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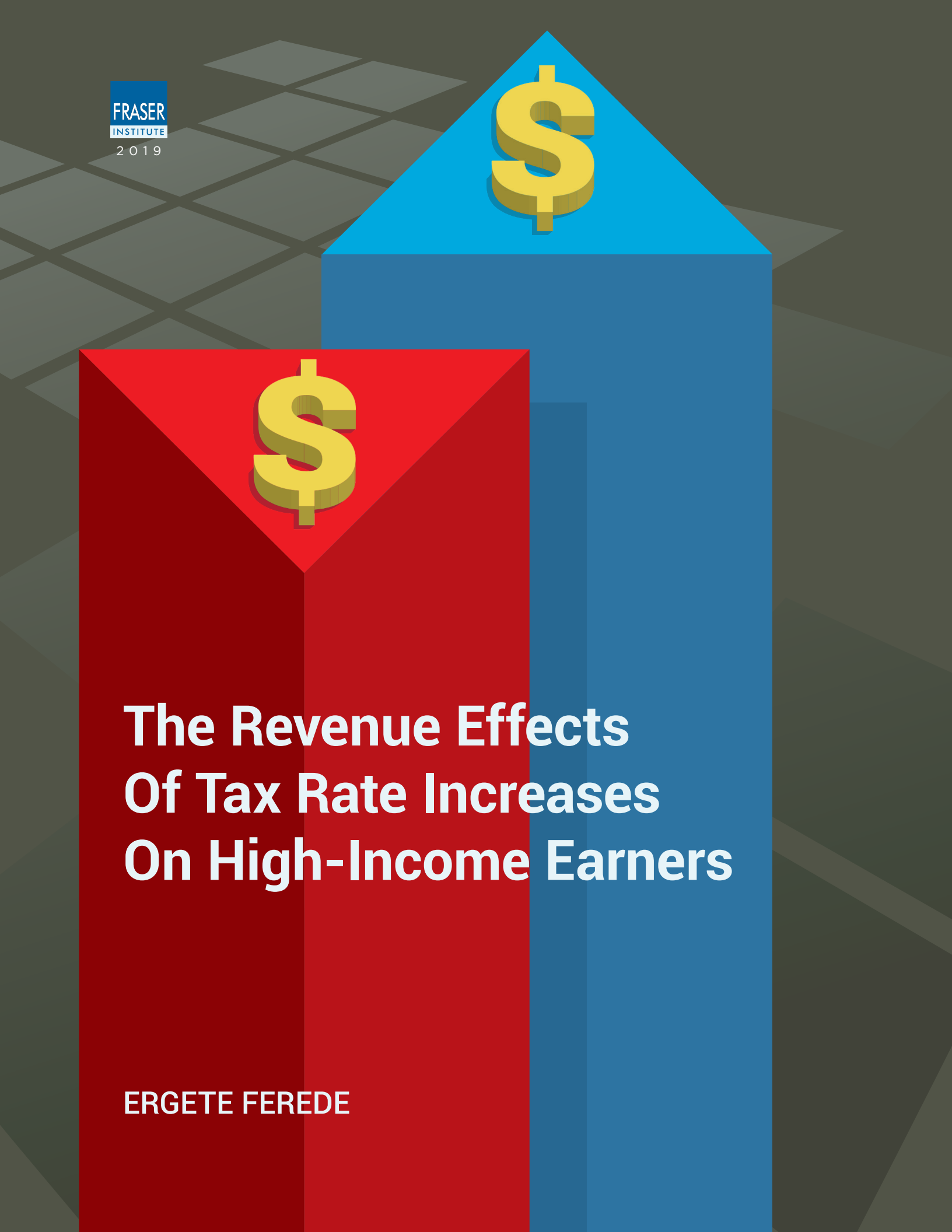

# The Revenue Effects Of Tax Rate Increases On High-Income Earners

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# Contents

# Executive Summary

Canada's tax competitiveness has returned as a focus of discussion in academic and political circles. The primary reason for this is a major tax overhaul in the United States that took effect in 2018, and which dramatically improved the US business investment environment and dropped personal income tax rates for almost all taxpayers.

The Canadian federal government and some of the provinces, on the other hand, have raised their income tax rates for many, especially high-income earners, in an attempt to generate more tax revenue. This is a concern for all Canadians, because income tax rate increases are known to have adverse impacts on economic activity. Further, the revenue effects of raising income tax rates greatly depend on taxpayers' responsiveness to them. This leads to two questions. First, how responsive are taxpayers to tax rate increases? Second, can the Canadian federal government obtain more revenue by simply raising the income tax rate on high-income earners?

When budgetary challenges occur, as when planned or unplanned expenditures exceed revenue and public debt rises, governments often resort to raising income tax rates on high-income earners in an attempt to collect more tax revenue. The amount of additional revenue that governments can collect through income tax rate increases depends on how large the changes in tax rates are and for whom or what income levels—and taxpayers' behavioural responses to those changes.

Many studies indicate that an increase in the income tax rate has negative effects on economic activity because the rate change diminishes the rewards from or reduces the incentives for working, saving, and investing. Taxpayers' behavioural responses to tax rate increases may lead them to work or invest less within the jurisdiction, or to engage in more tax planning, tax avoidance, or even evasion, which leads to reduced taxable income. In turn, this means that governments collect less in tax revenue than otherwise. If taxpayers exhibit sufficiently strong responsiveness to tax rate increases, it is possible that governments that raise tax rates may collect less revenue than had they not done so. Estimating the behavioural responses of taxpayers to tax rate changes is therefore crucial to assessing the revenue implications of income tax rate increases.

This study's main objective is to investigate the revenue effects of the four percentage-point increase in the top federal personal income tax bracket rate, from 29 to 33 percent, that took effect in 2016 but was announced in the fall of 2015. The pre-announced increase in the tax rate would have been expected to encourage individuals to bring their income forward (for example, capital gains and dividends) to the 2015 tax year to avoid the new, higher income tax rate that would take effect in 2016.

Such behavioral responses of taxpayers caused by the pre-announcement of the increase would have had a one-off impact, increasing taxable income and tax revenue for 2015 and reducing it for 2016. To determine the responsiveness of taxable income to changes in the Canadian federal government's top personal income tax rate, we conducted a simulation exercise. Because taxable income data from 2015 or 2016 would be misleading, we chose 2014 as the base year for conducting the revenue simulation. We assume that in the absence of the tax rate increase, the federal total tax revenue would grow at an average annual rate of 4.3 percent from 2014 onward. This corresponds to the average growth rate of the tax revenue over the four years before the announcement of the tax rate increase (i.e., 2011 to 2014).

The study begins by estimating, for the 1972 to 2016 period, the responsiveness of taxable income to changes in the Canadian federal government's top personal income tax rate. According to this paper's preferred result, a one percentage-point increase in the top federal personal income tax rate is associated with a reduction of total taxable income by about 0.50 percent. The empirical analysis, which considers factors that can potentially affect taxable income and the key estimate, is robust to various sensitivity checks, broadly consistent with the findings of previous studies, and suggests taxpayers have strong behavioural responses to tax rate increases.

The responsiveness of taxable income to changes in the federal government's top personal income tax rate can be used to simulate the revenue effects of the federal government's recent four percentage-point increase in the top marginal personal income tax rate. The results presented here suggest that once behavioural responses are taken into consideration, the tax rate would yield some additional revenue for the first nine years. In the long-term, paradoxically, the federal government stands to gain less revenue through the tax rate increase than it would without any tax rate change owing to the shrinkage of taxable income. This casts doubt on the appropriateness of the recent policy of increasing the personal income tax rate of high-income earners as a practical route to increasing tax revenue.

# Introduction

The recent tax cut by the US government and its potential adverse effects on Canada's competitiveness has been a focus of discussion in academic and political circles. The Canadian federal government and some of the provinces have taken the opposite tack recently and raised their income tax rates on high-income earners in an attempt to gain more tax revenue.[1] Many commentators argue that this is a great concern for all Canadians since income tax rate increases are known to have adverse impacts on economic activities. So the question arises: What are the revenue effects of raising the personal income tax rate on high-income earners? Can the Canadian federal government collect more revenue by raising its top income tax rate? Is raising the income tax rate on high-income earners the best way to raise more revenue in the long-term?

When budget challenges occur and public debt rises, governments often resort to raising the income tax rate on high-income earners in an attempt to collect more revenue. The amount of additional revenue that governments can collect through tax rate increases depends on the magnitude of changes in the tax rate and the response of the tax base to those rate changes. A number of previous theoretical and empirical studies show that an increase in the income tax rate has adverse effects on economic activity as it discourages the incentive to save, work, and invest. The behavioural responses of taxpayers to tax rate increases, in the form of tax planning, tax avoidance, and tax evasion, cause the tax base to shrink. When the tax base shrinks, governments often collect less revenue than they anticipate the increases will yield. In fact, if the reduction in the tax base due to the tax rate increase is very large, it is possible for increases in tax rates to lead governments to collect less revenue than they otherwise would. Hence, estimating the behavioural responses of taxpayers to tax

[1] The Canadian federal government raised the top personal income tax rate by four percentage points beginning in 2016. Ontario (in 2012) Alberta (in 2015), Quebec (in 2013), and Newfoundland & Labrador (in 2015) also increased their personal income tax rates on high-income earners. Alberta introduced the largest income tax rate increase on high-income earners in 2015 by raising the personal income tax rate from the previous 10 percent to 15 percent.

rate changes is crucial to assessing the government revenue and efficiency cost of tax rate changes.

A number of previous studies have recognized the importance of behavioural responses to tax rate changes and have focused on providing econometric estimates of the responsiveness of taxable income to changes in the net-of-tax rate (one minus the tax rate).[2] Most of these empirical studies have used individual-level data from the United States. Lindsey (1987) and Feldstein (1995), using US individual tax return data, provide some early estimates. They find that there are behavioural responses to changes in net-of-tax rate in excess of one, though many later studies consider these estimates as being too high. On the other hand, using various empirical approaches, other studies such as Goolsbee (1999, 2000), Gruber and Saez (2002), and Giertz (2007) find very low estimates. See Saez et al. (2012) for an excellent survey of this strand of the literature.

There are a limited number of previous Canadian studies that provide estimates of taxable income responsiveness using individual tax return data. Sillamaa and Veall (2001) exploited the tax reform of 1988 to estimate taxable income elasticity using individual-level data. Their taxable income elasticity with respect to the net-of-tax rate estimate for the whole sample is close to 0.25. However, for self-employed and high-income individuals they find taxable income elasticity estimate well over one, suggesting a very strong behavioural response from this group of taxpayers. Milligan and Smart (2015) also studied the behavioural response of the top one percent of income earners to provincial tax rate changes using individual-level data. They find evidence of large taxable income responsiveness for high-income earners and their results suggest that the behavioural responses of high-income earners is greater than those of low-income earners.

Another strand of the Canadian empirical literature employs aggregate provincial-level data to estimate the responsiveness of taxable income to provincial tax rate changes. Dahlby and Ferede (2012) provided estimates of personal income tax base responsiveness for Canadian provinces by estimating provincial taxable income on top statutory personal income tax rate and other relevant variables. Further, Dahlby and Ferede (2018) focused on obtaining province-specific estimates which are more relevant for evaluating the revenue effects of individual provincial government tax rate changes. As both studies measure the response of personal income tax base to the top marginal income tax rate, their results are relevant in

[2] In the literature, the responsiveness of personal taxable income to changes in the net-of-tax rate (one minus the tax rate) is often termed as *taxable income elasticity*. Taxable income elasticity measures the percentage change in personal taxable income from a one percent change in the net-of-tax rate.

analyzing the revenue effects of raising provincial income tax rates on high-income earners. Laurin (2012) and Lafleur, et al. (2015) used estimates from these studies to investigate the revenue effects of recent top provincial income tax rate increases in Ontario and Alberta. Recently, Milligan and Smart (2019) used Canadian provincial data and provided estimates of the responsiveness of the income of different income groups to changes in the top provincial personal income tax rate. They focus on income, rather than taxable income, and find evidence of significant behavioural responses to provincial top income tax rate changes. However, as estimates of taxable income responsiveness from previous Canadian empirical studies such as Dahlby and Ferede (2012, 2018) and Milligan and Smart (2019) focus on provincial tax rates, their econometric results are not suitable in assessing the revenue effects of income tax rate changes by the federal government.

The main objective of this study is to investigate the revenue effects of the recent Canadian federal government increase in the top marginal personal income tax rate. This paper contributes to the literature in two important ways. First, to the best of our knowledge, this paper is the first to provide an econometric estimate of the responsiveness of the personal taxable income to changes in the federal government top personal income tax rate—an important issue that was largely ignored in previous studies. As high-income earners account for a significant part of the government's income tax revenue, measuring their behavioural responses to tax rate changes is important for policymakers. Although there were previous attempts to measure the responsiveness of the personal income tax base, none of them is suitable for assessing the effects of the changes to the recent federal income tax system. Second, using the estimated responsiveness of the federal personal income tax base, this paper conducts a simulation analysis of the revenue effects of the recent federal government increase in the top marginal income tax rate.

This paper's econometric analysis finds a total taxable income responsiveness for the top income tax rate of about - 0.50.[3] This suggests that a one percentage point increase in the federal top personal income tax rate is associated with a reduction of taxable income by about 0.50 percent. Our result is lower than the short-run similar estimates that Dahlby and Ferede (2012) find for Canadian provincial top income tax rates. This is expected since personal income tax avoidance is relatively lower at the

[3] As the econometric model estimates the log of taxable income on the top marginal income tax rate (and other variables), such an empirical estimate is often termed in the literature as *taxable income semi-elasticity*. See Dahlby and Ferede (2012, 2018) for a similar analysis. Taxable income semi-elasticity measures the change in taxable income (in percent) associated with a one percentage point change in the income tax rate.

federal government level. Our result also corresponds to the familiar taxable income elasticity with respect to the net of-tax-rate of about 0.33. This is well within the range of values that Saez et al. (2012) consider as the most reasonable estimate. However, the main result is lower than the rough estimate that Laurin (2018) obtained using preliminary tax statistics for 2016, the first year the tax rate hike was in place.

We also use our empirical estimate of taxable income responsiveness to simulate the revenue effects of the recent federal government increase in the statutory top marginal personal income tax rate from 29 percent to 33 percent. Our analysis indicates that the four percentage-point increase in the top personal income tax rate would yield only a limited amount of additional government revenue for the first 9 years. After this, the government will collect less tax revenue with the tax rate increase in effect as compared to the baseline state of no tax rate change. This paradoxical result occurs because the negative effects of the behavioural response on tax revenue outweighs the positive direct effects of the tax rate increase on tax revenue. Thus, in the long-term, the government would collect less tax revenue from the tax rate hike, which casts doubt the appropriateness of the tax rate increase policy on high-income earners as a suitable tool to gain more tax revenue.

The remaining part of this paper is organized as follows. The next section presents and discusses the empirical results. Based on these results, the section following simulates the revenue effects of the recent federal government income tax rate increase and discusses the policy implications of the empirical findings. The final section concludes.

# Empirical Results and Discussions

## Empirical specification and data

The responsiveness of taxable income to tax rate changes is a crucial parameter for investigating the revenue effects of changes in the income tax rate. It is also important for measuring the efficiency cost of any tax policy. Recognizing this importance, various earlier studies employ individual as well as aggregate data to estimate taxable income elasticity. While previous empirical studies use provincial tax rate data to provide various estimates for this parameter, there is no readily available estimate of the responsiveness of taxable income with respect to the Canadian federal income tax rate. Consequently, in Appendix 2 we specify our empirical model that we use to estimate the federal personal income tax base semi-elasticity which is important to investigate the revenue effects of tax rate changes on high-income earners. The empirical results can also be useful for measuring the efficiency cost of the personal income tax.

Our empirical model is specified in Appendix 2 and the methodology closely follows those of Dahlby and Ferede (2012, 2018) and Milligan and Smart (2019). However, unlike those studies, this paper focuses on the federal personal income tax rate. The empirical model is estimated using aggregate Canadian time-series data from 1972 to 2016. The data for the variables of interest come from various sources. Federal marginal top personal income tax rates and applicable surtaxes come from Canada Revenue Agency and Milligan's (2016) Canadian Tax and Credit Simulator (CTaCS) database. Federal personal taxable income, which is used to measure the personal income tax base, is obtained from various issues of the Canada Revenue Agency's *Income Statistics* (formerly *Tax Statistics on Individuals*). Data on the Consumer Price Index (CPI), population, and unemployment come from Statistics Canada's database, CANSIM. The corporate and GST tax rates are obtained from various issues of *Finances of the Nation* (formerly *National Finances*) published by the Canadian Tax Foundation. We obtained the terms of trade data from the World Bank.

**Table 1: Summary Statistics, 1972–2016**

| Variable | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| Growth rate of PIT Base | 0.025 | 0.072 | -0.054 | 0.445 |
| Change in Top Statutory PIT rate | -0.003 | 0.019 | -0.090 | 0.040 |
| Change in Unemployment rate | 0.018 | 0.933 | -1.000 | 3.400 |
| Terms of trade | 0.945 | 0.067 | 0.858 | 1.086 |
| Change in Provincial PIT rate | 0.000 | 0.009 | -0.027 | 0.035 |
| Change in Federal CIT rate | -0.005 | 0.013 | -0.041 | 0.025 |
| Change in Federal GST rate | 0.001 | 0.011 | -0.010 | 0.070 |

Source: ??

Table 1 presents summary statistics for our key variables of interest. As specified in equation 1.5 in Appendix 1, the dependent variable is the change of the log of total taxable income. Thus, the dependent variable simply represents the growth rate of the personal income tax (PIT) base. Table 1 shows that there is a lot of variation in the growth rate of the PIT base during the period under consideration. On average, the real per capita total taxable income grew by about 2.5 percent during the sample period. Note that the largest increase in the taxable income occurred in 1988 following the significant tax reform that occurred in that year. As a result of the reform, the personal income tax base increased by 44.5 percent in that year.

Our key variable of interest, the federal top PIT rate, also shows some variations. The most recent four percentage-point increase in the federal top PIT rate that was introduced in 2016 is the largest income tax rate increase during the period under investigation. The largest reduction in the federal PIT rate occurred in 1982 when the top income tax rate was cut from 43 to 34 percent.

## Empirical results

We report the main regression results in table 2. As indicated earlier, the dependant variable is the growth rate of real per capita total taxable income. The reported standard errors are robust to heteroscedasticity and autocorrelation. As the first observation is lost through first differencing, we have 44 observations for estimation. Our focus is on the coefficient of the federal PIT rate which is the taxable income semi-elasticity. It shows

## Table 2: The Response of Taxable Income to Federal PIT, 1972–2016

| | (1) OLS | (2) OLS | (3) IV | (4) IV | (5) IV |
|---|---|---|---|---|---|
| Federal PIT | -0.529** | -0.504** | -0.434*** | -0.475*** | -0.502*** |
| | (0.239) | (0.245) | (0.074) | (0.071) | (0.085) |
| Unemployment rate | -0.023*** | -0.023*** | -0.021*** | -0.021*** | -0.021*** |
| | (0.003) | (0.003) | (0.002) | (0.002) | (0.002) |
| Provincial PIT | | -0.397** | -0.402*** | -0.517*** | -0.532*** |
| | | (0.154) | (0.104) | (0.086) | (0.084) |
| Terms of trade | | | | 0.114* | 0.123** |
| | | | | (0.056) | (0.058) |
| Federal CIT | | | | | 0.241** |
| | | | | | (0.109) |
| Dummy 1988 | 0.380*** | 0.372*** | 0.379*** | 0.379*** | 0.386*** |
| | (0.012) | (0.011) | (0.004) | (0.003) | (0.005) |
| Constant | 0.015*** | 0.015*** | 0.014*** | -0.094* | -0.102* |
| | (0.005) | (0.006) | (0.004) | (0.049) | (0.051) |
| Implied elasticity with respect to net-of-tax ratea | 0.350** | 0.334** | 0.287*** | 0.315*** | 0.332*** |
| Over-id test (p-value) | | | 0.710 | 0.767 | 0.739 |
| Observations | 44 | 44 | 43 | 43 | 43 |
| Adjusted R2 | 0.867 | 0.866 | 0.889 | 0.898 | 0.897 |

Notes: In columns (3) to (5), the federal top personal income tax rate is instrumented with one period lagged values of change in accumulated deficit to GDP ratio and Party dummy as well as change in the U.S. top PIT rate. Heteroscedasticity and autocorrelation robust standard errors in parentheses. Significance levels are shown by * for 10%, ** for 5% and *** for 1%.

a The implied elasticity of total taxable income with respect to net-of-tax rate is simply obtained by multiplying the semi-elasticity estimate by (1-PIT rate) using the mean PIT rate of the sample period, which is 0.3378.

the responsiveness of the tax base to the tax rate change. However, to make our results comparable with those of previous studies that use the net-of-tax rate rather than the tax rate as an explanatory variable, we also compute the implied taxable income elasticity estimate at the bottom of table 2.

We begin our analysis in column 1 by estimating the taxable income on the tax rate and the state of the economy as proxied by the unemployment rate with the Ordinary Least Square (OLS) estimation method. As expected, the top income tax rate is negative and statistically significant at the five percent level. The coefficient of the income tax rate shows that a one percentage-point increase in the top income tax is associated with 0.529 percent reduction in total taxable income. The coefficient of the unemployment is also, as expected, negative and statistically significant, suggesting that economic downturns reduce the personal income tax base.

Column 2 includes the weighted average (weighted by population) top personal income tax rate of the 10 provinces to capture the vertical fiscal externality in the PIT system. Since the federal and provincial governments co-occupy the same tax base, an increase in the provincial PIT rate is expected to reduce taxable income. The results show that, as expected, the provincial PIT rate has negative and statistically significant effects on taxable income. But more importantly, the coefficient of the federal PIT tax rate is still negative and significant at the five percent level.

Our OLS estimates of columns 1 and 2 are likely to be affected by the problem of endogeneity and simultaneity bias. When tax bases shrink and tax revenue falls, governments may resort to increasing the tax rate in attempt to raise more revenue. This makes the tax rate endogenous and as a result OLS estimates can be inconsistent.

Column 3, uses the instrumental variable (IV) estimation method to address the possible endogeneity of the income tax rate. We use a one period lagged value of change in the accumulated deficit-to-GDP ratio, a one period lagged Party dummy, and the change in the US top PIT rate as instruments. The party dummy is equal to one in the years in which the federal Liberal party was in power and zero otherwise. The choice of these instruments is justified on the ground that when the federal government's budget deficit increases and fiscal challenges ensue, the government may be forced to raise the tax rate on high-income earners in an attempt to raise more revenue (Ferede et al., 2015). The budget deficit can therefore serve as a valid instrument for the top income tax rate. Political economy studies also show that left-leaning governments tend to raise tax rates more often than right-leaning governments. Thus, the party dummy variable (Party), which is equal to one when the Liberal government is in power and zero otherwise, can be a good instrument. We know that the

US is Canada's largest trading partner, and we expect that the federal top income tax rate will be affected by the US personal income tax rate (see, for example, Lammam, et al., 2016). Consequently, the US top personal income tax rate can serve as a valid instrument for the Canadian top income tax rate. The first-stage regression results shown in the appendix indicate that the chosen instruments are appropriate. The various relevant statistical tests also show the validity of the instruments.

Comparing results reported in column 3 with those of column 2, the coefficient of the tax rate is still negative and statistically significant. More importantly, the coefficient estimate is lower in absolute value, suggesting that not addressing the potential endogeneity problem associated with the tax rate overestimates the tax base semi-elasticity estimates. The other control variables remain to be statistically significant with their respective anticipated signs.

Column 4 includes terms of trade as an additional explanatory variable to capture the possible effects of global shocks on taxable income. As expected, the terms of trade variable is positive and significant, suggesting that improvements in Canada's terms of trade boost domestic economic activities and raise taxable income. The coefficient of the federal PIT rate is still negative and statistically significant, suggesting the robustness of the results to the control of global factors as proxied by the terms of trade.

Finally, column 5 includes the federal corporate income tax rate as an additional explanatory variable to account for possible income shifting between the corporate and personal income tax systems. As column 5 includes all the relevant control variables and satisfies the battery of statistical tests, this is our preferred estimate. Thus, the analysis here focuses on the empirical results reported in column 5. The coefficient of the federal top PIT rate continues to be negative and statistically significant at the one percent level. The taxable income semi-elasticity estimate is -0.502. This suggests that a one percentage-point increase in the top federal marginal income tax rate is associated with a reduction in the total taxable income by about 0.502 percent. This, in turn, will have an adverse impact on the amount of tax revenue that the government can collect. To make a comparison with earlier studies possible, we compute and present the taxable income elasticity (i.e., the elasticity of taxable income with respect to the net-of-tax rate) at the bottom of table 2. Thus, evaluated at the sample average PIT rate, our preferred taxable income semi-elasticity of -0.502 is equivalent to taxable income elasticity of 0.332 and is statistically significant at the one percent level.

How does our preferred result compare with those of previous studies? The taxable income semi-elasticity estimate is lower than what Dahlby and Ferede (2012) obtained for the Canadian provincial top PIT

rate, which is -0.62. This is expected as taxable income is generally more responsive to provincial tax rates than the federal tax rate. This is because individuals can avoid provincial tax rate increases by moving themselves or their income from a high-tax province to a low-tax province, but the federal PIT is not so easily avoided. Personal income tax avoidance is therefore lower at the federal level, and taxable income is generally less sensitive to federal tax rate changes than to equivalent provincial tax rate changes.

As indicated before, most previous similar studies focused on estimating taxable income elasticity. Consequently, it may be more interesting to compare our preferred implied taxable income elasticity of 0.332 with those of the estimates in earlier studies. There is a significant variation in the magnitude of taxable income elasticity estimates and even some studies such as Feldstein (1995) find estimates in excess of one for the US. However, a survey of the previous literature (most of which are based on US data) by Saez et al. (2012) shows that the most reasonable estimate of the taxable income elasticity (with respect to the net-of-tax rate) is in the range of 0.12 to 0.4. Thus, our preferred taxable income elasticity estimate is well within this range.

It should be noted that our results are not directly comparable to those of individual-level based Canadian studies such as Sillamaa and Veall (2001) and Milligan and Smart (2015) as these studies focus on provincial tax rate variations rather than variations in the federal PIT rate. Nonetheless, our taxable income elasticity estimate is slightly higher than Sillamaa and Veall's (2001) preferred estimate, but lower than those of Milligan and Smart (2015, 2019).

## Sensitivity analysis

We subjected our main preferred empirical result to various robustness checks. More specifically, we used alternative estimation methods, controlled for the capital gains inclusion rate, included the threshold income level for the top income tax bracket, controlled for Goods and Services Tax (GST), and used the net-of-tax rate as an explanatory variable directly. Table 3 reports the results. We report only the key variable of interest; the coefficient estimates of the other control variables are not reported for the sake of brevity.

As in similar previous studies, our main empirical analysis employs the two-stage least square (2SLS) instrumental variable estimation method to address the potential endogeneity of the tax rate. As a robustness check, in column 1 and column 2, we use Limited Information Maximum Likelihood (LIML) and General Methods of Moments (GMM) estimation

## Table 3: The Response of Taxable Income to the Federal Personal Income Tax, 1972 to 2016

| | (1) LIML | (2) GMM | (3) Capital gain inclusion rate | (4) Top income tax bracket threshold | (5) Including GST | (6) Using net-of-tax rate |
|---|---|---|---|---|---|---|
| Federal PIT | -0.436*** | -0.594*** | -0.479*** | -0.582*** | -0.484*** | |
| | (0.087) | (0.119) | (0.095) | (0.084) | (0.121) | |
| Inclusion rate | | | -0.030* | | | |
| | | | (0.018) | | | |
| Threshold income | | | | 0.01 | | |
| | | | | (0.028) | | |
| GST | | | | | (0.05) | |
| | | | | | (0.139) | |
| Net-of-tax rate | | | | | | 0.304*** |
| | | | | | | (0.052) |
| Constant | -0.100* | -0.087** | -0.103* | -0.104** | -0.100** | -0.101* |
| | (0.051) | (0.041) | (0.051) | (0.051) | (0.048) | (0.051) |
| Observations | 43 | 43 | 43 | 43 | 43 | 43 |
| Adjusted R2 | 0.897 | 0.872 | 0.894 | 0.894 | 0.894 | 0.896 |

Note: Heteroscedasticity and autocorrelation robust standard errors in parentheses. Significance levels are shown by * for 10%, ** for 5% and *** for 1%.

methods. These IV estimation methods are relatively better than the 2SLS method employed in our empirical analysis for those worried about the possibility of the presence of weak instruments. The LIML estimates are very close to the 2SLS estimates, which confirms the absence of a weak instrument problem in our analysis.

In Canada, capital gains are included as income for personal income tax purposes. However, the capital gains inclusion rate has varied over the sample period. Other things remaining the same, a higher capital gains inclusion rate increases taxable income. Column 3 provides a check on the robustness of our key finding by using the capital gains inclusion rate as an

additional explanatory variable. The coefficient of the capital gains inclusion rate is negative although it is significant only at the 10 percent level. More importantly, our key finding is not sensitive to this robustness check as the coefficient of the federal PIT rate is still negative and statistically significant.

As indicated before, the focus of this study is on the federal government revenue implications of raising the tax rate on those high-income earners whose taxable income falls in the top income tax bracket. In column 4, therefore, we have also checked the robustness of our results to the inclusion of the income threshold for the top income tax rate bracket. We deflated the threshold income level with CPI to account for the effects of inflation. While the coefficient of the threshold income level is not statistically significant, our key finding is still robust to this sensitivity check.

Many of the previous individual-based studies focused on estimating the responsiveness of total taxable income with respect to the net-of-tax rate rather than the tax rate. In such studies the coefficient of the net-of-tax rate is commonly called "taxable income elasticity." Although there is a simple relationship between taxable income elasticity and our taxable income semi-elasticity estimates, to make our results directly comparable to those of previous studies, we used the log of net-of-tax rate (one minus the tax rate) instead of the tax rate as an explanatory variable in column 5. The net-of-tax rate shows the share of income that individuals keep after paying taxes. Thus, the lower the tax rate, the higher the net-of-tax rate would be, and this is expected to increase the taxable income due to an increase in economic activities and a reduction in tax avoidance associated with the lower tax rate. Consequently, the coefficient of the net-of-tax rate (which is the taxable income elasticity estimate) is expected to be positive. Column 5 shows that the taxable income elasticity is, as expected, positive and statistically significant. The magnitude of the taxable income elasticity estimate is close to the implied result reported in table 2.

In sum, our main empirical result—that raising the top marginal income tax rate reduces taxable income—is robust to the various sensitivity checks. If tax rate increases have adverse effects on the tax base, as our results suggest, then the shrinkage of the tax base reduces tax revenue. Thus, policymakers need to take this fact into account when they contemplate raising more tax revenue by simply hiking tax rates. In the next section, we use our preferred econometric result to shed some light on the revenue effects of the recent federal income tax rate increase by simulating the additional revenue that the tax rate increase would yield to the federal government.

# Simulating the Revenue Effects of the Recent Federal Tax Rate Increase

Simulation exercises often require a certain baseline or benchmark values for comparison purposes. In this exercise, we begin by indicating the key assumptions used in the revenue simulation. The four percentage-point increase in the federal top personal income tax rate was announced in 2015 and it took effect beginning in 2016. We would expect that the pre-announced increase in the tax rate would encourage individuals to bring income (such as capital gains and dividends) forward to the 2015 year to avoid the new, higher income tax rate that was to take effect in 2016. Such behavioral responses by taxpayers that are caused by a tax rate increase pre-announcement are anticipated to have a one-off impact by increasing the taxable income and tax revenue for one year (in this case, 2015) and reducing it for another year (in this case, 2016).[4] Thus, conducting the simulation exercise based on taxable income data from 2015 or 2016 would be misleading. Hence, we chose 2014 as the base year from which to conduct the revenue simulation. We also assumed that in the absence of the tax rate increase, total federal tax revenue would have grown at an average annual rate of 4.3 percent.[5] This corresponds to the actual average tax revenue growth rate over the four-year period before the announcement of the tax rate increase (i.e., 2011 to 2014).

An increase in the federal income tax rate also reduces provincial taxable income and provincial personal income tax revenue. In our simulation analysis, we focused only on the federal government's PIT revenue

[4] The federal government's tax revenue from high-income earners fell by about $4 billion in 2016 due to the tax rate increase. Such income shifting to a low-tax period, while temporary, is a common problem associated with tax reforms when a government pre-announces tax rate changes. A similar problem occurred in the UK following the addition of a 50 percent top personal income tax bracket in 2010. See HM Revenue and Customs (2012).

[5] The main finding is robust to the use of an alternative assumption about the growth rate of revenue.

## Table 4: Simulated Revenue Effects of a Tax Rate Hike on High-Income Earners (in $ billions)

| | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Pre-behavioural revenue yield (static estimate) | 9 | 9.3 | 9.7 | 10 | 10.3 |
| Behavioural responses | -7.9 | -8.3 | -8.7 | -9.2 | -9.7 |
| Post-behavioural revenue yield (dynamic estimate) | 1.1 | 1 | 1 | 0.8 | 0.7 |

Source: Author's calculations. The tax base semi-elasticity estimate reported in column 5 of table 2 and the four percentage-point federal PIT rate increase are used to compute the behavioural responses of the tax rate increase. See the text for a discussion of the method of computing the revenue effects.

and ignored the potential adverse effects on provincial government tax revenue. Further, if a provincial government changes the personal income tax rate, the change can also reduce federal personal income tax revenue as the federal and provincial governments co-occupy the same tax base. Our econometric analysis controlled for such effects, but our simulation analysis focused only on the federal income tax rate changes.

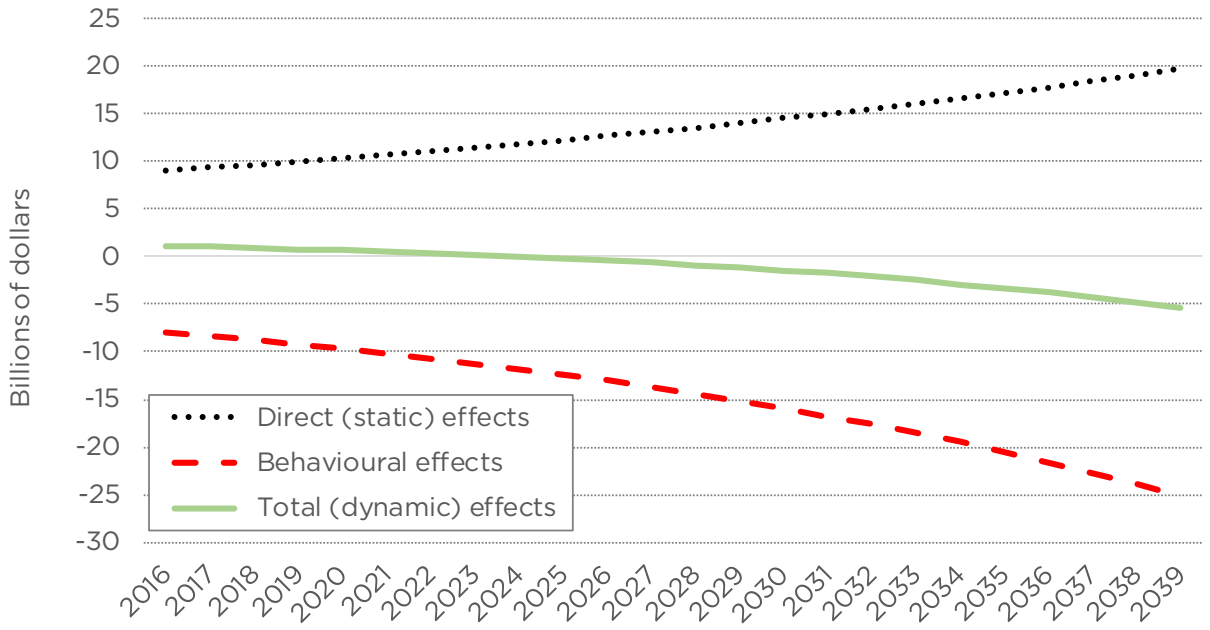
Table 4 shows the simulated federal revenue effects of the four percentage-point increase in the top personal income tax rate. The table shows the results for the first five years in which the new higher income tax rate is in effect. To highlight the importance on revenue of behavioural responses to tax rate changes, we show both the static and dynamic revenue estimation results.

The first row of table 4 shows the additional revenue that the federal government would collect by raising the top personal income tax rate by four percentage points were there no behavioural responses from taxpayers. This is the mechanical or direct effect of the tax rate increase on the federal government's revenue and it is obtained by simply multiplying the change in the top tax rate by the taxable income corresponding to the top income tax bracket. This static revenue estimation assumes that the tax base remains unaffected in the face of the increase in the tax rate. According to this estimate, the four percentage-point increase in the top personal income tax rate would have brought in about $9 billion additional tax revenue for the federal government in 2016. The table shows the additional revenue increasing in subsequent years because the tax base would be expected to grow over that time.

The second row of table 4 shows the effect of taxpayers' behavioural responses to the tax rate increase. The negative values indicate that the way taxpayers change their behaviour in response to the tax increases reduce tax revenue. The tax rate increase reduces the tax base and as a result the tax revenue falls. For 2016, the behavioural responses prompted by the tax rate increase results in a decrease in the government's tax revenue by about $7.9 billion. This significant impact suggests that any realistic revenue projection following tax rate changes need to incorporate behavioural responses. Row 3 of table 4, provides a dynamic revenue estimate associated with the federal tax rate increase using the method discussed in the previous section. The dynamic effects of the tax rate increase on revenue shows the sum of both the direct effects and the behavioural responses; as a result, it tells us the net proceeds the federal government will see from the four percentage-point increase in the top personal income tax rate. Our simulation analysis suggests that the government would have collected an additional $1.1 billion in 2016 from the tax rate increase. This is much less than what the static revenue projection suggests but higher than the actual revenue effect observed in 2016. The federal government's fiscal report for 2016 indicates that it collected $4.6 billion dollars less from high-income earners in 2016 than in 2015. The discrepancy between the actual revenue change and the simulated revenue results from table 4 are likely the result of forestalling following the 2015 pre-announcement of the tax rate hike, as discussed earlier.

Figure 1 shows the results reported in table 4 for an extended period to shed light on the long-term revenue effects of the tax rate increase. A rise in the income tax rate has a direct positive effect on tax revenue, which is given by the product of the amount of tax rate increase and the applicable taxable income. The dotted line in figure 1 shows the additional revenue that the government would expect to gain through the four percentage-point tax rate increase. The static revenue estimation seems to suggest that the tax rate increase would enable the government to collect more revenue. However, as explained earlier, tax rate increases discourage economic activity; the behavioural responses of taxpayers following a tax rate increase reduce the tax base and the revenue. This behavioural-effect-induced reduction in the tax revenue associated with the tax rate increase is shown with the dashed line in figure 1. Note the additional revenue associated with the behavioural response is negative because the tax rate increase results in the shrinkage of the tax base and this in turn reduces tax revenue. Of course, as indicated in equation 1.4 in Appendix 1, this behavioural response depends on the sensitivity of the taxable income to the tax rate change. And we use our empirical estimate of the tax base semi-elasticity estimate to obtain the behavioural effects.

## Figure 1: Simulated Change in the Federal PIT Revenue from a Four Percentage-Point Increase in the Top PIT Rate




Source: Author's computation. See the text for the method of computation.

The recognition that tax rate changes induce taxpayers to make behavioural changes implies that governments need to use dynamic revenue estimation to reasonably forecast the revenue effects of tax rate changes. Thus, a realistic assessment of the potential additional tax revenue that the federal government can collect from the recent tax rate increase should consider both the direct revenue effects and the behavioural revenue effects. The dynamic additional revenue effect from the recent increase in the tax rate on high-income earners is shown with the solid line in figure 1. The figure suggests in the first nine years the tax rate increase will yield very limited additional revenue for the federal government. But this additional revenue is likely to be much lower than what the government anticipated it would collect from the tax rate increase. In fact, after the ninth year, the government will likely collect less tax revenue with the tax rate increase than it would have had it made no tax rate change. This is because the negative effects of the behavioural response on tax revenue outweigh the positive direct effects of the tax rate increase on tax revenue. Thus, in the long-term, the government will actually collect less tax revenue from the recent increase than it would have had it not implemented the change,

which casts doubt on the appropriateness of the policy of raising the tax rate on high-income earners as a suitable tool for gaining additional revenue.

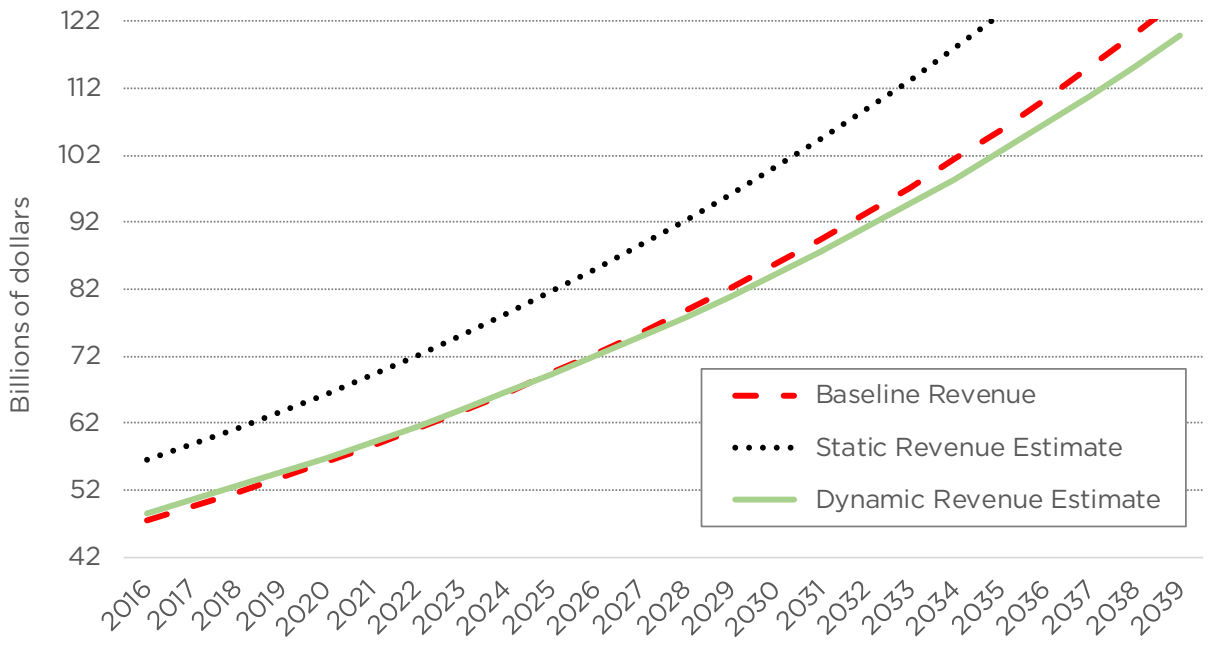
In order to shed more light on the federal government revenue trajectory associated with the tax rate change, we project the government's tax revenue from high-income earners from 2016 to 2035. Note that this revenue projection considers only the four percentage-point increase in the federal top PIT rate and assumes that there will be no additional personal income tax rate changes.

As indicated earlier, we assume that had there been no tax rate increase, the federal tax revenue from high-income earners would have grown at the average annual rate of 4.3 percent. This corresponds to the actual annual average growth rate of the federal total tax revenue over the four-year period before the announcement of the tax rate increase (i.e., from 2011 to 2014). The dashed line in figure 2 shows the baseline tax revenue that would have occurred without the tax rate increase. As mentioned earlier, the baseline projection begins from 2014 rather than 2015 because the pre-announcement of the tax rate increase in 2015 led to a very significant spike in both the total tax revenue and total taxable income that year. This is generally considered to be a one-off increase caused by tax planning and tax avoidance activities that occurred before the announced tax rate increase became effective. This occurs when individuals adjust the time of declaring their income from 2016, the year in which the new higher tax rate takes effect, to 2015.

In the absence of behavioural responses, the four percentage-point increase in the federal top PIT rate raises the government's total tax revenue from the baseline by the amount of the tax rate increase times the amount of taxable income in the top income tax bracket. This is a static estimate of the revenue effect of the tax rate increase and it is shown with the dashed line in figure 2.

Our empirical analysis in the previous section shows that there would be behavioural responses to changes in the tax rate. Governments usually collect less revenue than anticipated with tax rate increases due to the behavioural responses. Thus, static revenue projections that ignore behavioural responses overestimate the additional revenue yield that a government would obtain through tax rate increases. A realistic assessment of the revenue effects of tax rate increases need to incorporate the behavioural responses and the associated shrinkage of the tax base. In figure 2, the solid line shows the dynamic revenue estimate that incorporates the behavioural response of high-income earners to the tax rate increase. The figure indicates that the dynamic projected revenue is lower than what the static projection suggests. In fact, the projected dynamic tax revenue estimate from the high-income earners would be lower than the baseline

## Figure 2: Projected Total Federal PIT Revenue from High-income Earners




Source: Author's computation based on the tax base semi-elasticity estimate from table 2. See the text for the method of computation..

estimates after 9 years. This is because the reduction in tax revenue due to the behavioural response of taxpayers dominate after this year. Thus, according to our projection, the government actually collects less revenue with the tax rate increase in about 10 years due to strong behavioural responses that shrink the tax base.

What are the policy implications of these findings? The results suggest that high-income earners have strong behavioural responses to tax rate changes. The recent increase by the federal government in the top marginal income tax rate has had an adverse effect on its ability to raise revenue. Furthermore, since both the federal and provincial governments co-occupy the same personal income tax base, the decrease in taxable income due to the hike in the federal top personal income tax rate also reduces the revenue generation capacities of provincial governments. This, of course, diminishes the ability of the provincial governments to provide vital public services to Canadians.

While the federal government's recent allocation of more resources to the Canada Revenue Agency to attempt to minimize tax evasion might

mitigate some of this problem, it is unlikely to have a significant effect on the tax shifting and tax avoidance activities that reduce federal tax revenue in the manner discussed here. The federal government's decision to raise the personal income tax rate has had an adverse effect on Canada's tax competitiveness. The recent rise in the top federal marginal personal income tax rate as well as rate increases by some of the provincial governments contribute to the country's falling tax competitiveness. This is true in a comparison of Canada with the United States and with other OECD countries as well (see Lammam et al., 2016).

The upshot of the above analysis is that Canadian federal and provincial governments should seriously consider the long-term economic and revenue implications of income tax rate increases on high-income earners. Although this policy choice may seem like a popular way to gain more tax revenue, in the long term, strong behavioural responses associated with the increase in tax rates contribute to reduced economic activities overall and less taxable income. Consequently, governments are unlikely to gain any additional revenue with their tax increases. Perhaps public policies that encourage economic activity and raise the income of residents have more potential to expand taxable income and increase governments' tax revenue from this source.

The federal government's decision to raise the top personal income tax rate may have had an adverse effect on Canada's tax competitiveness. The increase, alongside those of some provinces, have contributed to reduced competitiveness relative to the US as well as other OECD countries (Lammam et al., 2016).

# Conclusions

Tax rate hikes on high-income earners seem to be a common and popular policy choice that governments turn to when they face budgetary challenges. But tax rate increases affect economic activity adversely since they reduce the incentive to work, save, and invest. Thus, the revenue effect of raising income tax rates depends to a large extent on the responsiveness of taxable income to the tax rate increase. Consequently, an estimate of taxable income responsiveness is considered to be a crucial parameter in any assessment of the revenue effects and economic costs associated with tax rate changes. This is because the parameter provides important information about the behavioural responses of taxpayers. While previous Canadian empirical studies provide taxable income responsiveness estimates for the Canadian provincial income tax system, to the best of our knowledge, there is no estimate available for the federal income tax system. This poses a significant challenge for those investigating and measuring the possible additional revenue that the federal government might expect to gain by raising its tax rate on high-income earners.

This paper provides an econometric estimate of the taxable income responsiveness of the Canadian federal personal income tax system. We find a total taxable income semi-elasticity with respect to the federal top income tax rate of about -0.50. This indicates that a one percentage-point increase in the top personal income tax rate is associated with a reduction of taxable income by about 0.50 percent. The result also corresponds to the taxable income elasticity with respect to the net-of-tax rate of about 0.33—an estimate which is well within the range of reasonable values obtained in other studies. As expected, since personal income tax avoidance is relatively lower at the federal government level, our empirical estimate is less than similar values obtained for Canadian provincial top income tax rates. Our main finding is robust to various sensitivity checks.

The finding of evidence of strong behavioural responses by taxpayers suggests that tax rate increases may yield less revenue than what the government expects. To this end, we use our taxable income responsiveness estimate to simulate the revenue effects of the recent federal government increase in the top marginal personal income tax rate. Static revenue

estimation that ignores the behavioural responses of taxpayers tends to show a significant additional revenue gain for the federal government. In fact, governments that anticipate gaining additional revenue with a tax rate increase often ignore the behavioural responses of taxpayers. However, taxpayers' behavioural responses to tax rate hikes reduce the taxable income and tax revenue. Our dynamic revenue estimation that explicitly incorporates behavioural responses shows that the recent four percentage-point increase in the federal top income tax rate would yield very limited additional revenue—and for the first nine years only. In the long-term, paradoxically enough, due to the shrinkage of the taxable income, the federal government will gain less revenue from the tax rate increase than it would had it not changed the tax rate at all. This casts doubt on the appropriateness of the recent policy to increase tax rates on high-income earners as a suitable tool to gain more tax revenue.

# Appendix 1: Analytical Framework and Methodology

This appendix outlines the analytical framework that is used to simulate the revenue effects of the federal government's recent top PIT rate changes. As indicated earlier, our main objective is to investigate the revenue effects of increases in the top marginal personal income tax rate (PIT). To this end, in this section, we provide the analytical framework we used to assess the revenue effects of the recent income tax rate hike by the federal government on high-income earners. The federal income tax system has various tax brackets and the top PIT rate is applicable only to those individuals whose taxable income falls in the top income tax bracket. For the sake of empirical tractability, we consolidated all income brackets into two: the top income tax bracket and all other tax brackets. This enabled us to divide the total taxable income into the top taxable income $B_t^a$ and taxable income from all other lower tax brackets $B_t^b$. Thus,

$$B_t = B_t^a\ (\tau_t^a; Z) + B_t^b\ (\tau_t^b; Z) \qquad (1.1)$$

where $B^a$ denotes the taxable income from the highest or top income tax bracket in year $t$ and $B_t^b$ denotes the taxable income from all other tax brackets in that same year. Similarly, $\tau_t^a$ is the top marginal income tax and $\tau_t^b$ denotes the tax rate for all tax brackets other than the top bracket. $Z$ denotes other factors that can influence tax bases. The federal government's personal income tax revenue is simply the product of the taxable income and the corresponding tax rates. Thus, using equation 1.1 we can specify the federal government's total personal income tax revenue ($R_t$) as:

$$Revenue = R_t = \tau_t^a B_t^a(\tau_t^a; Z) + \tau_t^b B_t^b(\tau_t^b; Z) \qquad (1.2)$$

Suppose the federal government raises its marginal income tax rate on the top tax bracket but leaves all other tax brackets unchanged. Such a tax rate change affects only those individuals whose taxable income falls in the top tax bracket. More specifically, it is the income of these high-income earners that is above the threshold value of the top income bracket that will be affected by changes in the top personal income tax rate. Thus,

we expect $B_t^a$ to change in response to the top tax rate increase, but $B_t^b$ to remain unaffected. Using equation 1.2, the effect on government total tax revenue ($R_t$) associated with the change in the top marginal income tax rate ($\Delta\tau_t^a$) can be shown as:

$$\textit{Change in Revenue} = \Delta R_t = (B_t^a + \tau_t^a B_t^a \alpha_a)\Delta\tau_t^a \qquad (1.3)$$

where $\Delta$ denotes change and $\alpha_a = \Delta \ln(B_t^a) / \Delta\tau_t^a$ is the semi-elasticity of the top taxable income with respect to the top PIT rate. That is, $\alpha_a$ shows the change in the top taxable income arising from a one percentage-point change in the top income tax rate. We expect $\alpha_a$ to be negative since an increase in the top income tax rate reduces the top taxable income due to behavioural responses.

Since we expect that a change in the top income tax rate will affect only the top taxable income, one can show that there is a relationship between the semi-elasticity of top taxable income ($\alpha_a$) and the semi-elasticity of total taxable income with respect to the top personal income tax rate ($\varepsilon$), $\varepsilon = \Delta \ln(B_t) / \Delta\tau_t^a$. More specifically, $\varepsilon = \left(\frac{B_t^a}{B_t}\right)(\alpha_a)$, where $\left(\frac{B_t^a}{B_t}\right)$<1 is the share of the top income tax bracket in the total taxable income. Thus, given the importance of the contribution of high-income earners to the country's total personal income tax revenue and total taxable income, equation 1.3 can be re-written as:

$$\Delta R = B_t^a \Delta\tau_t^a + (\tau_t^a B_t \varepsilon \Delta\tau_t^a), \qquad (1.4)$$

where $B_t$ is total taxable income, $\varepsilon$ is the semi-elasticity of total taxable income with respect to the top marginal income tax rate, and the other variables are as defined earlier. Equation 1.4 shows that increases in the top income tax rate have two opposite effects on tax revenue. The first one is the direct and positive effect of the tax rate change on revenue and it is shown by the first expression in equation 1.4. This is simply the mechanical effect of changes in the tax rate on tax revenue and it is given as the product of the change in the tax rate and the tax base above the threshold income level for the top income tax bracket ($B_t^a \Delta\tau_\tau^\alpha$). But tax rate increases cause behavioural responses and the tax base will not remain the same in the face of tax rate changes. This indirect effect of tax rate changes on government revenue is shown by the behavioural response $\tau_t^a B_t \varepsilon \Delta\tau_t^a$ in equation 1.4. Note that this indirect behavioural effect of the tax rate increase is negative since taxable income semi-elasticity ($\varepsilon$) is negative and it tends to reduce tax revenue when the tax rate is increased. The upshot of the above relationship is that a realistic assessment of the possible revenue

effects of tax rate increases should consider both the *direct positive effect* and the possible reduction in tax revenue caused by *behavioural responses*. The literature often refers to such a revenue assessment as "dynamic scoring," or "dynamic revenue estimation."

As discussed above, the tax base semi-elasticity estimate (ε) is a crucial parameter for investigating the revenue effects of changes in the income tax rate. It is also important for measuring the efficiency cost of any tax policy. Recognizing this importance, various earlier studies employed individual as well as aggregate data to estimate taxable income elasticity. While previous empirical studies provided various estimates for this parameter using provincial tax rate data, there is no readily available estimate of the tax base elasticity estimate for the federal income tax rate.

This appendix specifies the empirical model that is used to estimate the federal personal income tax base semi-elasticity, which is important for an investigation of the revenue effects of tax rate changes on high-income earners. Suppose $B_t$ denotes the total taxable income in year $t$ which is the tax base for the federal personal income tax system. The tax base is assumed to depend on the top marginal personal income tax rate ($\tau_t^a$) and other macroeconomic factors (Z). Thus, as in Dahlby and Ferede (2012, 2018) and Milligan and Smart (2019), our empirical model is specified as:

$$\Delta \ln B_t = \theta + \varepsilon \Delta \tau_t^a + Z + \upsilon_t \,. \qquad (1.5)$$

In equation 1.5, Δ denotes change, $lnB_t$ is the log of total taxable income for the federal government, and $\tau_t^a$ is the federal statutory top marginal personal income tax rate. Note that the personal income tax rate variable is the federal marginal income tax rate that is applicable for the highest income tax bracket and it includes all applicable surtaxes.[6] We deflate the taxable income with the Consumer Price Index (CPI) (2002=100) to account for the effects of inflation. We also express the tax base as per capita to account for population growth. Thus, our dependent variable is per capita total taxable income in 2002 Canadian dollars expressed in logarithmic form. Note that we use total taxable income rather than the taxable income of the top income bracket due to lack of complete data for the latter. $Z$ denotes a vector of various control variables that can influence taxable income and $\upsilon_t$ is the error term. In equation 1.5, our key variable

[6] Milligan and Smart (2015) used simulated provincial tax rates from the Canadian Tax and Credit Simulator (CTaCS) rather than actual statutory rates to estimate tax base elasticity for high-income earners. Such tax rates rely on family composition and other factors. As our focus is on assessing the revenue effects of federal statutory tax rate changes, we believe that using the statutory rate is more suitable for the problem at hand. See Dahlby and Ferede (2012) for the use of a similar specification.

of interest is ε, which is the semi-elasticity of total taxable income with respect to the top personal income tax rate. That is, $\varepsilon$ shows the change in total taxable income due to a one percentage-point increase in the top income tax rate. Such a specification provides an easier way to evaluate the effects of tax rate changes on the tax base and tax revenue than the familiar specification used in individual-level based studies.[7]

In the section "Simulating the Revenue Effects of the Recent Federal Tax Rate Increase," we simulated the revenue effects of raising the top income tax rate on the federal personal income tax revenue using equation 1.4 and our preferred taxable income semi-elasticity estimate obtained by estimating equation 1.5.

[7] Most previous individual-level studies estimate the taxable income elasticity with respect to the net-of-tax rate (one minus the tax rate) rather than the tax rate. Such studies regress the first-difference of the log of the tax base on the first-difference of the log of the net-of-tax rate and various individual characteristics. See, for instance, Milligan and Smart (2015) and the reference contained therein. This paper, on the other hand, follows the approach of aggregate-based studies such as Haughwout, et al. (2004) and Dahlby and Ferede (2012, 2018) as it provides a more straightforward relationship between the tax rate, the tax base, and tax revenue. Of course, there is a direct and simple algebraical relationship between the two elasticity estimates and such implied elasticities are presented for the sake of comparison with those of the previous studies that employ this strategy.

# Appendix 2: First Stage Regressions

## Table A1: First Stage Regressions, 1972 to 2016

| | (1) For column (3) of Table 2 | (2) For column (4) of Table 2 | (3) For column (5) of Table 2 |
|---|---|---|---|
| Unemployment rate | -0.005*** | -0.005*** | -0.005*** |
| | (0.001) | (0.001) | (0.001) |
| Provincial PIT rate | -0.734*** | -0.773*** | -0.776*** |
| | (0.085) | (0.085) | (0.081) |
| Terms of trade | | 0.02 | 0.02 |
| | | (0.014) | (0.014) |
| Federal CIT rate | | | (0.12) |
| | | | (0.073) |
| Dummy88 | -0.038*** | -0.037*** | -0.042*** |
| | (0.004) | (0.004) | (0.003) |
| Constant | 0.003** | (0.02) | (0.01) |
| | (0.001) | (0.014) | (0.014) |
| | | **Instruments** | |
| Lagged deficit-to-GDP ratio | 0.078** | 0.101*** | 0.106*** |
| | (0.030) | (0.035) | (0.039) |
| US federal top PIT rate | 0.363*** | 0.365*** | 0.367*** |
| | (0.052) | (0.049) | (0.048) |
| Lagged Party dummy | -0.006*** | -0.004*** | -0.004*** |
| | (0.002) | (0.001) | (0.001) |
| Observations | 43 | 43 | 43 |
| Adjusted $R^2$ | 0.690 | 0.686 | 0.682 |

Note: The dependent variable is the change in federal top PIT rate. Heteroscedasticity and autocorrelation robust standard errors in parentheses. Significance levels are shown by * for 10%, ** for 5% and *** for 1%.

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*Notre mission consiste à améliorer la qualité de vie des Canadiens et des générations à venir en étudiant, en mesurant et en diffusant les effets des politiques gouvernementales, de l'entrepreneuriat et des choix sur leur bien-être.*

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