Macroeconomic Effects of Discretionary Tax Changes in Canada: Evidence from a new narrative measure of tax shocks*

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Abstract

In this paper we study the macroeconomic effects of changes in federal taxes for the Canadian economy for the time period 1961 - 2014. We document all legislated tax changes and the motivations behind them. We then employ the narrative methodology of Romer and Romer (2010) and Cloyne (2013) to identify exogenous changes in federal taxes. Our main empirical result shows that a tax cut of 1 percent of GDP leads to an increase in GDP of 2.1 percent on impact and a peak increase of 2.68 percent after 3 quarters of the initial shock. Disaggregated analysis shows that the response of output is driven by consumption and investment. We also find changes in personal income and other (sales and production) taxes to have strong effects on output.

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1 Introduction

How do tax changes affect the economy? In this paper we investigate this question for the Canadian economy for the time period 1961 - 2014. The financial crisis of 2008-09 and the COVID-19 induced economic crisis have renewed academic and policy makers' interest in the macroeconomic effects of fiscal policy changes. Recent literature has developed a general consensus that tax cuts tend to raise GDP. But, the size of the tax multiplier may vary.[1] This is in part due to the difficulty that arises in identifying exogenous tax changes - changes that are uncorrelated to contemporaneous movements in the economy. The problem is that of simultaneity - while there is no doubt that tax changes affect GDP, at the same time GDP affects variables that are used to measure tax revenues.

This identification problem has been tackled by two different approaches in the literature. One is to add structural restrictions to the econometric framework. The seminal work using this approach is Blanchard and Perotti (2002) who use a structural VAR framework to study the effects of fiscal policy changes. To achieve identification, they rely on institutional information about the tax and transfer systems and the timing of tax collections to construct the automatic response of fiscal policy to economic activity, and, by implication, to identify the shocks to fiscal policy. They find that for the US, a tax cut of 1 percent of GDP leads to a peak increase in output of around 1.4 percent after eight quarters of the initial shock.[2] The other approach is the narrative approach. It uses policy documents to identify those movements in policy variables that are contemporaneously uncorrelated with other shocks in the economy.[3] Romer and Romer (2010) construct a narrative measure of tax policy shocks for the US. Mertens and Ravn (2012) and Mertens and Ravn (2013) use the Romer and Romer (2010) data set to study the disaggregated effects of changes in corporate and labor income tax changes and also the effects of anticipated and unanticipated tax changes.

[1] The size of the tax multiplier varies across studies. Romer and Romer (2010) find that tax changes in the US have a significant impact - an exogenous tax decrease of 1 percent of GDP raises GDP by nearly 3% in the medium term. However, using Romer and Romer (2010) exogenous tax shock series in a VAR framework, Favero and Giavazzi (2012) find smaller effects - 0.5 percentage points of GDP. Perotti (2012) shows that the effect of tax shocks on output is not so large as in Romer and Romer (2010), but not so small either as in Favero and Giavazzi (2012) - typically about 1.5 percentage points after 3 years. Furthermore, effects of tax changes may differ across countries. In applications of the narrative approach to the United Kingdom and Germany, Cloyne (2013) and Hayo and Uhl (2013) find results very similar to the results in Romer and Romer (2010). But, some multi-country studies on tax changes do not provide convincing evidence for the effectiveness of fiscal policy. In some specifications, Perotti (2005) and Afonso and Sousa (2012) report unexpected signs for certain tax multipliers.

[2] Perotti (2005) used the same identification scheme to study the effects of fiscal policy shocks for all OECD countries. Mountford and Uhlig (2009) used sign-based restrictions to identify tax revenue and government spending shocks. They find that the tax multiplier can be as high as 5 if the tax cuts are deficit financed.

[3] In addition to identifying tax shocks, the narrative approach has been used to identify other shocks as well. Romer and Romer (1989) and Romer and Romer (2004) used this approach to identify monetary policy shocks. Ramey and Shapiro (1998), Ramey (2011), Owyang et al. (2013), and Hussain and Liu (2018) use this approach to identify government spending shocks.

Hussain and Malik (2016) used the same data set to study asymmetric effects of tax increases and tax decreases.

The narrative approach has been extended to other countries including UK (Cloyne, 2013; Hussain and Liu, 2017), Germany (Hayo and Uhl, 2013), Spain (Gil et al., 2018), and Portugal (Pereira and Wemans, 2015). In this paper, we add to this literature by constructing a novel data set of all federal tax changes enacted in Canada for the 1961:1-2014:4 period. There is a similar work by Lopes (2016).[4] Compared to his study, our paper utilizes a much longer data series, which enables us to investigate how the effects of tax cuts change over time.

Canada is an interesting case study to extend this literature for various reasons. First, Canada, like the UK, has a centralized budget process where most of fiscal policy changes are saved for budget speeches. It is possible to document all the tax changes from a few sources. Second, budget secrecy has traditionally been an important part of the Canadian Budget process, which ensures that no important information about upcoming policy changes is leaked. We can document the *announcement* dates of tax changes, as it can reasonably be argued that announcements in the budget represent the first credible news about upcoming policy changes. Finally, Canada went through a structural change in its monetary policy in 1991 when it switched to inflation targeting. It is interesting to study how the effectiveness of tax policy could have been impacted by such a change.

To conduct our analysis, we collect all legislated tax changes from various budget documents. We then use the Romer and Romer (2010) and Cloyne (2013) methodology to classify tax changes as exogenous or endogenous. Exogenous tax changes are those that are not taken in response to contemporary fluctuations in the economy. Endogenous tax changes are the ones taken in response to other shocks hitting the economy or in response to concerns about contemporaneous performance of other variables. We estimate the effects of tax changes on the economy using the proxy Vector Autoregression method (proxy-VAR), following Mertens and Ravn (2013).

The main empirical result of the paper is that a tax cut of 1 percent of GDP results in an increase in GDP of 2.1 percent on impact, which rises to 2.68 percent after 3 quarters of the initial shock. The expansionary effects of tax cuts persist for more than two years. Further disaggregated analysis provides some more interesting findings.

First, we find that changes in personal income and other taxes (that include excise, sales, and production taxes) have significant effects on output. Cuts in corporate taxes have short-lived expansionary effects on output that are insignificant. Second, the responses of output are largely driven by movements in consumption and investment. Open economy variables like imports and real exchange rate do not significantly respond to tax changes, while exports

[4]We began working on this paper in 2015. In 2016, we became aware of similar work by Lopes (2016) who constructs a narrative data set of discretionary tax changes for Canada. We informed the author of our work and decided to continue on our projects separately.

decline following a tax cut. Third, we find that personal income taxes significantly affect consumption, but other taxes do not. Corporate tax cuts lead to short-run expansion in investment and consumption although the responses of consumption come with large standard errors. Interestingly, we find an expansionary effect of cuts in other taxes on investment.

We also study how the effectiveness of tax changes has changed for the Canada for the pre and post-1991 period, since the Bank of Canada switched to an inflation targeting policy in 1991. We find that tax changes did not have any significant effect on output for the post-1991 period. However, this result is not driven by the interest rate moving in opposite direction to tax changes in the post-1991 period, as suggested by Romer and Romer (2010). The reduction in the expansionary effectiveness of tax cuts in the post-1991 period was caused by a contractionary spending policy adopted by the government in response to concerns about the long-run debt of the economy. We find evidence that tax cuts have regained their expansionary effects in the post-1999 period by when the period of spending cuts was largely over.

The remainder of the paper is organized as follows. Section 2 describes the construction of the exogenous tax series. Section 3 and section 4 present the results and robustness checks. Section 5 analyzes the tax effects over time. Section 6 concludes the paper.

2 Data

Data for all macroeconomics variables, except the exogenous tax series, is easily available from various sources like Statistics Canada. Table 1 provides details of the variables used in the paper. In this section, we focus our discussion on the construction of the exogenous tax series.

2.1 Overview of the Federal Budget Process

We begin by describing the procedure we follow to construct the series of exogenous tax changes. Our source of information is budget speeches and other budget documents that accompany budget speeches. Each year the Government of Canada presents federal budget to the House of Commons through finance minister of Canada. Budget consists of two parts. The first part, the revenue budget, is prepared by the Ministry of Finance. It reviews the current and projected state of the economy, presents the financial health of the government at the end of the previous fiscal year, and announces any planned changes in taxation or fiscal policy. The second part, the expenditure budget contains detailed information regarding the financial requirements of individual departments for the upcoming year in order to carry out the tasks that they are responsible for. The taxation and spending policies have often, but

not always, complemented each other (i.e. moved in the opposite direction). For example, in the 1980s and 1990s, there were some instances where both tax liabilities and government spending decreased.

Budget secrecy is a long-standing tradition of keeping the contents of the budget hidden till finance minister presents it in the house. The logic behind this secrecy is that some individuals might unfairly benefit from prior news about announcements to be made in budget speech. The House of Commons then votes on the budget. The vote is a matter of confidence for the government and if the House of Commons rejects the proposed budget then the government may fall as happened to the government of Prime Minister Joe Clark in 1979 when his minority government of the Progressive Conservative party failed to have to its budget passed by the House of Commons. In most years, the federal budget is presented in February or March.

In addition to the annual budget, the Government of Canada has also announced changes to its fiscal policy at other times. While typically the most important policy changes are reserved for the budget, at certain times the prevailing economic and political conditions necessitate the announcement of new measures outside the annual budget. Over the years, these statements have been called different names including Financial Statement, Mini-Budget, Supplementary Budget, and Economic and Fiscal Update. These statements are put forward typically in the middle of the fiscal year.

2.2 Construction of Tax Series

In this subsection, we provide details on how we construct the exogenous tax series using budget speeches and other budget documents.

2.2.1 Documenting Discretionary Tax Changes

To construct the exogenous tax series, we begin by documenting all discretionary tax changes at the federal level. For each tax change, we document a number of different characteristics.[5]

First, we document a brief description of the tax changes. For the year prior to 1975, we have to rely upon the budget speeches alone to find these tax changes. For the years after 1975, we use both the budget speeches and budget documents to document all tax changes.

Second, we document the size of tax change which is the forecasted revenue effect of tax change. For the years prior to 1975, we include only those tax changes that were announced in the budget speech and had their estimated revenue effects mentioned in the speech too.

[5]The data narrative that accompanies this paper contains the details of all documented tax changes. The data narrative and the online appendix to this paper can be found at `https://sites.google.com/site/syedmhussain1984/research`

For the years after 1975, we use either the budget papers or the budget reports to document the size of tax changes. For the later years of our sample, we also document tax changes and their sizes announced in the *Economic and Fiscal Updates* and *Economic Statement and Budget Updates*. Thus, wherever available, we use different types of budget papers to document the size of tax changes.

Third, we document the motivation for each tax change. For the tax measures announced in the budget speech, we use the statements used by the finance minister to identify the motivation of each tax change. For others, we rely upon the budget papers to document the motivation. For most tax changes, the motivation was explicitly given either in the speeches or the budget papers.

Fourth, we document the announcement and implementation dates for each tax change. We take the budget speech date to be the announcement date and document the implementation date from the budget speeches and budget papers. For a few temporary tax changes, instead of stating a particular date of implementation, the finance minister would use terms like "$\cdots$ for two years". In such case, we take the implementation date to be the same as announcement date.

Fifth, we document the nature of tax changes i.e. whether a tax change was intended to be permanent or temporary. The information in the budget speeches and budget papers is adequate to collect this information. For permanent tax changes, following Romer and Romer (2010) and Cloyne (2013), we use the full year revenue effect mentioned in the budget documents as the size of the measure. For the temporary changes, we use the full year revenue effect if the change was implemented for a year, or we adjust the size accordingly if the change was implemented for less than a year. At the expiration of a temporary tax change, we enter the negative value of the temporary tax change in the data set.

Finally, we document the type of tax changes i.e. whether it was a change in personal income taxes, corporate income taxes, or other types of taxes. Changes in personal income and corporate income taxes were spread throughout the sample period that we study. Examples of changes in personal income taxes include changes in income tax rates as well as other changes, for instance changes in deductibles or changes in tax credits, that affected personal incomes. Examples of changes in corporate income taxes include changes in corporate income tax rates and other changes, like changes in depreciation write-off rates and tax incentives for research and development, that affected corporate incomes.[6] Other taxes include different types of changes in sales taxes, excise taxes and production taxes.

A few specific issues regarding the data set deserve a brief discussion. First, we drop

[6]A note about dividend and capital gains tax changes: these can be classified as either changes in personal income or corporate income taxes. We classify almost all dividend capital gains taxes as changes in labor income. We made an exception to this classification only when the budget documents indicated that the intention of a change in these taxes was to affect businesses. None of the results presented in this paper are sensitive to classifying these taxes as changes in personal income or corporate income taxes.

those tax changes for which we could not find any size from either the budget speeches or budget reports. Second, for tax measures with retroactive components, we assign the full year effect of the tax change to the date of announcement. Third, some tax changes were to be implemented in steps. For such tax measures, we assign to the relevant size to the date of implementation of each step.

2.2.2 Classifying Tax Changes by Motivations

Having collected all the relevant information about tax measures, we classify them as exogenous or endogenous by examining the motivation put forward for each tax change.

Exogenous tax changes are those which are not responding to contemporary movements in the economy. Following Cloyne (2013), there are mainly three reasons for exogenous tax changes. First, tax changes due to concerns about fiscal health of the economy and long run debt. For example, in 1989, the government made it clear that it was concerned about the long-run debt which stood at $320 billion at the time. Hence it enacted a number of measures to raise revenue to reduce this debt. The second is for political or philosophical reasons. Examples would include the introduction of a new system for child tax benefit to improve the efficiency and fairness of the tax system and the changes in the tax code resulting in common-law couples being treated the same way as married couples. Both of these changes are from the 1992 budget. Finally, tax changes can be made to improve the long-run performance of the economy. For example, in 2000, the government accelerated the plan to lower the corporate tax rate with a view to boost investment and hence the long-run performance of the economy.

Endogenous tax changes are those that are taken to offset macroeconomic shocks. There are mainly three reasons for endogenous tax changes. First, tax changes can be countercyclical, which affect aggregate demand (demand management changes) or production side of the economy (supply stimulus changes). One example of demand management is tax changes in personal income tax rates in the aftermath of the 1973 recession and the reduction in goods and services tax rate in 2008. An example of supply stimulus is the reduction in sales tax on construction materials in 1974 and reduction in corporate income tax rates between 2008 and 2012. Second, tax changes can be made to reduce current deficit in the economy. Examples of such changes would include the temporary 5 percent surtax on corporations in 1979 and the increase in federal sales tax on some goods in 1989. Finally, tax changes can be motivated by an increase in current spending of the government. For example, the government imposed a new tax of 8 percent on revenue from oil and gas production in 1981 to raise revenue to fund federal spending in the field of energy.

Having classified all tax changes into two series – exogenous and endogenous, we convert them into quarterly time series. We assign each tax change to the quarter in which it was implemented. Here, we use the methodology by Romer and Romer (2010) and Cloyne (2013).

In particular, if a tax change was to be implemented in the second half a quarter, we assign it to the following quarter. We then normalize the series by nominal GDP of that quarter.

2.3 The Narratively Constructed Series of Tax Changes

The top panel of Figure 1 shows the quarterly data set on exogenous tax changes that we have constructed. The mean of the exogenous series is -0.009 percent of GDP, and the standard deviation is 0.12 percent of GDP. There are 47 quarters of tax increases and 64 quarters of tax decreases. The single largest exogenous tax change took place in 1991 when the introduction of the new Goods and Services tax resulted in a revenue increase of over 20 billion dollars. However, this change was largely offset by the simultaneous elimination of the manufacturer's sales tax.

The bottom panel shows the endogenous tax series which has a mean of -0.009 percent of GDP and a standard deviation of 0.16 percent of GDP. Most of the countercyclical tax changes were clustered around times of recession. For example, tax changes were taken in the 1970s and 1980s in the aftermath of the 1973 and 1979 oil price increases. Some major tax cuts were also enacted after the financial crisis of 2008. The tax increases in the early 1980s were spending driven tax changes, with an aim to collect more revenue to finance government spending on new energy related projects.

2.4 Tests of Predictability

In this subsection, we test the predictability of the exogenous tax change series. Following Mertens and Ravn (2012) and Cloyne (2013), we conduct two tests.

One is the Granger causality test. We estimate a VAR which includes 4 lags of growth rates of output, government spending, and first difference of short-term interest rates and inflation, together with the exogenous tax series. The results are shown in Table 2. The first row shows that the p-value of the granger causality test comes out to be 0.14 for the narrative tax series. It suggests that we cannot reject the null hypothesis that all coefficients in the tax equation are jointly zero thereby supporting our claim of exogeneity of the tax shock series. Next, we conduct the Granger test for the endogenous measures of tax series.[7] The results in table 2 show that the p-value of the test statistic comes out to be 0.01. This shows that the tax series we classify as endogenous can indeed be predicted on the basis of past information.

The other test that we conduct checks whether the timing of announcement of the exogenous tax changes can be predicted on the basis of past information. For this, we construct the

[7]If we use the narrative measure without cancellations, we get a p-value of 0.24 which shows that this measure can also not be predicted on the basis of past information.

exogenous tax series according to the dates when each of these tax changes were announced.[8] We then define a dummy variable ω_t such that

$$\omega_t = \begin{cases} 1 & \text{if } d_t > 0 \\ 0 & \text{if } d_t = 0 \\ -1 & \text{if } d_t < 0 \end{cases}$$

where d_t is the exogenous tax series according to announcement date. We then conduct an ordered probit regression using the same variables as the ones used in the first test as the regressors. The results from this test show that we cannot reject the null-hypothesis that the announcement of exogenous tax series cannot be predicted on the basis of past information. The p-value of the test statistic comes out to be 0.33. The p-value for the same test for the endogenous series comes out to be 0.05 which allows us to reject the null hypothesis of no predictability.

Therefore, the results of these tests provide credibility to the classification methodology that we use. We should mention that the proxy-VAR methodology used for most of this paper does not require the proxy to be uncorrelated with past values of non-policy variables. Nonetheless, the results from exogeneity tests are reassuring and will allow us to use a reduced form VAR model (that does require the tax shock series to be exogenous) as a robustness exercise.

3 Empirical Results

In order to estimate the effects of tax changes, there are two estimation methods using narratively constructed shock series. One approach is to take narratively constructed shocks series as the macroeconomic shocks of our interest. It takes the shock series as truly exogenous and directly estimates the effects of narratively constructed shocks with an OLS or VAR estimation. Romer and Romer (2010), in their baseline specification, regress output growth on contemporaneous and lags of the exogenous tax changes.[9] Cloyne (2013) uses a three variable VAR estimation including log GDP, consumption and investment. The narrative tax shocks are included as an exogenous variable in their VAR estimation. The other approach is to take narratively constructed shock series as a partial measure of the true shock of interest. Moreover, the constructed measure can contain measurement error, which could lead to bias if the measure is treated as the true shock. Therefore, studies like

[8] For this series, we drop the cancellation measures corresponding to the temporary tax changes.

[9] Romer and Romer (2010) use three econometric specifications: 1) An OLS estimation - regressing output growth on contemporaneous and lags of the exogenous tax changes; 2) An OLS estimation - regressing output growth on contemporaneous and lags of the exogenous tax changes with various control variables; 3)A two-variable VAR with the exogenous tax changes and log output.

Stock and Watson (2018), Mertens and Ravn (2013), and Gertler and Karadi (2015) adopt an estimation strategy, known as the proxy-VAR or SVAR-IV. It exploits the informational content of narrative measures of exogenous changes for identification in a structural VAR (SVAR) framework. We think that the narratively constructed shock series are best thought of as instrument, and choose to use the proxy-VAR approach with the exogenous tax change series as an external instrument to the VAR. The assumption is that the series of exogenous tax changes are correlated with the structural tax shocks of our interest, but uncorrected with other structural shocks.

Specifically, consider the $n \times 1$ vector of time series variables, denoted by X_t. The reduced form dynamics follows

$$X_t = A(L)X_{t-1} + e_t,$$

where A(L) is a lag polynomial with 4 lags, and e_t is the $n \times 1$ vector of innovations. The baseline specification includes log tax revenues (TR), log output (Y), log government spending (G) and interest rate (R). That is, $X_t = [TR_t, Y_t, G_t, R_t]'$. Government spending and interest rate are included to control for government spending policy and monetary policy. Romer and Romer (2010), Cloyne (2013), and Mertens and Ravn (2013) have all incorporated fiscal and monetary variables in their analysis on tax effects. We also include a constant and quadratic time trend in the estimation.

Let v_t be the $n \times 1$ vector of structural shocks, which are related to the VAR innovations by

$$e_t = Fv_t.$$

Consider the partition $v_t = [v_{1t}, v_{2t}']'$, where v_{1t} is the structural tax shock of interest and $(n-1) \times 1$ vector v_{2t} contains all other $n-1$ non-tax shocks.[10] Then, the objective is to estimate the first column of F - denoted as F_1, that corresponds to the latent tax shocks v_{1t}. Since $E[e_t e_t'] = FF'$, an estimate of the covariance matrix of e_t provides $n(n+1)/2$ independent identifying restrictions. However, identification of F_1 requires more restrictions.

Let d_t denote the series of narratively identified exogenous tax changes, which are correlated with the latent tax shocks v_{1t}, but orthogonal to other shocks v_{2t}. That is, we assume that the following conditions are satisfied:

$$\begin{aligned} E[d_t v_{1t}] &= \phi \\ E[d_t v_{2t}'] &= 0, \end{aligned}$$

where ϕ is an unknown scalar. These key identifying assumptions translate to additional

[10]The structural shocks are assumed to satisfy the following: $Ev_t = 0$, $E[v_t v_t'] = I$, $E[v_t v_s'] = 0$ for $s \neq t$ where I is the identity matrix.

linear restrictions on the elements of F, which identifies F_1.[11]

To implement the proxy-VAR method, we follow the detailed estimation steps by Mertens and Ravn (2013). First, we estimate the VAR through least squares and collect the reduced form errors $\hat{e}_t$. Consider the partition $\hat{e}_t = [\hat{e}_{1t}, \hat{e}'_{2t}]'$, where $\hat{e}_{1t}$ is the reduced form errors from the first equation with tax revenue and $(n-1) \times 1$ vector $\hat{e}_{2t}$ contains all other reduced form errors. Second, we regress the residuals from the first equation ($\hat{e}_{1t}$) on the instruments and collect the fitted values. In the estimation, we include 4 lags of the narratively constructed tax shock series along with the contemporary values as instruments. This is to capture the delayed effect of a change in tax policy on tax revenues. Third, we regress the reduced form residuals from other variables in the VAR ($\hat{e}_{2t}$) on the fitted values of tax from the previous step. Finally, we calculate the impulse responses.

Since the latent tax shock is unobserved and its scale is indeterminate, unit effect normalization is often used to present the impulse responses, that is, the percentage change in output in response to 1 percentage decrease in tax revenue. Then, tax multipliers - the change in output in response to 1 unit change in tax revenue, are derived by multiplying the impulse responses by the average ratio of output and tax revenue. As our discussions focus on tax multipliers, we present the results after rescaling the impulse responses by the average ratio of output and tax revenue, such that, in all figures the output responses can be directly interpreted as dynamic tax multipliers. As a result, our impulse responses are comparable with the responses in Romer and Romer (2010) and Cloyne (2013). They use the narrative shocks directly in the estimations, and the estimated impacts of the tax change (the impulse responses) are the dynamic multipliers. We use the recursive wild bootstrap method to calculate the standard errors. We report both 68 and 90 percent confidence intervals.[12]

3.1 Effects of Tax Changes

The baseline proxy-VAR includes the log of real tax revenues, log of real GDP, log of real government spending, and interest rate. Figure 2 presents the estimation results. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues. This transformation allows us to interpret the impulse response coefficients as dynamic tax multipliers interpreted as the $ change in output at various forecast horizons to a decrease in tax revenues of $1 at time 0. The first panel shows the response of tax revenues.[13] After the initial decrease, tax revenues stay below their pre-shock levels for the

[11] For more details on the Proxy-VAR or SVAR-IV estimation method, refer to Stock and Watson (2018) and Mertens and Ravn (2013).

[12] The standard errors are the standard deviations of the bootstrapped sample produced using the wild bootstrap method. See Lopes (2016) for details.

[13] We show both the 68% and 90% confidence intervals for the impulse responses reported in this paper. In our discussions, when we refer to any result being significant, it would be with respect to the 68% confidence interval.

duration of the forecast horizon but the response becomes insignificant at 68% confidence level after 5 quarters of the initial shock although it regains significance in the long-run.

The second panel is the response of output to a decrease in taxes equal to 1 percent of GDP. Output increases significantly by 2.1 percent on impact and continues to increase for a few quarters after the initial shock. The peak response of output takes place after 3 quarters of the initial shock and is equal to 2.68 percent. The response of output persists for several more quarters, which remains positive for the entire projection horizon. Our results are consistent with Lopes (2016) who also find strong expansionary effects of tax changes in the short-run.

The third panel of Figure 2 presents the response of government spending to a decrease in taxes. Initially the responses are mostly insignificant. After 6 quarters, the increase in government spending becomes more persistent. The largest increase takes place after 15 quarters of the initial shock and is equal to around 1.37 percent. The fourth panel of Figure 2 shows the response of interest rate to a tax decrease. The interest rate shows no effect on impact, and then starts to increase with a lag of one quarter. The maximum increase in interest rate takes place 5 quarters after the tax cut and is equal to 1.45 percentage points. It suggests that the central bank may try to raise interest rate to offset the inflationary effects resulting from a tax cut.[14] [15]

Figure 3 provides robustness checks. The left panel shows the output responses when we use as proxy the measure of exogenous tax changes that excludes cancellations of temporary measures. The overall output responses are somewhat smaller and more sluggish, with a peak increase of 2.1 percent after 7 quarters of the initial shock. The right panel shows the response of output when we exclude anticipated tax changes from out exogenous tax series.[16] The output responses are slightly larger but more sluggish, with a peak increase of 2.9 percent after 7 quarters of the initial shock.

3.2 Effects of Different Types of Tax Changes

While constructing our data set, we keep track of whether a tax change was intended to affect personal income tax liabilities, corporate income tax liabilities, or whether it was

[14] When we study the effect of tax cuts on (quarterly) inflation, we observe a significant increase in inflation on impact. The increase in inflation becomes smaller in the following quarters but remains positive at all forecast horizons and is significant at most of these quarters.

[15] Mertens and Ravn (2013) discuss that government debt can be a potentially important variable to include in the VAR. Quarterly data for federal government debt for Canada is not available for our sample period. Instead, we included government deficit in the model and found the results to be very similar to the baseline case. We included the percentage change in real deficit since taking logs of the variable was not possible due to the negative values in the series.

[16] Following Mertens and Ravn (2012), we define a tax change as anticipated if it is announced more than 90 days before the implementation date.

any other type of tax. Figure 4 presents the exogenous tax series of different types of tax changes. Changes in personal and corporate income tax changes have been normalized by pre-tax personal income and pre-tax corporate profits respectively. The changes in other taxes have been normalized by nominal GDP. Changes in personal income taxes were spread throughout the sample with most of these taking the form of changes in marginal tax rates. Changes in corporate income tax rates were also spread out with some of the biggest changes taking place in the 1980s. These changes were motivated by concerns about long-run debt of the economy and long-run performance of the economy. There were also some substantial cuts to the corporate income tax rates in the late 1990s. The largest tax changes in the other category also took place during the 1980s with a number of these being motivated by concerns about long-run debt of the economy.

In this section, we look at the effects of each of these types of tax changes with the proxy-VAR estimation method. In our baseline specification, we replace the total real federal tax revenues with real personal incomes tax revenues, corporate income tax revenues, and production tax revenues when studying the effects of changes in labor, corporate, and other taxes, respectively. We also include the sum of other types of taxes in each of our estimations.[17] The results are shown in Figure 5. In each case, we normalize the initial impact on the relevant tax revenues to be the average of ratio of nominal GDP and tax revenues in the respective category.

The first row of figure 5 shows the effects of a cut in personal income taxes equal to 1 percent of GDP. The left panel shows that personal income tax revenues decrease on impact and stay significantly below the pre-shock levels for most of the forecast horizon. The right panel shows the response of output. On impact, GDP rises by 0.73 percent, but the effect is insignificant. Output continues to grow for several quarters after the initial impact. The maximum impact on output takes place after 3 quarters and is equal to 1.76 percent. The effect on output remains large and significant for several more quarters.

The second row of figure 5 shows the effects of a cut in corporate income taxes equal to 1 percent of GDP. The left panel shows that the corporate tax revenues stay significantly below the pre-shock levels for the entire forecast horizon. The right panel shows that after the initial shock, output shows an immediate increase of 1.5 percent but this increases quickly dissipates. Furthermore, the increase in output is insignificant.[18] The third row shows the effects of cuts in other taxes. The left panel shows that the decrease in other tax revenues is

[17]Specifically, we add the nominal values of the tax revenues and divide that by the GDP deflator before taking the log of it.

[18]We should note that corporate tax revenues represent a smaller fraction of GDP than personal income tax revenues or other tax revenues. In the online appendix, we use average tax rates as the key variables in the proxy-VAR. The results from that exercise show that to induce a decrease in corporate tax revenues equal to 1 percent of GDP, the average corporate tax rate would need to decrease by almost 18 percentage points. For comparison, average personal income tax rate needs to decrease by 1.6 percentage points to cause a decrease in personal income tax revenues equal to 1 percent of GDP.

short-lived after the initial shock. The drop in tax revenues becomes small and insignificant after 5 quarters of the initial shock. The right panel shows that cut in other taxes increase output on impact but the estimate is insignificant. The peak increase in output take place after four quarters of the initial shock and is equal to 1.96 percent.

Overall, we find that all personal income and other taxes have strong short and medium run effects on output. Corporate income taxes have very short-lived effects on output that are insignificant statistically. Our results show that the drops in personal and corporate tax revenues show a similar persistence to their respective shocks. Still, the effects of cuts in personal income taxes are more significant and longer-lasting than the effects of changes in corporate taxes. Our results are in line with Lopes (2016) who also finds that changes in personal income taxes have a longer lasting effect on output and that corporate income taxes have no significant effect on output.

3.3 Effects of Tax Changes on Different Components of Output

In this subsection, we study the effects of tax changes on different components of output. We augment the baseline proxy-VAR with one additional variable of interest, to examine how it responds to tax changes.

We begin by studying the effects of tax changes on consumption and investment, shown in Figure 6. Consumption shows an immediate and significant increase of 2.2 percent on impact. It stays above its pre-shock levels for 10 quarters. Investment, like consumption, shows a strong increase on impact of 3.8 percent. It continues to rise and peaks at 5.3 percent after 1 quarter of the initial shock. The response of investment stays above its pre-shock level for the entire forecast horizon. That investment is more responsive to tax changes than output is consistent with other studies in the literature. For example, Romer and Romer (2010) and Cloyne (2013) both find investment to respond more to tax changes than output. However, unlike those studies, we find a much more immediate response of investment.

We then study the effects in labor market, shown in Figure 7. The left panel shows that unemployment remains mostly unresponsive to a tax cut. The middle panel shows that employment increases significantly by up to 1.4 percent following a tax cut. The increase in employment becomes smaller at longer horizons but still remains positive. This can be rationalized by looking at the labor force participation rate. It increases significantly one quarter after the initial tax cut, and stays above its pre-shock level for the remainder of the forecast horizon.

Finally, we look at the open economy variables, shown in Figure 8. We see an immediate increase in imports following a tax cut. This may represent the increase in overall consumption of the economy. The increase in imports is only in the short-run. However, exports show a persistent and significant decline throughout the forecast horizon. Moreover,

both real and nominal exchange rates remain unresponsive to tax cuts in the short-run. In the long-run, both exchange rates show evidence of appreciation which is consistent with a standard Mundell-Fleming model. We also looked at the responses of the open economy variables for the post-1970 period when Canada adopted the floating exchange rate system. The responses of exchange rates are also very similar to the overall sample results with one minor quantitative difference: the long-run appreciation is stronger for the post-1970 period.

3.4 Discussion

We have presented a number of results regarding the effects of tax cuts on output and its components. In this subsection, we try to piece together various empirical evidences and provide discussions.

Our results show that a tax cut of 1 percent of GDP leads to an increase in GDP of 2.1 percent on impact and a peak increase of 2.68 percent after 3 quarters of the initial shock. The short-run increases in output last for about two years. This is largely in line with the results from the recent literature using the narrative approach. Romer and Romer (2010) find that a tax decrease of 1 percent of GDP increases output over the next three years by up to 3 percent in the US. Cloyne (2013) finds that for the UK, a 1 percentage point cut in taxes as a proportion of GDP causes a 0.6 percent increase in GDP on impact, rising to a 2.5 percent increase over nearly three years. Based on a historical account of German tax legislation, Hayo and Uhl (2013) find a substantial and statistically significant reaction of output following implementation of a tax change. In response to a tax cut of 1 percent of GDP, output increases by 2.4 percent.

The strong short-run responses of output to tax changes are driven by responses of both consumption and investment. While the response of consumption starts to fade away after a few quarters, investment stays high for several more quarters. Further analysis from three different types of tax changes show that personal income and other taxes play important roles in explaining how tax changes affect the economy. The effects of corporate income taxes on output are insignificant and fade away quickly. Personal income and other taxes have a more delayed effect that persists for around two years.

We also study how various types of tax changes affect consumption and investment. In Figure 9, we can see the cuts in personal income taxes cause consumption to rise significantly in the short-run , and the effects persist for more than three years. Corporate tax changes have large short-run effects on consumption, though the estimated standard errors are large. Other taxes do not seem to affect consumption significantly. It suggests that the observed response of consumption is mostly driven by changes in personal income tax changes. These results are in line with those found by Nguyen et al. (2021) for the United Kingdom. Using a similar empirical methodology as ours, they find that decrease in average income tax

rates - defined as an aggregate of personal and corporate taxes - have strong but short-lived expansionary effects on output. They also find that these tax cuts to have strong short-run expansionary effects on consumption. The observed expansionary effects of corporate tax cuts on consumption is also in line with Ljungqvist and Smolyansky (2014) who find that corporate tax cuts can lead to an increase in wage income. Since consumption decisions are affected by income, it follows that consumption would increase as well. Similarly Baker et al. (2020) find that 31% of corporate tax incidence falls on consumers which is consistent with our results that consumption responds to changes in corporate taxes.

Figure 10 presents the effects of various types of tax changes on investment. Unsurprisingly, we find corporate tax cuts having large and significant effects on investment in the short-run. Interestingly, we also find evidence of cuts in other taxes having an expansionary effect on investment. These results are consistent with studies like Jacob et al. (2018), who show that consumption tax cuts can have expansionary effects on investment. The fact that these other taxes have no significant effect on consumption but expansionary effects on investment suggests that firms face an elastic demand for their goods. Therefore, they bear at least some burden of these taxes and hence a decrease in them increases their profit margins and consequently investment.[19]

Among the open economy variables (results shown in figure 8), we find a significant drop in exports following a tax cut. While it is not possible to fully explain the response of exports based on tax changes in the home country alone, our results shed some light on what may be causing a decrease in exports. We see that tax cuts lead to a significant increase in domestic investment. Since there is no change in the exchange rate, it is unlikely that there is a decrease in export of consumption goods. These results suggest that the observed decline in exports may be in the form of capital goods that find a higher demand at home. We also find a short-term increase in imports which mirrors the increase in consumption that follows a tax cut.

To confirm these speculations, we look at the responses of exports and imports of capital and consumer goods.[20] The results (not shown here) show that tax cuts are followed by significant decrease in exports of capital goods in the short-run and long-run whereas the exports of consumer goods do not show any significant response. We also find imports of consumer goods increasing following a tax cut which is consistent with the observed increase in overall consumption. These results confirm that the decrease in exports following a tax cut is caused by a decrease in exports of capital goods whereas the increase in imports is caused by an increase in imports of consumer goods. Finally, the long-run appreciation of

[19]That corporate tax cuts have short-run effects on consumption and investment but no effect on output overall, may seem contradictory at first. However, these results can be reconciled by looking at the response of exports (not reported here) to cuts in corporate taxes. We find that exports decline significantly following a corporate tax cut.

[20]The data on exports and imports of capital and consumer goods is only available for 1988 onwards. We studied the effects of tax changes on the disaggregated exports and imports for this sub-sample.

the exchange rate is consistent with the Mundell-Fleming model. It is also consistent with the increase in domestic interest rates (see Figure 2) that takes place following a tax cut.

4 Robustness Analysis

One of the problems with the proxy-VAR method is the weak Instrumental Variable (IV) issue. Ramey (2011) points out that most macroeconomic shock series, like monetary and oil price shocks, fail to meet the criterion suggested by Staiger and Stock (1997) for a series to be a strong IV. To check our narrative series, we regress the growth in real tax revenues on fours lags of itself, four lagged values of change in (log of) real GDP, (log of) government spending, interest rate, and contemporary and four lagged values of our measures of exogenous tax changes. The F-statistic corresponding to the coefficients of the exogenous tax series comes out to be 0.60, which is substantially below the threshold of 10 suggested by Staiger and Stock (1997). The F-statistics for the personal and corporate income tax series come out to be 2.08 and 0.4 respectively.

This issue of weak IV is not exclusive to our narrative measure of tax changes. Ramey (2016) and Stock and Watson (2012) computed F-statistics of 1.6 and 0.5 respectively for the Romer and Romer (2010) narrative tax series for the US. Lopes (2016) reports an F-statistic of 0.7 for the narrative tax series of Cloyne (2013). We also computed the F-statistics for these two series using our specification and got similarly low values of 2.12 and 1.54 for the Romer and Romer (2010) and Cloyne (2013) series.[21] These results show that the weak instrument issue that we face is faced by other similar measures. Therefore, in this section, we check robustness of the baseline results with two other commonly used estimation methods.

In particular, we take the narrative tax changes as the true shock of interest and estimate a reduced form VAR along the lines of Romer and Romer (2010) and Cloyne (2013). We also estimate a recursive SVAR with the narrative tax series ordered first in the system (this method is called the internal instrument approach in Li et al. (2022)). Finally, we also report results from a reduced form local projection (LP) method of Jordà (2005).[22]

[21] The problem of weak IV extends beyond the literature on effects of tax changes. For example, the military news shock of Ramey (2011) has a reported F-statistic of 2 for the post-Korean war period. Ramey (2016) reports similarly low F-statistics for the Ben Zeev and Pappa (2017) and Fisher and Peters (2010) government spending shock series for the post-Korean war period. Stock and Watson (2012) study different types of variables used as proxies for various macroeconomic shocks and find that most of them fail to meet the Staiger and Stock (1997) threshold.

[22] Plagborg-Møller and Wolf (2021) show that LP and VAR methods in fact estimate the same impulse responses asymptotically, regardless of identification scheme. Li et al. (2022) further conduct a simulation study of LP and VAR estimators, considering various identification schemes and several variants of LP and VAR estimators. They show that LP estimators have lower bias than VAR estimators but substantially higher variance at intermediate and long horizons.

4.1 Estimation with Reduced form VAR

We estimate the effects of exogenous tax changes in a simple reduced form VAR. The specific model that we estimate is

$$X_t = A + B(L)X_{t-1} + C(L)d_t + \epsilon_t,$$

where X_t is a vector of endogenous variables and d_t is the exogenous shock - the exogenous tax series in our case. $B(L)$ and $C(L)$ are lag polynomials with P and $Q+1$ lags respectively. This specification mimics the one used by Cloyne (2013). In our estimation, we choose $P = 4$ and $Q = 4$. We use the same four endogenous variables - log real tax revenues, log real government spending, log real GDP, and short-term interest rates - as our baseline proxy-VAR.

The response of output to a decrease in taxes equal to 1 percent of GDP is show in Figure 11. We also plot the response of output from the baseline specification for comparison. The results show that the response of output from the reduced form VAR closely resembles our baseline results. Output shows a strong response to a tax cut in the short-run with a peak of 1.93 percent taking place 3 quarters after the initial shock. Like the baseline results, the response of output starts to fade away after about two years of the initial shock.[23]

4.2 Internal Instrument Approach

Next, we present our results from an internal instrument approach. This involves estimating a recursively identified structural VAR (SVAR) with the narrative tax shock ordered first in the system. Plagborg-Møller and Wolf (2021) show that the internal instrument approach yields valid normalized impulse responses even if the instrument (the narrative series in our case) contains measurement error. We include the same endogenous variables as before i.e. log of tax revenues, log of real GDP, log of real government spending, and interest rates, together with the narrative shock series which is ordered first in the system.

We normalize the initial response of the narrative shock series to 1. The results from this exercise are shown in figure 12. The first panel shows that the response of output to a decrease in tax equal to 1 percent of GDP is very similar to the ones estimated through the reduced form VAR and the proxy-VAR model. The peak response of output takes place after 3 quarters of the initial shock and is equal to 2.13 percent. The response of output remains positive for several more quarters but becomes insignificant after 2 years of the initial shock.[24]

[23] Cloyne (2013) uses $P = 4$ and $Q = 12$ in the estimation of their model. Using these values, we get a peak response of output of 2.44 percent four quarters after the initial shock.

[24] The response of total tax revenues, not shown here, is also very similar across the reduced form VAR and the internal instrument approach. Tax revenues decrease on impact and stay below the pre-shock levels

4.3 Estimation with Jordà's Local Projection Method

Our methodologies so far have relied upon standard methods of estimating the impulse responses and the multipliers. There are, however, two issues with this approach. One is, as pointed out by Jordà (2005), the impulse responses are normally calculated as linear combinations of model coefficients. Extrapolating these combinations at increasingly distant horizons can compound any misspecification errors. The other issue is that the standard way to compute multipliers is to multiply the ratio of change in log GDP and log tax revenues by the average of ratio of nominal GDP to nominal tax revenues. As argued by Owyang et al. (2013), the average of GDP to tax revenues can fluctuate over the sample period. In our case, this value ranges between 5.45 and 7.92 with an average of 6.78 which is what we use in our baseline estimation.

Following Auerbach and Gorodnichenko (2012), Ramey (2016), and Owyang et al. (2013), we estimate the response of output to an exogenous change in taxes using Jordà's methodology. In particular, we estimate a set of regressions for each horizon h as follows:

$$y_{t+h} = \alpha_h + \Psi(L)X_{t-1} + \beta_h d_t + \epsilon_t.$$

X_t is a vector of control variables that includes log of GDP, log of government spending, log of total tax revenues, and interest rate. $\Psi(L)$ is a polynomial in the lag operator and d_t is the series of narratively identified exogenous tax changes. We include 4 lags of the control variables. We also include a constant and quadratic time trend in the estimation. The dependent GDP variable, y_{t+h}, is defined according to the variable transformation of Hall (2009) and Barro and Redlick (2011) as described in Owyang et al. (2013).

$$y_{t+h} = \frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}}$$

The estimation of equation 1 involves regressing the GDP variable at $t+h$ on the shock at time t while controlling for lags of other variables. β_h from each equation is the estimate of the dynamic multiplier at each forecast horizon h. This methodology has the advantage that it estimates the multiplier at each horizon directly without imposing the implicit dynamic restrictions involved in the VARs.

The results are shown in Figure 13. We also plot the baseline result for comparison. The peak response of output takes place after 4 quarters of the initial shock and is almost 2.9 percent. The response of output starts to then fade away and becomes insignificant after 2 years of the initial shock. The response of output from this exercise is qualitatively similar to the responses estimated through the proxy-VAR and the internal instrument models for the first 2 years after the initial shock. This is consistent with the findings of Plagborg-Møller

for the duration of the forecast horizon. The effects, however, are insignificant.

and Wolf (2021) who show that the responses from the internal instrument approach and the local projection method should agree at short horizons.[25] The online appendix also provides empirical estimation results with the LP-IV method, along the lines of Ramey and Zubairy (2018).

5 Effects of Tax Changes Over Time

In this section, we look at how the effects of tax changes have varied over time for Canada. Romer and Romer (2010) conduct a similar exercise for the US and find that the effectiveness of tax policy has become somewhat smaller in the post 1980 period. They suggest that the Federal Reserve bank became more reactive to fiscal policy changes in the post 1980 period thereby muting the effects of tax policy changes. For Canada, we study how the effectiveness of tax policy has changed in the pre and post 1991:1 period. We choose 1991:1 as the splitting point because this is when Bank of Canada adopted the inflation targeting monetary policy. Ex-ante, we expected effectiveness of the tax policy to decrease in the post-1991 period, as suggested by Romer and Romer (2010).

We estimate the proxy-VARs for pre-1991 and post-1991 periods. The responses of output are shown in Figure 14. The results are what we expected. In pre-1991 period, output responses are qualitatively similar to the baseline result for the entire sample. For the post-1991 period, output responses are small and insignificant. It suggests that tax policy has indeed lost its effectiveness in the post-1991 period.

To investigate the reason behind the smaller output response to a tax cut in post-1991 period, we look at the response of interest rate to a decrease in tax in the pre- and post-1991 periods. The results are shown in Figure 14. The responses of interest rate are surprising. We do not see any evidence of interest rate increasing in response to a tax cut in the post-1991 period. The response is small, insignificant, and not of a consistent sign throughout the forecast horizon. We also looked at the response of inflation to a tax cut in the post-1991 period. Our results showed that inflation did not show any increase following tax cuts in the post-1991 period.

Then, we studied some of the monetary policy reports[26] for the post-1991 period to look for the reason for these results. In particular, we study the monetary policy reports around the October 2000 personal income tax cuts and the May 2006 cuts in goods and services tax (GST). We focus on these episodes, as they were the two largest tax cuts in the post-1991 period.

[25] Specifically, Plagborg-Møller and Wolf (2021) show that the impulse responses from the two exercises should agree up until horizon p where p is the number of lags (4 in our case) in the estimation of the models.

[26] The monetary policy reports of the Bank of Canada can be found at `https://www.bankofcanada.ca/publications/mpr/`.

October 2000 Tax Cuts: In October 2000, the government announced a series of tax changes designed to reduce personal income tax liabilities. The tax cuts went into effect on January 1, 2001. The November 2000 Monetary Policy report noted the announced (but not yet implemented) tax cuts and expected them to cause the domestic household spending to grow at a robust rate. At the same time, the report mentioned uncertainties rising from slowing down in the United States economy and higher oil prices. Overall, the report expected the inflation rate to be at the midpoint of the Bank of Canada's target inflation range. The report's message was clearly about the fears of a slow-down in the Canadian economy rather than an overheating of it.

The May 2001 Monetary Policy Report noted that the slow-down in the United States economy turned out to be stronger than anticipated which resulted in a lower-than-expected growth of the Canadian economy. This, as the report noted, put a downward pressure on the core inflation. The Bank of Canada reacted by decreasing the interest rate by 100 basis points in January 2001. The report mentioned the personal income tax cuts and their expected positive effect on household spending. But it also expressed fears that slower employment growth and drop in equity prices could negatively affect consumer confidence.

Our reading of the two monetary policy reports shows that while there were large cuts in personal income taxes in 2001, they were accompanied by other, unrelated, macroeconomic events that necessitated a decrease in interest rates rather than an increase.

May 2006 Tax Cuts: In May 2006, the government announced a decrease of 1 percent in the GST. The tax cut was enacted in July 2006. The July 2006 Monetary Policy Report stated that the reduction in GST was expected to *decrease* inflation by 0.6 percentage points. The October 2006 Monetary Policy Report confirmed this decline in inflation and also stated that the recent decrease in crude oil prices further lowered the inflation rate. The report stated that inflation was supposed to stay low until mid-2007 and reach the midpoint of its target range after that. Overall, our reading confirms that there was no increase in inflation resulting from this tax cut and hence no need for an increase in the interest rate.

Our reading of the Monetary Policy Reports uncovers why interest rate has not responded to tax changes in the post-1991 period. However, it leaves the original question, about tax policy becoming less effective, open. We turn our attention to how government spending has reacted to tax changes in the pre- and post-1991 periods. The results are in Figure 14. The pre-1991 plot shows that government spending was mostly non-reactive to tax changes. There is some evidence that government spending increased in the very short-run but the estimates are insignificant. The response of government spending in the post-1991 period shows that government spending moved in the same direction as tax changes. This means that tax cuts were accompanied or followed by government spending cuts. Government spending decreases by 1.85 percent on impact and the effect does not dissipate even in the long-run. The strong response of government spending can thus explain why the effects of

tax changes on output have become muted since 1991.

What explains how government spending behaved in the post-1991 period? Gordon Thiessen, the former Governor of the Bank of Canada, remarked in one of their lectures that the Canadian economy was going through a recession in the early 1990's.[27] The Canadian government was also concerned about its large debt and engaged in several spending cuts in the early to mid-1990's. Our reading of the budgets for this time period confirms this finding: between 1992 and 1995, the government spending decreased several times in the form of cuts to defense and other departmental spending. Gordon Thiessen stated by that by 1998, the Canadian government had returned to a balanced budget and that the debt fell from a high of 104 percent of GDP to 80 percent of GDP by 2000.

Finally, to confirm our findings, we look at the response of output to tax cuts in the post-1999:1 period by when most of the debt related issues in the economy had subsided. The results are shown in Figure 15. We see an immediate increase in output which dissipates quickly. Output then starts to grow again after 6 quarters and reaches a peak of 1.43 percent after 9 quarters of the initial tax cut. The increase in output becomes smaller afterwards but persists for several more quarters. We should note that we only had 64 observations in this sub-sample which would have affected some of the estimates. Nonetheless, the result provides further support to our claim that the debt issues and resulting contractionary spending policy of the 1990s resulted in tax changes losing their effectiveness. Since 1999, tax cuts seem to have regained their expansionary effect on output.

6 Conclusion

This paper adds to the growing literature on macroeconomic effects of exogenous tax changes identified through the narrative approach. The main contribution is the construction of a novel data set of exogenous tax changes for Canada for the time period 1961:1 - 2014:4. We use various budget documents to document all legislated federal tax changes, and then use the motivation behind each tax change to classify it as exogenous or endogenous.

Our baselines results estimated with the proxy-VAR model, show that tax cuts have strong expansionary effects on output in the short-run with the multiplier reaching 2.68 after three quarters of the initial shock. The expansionary effects persist for several more quarters. The strong responses of output to tax changes are mainly driven by changes in consumption and investment. Our further disaggregated analysis shows that cuts in personal income and other taxes have strong expansionary effects on output. Cuts in corporate income taxes have short-lived and insignificant effects on output but affect investment significantly in the

[27]Gordon Thiessen was the governor of Bank of Canada from 1994 to 2001. They made these remarks to the Canadian Club of Toronto. The lecture can be found at `https://www.bankofcanada.ca/2001/01/canada-economic-future-what-have-we-learned/`

short-run.

We also study how the effects of tax changes have changed for Canada for the pre- and post-1991 periods, since the Bank of Canada switched to an inflation targeting policy in 1991. We find that tax changes did not have any significant effect on output for the post-1991 period. However, we find that this result is not driven by the interest rate moving in opposite direction to tax changes in the post-1991 period, as suggested by Romer and Romer (2010). The absence of a significant effect of tax changes on output during this period was caused by a contractionary spending policy adopted by the government in response to concerns about the long-run debt of the economy.

There are several routes for future research. First, our data can be used to study how tax changes in Canada affect the trade variables of its trading partners, in particular the US. Canada is an important export destination for goods from the US and it would be interesting to see how changes in taxes in Canada affect exports of the US. Second, our series on personal income tax changes can be used to study how its effects can vary across different income groups along the lines of Mertens and Montiel Olea (2018). Third, it would be interesting to study how changes in provincial taxes affect incomes and GDP, both at the provincial and national level.

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Table 1. Data Sources

Variable	Source
Nominal GDP	Statistics Canada; Table: 36-10-0104-01
Real GDP	Statistics Canada; Table: 36-10-0104-01
Personal Income	Statistics Canada; Table: 36-10-0112-01
Personal Income Tax	Statistics Canada; Table: 36-10-0477-01
Pre-tax Corporate Profits	Statistics Canada; Table: 36-10-0125-01
Corporate Tax	Statistics Canada; Table: 36-10-0477-01
Federal Tax Revenues[1]	Statistics Canada; Table: 36-10-0477-01
Production Tax Revenues	Statistics Canada; Table: 36-10-0477-01
GDP Deflator	FRED - Series ID: CANGDPDEFQISMEI
Real Consumption	Statistics Canada; Table: 36-10-0104-01
Real Investment	Statistics Canada; Table: 36-10-0104-01
Unemployment	FRED - Series ID: LRUNTTTTCAQ156S
Employment[2]	Statistics Canada; Table 14-10-0355-01
Labor Force Participation Rate[2]	FRED - Series ID: LRACTTTTCAQ156S
Government Spending	FRED - Series ID: NAEXKP03CAQ661S
Interest Rate[3]	FRED - Series ID: IR3TIB01CAQ156N
Inflation[4]	FRED - Series ID: CANGDPDEFQISMEI
Exports	Statistics Canada; Table: 36-10-0104-01
Imports	Statistics Canada; Table: 36-10-0104-01
Nominal Exchange Rate	FRED - Series ID: CCUSSP01CAQ650N
Real Exchange Rate	Calculated from Nominal ER and inflations of Canada (FRED: CANCPIALLQINMEI), and the US (FRED: USACPIALLQINMEI)

[1] Government Revenue less transfers from non-residents, investment income, and sale of goods and services. Normalized by GDP Deflator

[2] Data available from 1976 onwards. For the data before that, we looked at the Historical Labour Force Statistics 1977 version. The data in that version was available from 1966 onwards. We normalized the 1966-1975 data by the average of ratio of the data for 1976 found in the historical statistics and that from Statistics Canada and FRED. The numbers were very close and the average of this ratio turned out to be 0.982 for the employment series and 0.993 for labor force participation rate

[3] 3-month rates

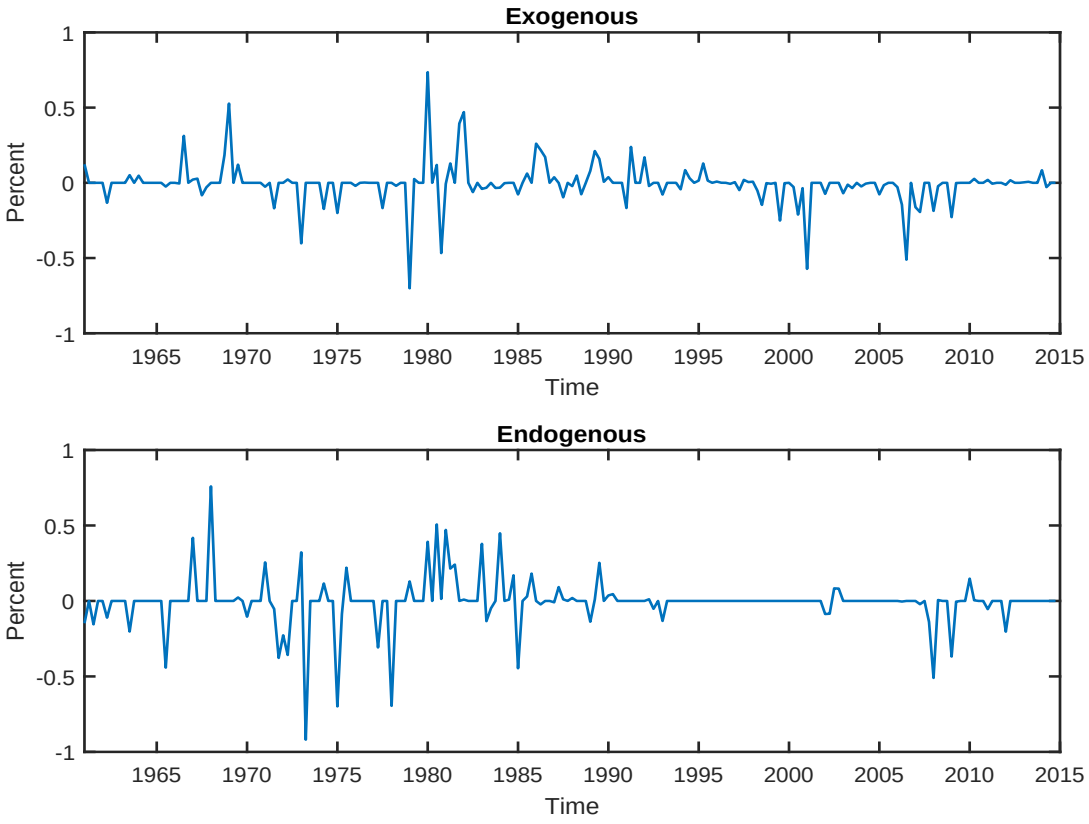
[4] Calculated from Implicit GDP Deflator

Table 2. Tests of Predictability

Granger Causality Test		
Series	Test Statistic	P-value
Exogenous Series	22.17	0.14
Endogenous Series	32.15	0.01
Ordered Probit Test		
Series	Test Statistic	P-value
Exogenous Series	17.86	0.33
Endogenous Series	26.12	0.05

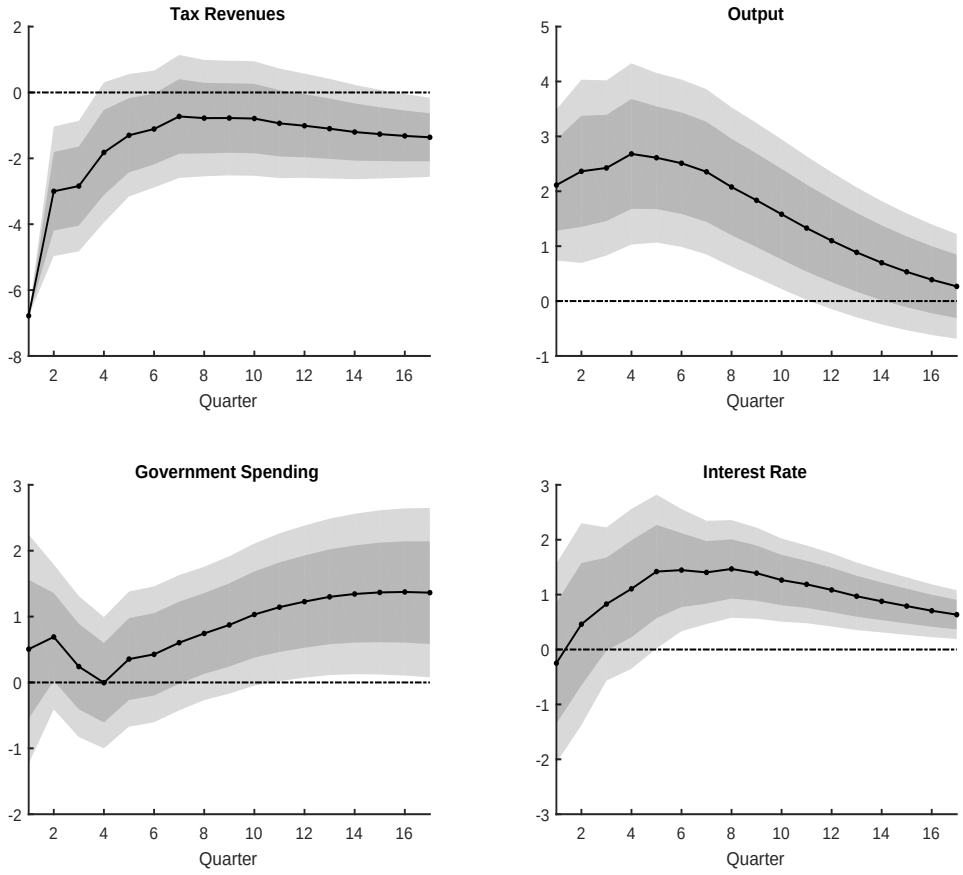
Note: The top panel presents the estimation results from Granger causality test. We estimate a VAR which includes 4 lags of growth rates of output, government spending, and first difference of short-term interest rates and inflation rates, together with the exogenous/endogenous tax series. The bottom panel presents the estimation results from the Ordered Probit test for exogenous/endogenous series.

Figure 1. The Taxes Series by Narrative Approach



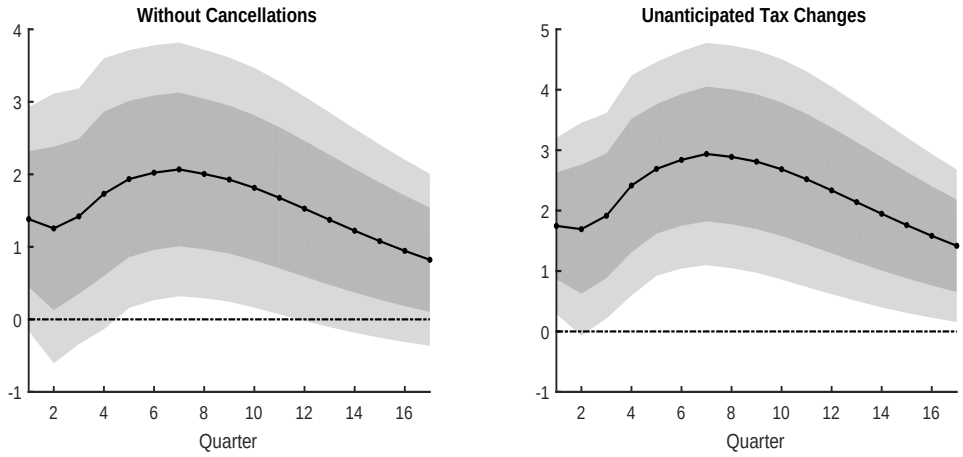
Note: The top panel is the narratively constructed exogenous tax series, and the bottom panel is the endogenous tax series from 1961 to 2014.

Figure 2. Effects of Tax Changes Using Proxy-VAR



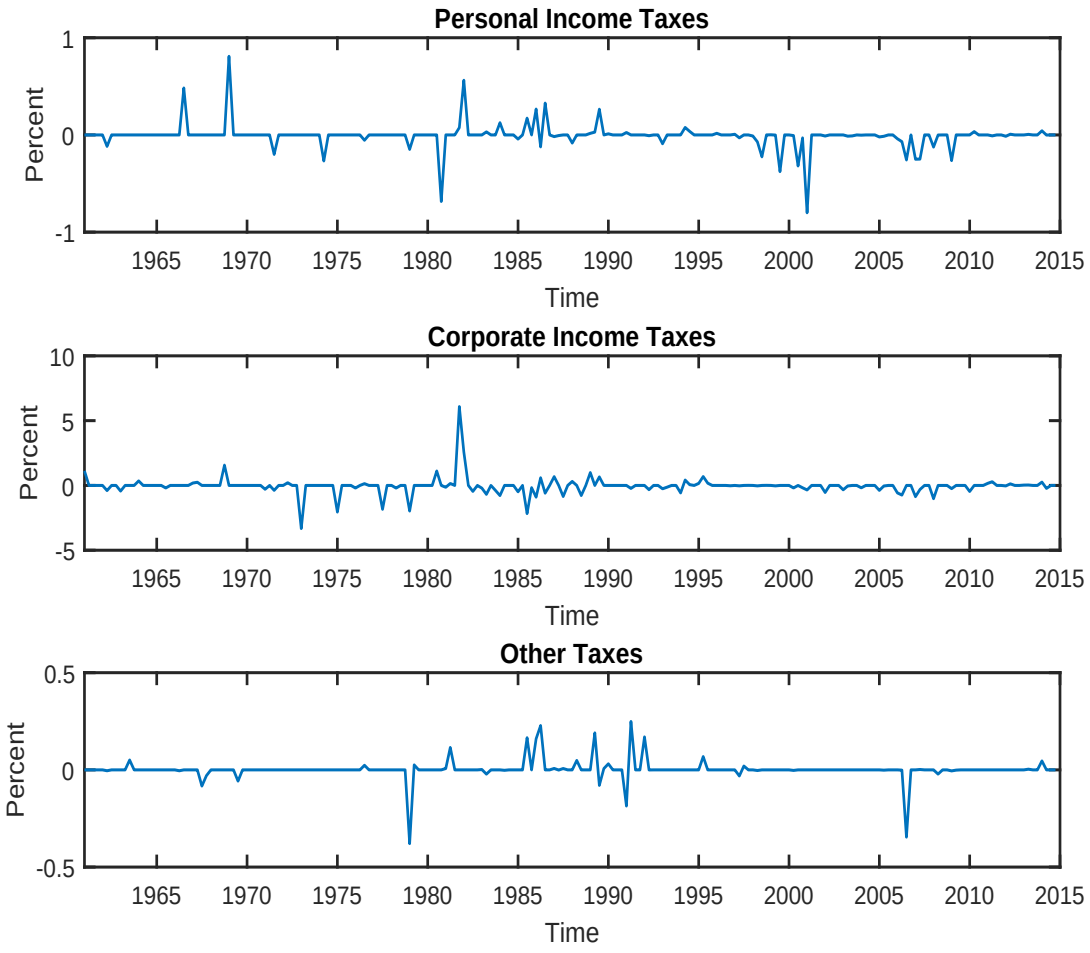
Note: The figure presents the effects of tax changes estimated using the proxy-VAR method. We include log tax revenue, log output, log government spending, and interest rate in the estimation. We identify the structural tax shocks by using the series of narratively identified exogenous tax changes as proxy variable or instrumental variable. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues.

Figure 3. Robustness Check on the Output Responses



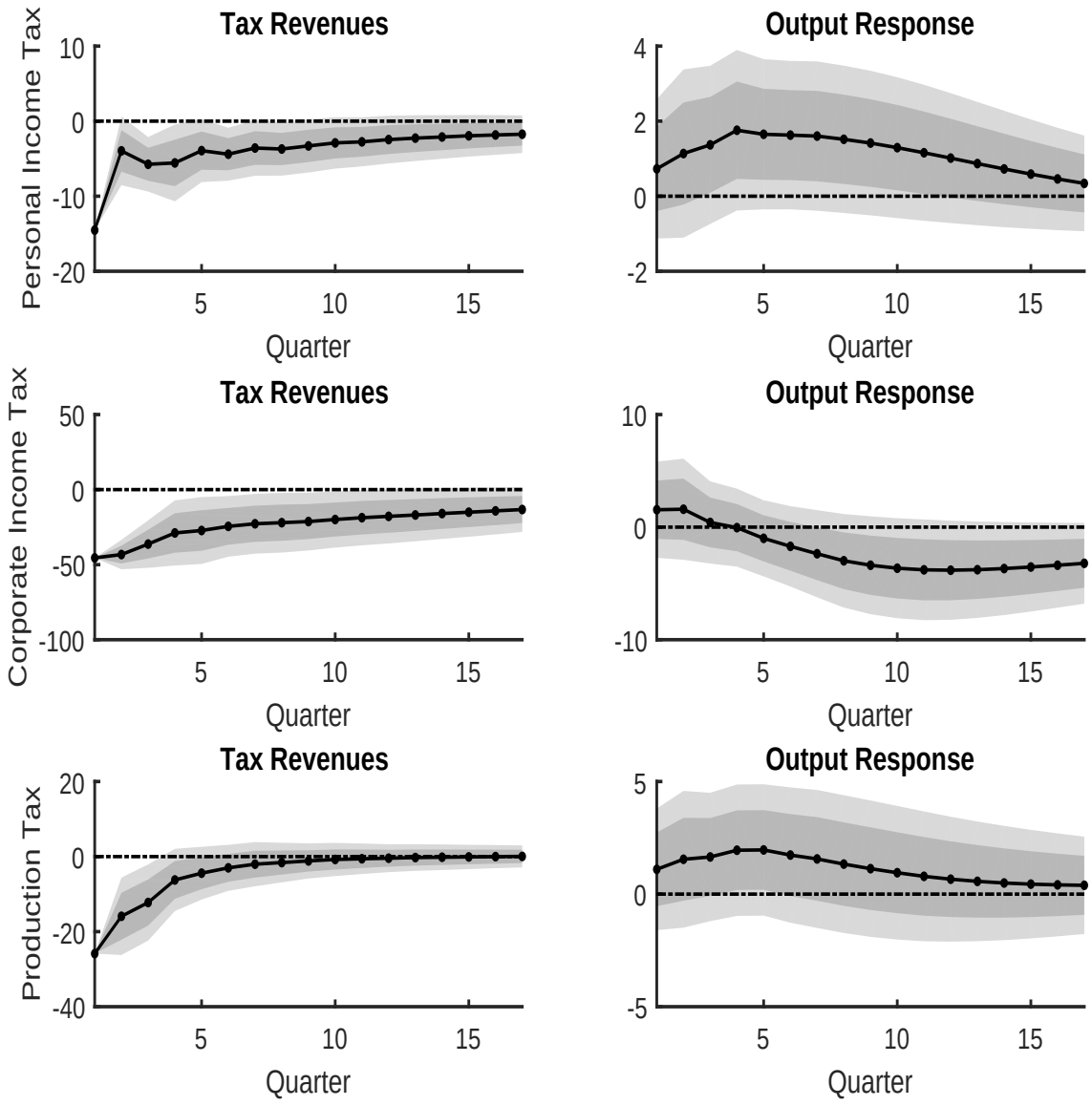
Note: The figure presents the robustness checks with the proxy-VAR method. The left panel is the estimated output responses when the proxy is the measure of exogenous tax changes that excludes cancellations of temporary measures. The right panel is the estimated output responses when we exclude anticipated tax changes from the exogenous tax series. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues, though not shown here.

Figure 4. Personal Income taxes, Capital Taxes and Other Taxes



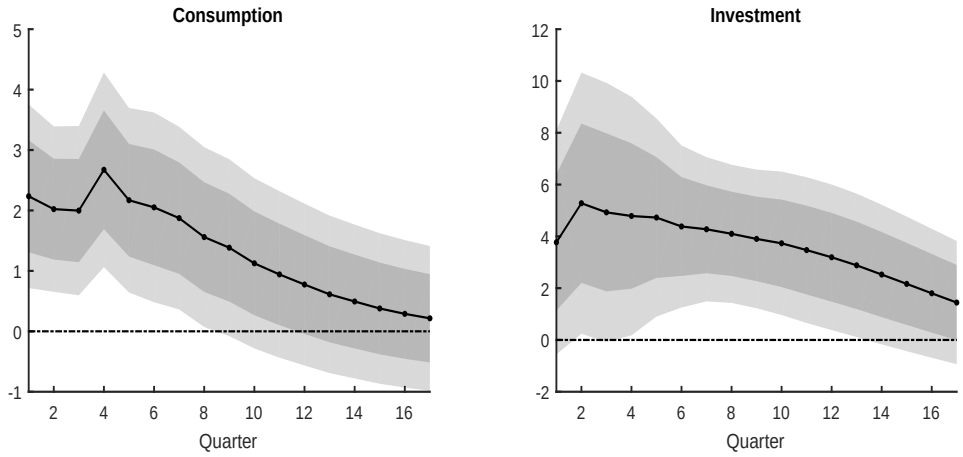
Note: The figure presents three different types of exogenous tax series - personal income tax changes, corporate tax changes and other tax changes. Other tax changes include changes in excise and sales taxes and production taxes. Changes in personal and corporate income tax changes have been normalized by pre-tax personal income and pre-tax corporate profits respectively. The changes in other taxes have been normalized by nominal GDP.

Figure 5. The Output Responses to Different Types of Tax Changes



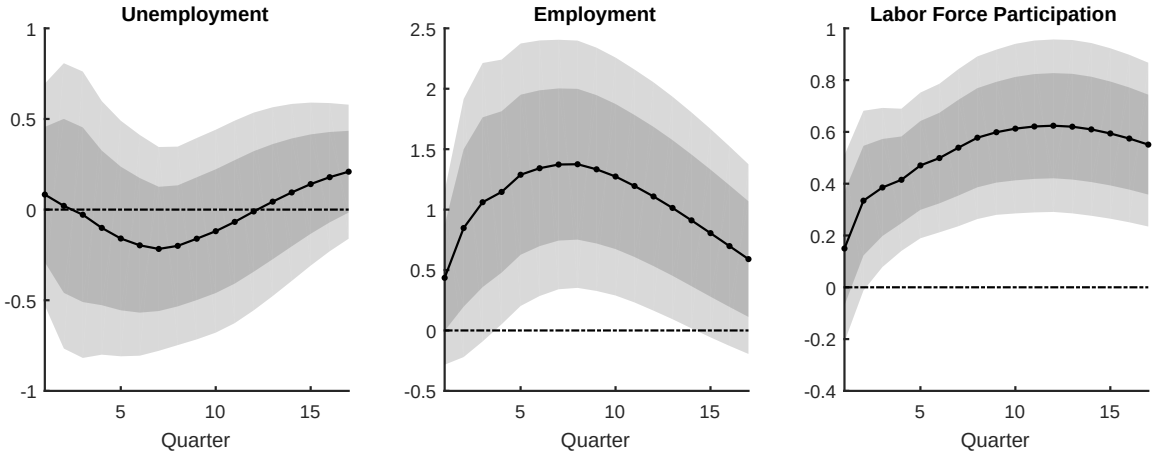
Note: The figure presents the output responses to changes in each type of taxes - personal income taxes, corporate taxes and other taxes. Other tax changes include changes in excise and sales taxes and production taxes. In our baseline specification with the proxy-VAR method, we replace the total federal tax revenues with personal income tax, corporate income tax, and production tax revenues when studying the effects of changes in labor, corporate, and other taxes, respectively. We also include the sum of other two types of taxes in each of our estimations. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues in each category.

Figure 6. Effects of Tax Changes on Consumption and Investment



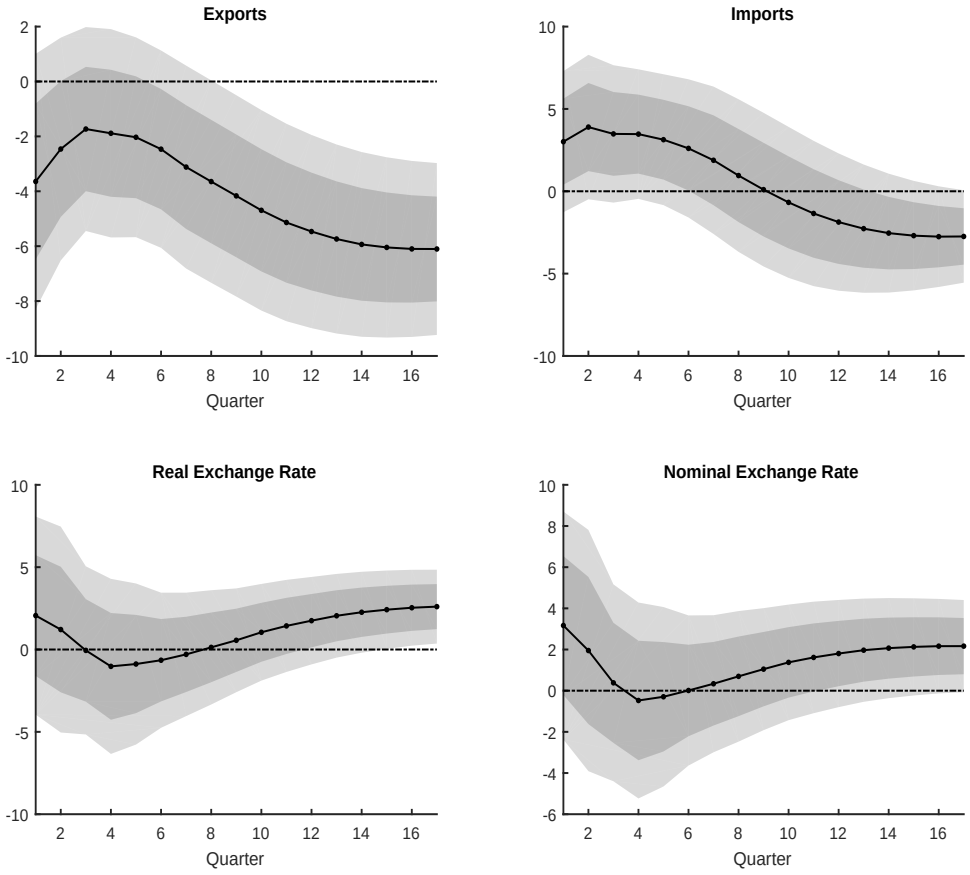
Note: The figure presents the effects of tax changes on consumption and investment. We augment the baseline proxy-VAR model with one additional variable of interest - consumption or investment. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues, though not shown here.

Figure 7. Effects of Tax Changes on Labor Market



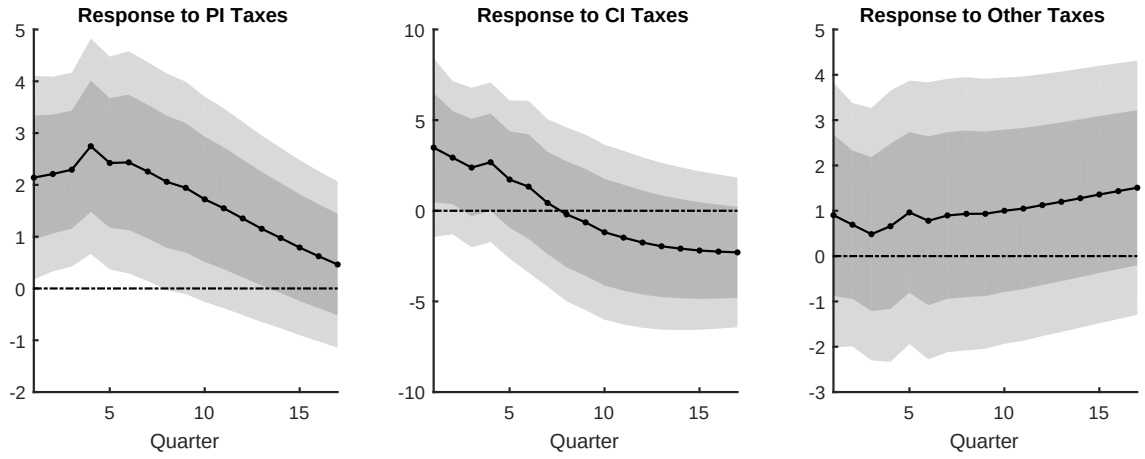
Note: The figure presents the effects of tax changes on labor market. We augment the baseline proxy-VAR model with one additional variable of interest - unemployment rate, employment rate, and labor force participation rate. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues, though not shown here.

Figure 8. Effects of Tax Changes on Open Economy Variables



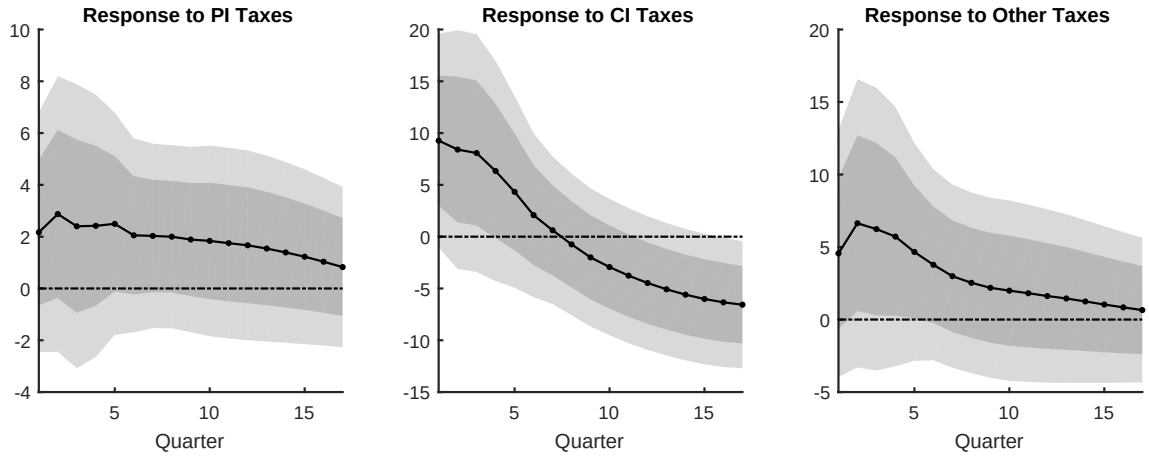
Note: The figure presents the effects of tax changes on open economy variables. We augment the baseline proxy-VAR model with one additional variable of interest - exports, imports, real exchange rate and nominal exchange rate. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues, though not shown here.

Figure 9. Response of Consumption by Different Types of Tax Changes



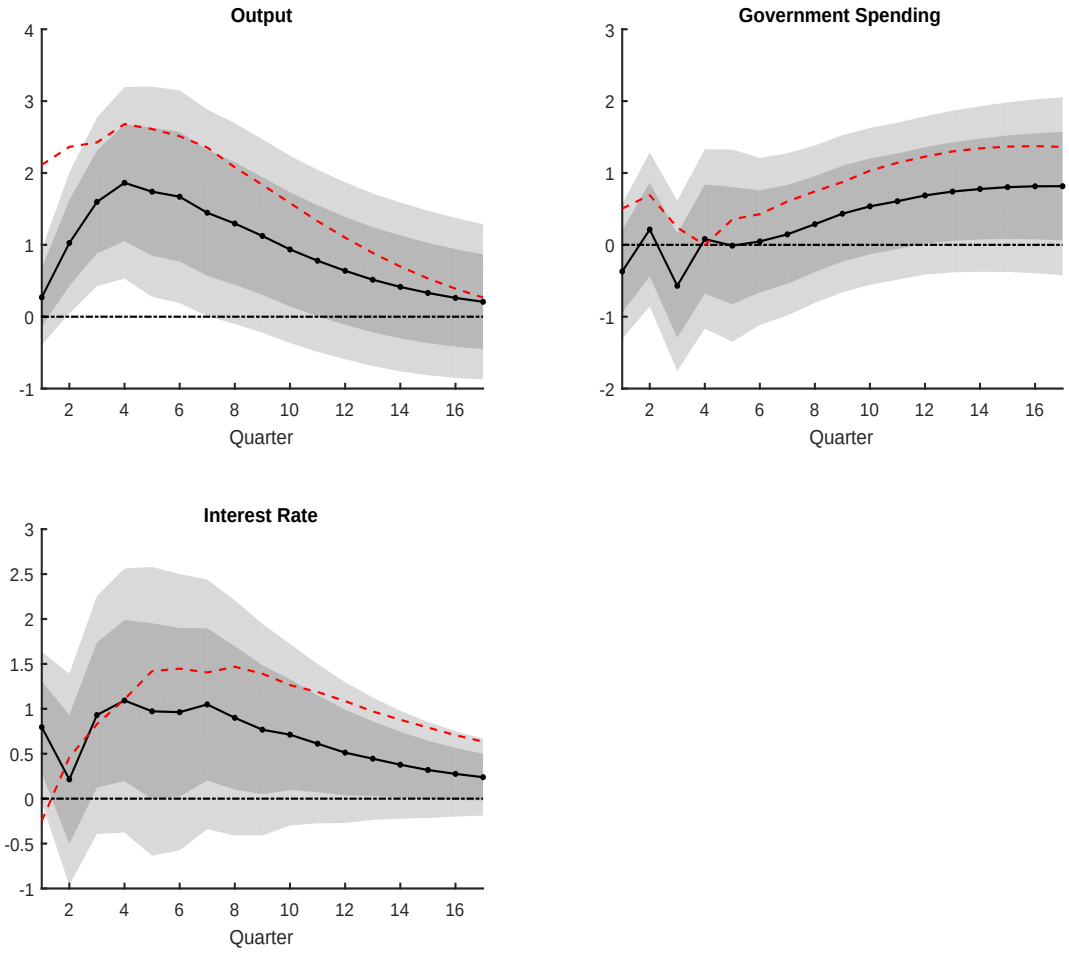
Note: The figure presents the responses of consumption to changes in different types of taxes - personal income taxes, corporate taxes and other taxes. In our baseline specification with the proxy-VAR method, we replace the total federal tax revenues with personal income tax, corporate income tax, and production tax revenues when studying the effects of changes in labor, corporate, and other taxes, respectively. Other taxes include changes in excise and sales taxes and production taxes. We also include the sum of other two types of taxes in each of our estimations. We then augment the VAR with one additional variable of interest - consumption. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues in each category, though not shown here.

Figure 10. Response of Investment by Different Types of Tax Changes



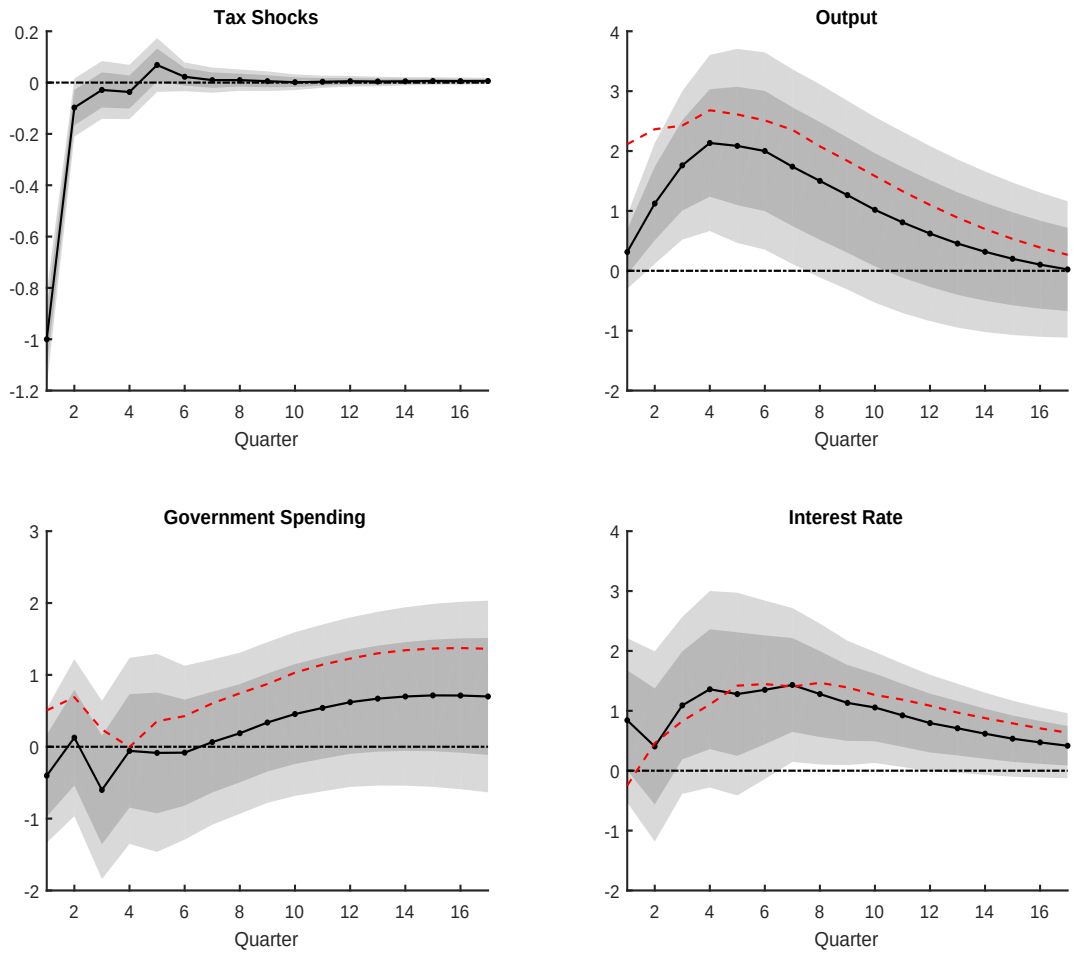
Note: The figure presents the responses of investment to changes in different types of taxes - personal income taxes, corporate taxes and other taxes. In our baseline specification with the proxy-VAR method, we replace the total federal tax revenues with personal incomes tax, corporate income tax, and production tax revenues when studying the effects of changes in labor, corporate, and other taxes, respectively. Other taxes include changes in excise and sales taxes and production taxes. We also include the sum of other two types of taxes in each of our estimations. We then augment the VAR with one additional variable of interest - investment.The shaded area are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues in each category, though not shown here.

Figure 11. Effects of Tax Changes Using the Reduced form VAR



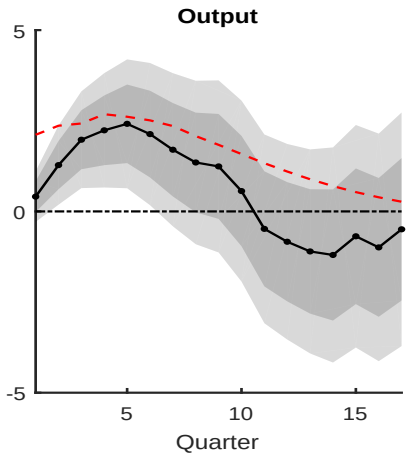
Note: The figure presents the effects of tax changes estimated using the reduced form VAR. The VAR includes log real GDP, log real government spending, log real tax revenues, and interest rates as the endogenous variables along with the narrative shock series as the exogenous variable. The shaded areas are 68% and 90% confidence intervals. For easy comparison, the dashed line is the baseline results estimated with the baseline proxy-VAR model.

Figure 12. Effects of Tax Changes Using Internal Instrument Approach



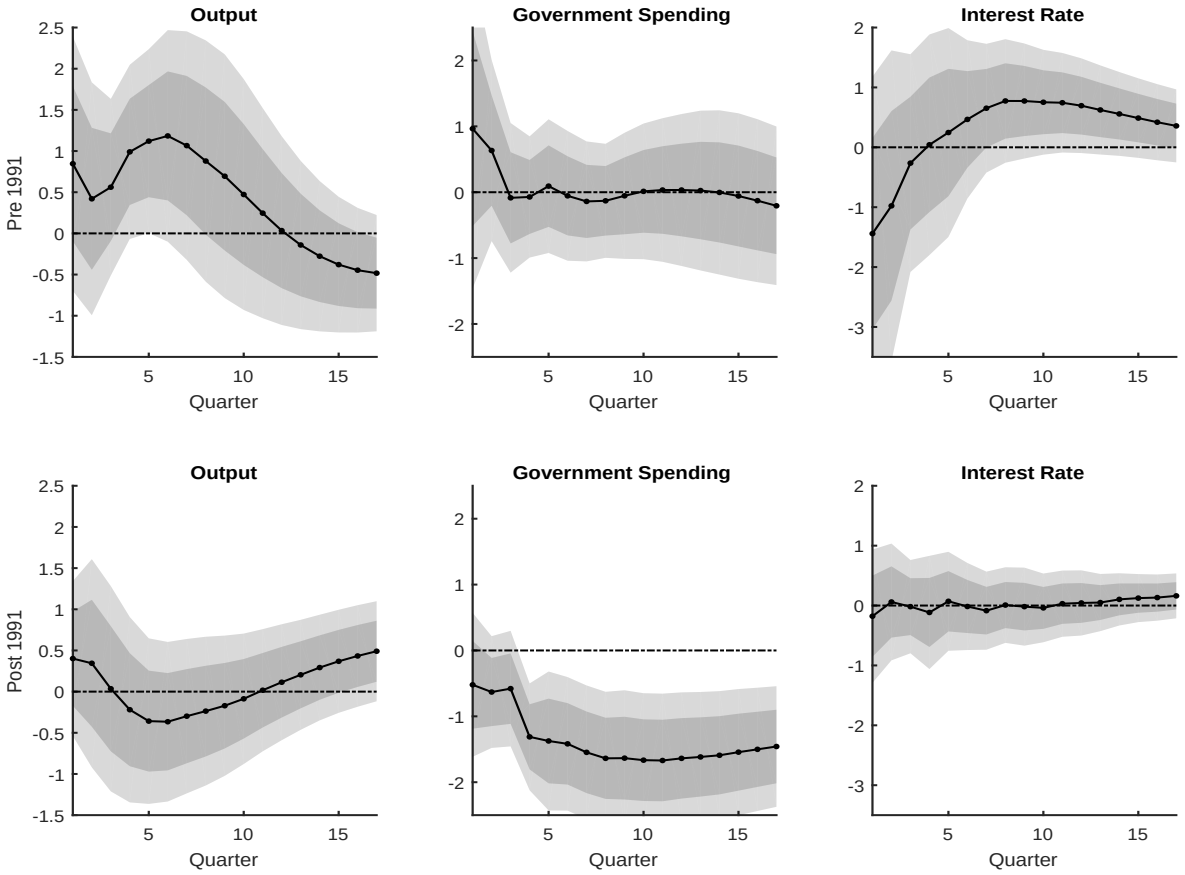
Note: The figure presents the effects of tax changes estimated using the internal instrument approach. The model includes the narrative shock series ordered first in a recursive VAR which also includes real log GDP, log real government spending, log real tax revenues, and interest rates. The shaded areas are 68% and 90% confidence intervals. We normalize the initial response of the narrative tax shock series to equal 1. For easy comparison, the dashed line is the baseline results estimated with the proxy-VAR.

Figure 13. Effects of Tax Changes Using Jordà's Method



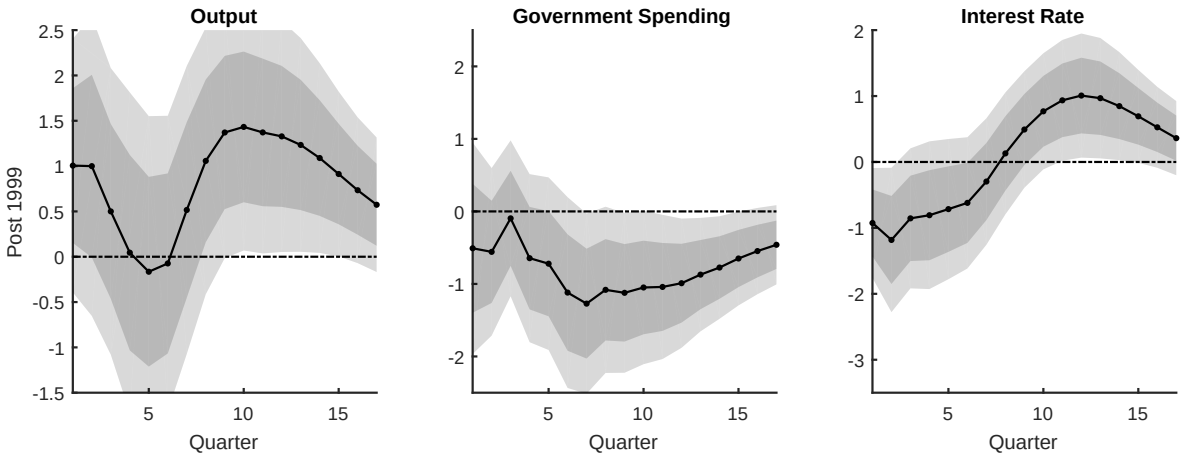
Note: The figure presents the estimated output responses using Jordà's Local Projection Method. The shaded areas are 68% and 90% confidence intervals. For easy comparison, the dashed line is the baseline results estimated with the proxy-VAR.

Figure 14. Effects of Tax Changes Pre-1991 and Post-1991



Note: The figure presents the effects of tax changes estimated using the proxy-VAR method for pre-1991 (the top panels) and post-1991 (the bottom panels) periods. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues.

Figure 15. Effects of Tax Changes Post-1999



Note: The figure presents the effects of tax changes estimated using the proxy-VAR method for post-1999 period. The shaded areas are 68% and 90% confidence intervals. We normalize the initial impact on tax revenues to be equal to the average of ratio of nominal GDP and tax revenues.