Corporate Income Tax and Economic Growth: Further Evidence from Canadian Provinces

Bev Dahlby and Ergete Ferede*

Received 20 October 2020; in revised form 03 December 2020; accepted 04 December 2020

This paper investigates the effect of corporate income tax (CIT) rate on economic growth, using panel data from Canadian provinces over the period 1981–2016. Our empirical approach enables us to examine the long-run relationship between provincial tax rates and economic growth by allowing short-run dynamics to vary across provinces. We find that a reduction in the CIT rate has a statistically significant positive effect on the economic growth rate. Based on our main specification, a one-percentage-point reduction in the provincial CIT rate increases the growth rate by 0.12 percentage point four years after the initial CIT rate cut.

Keywords: corporate income tax, economic growth, investment, fiscal federalism

JEL classification: H 20, H 70, O 51

1. Introduction

The impact of taxes on economic activities has long been one of the most debated issues in the literature. A large number of earlier theoretical and empirical studies focus on analyzing the economic effects of a corporate income tax (CIT). This issue has particularly attracted a lot of attention following the recent tax cut by the U.S. government. Various commentators and analysts argue that similar pro-growth tax policies are essential to boost economic activities around the world. In this regard, the recent CIT rate cut adopted by the provincial government of Alberta is a good example of such a tax policy. In May 2019, the newly elected government of Alberta announced that it would gradually reduce the provincial general statutory CIT rate from 12 percent to 8 percent in 2022. What are the effects of such corporate income tax rate cuts on economic growth? Can Canadian provinces benefit from CIT tax rate cuts?

* Dahlby: University of Calgary, Alberta, Canada (bdahlby99@gmail.com); Ferede: MacEwan University, Edmonton, Canada (feredee@macewan.ca). Financial support by the School of Public Policy, University of Calgary, is gratefully acknowledged. An earlier version of the paper was published in The School of Public Policy Publications, https://www.policyschool.ca/publications/.

FinanzArchiv 77 (2021), 59–82
ISSN 0015-2218
doi: 10.1628/fa-2021-0002

The literature on tax policy shows that a corporate income tax can have adverse effects on total productivity and private investment. The neoclassical theory of investment indicates that an increase in the CIT rate raises the cost of capital for investors and this discourages private investment in an economy. See Jorgenson (1963) and Hassett and Hubbard (1997). The reduction in private investment in turn affects economic growth adversely. Further, a higher CIT rate decreases the total productivity in an economy to the extent that it discourages entrepreneurship. Studies such as Gentry and Hubbard (2000) and Cullen and Gordon (2007), among others, suggest that taxes discourage entrepreneurial activities. Thus, an increase in CIT rate can have negative effects on the economic growth rate through its adverse effects on productivity and private investment.

A number of previous empirical studies also suggest that a higher CIT rate has adverse effects on economic growth. These studies often vary in their empirical methodologies. Some of the earlier studies such as Lee and Gordon (2005), Reed (2008), and Ferede and Dahlby (2012), among others, employ a dynamic panel fixed-effects estimation strategy and find that the corporate income tax rate has a statistically significant negative effect on economic growth. In particular, Ferede and Dahlby (2012) use panel data from Canadian provinces over the period 1977–2006 and find that a one-percentage-point increase in the statutory corporate income tax rate is associated with a 0.1–0.2-percentage-point decrease in the growth rate. Similar studies such as Miller and Russek (1997), Kneller, Bleaney, and Gemmell (1999), Bleaney, Gemmell, and Kneller (2001), Folster and Henrekson (2001), Padovano and Galli (2002), Tomljanovich (2004), Holcombe and Lacombe (2004), Arnold et al. (2011), and others also find evidence of a negative relationship between taxes and economic growth.

Although the dynamic panel fixed-effects estimation approach is common in the literature, it implicitly assumes the homogeneity of regression estimates and restricts economies to have the same short-run dynamics as well as long-run equilibrium. In particular, one may question the implicit assumption in such an approach that provinces with varied economic structures would converge to their long-run equilibrium at the same rate. An alternative to this approach of restricting coefficients to be the same for all provinces is to estimate the effects of fiscal policy on economic growth for each province separately. This method, however, does not take advantage of the rich variations that panel-data analysis provides. Consequently, Pesaran et al. (1999) propose a pooled mean group (PMG) estimator that is an intermediate between the above two alternative estimation methods. The PMG allows each province to have different short-run dynamics but assumes that they will have the same long-run equilibrium. For this reason, PMG has recently become popular, and some of the recent empirical studies such as Baiardi et al. (2019), Xing (2012), Ojede and Yamarik (2012), Gemmell et al. (2011, 2014), and others employ this method to analyze the effects of fiscal policies on economic growth.

In this paper, we use PMG estimator to investigate the effects of corporate income tax on economic growth rate using annual panel data for Canadian provinces over the sample period 1981–2016. This empirical approach enables us to investigate the long-run relationship between provincial tax rates and economic growth by allowing short-run dynamics to vary across provinces. That is, as the provinces in the same federation are highly interconnected and influenced by many similar factors, they are expected to have the same long-run equilibrium. However, due to variations in the structure of their economies, they may tend to reach the common long-run equilibrium at their own respective convergence rates. Our empirical results obtained from the PMG estimator show that the corporate income tax (CIT) rate has a statistically significant negative long-run effect on the economic growth rate. In studies such as ours, based on the neoclassical growth model, this growth effect is temporary, as the growth rate eventually returns to its long-run equilibrium value. According to our preferred specification of the econometric model, a one-percentage-point reduction in a provincial government's statutory CIT rate increases the growth rate by 0.12 percentage point four years after the initial CIT rate cut and increases real per capita GDP by 1.2 percent in the long run. This result is broadly consistent with the findings of previous Canadian studies such as Ferede and Dahlby (2012) and U.S.-based studies such as Reed (2008). Further, the main empirical finding of this paper is robust to various sensitivity checks.

We also use the empirical estimates to simulate the recently announced reduction in the CIT rate in Alberta from 12 percent in 2018 to 8 percent in 2022. The simulation results indicate that the growth rate of real per capita GDP would increase by 0.92 percentage points in 2022 and by 0.28 percentage points in 2029. The model also predicts that real per capita GDP would be 2.5 percent higher in 2022 and 6.5 percent higher in 2029. An important policy implication of this paper is that provincial governments could significantly improve economic performance by lowering provincial corporate income tax rates.

The remaining part of the paper is organized as follows. Section 2 provides an overview of the Canadian corporate income tax system to highlight the differences between the tax systems of the Canadian provinces and the U.S. states and to put our econometric results in perspective. The econometric results are presented and discussed in section 3. In section 4, we use the empirical estimates to simulate the growth rate and income gains associated with the recent corporate income tax cuts in Alberta. Section 5 concludes.

2. Background

A distinctive feature of Canadian fiscal federalism is the substantial amount of tax revenue raised by the provincial governments.[1] The provinces levy all of the major taxes, except customs duties. They levy property taxes and collect royalties on natural resources, sources of revenue that are not tapped by the federal government. Among countries around the world, only Switzerland – where the cantons and communes raised 39.6 percent of total tax revenues – and the United States – where state and local governments raised 33.0 percent – come close to rivaling the 49.9 percent of total tax revenues raised by Canadian provincial and local governments in 2015.[2] From a taxation perspective, Canada is the most decentralized country in the world.

In particular, the provincial governments are major players in the corporate income tax field. For instance, the Canadian provinces' share of corporate income tax revenues has increased from 23.0 percent in 1965 to 38.7 percent in 2017, whereas in the United States the states' and local governments' share of CIT revenues has declined from 27.6 percent in 1983 to 14.6 percent in 2017. According to Ljungqvist and Smolyansky (2018), corporate income taxes represented around five percent of U.S. state government revenues in 2010. In Canada, corporate tax revenues averaged 7.0 percent of provincial government revenues from 2008 to 2017.[3] However, reliance on corporate tax revenues varied greatly, from 3 percent of revenues in Prince Edward Island to 10 percent in Alberta.

Also, in contrast to other federal countries such as Germany, the provinces have complete autonomy in setting corporate tax rates.[4] Even though the federal Canada Revenue Agency (CRA) administers the collection of corporate income taxes for eight of the ten provinces, provinces have substantial control in defining the CIT base, within limits determined by their tax collection agreements with the federal government. While Alberta and Quebec administer their own CITs, their tax bases generally parallel the federal and other provinces' tax bases, to reduce businesses' tax compliance costs. As a result, the provincial corporate income tax systems display a greater degree of harmonization than among the OECD countries or U.S. states.

1 The 10 Canadian provinces in descending order of their economic sizes are Ontario (ON), Quebec (QB), Alberta (AB), British Columbia (BC), Saskatchewan (SK), Manitoba (MB), Nova Scotia (NS), New Brunswick (NB), Newfoundland & Labrador (NFL), and Prince Edward Island (PEI).

2 Based on the OECD Fiscal Decentralization Data Base. Available at http://www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm#C_5.

3 In Canada, corporate tax revenues averaged 7.0 percent of provincial government revenues from 2008 to 2017, according to Statistics Canada.

4 Note that in Germany, while states have little authority over tax rates, local business taxes are differentiated on the municipal level.

One notable example of the greater degree of subnational tax harmonization in Canada is the use of a common allocation formula for taxable income, based on equal weights for shares of sales and payrolls generated by corporations with permanent establishments in more than one province.[5] This contrasts with the situation in the USA. Traditionally, states used three equally weighted factors – the shares of sales, payrolls, and property of a corporation in a state – to determine the corporate tax liability in a state. However, since 1986, many states have started to "double weight" the sales factor and thereby reduce the weights on payroll and property in an attempt to attract employment and investment. Now, 30 percent of states only use the share of sales in a state to determine the tax liability of a corporation with operations in more than one state.[6] Suárez Serrato and Zindar (2016, p. 159) argue that these changes to the allocation formulas and other measures that have narrowed the states' tax bases mean that "a tax rate increase mechanically raises less revenue since taxable income is a smaller portion of overall income. In addition, tax changes have smaller incentive effects, so the behavioral responses to tax rate increases are likely attenuated." Changes in the states' allocation formulas over time and differences across states in the allocation formula and other policies that determine taxable income make it difficult to estimate the effects of corporate income tax rate changes on the U.S. states' economic performance in panel regression models that do not take these factors into account. While there are variations in the provincial corporate tax bases and available tax credits across provinces and over time, observers familiar with the tax systems on both sides of the Canada–U.S. border generally agree that there is a greater degree of tax base harmonization in Canada. For instance, all provinces (with the exception of Alberta and Quebec) use the federal government's definition of corporation taxable income, and the federal government administers the tax system on behalf of the provinces. Alberta and Quebec, which administer their own corporate income tax systems, use tax base definitions that are not significantly different from the federal tax base.

Two other important fiscal differences between the U.S. states and the Canadian provinces should be noted. First, provincial personal and corporate income taxes are not deductible from Canadian federal taxes whereas state and local taxes are eligible for federal deductions in the U.S. This means that a provincial corporate income tax increase has a larger impact on incentives to invest than a similar state corporate income tax increase. A second important difference between Canadian provinces and U.S. states is that the provinces either do not have balanced-budget laws or have balanced-budget

5 Special allocation rules apply to the finance and transportation sectors. In the 2011–2015 period, 40 percent of federal taxable income was allocated among the provinces.

6 Clausing (2014, p. 8).

laws that have not effectively constrained their ability to run deficits, whereas many U.S. states are required to run balanced budgets. As Gale, Krupkin, and Reuben (2015, p. 920) point out, "state balance budget requirements imply that revenues and spending should co-vary closely, making it more difficult to study independent influences of taxes or spending." Using Musgrave's distinction between absolute, differential, and balanced-budget fiscal adjustments, our empirical analysis can be interpreted as an absolute fiscal adjustment where the government's surplus or deficit adjusts in response to a change in the corporate tax rate, whereas in the U.S. context the fiscal adjustment is more likely to be an offsetting change in another tax or expenditures, as governments still face the intertemporal budget constraint.

Figure 1a

Statutory General CIT Rates in the Atlantic Provinces, 1981 to 2016

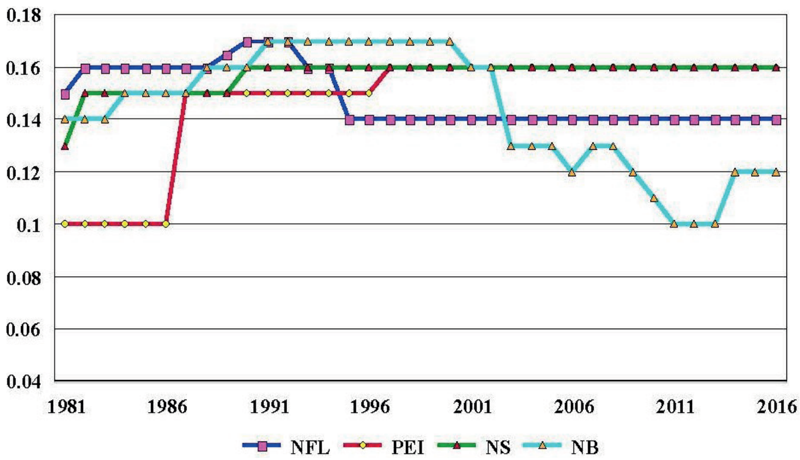
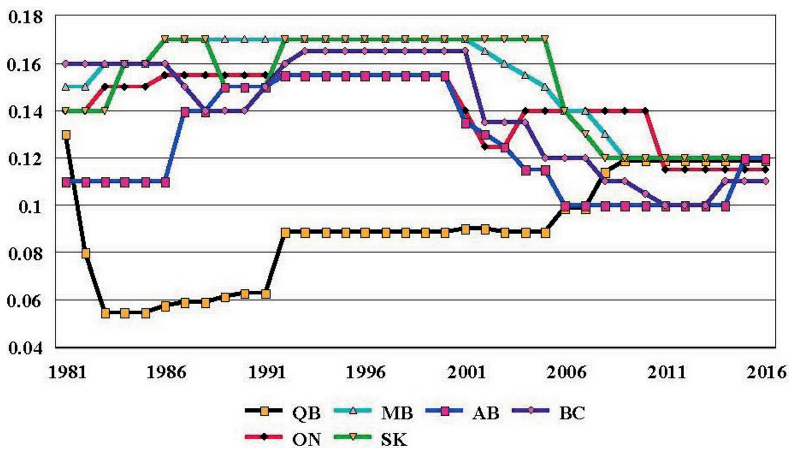


Figure 1a shows the trend in the general statutory tax rates of the four Atlantic provinces, and figure 1b shows the rates for the other six provinces from 1981 to 2016.[7] We show the CIT rates for these two groups separately for visual clarity and because the Atlantic provinces have smaller populations and have had poorer economic performances than the other six provinces. Note that with the exception of New Brunswick, the CIT rates of the other three Atlantic provinces have generally been higher and more stable than those of the other six provinces. Turning to figure 1b, we see that Quebec sharply reduced its CIT rate in 1982 from 8 to 5.5 percent and maintained a rate that was

7 The provinces also set lower tax rates for small businesses and in some cases for manufacturing and processing activities, but these are excluded from this analysis.

Figure 1b
Statutory General CIT Rates in the Other Provinces, 1981 to 2016



lower than in any other province until 2006. In contrast, the other provinces increased their CIT rates in unsynchronized steps from 1981 to 1992. Over this period, the median provincial CIT rate increased from 12 percent to 16 percent. From 1992 to 2000, the nine provinces maintained their CIT rates in a relatively narrow band, from 14 to 16 percent. Starting in 2001, with cuts in Alberta and Ontario, the CIT rates started to decline in the other provinces, except in Nova Scotia and P.E.I., which maintained their 16-percent tax rates. On the other hand, Quebec started to increase its CIT rate. Over this period, from 2001 to 2016, the median provincial CIT rate declined from 16 percent to 12 percent in 2016, and the CIT rate differential among the six provinces shown in figure 1b has shrunk.

Given the large differences in size and performance of the provincial economies, it should not be surprising that there are large variations in provincial CIT revenues. Four provinces – Ontario (35.4 percent), Quebec (21.3 percent), Alberta (20.0 percent), and British Columbia (10.7 percent) – accounted for 87.4 percent of provincial CIT revenues from 2008 to 2014.[8]

8 Calculations based on Statistics Canada, CANSIM table 385-0034.

3. Empirical Results and Discussion

3.1. Specification

Earlier studies of the tax–growth nexus follow various empirical methods. A number of these studies use the dynamic panel fixed-effect estimation approach. One limitation of this empirical method is that it implicitly assumes the homogeneity of regression estimates and restricts economies to have the same short-run dynamics and the same long-run equilibrium. In particular, one may find the implicit assumption in such an approach – that the provinces, with varied economic structure, would converge to their long-run equilibrium at the same rate – to be questionable. An alternative to this approach of restricting coefficients to be the same for all provinces is to estimate the effects of fiscal policy on economic growth for each province separately. This method, however, does not take advantage of the rich variations that panel-data analysis provides. Consequently, Pesaran et al. (1999) propose a pooled mean group (PMG) estimator that is an intermediate between the above two alternative estimation methods. The PMG allows each province to have different short-run dynamics, but assumes that they will have the same long-run equilibrium. For this reason, PMG has recently become popular, and some of the recent empirical studies such as Xing (2012), Ojede and Yamarik (2012), Gemmell et al. (2011, 2014), and others employ this method to analyze the effects of fiscal policies on economic growth.

One important advantage of the PMG estimator is that it allows the constant-term and short-term effects to vary across provinces while the long-term effects remain the same for all the provinces. Our main interest is in investigating the long-term economic growth effects of tax rate changes, but due to variations in the structure of their respective economies, we expect the provinces to adjust to their long-term equilibrium differently. It is reasonable to expect similar provincial responses in the long term, as they are subject to significant labor and capital mobility and operate within similar legal, monetary, and regulatory frameworks. In the short run, on the other hand, due to the unique features of each province, they may tend to adjust to economic shocks and policy changes differently. Thus, our analysis is based on an error correction model specified in a logarithmic form as[9]

$$\Delta \ln(Y_{it}) = \alpha_{Y,i}(\ln Y_{it-1}) + \alpha_{\text{CIT}}(\ln \text{CIT}_{it}) + \sum_{j=0}^{n} \theta_{1i} \Delta \ln \text{CIT}_{it-j} + \mu_i + \epsilon_{it}, \quad (1)$$

9 For the theoretical foundation of the empirical model, see for instance Ferede and Dahlby (2012) and the references contained therein.

where ln denotes the logarithm, Y_{it} is the real GDP per person in province i in year t, and CIT_{it} is the corporate income tax rate in province i in year t. Also, μ_i is the province-specific constant term and ϵ_{it} is the error term. Note that the dependent variable is the growth rate of real GDP per capita. In the above specification, only the key variables of interest are shown. However, the model incorporates various control variables that are generally deemed important in explaining economic growth. These other control variables are not shown, for brevity. In equation (1), the coefficient of the error correction term (α_{Yi}) is expected to be negative and is allowed to vary across provinces so that each province will have its own adjustment path to the common long-term equilibrium. In equation (1), the long-term effects of the tax rate on economic growth are given by α_{CIT}. This coefficient is the same for all provinces and, as is common in the related literature, α_{CIT} can be interpreted as the percentage change in the annual growth rate associated with a one-percent change in the CIT rate. The dynamics of adjustment to long-run equilibrium vary by province and are given by α_{Yi}. If the variables of interest are nonstationary, they will enter the error-correction expression in levels and the short-run dynamics in first differences. Stationary variables will enter only in the short-run dynamics.

The PMG requires long-term panel data. With 35 years of annual provincial panel data, PMG is suitable for our empirical analysis.[10] One may be concerned about the endogeneity of the explanatory variables and the associated bias in coefficient estimates. However, in a series of papers, Pesaran and his collaborators argue that in the context of ARDL models, PMG overcomes the endogeneity problem in estimating long-run coefficients. Thus, as discussed in Pesaran (1997, pp. 182–184), Pesaran and Shin (1999, p. 386), and Pesaran, Shin, and Smith (1999, p. 624) among others, the PMG estimator effectively deals with the potential problems of endogeneity and autocorrelation, and this avoids the need to find instruments for endogenous explanatory variables.[11] In an attempt to highlight the channels through which taxes affect economic growth, Ferede and Dahlby (2012) included private investment in the growth regression and provided a separate estimate of the effect of tax rates on investment. In this paper, however, we do not control for private investment in our regression, and hence the growth regression can be considered a reduced form that encompasses the effects of taxes on growth through both the level of investment and productivity. Such an empirical specification is common in the empirical literature. See, for instance, Lee and Gordon (2005).

10 Pesaran (2015) indicates that the coefficient of the lagged dependent variable in PMG may be downward bias in the presence of small T. However, given the 35 years of data, this is less of a concern in our case.

11 See also Gemmell et al. (2011, 2014) for similar discussions and applications in the context of an empirical analysis of the determinants of economic growth.

Although this paper focuses on the CIT rate, the empirical analysis also controls for personal income tax, provincial sales tax, and the share of other own-source revenue in total revenue as additional explanatory variables. In addition to the tax rates, we also include additional control variables that were deemed to have effects on economic growth in previous studies. These control variables are the ratio of government expenditure to GDP, the ratio of public investment to GDP, the provinces' main-export commodity price index, and U.S. real GDP. All variables enter in the regression in natural-log form. Since Alberta does not impose a provincial sales tax, we use the log of one plus the sales tax rate in the regression.

3.2. Data

In our empirical analysis, we use annual data for all 10 provinces for the period 1981–2016. We obtained the data on tax rates from Finances of the Nation and the Canada Revenue Agency. In addition, the key macroeconomic variables of GDP, government expenditure, public investment, population, exports, and imports come from the Statistics Canada data source CANSIM. We provide the basic summary statistics for the relevant variables in table 3 in the appendix.

It should be noted that Statistics Canada has revised the Canadian GDP figures, so that consistent provincial data are available only from 1981 onwards.[12] Thus, direct comparison between the pre- and post-1981 GDP data series is impossible. This also makes replicating the results of Ferede and Dahlby (2012) by simply extending their data series infeasible. Consequently, we limit our analysis to the period 1981–2016. Thus, this paper focuses on investigating the relationship between corporate income tax rate and economic growth by employing a different data set, a different time period, and a different empirical methodology from those used in Ferede and Dahlby (2012). This will help shed light on whether the previously obtained adverse effects of the corporate income tax rate on economic growth are robust to an alternative data set, time period, and empirical methodology.

3.3. Econometric Results

As discussed above, our empirical strategy enables us to estimate the long-run relationship between tax rates and economic growth by allowing their short-run dynamics to vary across provinces. This methodology requires a long time series that will be sufficient to estimate the short-run dynamics for each province separately. However, in studies that use long-time-series data

12 See Statistics Canada CANSIM table 36-10-0222-01 (formerly CANSIM 384-0038).

such as ours, one needs to first investigate the time-series properties of the various variables of interest. The reason is that the PMG method assumes that the variables in the long-run relationship are nonstationary. For this reason, the first step in the time-series analysis is to check for the order of integration of the various variables, and this is how we begin our analysis.

The results of the unit-root tests reported in table 4 in the appendix show that all the variables with the exception of population growth rate, PIT rate, and PST rate are nonstationary in levels, but they are stationary in first differences, suggesting that they have possible long-term effects on growth and can enter the cointegrating vector.[13] The unit-root tests, on the other hand, show that population growth and the PIT and PST rates are stationary in levels. Thus, these variables will be excluded from the long-term relationship that requires nonstationarity, but will be included as part of the short-run dynamics of the model. Thus, it should be noted from the outset that due to the stationarity of PIT and PST rates, our analysis focuses on the long-term growth-rate effects of the CIT rate rather than the other tax rates.

Table 1 reports the long-run coefficient estimates of the various variables of interest obtained from the PMG estimator. The short-run coefficient estimates that vary across provinces are not shown, as our focus is on the long-term relationship between tax rates and economic growth. The dependent variable is the growth rate of real per capita GDP, and the explanatory variables all enter in log forms. Although our empirical approach provides a separate convergence effect (i.e., coefficient for the lagged real per capita GDP) for each province, we present the mean convergence effect for all provinces, to make a comparison possible with those studies that employ a different empirical approach. Generally, PMG estimation provides higher convergence coefficients than the dynamic panel fixed-effects estimation methods such as those used in Ferede and Dahlby (2012). This is because the latter tend to underestimate such a coefficient due to its inherent downward bias.

We begin our analysis in column (1) with the estimation of the long-run growth rate effects of CIT rate by controlling for government expenditures (*GovGDP*) and public investment (*PubInvGDP*). The results suggest, as expected, that the CIT rate has a statistically significant negative long-term effect on the economic growth rate. As explained before, the empirical methodology allows the error correction term to vary by province. Thus, the reported convergence rate is the mean of the error correction terms for all the provinces.

13 Statistically speaking, a variable is said to be stationary if its probability distribution (for example, its mean and variance) remains constant over time. If the variable's mean and variance change over time, it is considered nonstationary. Those variables that are nonstationary in levels but become stationary in their first differences are said to be integrated of order 1, or I(1).

Note also that the coefficient of the error correction term (or the convergence effect) is, as expected, negative and statistically significant. The statistical significance of the convergence effect confirms that the growth rate and the fiscal variables are cointegrated or have a stable long-term relationship. This supports the choice of PMG as an appropriate method to investigate the long-term effects of CIT rate on growth.[14]

All Canadian provinces are small, open economies that are influenced by global economic and noneconomic events. In particular, Canadian economic performance is highly dependent on the U.S. economy, as this country is its neighbor and largest trading partner. Furthermore, fluctuations in global prices of the Canadian provinces' main export commodities can affect economic growth and business activities in the provinces. For instance, the overall economic activity in Alberta greatly depends on global energy prices. Consequently, in column (2), we include the log of the commodity price index of the main export item of provinces (*CommodityPrice*) and the U.S. real GDP as additional control variables. The commodity price index is deflated by the GDP deflator to take into account the effect of inflation. The regression results reported in column (2) show that, as expected, global commodity prices and the U.S. real GDP have statistically significant positive effects on the growth rate. More importantly, the coefficient of CIT, our key variable of interest, continues to be negative and statistically significant, suggesting its strong long-term effects on real GDP growth rate. But note that the numerical magnitude of the coefficient of CIT shows a marked decline (in absolute value) once these additional variables are controlled for.

Although our empirical approach includes province-specific constant terms to capture province fixed effects, there may still be some time-dependent important determinants of economic growth that our model excludes. To circumvent this problem, in column (3) we include a time trend.[15] The time trend

14 Another common way to confirm the appropriateness of the use of PMG is to compare these estimates with those obtained from the mean group (MG) estimator. The MG estimator estimates both the short-run and long-run growth rate effects of the variables for each province separately and uses the averages of these coefficients as the total estimate. While both PMG and MG allow the short-run dynamics to vary across provinces, the former constrains the long-run coefficients to be the same for all provinces. Pesaran et al. (1999) show that this is consistent and a much superior method. In the literature, the Hausman test is used to test between these two models. In our case, the Hausman test statistic is not rejected at the conventional 5-percent level, and we do not reject the null hypothesis that PMG is efficient and preferred to MG. For this and other reasons discussed in the previous section, our empirical analysis is conducted with PMG.

15 The time trend will help us capture time effects. Including year dummies in the empirical model is an alternative way to capture time effects. Ideally, we would have liked to include year fixed effects in the growth regression. However, in the PMG model, which relies on long panels, including many year dummies in the regression as additional explanatory variables is not feasible. This is a common challenge in all empirical studies that employ PMG. Never-

Table 1

Corporate Income Tax Rate and Economic Growth, 1981–2016

	(1) PMG	(2) PMG	(3) PMG	(4) PMG	(5) PMG	(6) IV
Long-run Coefficients						
ln (CIT)	−0.498**	−0.087**	−0.095*	−0.050***	−0.045***	−0.076**
	(0.201)	(0.040)	(0.049)	(0.012)	(0.015)	(0.038)
$\ln(GovGDP)$	−0.438	−0.102	−0.119	−0.386***	−0.401***	−0.153***
	(0.280)	(0.085)	(0.097)	(0.061)	(0.064)	(0.032)
$\ln(PubInvGDP)$	−0.415***	0.065	0.082	0.157***	0.158***	−0.015
	(0.131)	(0.047)	(0.068)	(0.029)	(0.029)	(0.014)
$\ln(CommodityPrice)$		0.093***	0.099***	0.033**	0.032**	−0.001
		(0.022)	(0.028)	(0.013)	(0.013)	(0.006)
ln (U.S. GDP)		0.547***	0.592***	0.210***	0.209***	0.032**
		(0.026)	(0.147)	(0.033)	(0.033)	(0.014)
$\ln(OtherOwn)$				−0.072**	−0.070**	0.038***
				(0.029)	(0.029)	(0.011)
RST dummy					−0.006	−0.002
					(0.012)	(0.008)
(Mean) convergence rate	−0.059***	−0.128***	−0.120***	−0.255***	−0.253***	−0.301***
	(0.010)	(0.035)	(0.032)	(0.064)	(0.063)	(0.050)
Observations	340	340	340	340	340	340
Trend	No	No	Yes	Yes	Yes	Yes
PIT and PST included	No	No	No	Yes	Yes	Yes

Note: Pooled mean group (PMG) estimation method results. Dependent variable is the growth rate of real GDP per capita. Significance levels are shown by * for 10 percent, ** for 5 percent, and *** for 1 percent. The short-run dynamics are not reported. In the above table, the "(mean) convergence rate" is the average convergence-rate estimate for all 10 provinces. The convergence rate for Alberta, corresponding to column (5), is −0.158, and it is statistically significant at the 1-percent level, since its standard error is 0.045. In column (6), the CIT rate is instrumented with current and one-period lagged values of weighted-average (weighted by the reciprocal of the distance between major population centers) CIT rates of other provinces. We also use one-period lagged real per capita deficit as an additional instrument. The lagged dependent variable is also instrumented with its own lagged value.

helps us capture the effects of those exogenous time-dependent factors that are excluded from the model, but can influence the provincial economic growth rate.[16] The coefficient of the time trend is positive and statistically significant, suggesting the importance of allowing for those excluded time-dependent factors. More importantly, the coefficient of the CIT rate is still negative and statistically significant, but the coefficient estimate is slightly higher in absolute value.

So far, our analysis excludes PIT and PST rates, as these variables are stationary and it is not feasible to include them in the long-run relationship. However, given the importance of these variables for provincial governments and the possible relationship between various tax rates, it would be possible to take account of these tax rates in the short dynamics of the growth regression. For this reason, we include the PIT and PST rates in column (4). Further,

theless, in our sensitivity analysis we include five-year period dummies following previous studies such as Gemmell et al. (2014), Bassanini and Scarpetta (2002), and others.

16 Such variables may include, for instance, monetary policy (e.g., interest rates) and other federal fiscal policies.

to take account of the government's budget constraint, we include the share of other own-source revenue in total government revenue (*OtherOwn*) as an additional explanatory variable. This enables us to interpret the tax-rate coefficient of CIT as the effect of deficit-financed tax-rate change on the provincial economic growth rate. The results show that the coefficient of CIT is still negative and statistically significant, but the magnitude of the coefficient estimate exhibits a noticeable decrease.

Finally, previous studies such as Ferede and Dahlby (2012) show that provincial retail sales taxes (RST) affect investment adversely as compared to those provinces that have harmonized their sales tax rate with the federal value-added tax, the GST. Thus, we include a dummy variable (RST dummy) to capture this potential differential effect of the two types of sales taxes in column (5). As column (5) includes all the relevant variables, this is our main regression model, and we focus our discussion on the coefficient estimates of column (5).

Column (5) shows that the CIT rate has negative and statistically significant effects on the real per capita GDP growth rate. Also, note that the coefficient of mean convergence is negative and statistically significant, indicating that the economies will converge to their long-run equilibrium. Thus, the empirical model is consistent with the neoclassical growth model, and tax rate changes have temporary effects on the economic growth rate. As indicated before, the empirical methodology allows each province to converge to the long-run equilibrium at its own convergence rate. Since we control for the various components of the government budget constraint, the coefficient estimates indicate that a one-percentage-point deficit-financed reduction in the CIT rate is associated with an increase in the growth rate of real per capita GDP by 0.12 percentage point four years after the initial CIT rate cut. Real per capita GDP would increase by 1.2 percent in the long run. These results are based on the average convergence rate for the provinces, which implies that two-thirds of the adjustment to the new long-run equilibrium occurs four years after the tax cut, and 95 percent of the adjustment occurs after ten years.

Regarding the other control variables, our main model shows that as expected, increases in the government's current expenditure and public investment are associated with lower and higher economic growth rates, respectively. Thus, the results imply that while deficit-financed increases in nonproductive government consumption expenditure affect growth adversely, increases in productive public investment, such as spending on infrastructure, are growth-enhancing. The empirical estimates suggest that a one-percentage-point increase in the ratio of public investment to GDP is associated with a rise in the growth rate of real GDP per capita by about 0.16 percentage point. Similarly, the results indicate that a one-percentage-point increase in the government spending to GDP ratio is associated with a decline of the growth rate of real GDP per capita by about 0.4 percentage point. The other own-source revenue is also found to have a statistically significant effect on growth rate. These results are broadly consistent with the findings of previous empirical studies such as Gemmell et al. (2011, 2014) Further, an increase in global price of the provincial economies' major export commodities raises economic activities and increases economic growth rates. Thus, as expected, we find that the coefficient of the log of commodity prices is positive and statistically significant, suggesting that increases in the global prices of major exports are favorable to economic growth. Similarly, we find that an increase in the U.S. economy positively influences the Canadian economic growth rate. This is not surprising, given the strong dependence of the Canadian economy on the U.S. economy, as the two are major trading partners and their economies are highly interrelated.

Governments may use tax policy as a powerful tool to influence economic activities. For instance, governments may lower the CIT rate during economic downturns. If this is the case, the CIT rate may be endogenous. Furthermore, since our empirical model is a dynamic panel one, the presence of the lagged dependent variable as an explanatory variable makes it also endogenous. One may be concerned that such endogeneity of the CIT rate and the lagged dependent variable may bias coefficient estimates if it is not addressed properly. However, the PMG estimator is designed to be used in a dynamic panel model such as ours and effectively deals with the endogeneity of the lagged dependent variable by incorporating multiple lagged values of the change in the lagged dependent variable. As Pesaran (1997) discusses in detail, asymptotic or long-run inferences can be made from the short-run and long-run coefficient estimates from PMG even when the explanatory variables are endogenous. Thus, we believe relying on PMG estimates for long-term policy analysis despite the possible endogeneity of the CIT rate is appropriate. Nevertheless, as an additional robustness check, we expanded our estimation to include the commonly used instrumental variable (IV) estimation method in column (6).

In column (6), we estimate our dynamic panel model using the IV method. Finding appropriate instruments is a common empirical challenge in employing the IV method. As in Lee and Gordon (2005), Ferede and Dahlby (2012), and others, we treated the CIT rate as endogenous and instrumented it with contemporaneous and lagged values of the weighted-average (weighted by the reciprocal of the distance between major population centers) CIT rate of other provinces. The lagged per capita GDP is also treated as endogenous, using its own period lagged values. Various statistical tests confirm the appropriateness of the instruments. The results of column (6) suggest that the CIT rate has a statistically significant effect on growth, but the coefficient estimate is higher in absolute value than for our main model in column (5). Note that although various statistical tests show the appropriateness of other provinces' tax rate as a valid instrument, one may be concerned about the implication of the presence of potential spillover effects between provinces. If the reduction of one province's CIT rate reduces the GDP of other provinces, this casts doubt on the relevance of such an instrument. If this is indeed the case, the empirical results of column (6) may be biased and less reliable.

How does our main result compare to those of previous studies? Often, direct comparison may not be possible, due to differences in methodology and specification. However, our results are broadly consistent with those of previous studies. Using the dynamic panel fixed estimation method, Ferede and Dahlby (2012) found that a one-percentage-point increase in the CIT rate is associated with a 0.184-percentage-point decrease in the real per capita GDP growth rate. This was the direct effect of the CIT rate on growth. They also found that CIT affects growth rate through investment. When the two effects are combined, their results suggest that a one-percentage-point reduction in the CIT rate is associated with about a 0.25-percentage-point increase in the growth rate. Thus, our current model has a slightly higher growth effect than in Ferede and Dahlby (2012).[17] Our coefficient of convergence is also higher in absolute value, suggesting that the provinces achieve their long-run equilibrium more quickly and the effects of tax rate changes on growth will be spread over a shorter time span than in Ferede and Dahlby (2012). This is generally expected, since dynamic panel fixed-effects methods are known to yield downward-biased convergence coefficients.

3.4. Sensitivity Analysis

Arguably, one of the most important findings of previous theoretical and empirical studies is that many factors can influence the long-term growth rate of economies. However, studies often focus on some of the key variables of interest, and we follow that common practice in our main analysis. In this subsection, we subject our main regression result to various robustness checks. In particular, we check the sensitivity of our result to the inclusion of additional control variables in the model. The results of the robustness checks are shown in table 2.

Our main empirical analysis attempts to capture time effects by including time trends in the model. Ideally, we would like to include year fixed effects in the analysis. However, in the PMG model it is not feasible to include time dummies. This is generally true in all empirical studies that rely on a PMG es-

17 Whereas Ferede and Dahlby (2012) estimate the growth rate on the CIT rate, this paper uses the log of the CIT rate. To make the results comparable, using the period average CIT rate of 0.14, we can transform the coefficient of this study as $-0.045/0.14 = -0.32$. This is slightly higher, in absolute value, than the estimate obtained in Ferede and Dahlby (2012).

timator. Following previous studies such as Gemmell et al. (2014), Bassanini and Scarpetta (2002), and others, we check the robustness of our results to the inclusion of five-year time dummies in column (1). This allows us to capture province-specific nonlinear trends in the model. The results show that the CIT rate still has a negative effect on growth, but the coefficient estimate is statistically significant at only 10 percent.

Previous studies such as Ferede and Dahlby (2012) find that the ratio of provincial government budget deficit to GDP and the population growth rate have significant effects on the economic growth rate. We do not include these two variables in our main analysis, because they are stationary in levels. However, to check the robustness of our key finding, we include the deficit-to-GDP ratio in column (2) and the population growth rate in column (3) as additional control variables in the short-run dynamics of the empirical model. The results reported in columns (2) and (3) show that our key finding that CIT has a statistically negative effect on economic growth rate still holds. The short-run coefficient of the deficit-to-GDP ratio in column (2) and the coefficient of the population growth in column (3) are both negative, as expected, but they are statistically insignificant.

Our empirical analysis is based on interprovincial variations in the CIT rate and its effects on economic growth rate. For this reason, the main empirical model does not include the federal government's CIT rate. We check the sensitivity of our main result by including the federal CIT rate (*CITfed*) in column (4) of table 2. Since the time-trend variable and the federal CIT rate are highly correlated, we drop the trend variable to include the federal CIT rate. The results show that the coefficient of the provincial CIT rate remains negative and statistically significant, implying the robustness of the results. As expected, the coefficient of the federal CIT rate is also negative and statistically significant at the 5-percent level.

As indicated before, we attempt to capture the effects of global shocks by including the commodity price index of each province's major export item. However, one may be concerned that just using a single sector or a single major commodity may not sufficiently capture the effects of global shocks. To address this concern, we use the total export price index (*ExportPrice*) instead of the commodity price index as a control variable in column (5). Again, the results are similar to our main estimates, suggesting the robustness of our results to the inclusion of additional control variables.

One may wonder if the results are robust to the use of an alternative empirical approach. Ferede and Dahlby (2012) employed an IV estimation method using five-year period panel data to investigate the effect of corporate income tax rate on economic growth for Canadian provinces. As a robustness check and for ease of comparison, in column (6) we use the empirical approach of Ferede and Dahlby (2012). In this approach, the growth rate of real GDP per capita is estimated on the initial period real GDP per capita, the corporate income tax rate, and all other relevant explanatory variables. To smooth out the effects of the business cycle, such an approach uses five-year period averages of the explanatory variables. Consequently, as in Ferede and Dahlby (2012), the real GDP per capita and government spending are initial period values, while all the relevant explanatory variables are period averages. The analysis is limited to the sample period 1982–2016 so that it is suitable for using five-year period averages of the variables of interest. Thus, we have seven five-year periods for the 10 provinces. We also treat the corporate income tax rate, the initial real GDP per capita, and government spending as endogenous, using similar instruments to those in Ferede and Dahlby (2012). Due to the use of lagged values as instruments for some of the variables, the sample size is just 60. The results reported in column (6) show that the corporate income tax rate has a statistically significant negative effects on growth. However, the numerical magnitude of the coefficient of the corporate income tax rate is slightly lower (in absolute value) than the preferred result of Ferede and Dahlby (2012). Thus, our key finding is robust to the use of an alternative empirical approach.

4. Simulating the Growth Effects of the CIT Rate Cuts in Alberta

To highlight the policy implications and relevance of our empirical results, in this section we use the CIT rate cut in the province of Alberta as a case study. We choose Alberta for the simulation exercise because it is the only province that has recently embarked on an ambitious CIT reform. In May 2019, the newly elected government of Alberta announced that it would fulfill its election platform commitment of reducing the provincial general statutory CIT rate from 12 percent to 11 percent on July 1, 2019, and then to 10 percent on Jan. 1, 2020, followed by further one-percentage-point reductions in 2021 and 2022. Thus, we model the impact of a sequence of provincial CIT rate reductions from 12 percent in 2018 to 8 percent in 2022, holding the federal CIT rate constant at 15 percent.

4.1. Analytical Framework

Suppose α_Y and α_{CIT} denote the coefficients of initial GDP per capita and the corporate tax rate in the growth regression as specified in equation (1), respectively. The effects of a change in the statutory corporate income tax rate

Table 2
Robustness Checks, 1981–2016

	(1) Incl. year effects	(2) Incl. deficit ratio	(3) Incl. population growth	(4) Incl. federal CIT rate	(5) Incl. total export price growth	(6) Alternative approach
ln(CIT)	−0.080*	−0.054***	−0.067***	−0.050**	−0.064***	−0.165*
	(0.047)	(0.014)	(0.017)	(0.020)	(0.019)	(0.089)
ln($GovGDP$)	−0.219***	−0.473***	−0.126	−0.356***	−0.333***	−0.111
	(0.056)	(0.083)	(0.080)	(0.093)	(0.079)	(0.104)
ln($PubInvGDP$)	0.158***	0.115***	0.083**	0.133***	0.163***	0.230
	(0.025)	(0.026)	(0.034)	(0.038)	(0.034)	(0.200)
ln($CommodityPrice$)	−0.020	0.066***	0.068***	0.085***		−0.000*
	(0.021)	(0.016)	(0.015)	(0.019)		(0.000)
ln(U.S. GDP)	0.145***	0.255***	0.314***	0.383***	0.210***	
	(0.024)	(0.038)	(0.046)	(0.034)	(0.036)	
ln($OtherOwn$)	−0.171***	−0.085***	−0.176***	−0.126***	−0.129***	0.029
	(0.031)	(0.032)	(0.040)	(0.042)	(0.033)	(0.033)
RST dummy	0.003	0.002	0.026*	−0.005	0.003	−0.014***
	(0.006)	(0.014)	(0.014)	(0.017)	(0.012)	(0.003)
ln($CITfed$)				−0.095***		
				(0.035)		
ln($ExportPrice$)					−0.095	
					(0.092)	
(Mean) convergence rate	−0.359***	−0.241***	−0.205***	−0.201***	−0.246***	−0.077**
	(0.069)	(0.069)	(0.056)	(0.048)	(0.053)	(0.032)
Constant	3.558***	1.687***	1.286***	1.242***	2.060***	0.879**
	(0.699)	(0.479)	(0.395)	(0.283)	(0.435)	(0.358)
Observations	340	340	340	340	340	60
Trend	Yes	Yes	Yes	No	Yes	
PIT and PST included	Yes	Yes	Yes	Yes	Yes	

Note: Dependent variable is the growth rate of real GDP per capita. Significance levels are shown by * for 10 percent, ** for 5 percent, and *** for 1 percent. In column (1) province-specific five-year time dummies (i.e., dummies for the periods 1987–1991, 1992–1996, 1997–2001, 2002–2006, 2007–2011, and 2012–2016) are included instead of the time trend. The short-run dynamics are not reported. The coefficient of the deficit-to-GDP ratio in column (2) and the coefficient of the population growth rate in column (3) are negative and statistically insignificant.
In column (6), we follow the approach of Ferede and Dahlby (2012) and the coefficients are not directly comparable with our main result. See the text for the details.

on the province's growth rate j years after the tax cut, g_{t+j}, can be computed as[18]

$$\Delta g_{it+j} = (1+\alpha_{Y,i})^j [\alpha_{\text{CIT}}] \Delta \ln \text{CIT}. \tag{2}$$

The expression in parentheses indicates that the effect of the tax rate change diminishes over time as the economies converge to their long-term equilibrium, because $0 < 1+\alpha_{Y,i} < 1$. Thus, the tax rate change will have a temporary effect on the growth rate until the economies reach their long-term equilibrium. Of course, reaching the long-term equilibrium takes a long time, and the speed of convergence depends on the magnitude of the coefficient α_Y. As discussed before, our specification allows this speed of convergence to vary across provinces in view of the inherent differences of their economies.

4.2. Growth Rate Gains from the CIT Rate Reductions

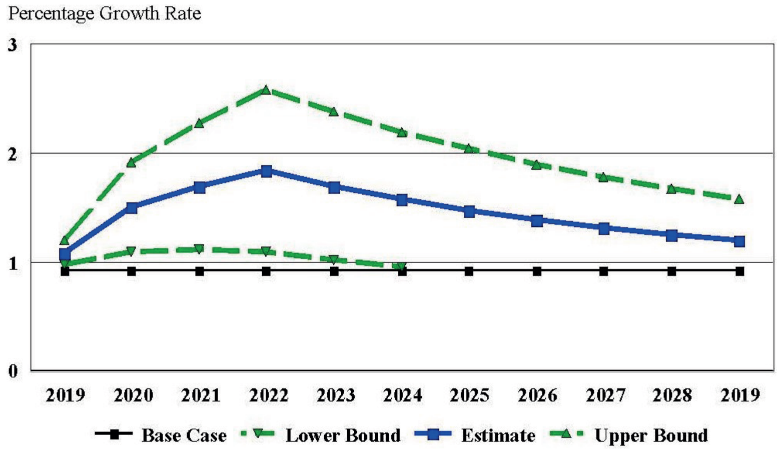
The simulation exercise is conducted using the coefficient estimates reported in column (5) of table 1, with $\alpha_Y = -0.158$ and $\alpha_{\text{CIT}} = -0.045$. The base-case real per capita GDP growth rate is 0.925 percent, the average projected growth rate of per capita real GDP from 2021 to 2024 in the Government of Alberta's 2018–19 Third Quarter Fiscal Update. The growth rate in year $t+j$ with the tax cut is therefore $g_{t+j} = g_{\text{Base}} + \Delta g_{t+j}$, where year t is 2018. It is assumed that the CIT rate cut in 2019 has only a small impact on the 2019 growth rate because the tax cut is in effect for only half the year and many investment plans for 2019 would have been made in advance of the announcement of the tax cut. The simulated growth rates are shown in figure 2.

In figure 2, the solid line is the simulated growth rates from 2019 to 2029 with the sequence of tax cuts. The model indicates that the growth rate of real per capita GDP would increase by 0.92 percentage points, compared to the base case, and peak at 1.84 percent in 2022, and then decline over time to the base-case growth rate of 0.95 percent. The key parameters, α_Y and α_{CIT}, are estimates with the standard errors reported in table 1. We have used the variances and covariance of the parameter estimates to approximate the 95-percent confidence interval for the simulated growth rates. The dashed lines show the upper and lower bounds for the 95-percent confidence interval for the simulated growth rates with the tax cuts. Although the bounds of the 95-percent confidence interval are wide, ranging from 2.59 percent to 1.10 percent in 2022, the confidence interval indicates that the tax cut will increase the Alberta's growth rate with a high degree of probability. Thus, our simulation results indicate that the growth rate of real per capita GDP in Alberta would increase by 0.92 percentage points in 2022 and by 0.28 percentage

18 The detailed derivation of the equation is available from the authors upon request.

Figure 2

Growth Rate with the Reduction in the CIT Rate in Alberta to 8 percent in 2022



points in 2029. This would also translate into increases in real per capita GDP of 2.5 percent in 2022 and 6.5 percent in 2029. An important policy implication of this analysis is that governments can foster economic growth through corporate income tax cuts.

5. Conclusions

This paper provides an empirical estimation of the effects of provincial corporate tax rates on economic growth, using annual panel data from Canadian provinces over the period 1981–2016. We find that a reduction in the provincial CIT rate has a statistically significant positive effect on economic growth rate. Based on our main specification of the econometric model, a one-percentage-point reduction in a provincial government's statutory CIT rate increases the growth rate by 0.12 percentage point four years after the initial CIT rate cut and increases real per capita GDP by 1.2 percent in the long run. Our results are robust to various sensitivity checks and consistent with those of previous studies that use different econometric methodologies and data sets.

We also use the empirical results to simulate the recently announced reduction in the CIT rate in Alberta from 12 percent in 2018 to 8 percent in 2022. The simulation results indicate that the growth rate of real per capita GDP would increase by 0.92 percentage point in 2022 and by 0.28 percentage point in 2029. The model also predicts that real per capita GDP would be 2.5 percent higher in 2022 and 6.5 percent higher in 2029. Thus, an important policy implication of this paper is that governments could improve economic performance by lowering corporate income tax rates. While this paper provides an empirical evidence on the adverse effect of CIT on economic growth, it is worthwhile highlighting an important caveat about the study. The paper relies on the estimation of a reduced growth equation, and it does not explicitly assess the various possible channels through which the CIT affects economic growth. Thus, investigating the effects of CIT on investment and productivity channels and their ultimate effects on growth provide fruitful avenues for future research.

6. Appendix

Table 3
Panel Unit-Root Tests (1981–2016)

Variable	Variables in level		Variables in first-difference	
	IPS	Breitung	IPS	Breitung
ln(CIT)	−1.17	0.11	−13.83***	−3.83***
ln(PIT)	−4.47***	−1.94**		
ln(PST)	−2.30***	−1.39*		
ln(GovGDP)	−1.62*	−0.001	−12.80***	−1.31*
ln(PubInvGDP)	0.05	−0.19	−12.22***	−3.24***
ln(CommodityPrice)	−0.74	0.37	−14.25***	−2.33***
ln(OtherOwn)	−6.18**	−1.01	−15.97***	−2.44***
ln(U.S. GDP)	−1.40*	−0.43	5.35***	−2.10**
Log(GDP per capita)	0.56	1.25	−11.86***	−1.77***

Note: Lag selection based on AIC. Maximum lag is set at four based on the short data. All variables in levels except tax rates include trend. Significance levels are shown by * for 10 per cent, ** for five per cent and *** for one per cent. ln(PST): log of (1+PST).

Table 4

Summary Statistics for Key Variables, 1981–2016

	Growth Rate				ln(CIT)			
Province	Mean	Std.	Min.	Max.	Mean	Std.	Min.	Max.
Newfoundland and Labrador (NFL)	0.024	0.042	−0.111	0.113	−1.910	0.075	−1.966	−1.772
Prince Edward Island (PEI)	0.018	0.021	−0.016	0.085	−1.918	0.162	−2.303	−1.833
Nova Scotia (NS)	0.015	0.020	−0.022	0.070	−1.847	0.027	−1.897	−1.833
New Brunswick (NB)	0.016	0.021	−0.025	0.084	−1.952	0.173	−2.303	−1.772
Quebec (QB)	0.012	0.019	−0.042	0.055	−2.449	0.262	−2.900	−2.129
Ontario (ON)	0.012	0.027	−0.047	0.071	−1.957	0.112	−2.163	−1.864
Manitoba (MB)	0.013	0.023	−0.042	0.068	−1.888	0.144	−2.120	−1.772
Saskatchewan (SK)	0.015	0.034	−0.051	0.092	−1.900	0.149	−2.120	−1.772
Alberta (AB)	0.012	0.036	−0.080	0.084	−2.081	0.180	−2.303	−1.864
British Columbia (BC)	0.011	0.027	−0.085	0.068	−1.985	0.183	−2.303	−1.802
All provinces	0.015	0.028	−0.111	0.113	−1.989	0.228	−2.900	−1.772

Note: The figures are in decimals. For instance, the average growth rate for Alberta is 0.012 which is 1.2 per cent.

References

Arnold, J.M., Brys, B., Heady, C. J., Johansson, A., Schwellnus, C., and Vartia, L. (2011), Tax Policy for Economic Recovery and Growth, Economic Journal 121, 59–80.

Baiardi, D., Profeta, P., Puglisi, R., and Scabrosetti, S. (2019), Tax Policy and Economic Growth: Does it Really Matter?, International Tax and Public Finance 26, 282–316.

Bassanini, A., and Scarpetta, S. (2002), Does Human Capital Matter for Growth in OECD Countries? A Pooled Mean-Group Approach, Economics Letters 74, 399–405.

Bleaney, M., Gemmell, N., and Kneller, R. (2001), Testing the Endogenous Growth Model: Public Expenditure, Taxation and Growth over the Long Run, Canadian Journal of Economics 34, 36–57.

Clausing, K.A. (2014), Lessons for International Tax Reform from the US State Experience under Formulary Apportionment, U.K. Institute of Development Studies ICTD Research Report 2.

Djankov, S., Ganser, T., McLiesh, C., Ramalho, R., and Shleifer, A. (2010), The Effect of Corporate Taxes on Investment and Entrepreneurship, American Economic Journal: Macroeconomics 2, 31–64.

Ferede, E., and Dahlby, B. (2012), The Impact of Tax Cuts on Economic Growth: Evidence from the Canadian Provinces, National Tax Journal 65, 563–594.

Ferede, E., Dahlby, B., and Adjei, E. (2015), Determinants of Statutory Tax Rate Changes by the Canadian Provinces, Economics of Governance 16, 27–51.

Gale, W.G., Krupkin, A., and Reuben, K. (2015), The Relationship Between Taxes and Growth at the State Level: New Evidence, National Tax Journal 68, 919–942.

Gemmell, N., Kneller, R., and Sanz, I. (2011), The Timing and Persistence of Fiscal Policy Impacts on Growth: Evidence from OECD Countries, Economic Journal 121, 33–58.

Gemmell, N., Kneller, R., and Sanz, I. (2014), The Growth Effects of Tax Rates in the OECD, Canadian Journal of Economics 47, 1217–1255.

Karkalakos, S., and Kotsogiannis, C. (2007), A Spatial Analysis of Provincial Corporate Income Tax Responses: Evidence from Canada, Canadian Journal of Economics 40, 782–811.

Kneller, R., Bleaney, M.F., and Gemmell, N. (1999), Fiscal Policy and Growth: Evidence from OECD Countries, Journal of Public Economics 74, 171–190.

Lee, Y., and Gordon, R.H. (2005), Tax Structure and Economic Growth, Journal of Public Economics 89, 1027–1043.

Ljungqvist, A., and Smolyansky, M. (2018), To Cut or Not to Cut? On the Impact of Corporate Taxes on Employment and Income, NBER Working Paper 20753.

Miller, S.M., and Russek, F.S. (1997), Fiscal Structures and Economic Growth at the State and Local Level, Public Finance Review 25, 213–237.

Ojede, A., and Yamarik, S. (2012), Tax Policy and State Economic Growth: The Long-Run and Short-Run of It, Economic Letters 116, 161–165.

Pesaran, M. H. (1997), The Role of Economic Theory in Modelling, Economic Journal 107, 178–191.

Pesaran, M.H. (2015), Time Series and Panel Data Econometrics, Oxford University Press, Oxford, UK.

Pesaran, M. H., and Shin, Y. (1999), An Autoregressive Distributed Lag Modelling Approach to Cointegration analysis, in: Strom, S. (eds.), Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Cambridge University Press, Cambridge, UK.

Pesaran, M.H., Shin, Y., and Smith, R.P. (1999), Pooled Mean Group Estimation of Dynamic Heterogeneous Panels, Journal of the American Statistical Association 94, 621–634.

Pesaran, M.H., and Smith, R.P. (1995), Estimating Long-Run Relationships from Dynamic Heterogeneous Panels, Journal of Econometrics 68, 79–113.

Reed, W.R. (2008), The Robust Relationship between Taxes and US State Income Growth, National Tax Journal 61, 57–80.

Suárez Serrato, J.C., and Zidar, O. (2016), Who Benefits from State Corporate Tax Cuts? A Local Labor Markets Approach with Heterogeneous Firms, American Economic Review 106, 2582–2624.

Xing, J. (2012), Tax Structure and Growth: How Robust is the Empirical Evidence?, Economics Letters 117, 379–382.