.678	-4.576***	-3.359***
	(2.397)	(2.384)	(0.740)	(0.478)
Provincial PIT rate	0.761	0.210		
	(1.604)	(1.173)		
Provincial CIT rate			6.955	1.440
			(4.440)	(7.062)
Commodity price index				0.001***
				(0.000)
Dummy88		0.236***		
		(0.031)		
Observations	45	45	43	43
Adjusted R-squared	0.934	0.940	0.584	0.693

Notes: Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Heteroskedasticity and autocorrelation robust standard errors in parenthesis. The dependent variables are the log of real per-capita tax bases. The explanatory variables are augmented with one period lagged, present, and lead values of the first difference of the non-stationary explanatory variables as suggested by the DOLS method.

PIT rate is associated with a 1.97 per cent reduction in the tax base. To put this semi-elasticity estimate in perspective, it is equivalent to an elasticity of taxable income with respect to the net-of-tax rate of 1.3, calculated at the period average federal top PIT rate of 34 percent. [15] This elasticity of taxable income estimate is well within the range of values that previous similar studies obtained. The implication of statistically significant PIT base responsiveness is that when the federal government raises the PIT rate on high-income individuals, the government is likely to collect less revenue than anticipated due to the negative behavioural responses associated with the tax hike.

We now turn to discuss the CIT base regression results of columns 3 and 4. In column 3, we estimate the CIT base on the federal statutory CIT rate, the federal statutory top marginal PIT rate, and the weighted-average provincial CIT rate. Moreover, in column 4, we include the commodity price index for major Canadian exports to account for

[15] Many of the previous individual data-based studies focus on estimating the elasticity of taxable income with respect to the net-of-tax rate (i.e., one minus the tax rate). See Gruber and Saez (2002) and Saez et al. (2012) for an excellent survey of the literature. One can easily obtain the implied elasticity of total taxable income with respect to net-of-tax rate by multi¬plying the long-run own semi-elasticity estimate by -(1-PIT rate) using the mean PIT rate of the sample period, which is 0.34.

the effects of global events following Dahlby and Ferede (2012). As column 4 includes all the relevant control variables, it is our main empirical model for CIT. The results indicate that the coefficient of the CIT rate is, as expected, negative and statistically significant. According to this model, the CIT base long-run own semi-elasticity estimate is about -3.36. This suggests that a one percentage point increase in the federal CIT rate is associated with a 3.36 percent reduction in the CIT base. The results show that the coefficient of the PIT rate is statistically insignificant in this regression. We use the long-run own semi-elasticity estimate of column 4 to compute the federal government's MCF for the corporate income tax.

Appendix 2: Computation of the MCF Based on Tax Base Semi-Elasticity Estimates

In this appendix, we present the analytical framework that is used to compute the Marginal Cost of Public Funds (MCF) for the federal government. This appendix heavily draws on Dahlby and Ferede (2018). The Canadian federal government collects tax revenues from various sources. As mentioned previously, this study focuses on only the personal and corporate income taxes, which account for, on average, three-fourth of total tax revenue. We exclude the federal Goods and Services Tax (GST) due to the lack of variation in this tax rate. Suppose we denote the federal tax base i in year t by B_t^i. Due to the possible relationship between the two income tax systems, we assume that the tax bases depend on the two tax rates: corporate and personal income tax rates. The tax base function can formally be specified as:

$$B_t^i = (\tau_t^p, \tau_t^c) \tag{1.1}$$

Where $i = c, p$ denotes the corporate income tax (c) and the personal income tax (p), bases, respectively.

The total amount of tax revenue that the federal government collects depends on the tax bases and their respective tax rates. That is, one obtains the total tax revenue (TR) from the two tax revenue sources in year t using the sum of the product of each tax base with its respective tax rate as:

$$TR_t = \tau_t^p . \mathrm{B}_t^p + \tau_t^c . \mathrm{B}_t^c \tag{1.2}$$

We are interested in assessing the revenue implications of changes in the federal tax rates. A tax rate change can influence the federal government's total tax revenue in two ways. First, the tax base related to the particular tax rate can directly be impacted by the tax rate change. Second, if the tax rate change affects other tax bases, this can indirectly affect the tax revenue. Consequently, suppressing the time subscript for brevity, the impact of a tax rate change on total tax revenue is obtained from equation (1.2) as:

$$\frac{dTR}{d\tau^i} = B^i + \tau^i . \frac{dB^i}{d\tau^i} + \tau^j . \frac{dB^j}{d\tau^i} = B^i + R^i . \mu_{ii} + R^j . \mu_{ji} \tag{1.3}$$

where i and j denote either the personal income tax (p) or the corporate income tax (c) as the case may be, $R^i = \tau^i B^i$ is the revenue raised from tax base i, $R^j = \tau^j B^j$ is the revenue raised from tax base j, $\mu_{ii} = dln(B^i)/d\tau^i$ is the semi-elasticity of tax base i with respect to tax rate i (i.e., *own semi-elasticity*), and $\mu_{ji} = dln(B^j)/d\tau^i$ is the semi-elasticity of tax base j with respect to tax rate i (i.e., *cross-base semi-elasticity*). As discussed before, we expect the own semi-elasticity (μ_{ii}) to be negative since tax rate increases encourage tax evasion and avoidance activities, which in turn cause shrinkage of the tax base. Similarly, if an increase in the tax rate associated with tax base i encourages taxpayers to shift their activities to tax base j to avoid the tax rate increase, we expect the sign of the cross-base elasticity (μ_{ji}) to be positive.

As indicated before, tax rate increases distort economic activities, and as a result, any attempt to raise more tax revenue causes direct and indirect costs to society. Dahlby (2008) provides a more detailed discussion of these important issues; see also Saez et al. (2009). The economic cost of raising tax revenue is measured by the MCF. In other words, the MCF measures the loss sustained by the private sector from a government's attempt to raise an additional dollar of revenue by raising the tax rate. Algebraically, the MCF associated with an increase in the tax rate, τ^i, can be computed as:

$$MCF_{\tau^i} = \frac{B^i}{dTR/d\tau^i} \tag{1.4}$$

Plugging equation (1.3) into equation (1.4), we obtain:

$$MCF_{\tau^i} = \frac{s^i}{s^i + \tau^i \,.\, s^i \,.\, \mu_{ii} + \tau^i \,.\, s^j \,.\, \mu_{ji}} \tag{1.5}$$

where s^i and s^j denote the tax revenue shares of tax base i and tax base j, respectively and all other variables as defined before. The tax revenue shares can simply be calculated by dividing the tax revenue from any given tax source by the relevant total tax revenue. Equation (1.5) indicates that tax base semi-elasticity estimates are crucial parameters to compute the social cost of raising additional revenue. Therefore, our main objective in this study is to obtain tax base semi-elasticity estimates. We then use these tax base semi-elasticity estimates and compute the MCF for the federal personal and corporate income taxes using equation (1.5).

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Bev Dahlby, Fraser Institute Senior Fellow, attended St. Peter's College, the University of Saskatchewan, Queen's University and the London School of Economics. He was Professor of Economics at the University of Alberta from 1978 to 2012 and Distinguished Fellow in Tax and Economic Growth at the School of Public Policy at the University of Calgary from 2012 to 2020. Bev has published extensively on tax policy and fiscal federalism. He has served as an Associate Editor of *Canadian Public Policy* and a member of the editorial board of the *Canadian Tax Journal*. He has been a member of the Executive Council of the Canadian Economics Association and the National Statistics Council. Bev has also served as a policy advisor to the federal and provincial governments. In 2010–11, he was a member of the Expert Panel on Federal Support to Research and Development (Jenkins Panel) and the Ecofiscal Commission from 2014 to 2019. In July 2016, he was appointed Chair of the British Columbia Commission on Tax Competitiveness by the BC Minister of Finance. In May 2019, Bev was appointed by the Government of Alberta to the Blue Ribbon Panel to review the province's finances. His international experience includes advisory work on tax reform for the IMF in Malawi, for the Thailand Development Research Institute, and for the World Bank in Brazil and Mexico.

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