*Tax Cuts, Economic Growth, and the Marginal Cost of Public Funds for Canadian Provincial Governments**

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Abstract

We examine the impact of tax rates on economic growth using panel data from Canadian provinces over the period 1977 to 2006. We find that higher statutory corporate and top personal income tax rates are associated with lower private investment and slower economic growth. Our empirical estimates suggest that a 10 percentage point cut in the corporate tax rate is related to a 1 to 2 percentage point increase in the annual growth rate. Simulation analysis conducted for British Columbia (BC) shows that tax rate cuts can produce a significant long-run increase in output. We also estimate the elasticities of total tax revenue with respect to corporate income, top personal income, and sales tax rates. Using the growth and revenue regression results, we compute BC's marginal cost of public funds (MCF) for the various tax rates. The results indicate that the MCFs from the corporate and personal income taxes are higher than from the sales tax.

Keywords: Tax policy; Economic growth; Marginal Cost of Public Funds

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1. Introduction

The impact of taxation on growth and investment has been hotly debated both in academic and political circles. Proponents of tax cuts point to the effects that taxes have on incentives to work, to save, and to invest and argue that reducing tax rates boosts economic growth. The tax cuts introduced by the provincial government of British Columbia (BC) in 2001 are an important example of this type of pro-growth tax policy. The tax reform was introduced in two stages. In an attempt to make its economy more competitive, the BC government reduced the corporate income tax (CIT) rate initially by 3.0 percentage points with an additional 1.5 percentage point reduction in 2005. The government also cut the personal income tax (PIT) rate by about 25 percent. The tax reform was based on the premise that the cut in the marginal tax rates would boost investment and economic growth in the province.

A number of theoretical and empirical studies have examined the effects of taxes on growth. See Myles (2000) for a survey of the theoretical studies on taxation and growth. Previous empirical studies have indicated that taxes can influence growth. Most of the empirical studies on taxation and growth have focused on cross-country analysis and only a few researchers have investigated the issue using data from sub-national governments, particularly US states.

In one strand of the empirical literature, researchers use aggregate average and effective marginal tax rates as measures of tax burden.[1] Using such tax measures Helms (1985), Mullen and Williams (1994), Becsi (1996), Miller and Russek (1997), Kneller et al.(1999) , Bleaney et al. (2001), Folster and Henrekson (2001), Padovano and Galli (2002), Tomljanovich (2004), and Holocombe and Lacombe (2004) find a negative relationship between taxation and growth. Koester and Kormendi (1989) and Mendoza et al. (1997), however, do not detect any significant negative impact of taxes on growth. In another strand of the literature, Katz et al. (1983) and Lee and Gordon (2005) have used statutory tax rates as measures of the tax burden. For a sample of

[1] See Engen and Skinner (1996) for a survey of some of the empirical studies.

cross section of countries, Lee and Gordon (2005) find that the corporate tax rate has a significant negative association with the growth rate, while the effect of the top personal income tax rate on growth was found to be insignificant. Katz et al. (1983) also find that the top personal income tax rate has no significant effect on growth.

In cross-country studies, there is variation among countries both in terms of income tax rates and tax bases. Canadian provinces however use more or less similar tax bases. Thus the Canadian provincial governments' tax policies provide a good framework for the study of the effects of tax rates on growth. However, to the best of our knowledge, there have been no empirical studies of the effects of fiscal policies on the growth of Canadian provinces. In addition, previous empirical studies fail to examine the relationship between tax rates and total government tax receipts.

The principal objective of this paper is to investigate the effects of taxation on growth using data from 10 Canadian provinces during 1977-2006. We also explore the relationship between tax rates and total tax revenue. We use the empirical results to assess the revenue and growth rate effects of the 2001 British Columbia's incentive-based tax cuts. We show that it is possible to compute the revenue effects of tax cuts incorporating the dynamic output effects of the tax cuts. Another important contribution of this paper to the literature is that it uses the growth and total revenue estimation results to compute the marginal cost of public funds for the three most important taxes imposed by the Canadian provinces.

We begin our analysis by exploring the effects of tax rates on growth and private investment. The results of this paper indicate that lower tax rates are associated with higher private investment and faster economic growth. Our analysis suggests that a 10 percentage point cut in the statutory corporate income tax rate is associated with a temporary 1 to 2 percentage point increase in per capita GDP growth rate. Similarly, a 10 percentage point reduction in the top marginal personal income tax rate produces a temporary one percentage point increase in the growth rate. We also find that the negative relationship between provincial CIT rate and growth is quite robust to various sensitivity checks. These growth effects from tax cuts are "temporary" because our model has the same property as the neo-classical growth model—in the long-run, the growth rate returns to its steady state rate based on technological change. However, the growth rate effects persist over a long period of time and long-run output is substantially increased. Overall, the CIT rate seems to have a stronger adverse impact on output and investment than the PIT rate.

We have conducted simulation exercises of the 2001 BC's tax cuts based on parameter values from our econometric model. The results suggest that the tax cuts can result in significant long-run output gains. In particular, our simulation results indicate that BC's 4.5 percentage point CIT rate cut will boost its long-run GDP per capita by 11 percent compared to the level that would have prevailed in the absence of the CIT tax cut. Another way of expressing the impact of the CIT rate cut is in terms of the present value of the increase in future output. Assuming a discount rate of 10 percent, we find that the present value of the output gain from the CIT rate cut is about 41 percent of current output. The corresponding present value of the output gain from the PIT rate cut is about 10 percent of current output.

In order to investigate the revenue implications of tax cuts we also estimate the elasticities of total tax revenue with respect to CIT, top marginal PIT, and sales tax rates. Our analysis of the effects of taxes on tax revenues, investment, and growth allows us to calculate the MCFs for CIT, PIT, and sales tax rates. Our estimates of the MCFs for the BC government based on the short-term economic adjustments are generally in line with previous estimates. The MCF for the PIT rate is 1.01 which is lower than the MCF for the CIT, 1.18. The MCF for the sales tax is only 0.96. However, when we incorporate the long-run output effects from tax changes, the MCF for the PIT increases to 1.14 based on a 10.0 percent discount rate for future tax revenues. Perhaps most importantly, our analysis indicates that the present value of the provincial government's total tax revenue can decline if it cuts its CIT rate. This implies that if CIT rates are cut citizens will be better off and current and future expenditures on public services can be increased, or other taxes cut.

The remaining part of the paper is organized as follows. In section 2, we present the econometric results on the effects of provincial tax rates on growth, investment, and total tax revenue. Based on these estimation results, in section 3 we simulate the impacts of the 2001 tax reform in BC on the province's growth rate and its future output. In section 4, we calculate the marginal cost of public funds for the BC government. Section 5 concludes.

2. Regression results

2.1. Data

The main sources of our dataset are Statistics Canada database (CANSIM) and *Finances of the Nation* (formerly *National Finances*) published by the Canadian Tax Foundation. Our data on, statutory corporate tax rate, top personal income tax rate, and sales tax rate come from various issues of *Finances of the Nation.* Data on GDP and private investment in 1997 constant prices were obtained from Statistics Canada, *Provincial Economic Accounts.* Tax revenue figures prior to 1989 are obtained from Statistics Canada, *Public Finance Historical data*, 1965/66-1991/92, catalogue no. 68-512 while data from 1989 onwards are from *CANSIM*. Similarly, data on the remaining variables are also obtained from *CANSIM*. A brief description of the data and definitions of the variables used in our empirical analysis is provided in Appendix 1. The basic summary statistics for the key variables in the growth regression are shown in Table 1.

(Insert Table 1 about here)

2.2. Growth regressions

In this section, we examine the effects of tax rates on economic growth rate. Our analysis uses annual data from the 10 Canadian provinces over the period 1977 to 2006. As in Lee and Gordon (2005), the empirical growth specification is based on a standard neo-classical growth model augmented with corporate and personal income tax rates. The specification for the growth regression takes the following form:

$$\Delta \ln y_{it} = \alpha_0 + \alpha_1 CIT_{it} + \alpha_2 PIT_{it} + \alpha' X_{it} + \eta_i + \lambda_t + \varepsilon_{it}, \quad (1)$$

where $\Delta ln\ y_{it}$ is the per capita GDP growth rate*,* *CIT* is the top statutory corporate tax rate, *PIT* is the top personal income tax rate, *X* denotes a vector of control variables, and ε_{it} is the error term. The time-invariant unobserved province-specific effects are captured by η_i . The λ_t, represents province-invariant time dummies. The dependent variable is the annualized average growth rate of real GDP per capita over the period 1977-1981, 1982-1986, 1987-1991, 1992-1996, 1997-2001, and 2002-2006. As is common in the growth literature, we use five-year period averages to smooth-out short-term business cycle. The control variables include initial income per capita, government consumption to GDP ratio, population growth rate, terms of trade, and U.S. growth rate. [2] The control variables with the exception of the US growth rate are commonly used in the growth literature. See Barro (1997) and Bleaney et al. (2001). We include the US growth rate to capture the potential effects of changes in the US economy on Canadian provincial growth rate.

Theoretical growth models indicate that marginal tax rates affect economic growth.[3] However, due to lack of data on marginal tax rates, many empirical studies have used overall average tax rates and effective marginal tax rates. Our investigation of the growth–tax nexus uses

[2] As complete provincial data on exports are not available for the period prior to 1981, we use the export price index of major exporting commodity for each province as a proxy variable. However, the result is similar if one uses the growth rate of terms of trade even though the number of observations will be reduced.

[3] See for example Padovano and Galli (2002) who argue that empirical tests of the relationship between taxation and growth should use marginal tax rates, not average tax rates.

data on statutory corporate tax rate and top personal income tax rates as in Lee and Gordon (2005). Since the marginal PIT rates change with income brackets it is problematic to use personal income tax rates in empirical analysis. Previous studies used weighted average statutory personal income tax rate (Easterly and Rebelo, 1993), effective average personal income tax rate (Mendoza, et al. 1997), and statutory top personal income tax rate (Lee and Gordon, 2005; Katz, et al. 1983). None of the above measures captures the effects of personal income tax rate on the growth rate precisely. Easterly and Rebelo (1993)'s approach, although theoretically interesting, requires information on income distribution and all the tax rates. Due to lack of data on income distribution, this approach is not feasible. Furthermore, as Katz, et al. (1983) explained the top marginal statutory PIT rate seems relatively more appealing because this rate affects the high income group that has the most income and the highest propensity to invest. This implies that the top PIT rate affects the incentive to invest by this group and ultimately affects growth adversely. Thus due to the aforementioned reasons we use the statutory top PIT rate in our analysis. The tax rate variables enter the growth equation as an average for the corresponding five-year period.

As Fischer (1993) has argued, economic variables, such as taxes, affect growth through changes in the level of investment per worker and/or the productivity of a given amount of investment per worker. Consequently, our basic specification of the growth model in equation (1) does not include investment as one of the control variables. We have adopted this specification because, if we control for the level of investment, any impact of taxes on growth is restricted to its effect on productivity. However, in other regressions that are reported later we include investment to GDP ratio in order to identify the transmission channels. Mendoza, et al. (1997) also employ a similar approach.

(Insert Table 2 about here)

The growth regression results are shown in Table 2. Column (1) in Table 2 provides Ordinary Least Squares (OLS) estimates of the growth regression. All the control variables have the expected signs and are statistically significant. The key variables of interest, the statutory corporate marginal tax rate and the top marginal personal income tax rate, have as expected negative coefficients but only the former is statistically significant at the 5 percent level.

It is well known that the OLS coefficient estimates can be sensitive to the presence of outliers in the data. To check the robustness of our results to outliers, in column (2), we use the robust estimation method which is less sensitive to the presence of influential observations. All the variables have the expected sign and are statistically significant. Comparing columns (1) and (2), one also sees that the point estimates of coefficient of the tax rates are slightly higher in the case of the latter.

Our econometric specification is a dynamic panel since it includes the log of initial per capita GDP as an additional explanatory variable. In such cases, even though we provide OLS estimates for comparison purposes, the appropriate econometric technique is to use Instrumental Variable (IV) estimation method.[4] In column (3), we employ the IV estimation method to account for the potential endogeneity problem that can arise in a dynamic panel model such as ours. As in Barro (1997), we treat the initial GDP per capita as endogenous and use its one-period lagged value as an instrument. The key variables of interest, the statutory corporate marginal tax rate and the top marginal personal income tax rate, have as expected negative coefficients and are statistically significant. This suggests that higher tax rates are related to lower growth rate. The point estimate of the coefficient of the corporate income tax rate implies that a 10 percentage point reduction in the tax rate is associated with a 1.15 percentage point increase in the growth rate of GDP per capita. Similarly, a 10 percent point reduction in the top personal income tax rate

[4] For a dynamic growth model, system General Method of Moments (GMM) is a preferable method of estimation. However, given our sample size (small individual and time dimensions), it is not feasible to use the system GMM.

is related to 0.54 percentage point increase in the growth rate. This is well within the range of estimates found in Lee and Gordon (2005).[5]

To capture unobservable provincial characteristics, we include provincial fixed-effects in column (4). The corporate income tax rate is still negative and significant with a numerical value slightly higher (in absolute value) than that obtained in column (3). The personal income tax rate, however, is now positive and insignificant. The adjusted R-squared shows only a slight increase despite the inclusion of provincial dummies. Furthermore, an F-test does not reject the null hypothesis that the provincial effects are jointly insignificant (*p*-value of 0.25). As a result, we drop the insignificant provincial effects in our subsequent regressions. But we include time dummies in our regression as discussed below.

We have assumed thus far that tax rates are exogenous. However, as explained in Lee and Gordon (2005), tax rates may be endogenous. A growing economy can afford to reduce tax rates, while governments may be forced to raise taxes when their economies decline and their tax bases contract. If tax rates are endogenous, the point estimates of the coefficients of the tax rates may be biased. To overcome this potential endogeneity problem, we treat the tax rates as endogenous in column (5). As in Lee and Gordon (2005), we use the average tax rates of other provinces as instruments.[6] We also treat the initial GDP per capita and population as endogenous variables using their respective one-period lagged values as instruments. We include time dummies in our regression. The time dummies are jointly significant implying the need to capture the time effects. The US growth rate is dropped from the regression as it is perfectly collinear with time dummies. The coefficient estimates of the tax rates are now statistically significant with point estimates of the coefficients slightly higher than those obtained in columns (3) and (4). Note also that the point

[5] Lee and Gordon (2005) find that the top personal income tax rate is insignificant.
[6] Lee and Gordon (2005) used the weighted-average tax rate of other countries (weighted by the inverse of their distances).

estimate of the coefficient of the corporate tax rate is higher than that of the top personal income tax rate implying that the former has a greater impact on the provincial growth rate.

So far we have not controlled for the level of investment. Thus the reported negative relationship between tax rates and provincial growth is through their influences on both productivity and investment levels. However, it is important to identify the transmission channels through which the tax rates affect growth. To accomplish this, in column (6) we include private investment to GDP ratio as an additional explanatory variable. Once we control for investment, any remaining effect of tax rates on growth must be through their influence on productivity. See Fisher (1993), Mendoza, et al. (1997), and Baldacci et al. (2004). As commonly used in the growth literature, we treat this variable as endogenous and use a one-period lagged value of the variable as an instrument. The period under investigation includes the time of tax reform for BC. As previously noted, the BC government introduced income tax cut in 2001. Thus to evaluate the possible growth effects of the tax reform, it is appropriate to first concentrate the analysis on the time period prior to the reform. Thus in column (6), we estimate the growth regression over the period 1977 to 2001. This reduces the number of observations to 50.

Regression results in column (6) show that when we control for private investment both the corporate and personal income tax rates are negative but only the former is statistically significant. This suggests that the main channel through which the top personal income tax rate affects growth is through its effect on the level of investment. Private investment is found to have a positive and statistically significant effect on per capita growth.

In column (7) we re-estimate the model after dropping the insignificant personal income tax rate. The exclusion of the personal income tax rate raises the explanatory power of the model as shown by a relatively higher R-squared. This is our preferred estimate. Our analysis of the effects of tax reform on the BC's growth in section 3 will be based on the estimated results reported in column (7).

We subject our preferred growth regression of column (7) to various robustness checks. [7] First, we consider controlling for additional variables separately. In particular, we include federal corporate and top personal income tax rates, national provincial average corporate tax rate, and resource abundance.[8] Second, we use relative provincial corporate tax rate (i.e., relative to national provincial average tax rate) instead of the actual tax rate. Third, as in Mendoza, et al. (1997), we also try excluding outliers.[9] Finally, we experiment with using an alternative instrument for the corporate tax rate. Again as in Mendoza, et al. (1997) for the corporate tax rate, we use a one-period lagged value of the variable as an instrument. Under all the various alternative robustness checks, we have found that our key result—that the corporate tax rate and provincial growth rates are negatively related—remains quite robust.

In general, our regression results suggest that higher corporate and personal income tax rates are associated with a lower per capita GDP growth rate. The negative impact of the corporate tax rate on growth is particularly robust to the estimation method employed, the time period considered, and various sensitivity checks. In addition, corporate income tax rate increases seem to have larger negative growth effects than personal income tax rate increases. A higher corporate tax rate is related to a lower growth rate through its effects on both productivity and private investment. The foregoing analysis suggests that the main transmission channel for the effect of the top personal income tax rate on growth rate, however, is only through its effects on private investment. In order to better understand the main transmission channel through which tax rates affect growth, we explore the effects of tax rates on investment in the next section.

[7] The results of the robustness checks are available upon request.
[8] As a proxy for resource abundance, following Barro and Sala-i-Martin (2004), we include the fraction of GDP in mining production (at the beginning of each period) as an additional control variable.
[9] As in Mendoza, et al. (1997), outliers are defined as observations that yield residuals in excess of two standard errors of the regression in column (6).

2.3. Investment regressions

The growth regression results of the previous section show that tax rates are negatively related to economic growth. An important issue related to the tax-growth nexus is identifying the channels through which the tax rates affect growth. Column (6) in Table 2 shows the impact of taxes on growth through their effect on productivity after controlling for investment. We now proceed to empirically explore the other main transmission channel through which taxes can affect growth: investment. To accomplish this, following Barro (1997), Mendoza et al. (1997), and Baldacci, et al. (2004), we estimate a structural equation of aggregate private investment using the right hand side variables of the growth regression as explanatory variables.

Tax rates can reduce investment through their effects on the supply of funds for investment or their impact on the user cost of capital and thus the incentive to invest. See Hulten (1984), Hubbard (1998) and Feldstein (2006).[10] For instance, McKenzie and Thompson (1997) indicated that over the period 1971 to 1996 the user cost of capital in Canada was higher than that of the US partly because of higher Canadian tax rates. To fully explore how tax rates and provincial growth rates are related, it is important to run a separate regression of investment on the tax rates and other control variables. This enables us to identify the channels through which corporate and personal income tax rates affect economic growth. Ideally, an analysis of the response of investment to tax rate changes would be best performed using disaggregated data on investment by sector to capture the potential differential effects of tax rates on investment levels in different sectors preferably using marginal effective tax rates. However, since our principal objective is to identify the channels through which tax rates affect the growth rate, we have focused on

[10] Mintz (1996) also provides an excellent survey of the literature on the effects of corporate taxation on investment.

aggregate private investment.[11] Furthermore, due to lack of sufficient data on marginal effective tax rate for most of the sample period, we use statutory tax rates. [12]

The investment regression equation is specified as:

$$INV_{it} = \beta_0 + \beta_1 CIT_{it} + \beta_2 PIT_{it} + \beta' X_{it} + \varepsilon_{it}, \quad (2)$$

where *INV* is private investment to GDP ratio, and the other variables are as defined before. The dependent variable is the average gross private investment to GDP ratio over the five-year periods. Basically, we use the same model as the growth regressions of the previous section except that now the dependent variable is the private investment to GDP ratio. The estimated coefficients from the above regression show the indirect effects of tax rates on the growth rate through their impact on the level of investment. The direct effects of tax rates on growth through the productivity channel are shown through the growth regressions that control for investment.[13] The results of the investment regressions are shown in Table 3 below.

(Insert Table 3 about here)

The empirical results indicate that, as expected, the tax rates have a negative and statistically significant relationship with investment. The baseline OLS estimates of the investment equation are given in column (1). All the fiscal policy variables are statistically significant with their expected signs. In column (2) we use a robust estimation method that is not sensitive to the presence of outliers. The result is similar to what we find in column (1).

In column (3), we treat the initial GDP per capita and tax rates as endogenous and use instruments similar to those in growth regression. Time dummies are also included to capture time effects. All variables with the exception of population and export price growth are found to be significant with their expected signs. These variables do not seem to add any explanatory

[11] For a theoretical explanation why tax rates may affect growth with or without controlling investment see Easterly et al. (1992).
[12] Chen and Mintz (2006) develop federal/provincial combined effective corporate tax rate on capital for the period 1997-2006. However, for our panel data analysis the data set does not provide enough number of observations for estimation.
[13] For a similar approach of isolating direct and indirect effects on growth see Knight, et al. (1996).

power to the model. Thus, in column (4), we drop these variables from our estimation and now all the variables are significant with their respective expected signs. The result indicates that a 10 percentage point reduction in the corporate marginal tax rate is associated with a 5.84 percentage point increase in the private investment to GDP ratio. Similarly, a 10 percentage point cut in the top personal income tax rate is related to a 4.48 percentage point rise in the private investment to GDP ratio.

Finally in column (5) we re-estimate the investment model over the period 1977 to 2001 to focus on the period before the tax reform in British Columbia. This is our preferred investment regression to be used in the policy analysis in section 3. The estimated results are generally similar to the ones we obtained previously. The point estimates of the tax rates are however slightly lower now. In summary, investment is one of the transmission channels in the tax-growth nexus. Our analysis indicates that corporate and personal income tax cuts encourage private investment and spur provincial economic growth.

2.4. Revenue regressions

The amount of tax revenue that a provincial government collects depends on both its tax rates and tax bases. Thus one major concern that policy makers have in cutting tax rates is the implication of tax cuts for government tax receipts. Previous studies mainly focus on the tax rate elasticities of tax bases. See for example Sillamaa and Veall (2001) and Gruber and Saez (2002). Some studies on the other hand examine the effect of tax rate changes on tax revenue. While Hsing (1996) estimates personal income tax revenue, Klassen and Shackelford (1998), Devereux (2006), Auerbach (2007), and Clausing (2007) examine the corporate tax revenue. In this section, we explore the relationship between tax rates and total tax revenue.

We assume that the total tax revenue regression takes the following log-linear form:

$$ln\ (TR_{it}) = \theta_1 + \theta_2\ ln\ (GDP_{it}) + \theta_3 ln\ (CIT_{it}) + \theta_4\ ln\ (PIT_{it}) + \theta_5\ ln\ (PST_{it}) + \beta' X + u_{it}\ , \qquad (3)$$

where *TR* is total tax revenue, GDP is provincial Gross Domestic Product, *PST* is provincial sales tax rate, *X* is a vector of other variables, u_{it} is the error term and the other variables are as defined before.[14] We expect the coefficients of the tax rates and GDP all to be positive. The coefficients of the tax rates indicate the elasticity of total tax revenue with respect to the various tax rates. Thus the above log-linear regression specification allows us to estimate the tax revenue elasticities directly. Due to this advantage, such empirical specification is quite common in the literature; see for instance Friedlaender et al. (1973), Hsing (1996), and Devereux (2006).

(Insert Table 4 about here)

Our regression results of total tax revenue on tax rates and various control variables are reported in Table 4. Column (1) reports the basic OLS estimates of the regression of the log of total provincial tax revenue on just the tax rates based on annual data for the 10 provinces from 1972 to 2006.[15] The coefficients for all three tax rates are positive and highly significant suggesting that tax rate cuts reduce total tax revenue. In order to see whether the tax rates have a non-linear effect on tax revenue, we also experiment by including the level of tax rates. However, these variables are insignificant and dropped from the regression. In principle we would like to include time dummies to capture the various policy interventions. However the time dummies are perfectly correlated with the federal PIT and CIT rates and it is not possible to include them in the regression. It is possible to include the time dummies after dropping the federal tax rates. This however does not qualitatively affect our results. As in Devereux (2006) and Clausing (2007), we also find that including the fixed-effects in

[14] In Dahlby and Ferede (2008) we estimated the effects of the CIT rate on CIT revenues and found that the peak of the CIT Laffer curve occurred when the provincial CIT rate was 13.60 percent. This result is comparable to the 11 percent revenue-maximizing corporate tax rate that Klassen and Shackelford (1998) obtained for Canadian provinces and US states.

[15] We also experiment with instrumental variable estimation method treating GDP and the tax rates as endogenous. However the results do not change much and all our revenue regressions are based on OLS estimations. Devereux (2006) also finds similarity between OLS and IV estimations.

our revenue regressions removes much of the cross-province variation in tax rates and as a result our revenue regression does not include province effects.

The tax revenues that a provincial government generates also depend on the tax policies of other provinces and on federal tax policies. The relatively free mobility of capital across provinces and the overlap in federal and provincial tax bases can lead to horizontal and vertical tax externalities.[16] To check for the possibility of horizontal and vertical tax externalities in corporate taxation, we include both the federal corporate income tax rate and the provincial tax rates in the revenue regressions. We expect the coefficient of the federal tax rate to be negative due to the possibility of vertical fiscal externality. To capture the effect of other provinces' tax rates, we use the weighted average of other provinces' corporate income tax rate, weighted by the GDP of the provinces. For the reasons explained above, we expect the coefficient on other provinces' tax rate to be positive.

These results are reported in column (2). As expected, the federal corporate income tax rate is negative and statistically significant consistent with other empirical studies indicating vertical tax externalities in a federation. The coefficient of other provinces' CIT rate is positive and statistically significant consistent with the presence of horizontal fiscal externality. The regression results in column (2) generally lend a strong empirical support to the notion that there are significant vertical and horizontal corporate income tax externalities in the Canadian federation.

In column (3) we include the federal top PIT rate. Now the federal CIT rate becomes insignificant while the federal PIT rate is statistically significant with the expected negative sign. The estimated results are however quite robust for all the other variables. The point estimates of the coefficients of the tax rates show that the personal income tax rate has the highest impact on tax revenue followed by sales tax rate. Note also that since we use the top personal income tax rate, the regression result overestimates the impact of personal tax rates on total tax revenue.

[16] See Dahlby (1996) and Dahlby and Wilson (2003). For empirical studies of the fiscal interdependence of the federal and provincial governments, see Esteller-Moré and Solé-Ollé (2001), Hayashi and Boadway (2001), Mintz and Smart (2004), and Karkalakos and Kotsogiannis (2007).

Finally, we estimate the revenue regression over the period 1977 to 2001 to be consistent with the growth regression and cover the period prior to the BC tax reform. This reduces the number of observations just to 250. The regression results are reported in column (4). All the variables maintain their expected signs and are statistically significant. Note in particular that even though we lost more than a quarter of the total observations, the variables of interest maintain their respective expected signs and are statistically significant. This shows how robust our result is to the time period considered. The regression result is also consistent with the horizontal and vertical tax externality as evidenced by the significance of the federal tax rates and the other provinces' CIT rate. Our computation of the MCF for BC will be based on this regression result.

3. Simulating the Effects of the 2001 BC Tax Cuts on Growth and Output

Our econometric results indicate that higher CIT rates are associated with lower investment and slower economic growth. Lower PIT rates are also associated with higher investment which also leads to faster growth. One implication of these results is that a pro-growth fiscal policy may involve a reduction in the tax rates to raise the level of investment and spur growth. In this section, we attempt to gauge the magnitude of the growth effects of the CIT and PIT rate cuts in BC in 2001 based on the econometric estimates in Tables 2 and 3.

We have seen that tax rates affect growth directly through productivity and indirectly through investment. Thus, in order to capture these direct and indirect effects of tax rate cuts on growth, we use both the growth and investment regression results.

3.1. The Growth Effects of the CIT Rate Cut

Let α_Y, α_{CIT}, and α_{INV} denote the coefficients of initial GDP per capita, the corporate tax rate, and investment in the growth regression, respectively. Let β_{CIT} and β_Y denote the coefficients of the corporate tax rate and log of the initial GDP per capita in the investment regression. The impact of a change in the statutory corporate marginal tax rate on the growth rate *j* years after the tax cut, g_{t+j}, can be calculated as:[17]

$$\Delta g_{t+j} = \left(1 + \alpha_Y + \alpha_{INV}\beta_Y\right)^j \left[\alpha_{CIT} + \alpha_{INV}\beta_{CIT}\right]\Delta CIT \ . \qquad (4)$$

The expression in square brackets indicates how a change in the CIT rate directly affects the current growth rate (α_{CIT}) and indirectly affects it through its effect on the investment rate ($\alpha_{INV}\beta_{CIT}$). The expression in the round brackets indicates that the effect of the tax rate change diminishes over time because $0 < 1 + \alpha_Y + \alpha_{INV}\beta_Y < 1$. In other words, the growth impact of the CIT rate cut diminishes over time because of the conditional convergence effect. Recall that our model has the characteristic of the neo-classical growth model that fiscal policy only has a temporary effect on the growth rate, although (as we will see) the "temporary" effect occurs over a very long period of time.

Our computations are based on the values of the coefficients in column (7) of Table 2 and column (5) of Table 3, assuming a 4.5 percentage point reduction in the CIT rate. It is assumed that, in the absence of the CIT cut, the BC economy would grow at an average annual rate of 1.275 percent.[18] The solid line in Figure 1 shows the simulated growth rate with the 2001 CIT rate cut compared to the baseline growth rate of 1.275 percent, the dashed line. Given our parameter estimates, it takes almost 100 years for the economy to return to the base line growth rate. Therefore the growth rate effect of the tax cut is temporary, but long-lasting. Figure 2 shows the

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[17] See Appendix 2 for the derivation of this equation.

[18] This is BC's average real per capita GDP growth rate over the period 1997-2001, the five-year period prior to the tax cut. See Dahlby and Ferede (2008, Appendix 5) where we experimented with alternative baseline growth rates.

output with the CIT rate cut relative to the no-tax cut output over the 120 years horizon. Our model indicates that in the long-run per capita output would be 11.1 percent higher with the 4.5 percentage point CIT rate cut.

Of course, we have to wait a long time to receive some of this increased output and therefore a better measure of the effect on total output is the increase in the present value of per capita output that occurs with a CIT rate change. In particular, we can calculate the elasticity of the present value of per capita output with respect to the CIT rate. This elasticity, γ_{CIT}, indicates the percentage reduction in the present value of output from a one percent increase in the CIT rate. Of course, the present value of the increased output depends on the discount rate that is used to calculate the present value of a future income stream, and there is a lot of controversy concerning the appropriate public sector discount rate; see Jenkins and Kuo (2007). Therefore we have calculated the γ_{CIT} with a "low" discount rate of 4.0 percent and a high discount rate of 10.0 percent. A discount rate of 10 percent is consistent with the recommendation of the Treasury Board of Canada (2007).[19] For the low discount rate, γ_{CIT} = -0.249 and with the high discount rate, γ_{CIT} = -0.129. These parameters measure, in present value terms, the long-run impact of the CIT rate changes. For example, the γ_{CIT} based on the high discount rate implies that a 10 percent reduction in the CIT rate will increase the present value of per capita output by 1.3 percent. The γ parameter is the best way of expressing the long-run output effect of a tax rate change, and as we will show in section 4, it plays an important role in the calculation of the long-run marginal cost of public funds.

(Insert Figures 1 and 2 about here)

3.2. The Growth Effects of the PIT Rate Cut

We have used a similar procedure to calculate the effects of the five percentage point reduction in the PIT rate in BC. Our computations for the PIT rate cut are also based on the

[19] A discount rate of 10% was recommended by the Treasury Board of Canada Secretariat in 1998. Jenkins and Kuo (2007), on the other hand, estimated that the discount rate for Canada is about 8%.

values of the coefficients in column (7) of Table 2 and column (5) of Table 3. Note however that α_{PIT} is zero and that the PIT cut only affects the growth rate through its effect on investment. The solid line in Figure 3 shows simulated relative output with the PIT rate cut compared to the output with the base line growth rate of 1.275. Our model indicates that per capita output would be 2.5 percent higher in the long run with the five percentage point PIT rate cut. With a 4.0 percent discount rate, γ_{PIT} = -0.061 and with a 10.0 percent discount rate, γ_{PIT} = -0.033. These parameters measure, in present value terms, the long-run impact of the PIT rate changes, and they indicate that the output effect of a CIT rate cut is about four times larger than the output effect of a PIT rate cut.

(Insert Figure 3 about here)

4. Calculating the Marginal Cost of Public Funds

The true cost of raising a tax rate to taxpayers is not just the direct cost of but also the loss of output caused by changes in taxpayers' economic decisions. The Marginal Cost of Public Funds (MCF) measures the loss created by the additional distortion in the allocation of resources when an additional dollar of tax revenue is raised through a tax rate increase. See Dahlby (2008) for a detailed description of the MCF concept and its application in the analysis of tax policies.

In this section, we calculate the MCFs associated with the CIT rate, top PIT rate, and sales tax rate in BC. The present value of a government's total tax revenues (PVR) can be expressed as:

$$\mathrm{PVR} = \frac{\mathrm{R}}{\mathrm{Y}}\mathrm{PVY}\,, \qquad (5)$$

where *R* is current total tax revenues, *Y* is current output and *PVY* is the present value of the current and future output. It is assumed that the economy's effective tax rate (*R/Y*) will remain constant at current tax rates.

The marginal cost of public funds from raising the tax rate, τ, on one of the tax bases, B, can be expressed as:

$$MCF_{\tau} = \frac{\left(\frac{B}{Y}\right) PVY d\tau}{\left(\frac{dPVR}{d\tau}\right) d\tau} \quad . \qquad (6a)$$

The numerator indicates that the harm that is incurred by taxpayers from a small tax increase $d\tau$ is proportional to the present value of the tax base. The denominator is the present value of the increase in total revenue from a small tax rate increase. The ratio is the additional harm inflicted on taxpayers in raising an additional dollar of tax revenue. This expression can be simplified as follows:

$$MCF_{\tau} = \frac{\left(\frac{B}{Y}\right) PVY}{\frac{1}{Y}\frac{dR}{d\tau} PVY + \frac{R}{Y}\frac{dPVY}{d\tau}} = \frac{\frac{\tau B}{R}}{\frac{\tau}{R}\frac{dR}{d\tau} + \frac{dPVY}{d\tau}\frac{\tau}{PVY}} \, . \qquad (6b)$$

Therefore the MCF for a tax rate increase on one of the government's tax bases can be calculated as:

$$MCF_{\tau} = \frac{s_{\tau}}{\rho_{\tau} + \gamma_{\tau}} , \qquad (6c)$$

where:

$s_{\tau} = \frac{\tau B}{R}$, the share of total tax revenues for the particular tax base;

$\rho_{\tau} = \frac{\tau}{R}\frac{dR}{\tau}$, the elasticity of total revenues with respect to the tax rate (holding output constant);

and

$\gamma_{\tau} = \frac{\tau}{PVY}\frac{dPVY}{d\tau}$, the elasticity of the present value of output with respect to the tax rate, τ.

Note in particular, that ρ_τ depends on the elasticity of total tax revenue and not just the responsiveness of the tax revenue generated by a particular tax because we need to assess the effects of a tax increase on all of the tax bases in assessing the cost of raising revenue from any particular tax source. We will also distinguish between the short-term MCF, where we set $\gamma_t = 0$, from the long-run MCF where we include the growth rate effects that are reflected in the γ_τ parameter. Note that if $\rho_\tau + \gamma_\tau < 0$, then the MCF_τ is not well defined because the government is on the negatively-sloped section of its present value revenue Laffer curve. If $\rho_\tau + \gamma_\tau < 0$, a tax rate reduction would increase the present value of the government's tax revenues. Under these circumstances, taxpayers would be better off if the tax rate were cut, and the government would have more revenue to cut other taxes or increase spending on public services. Finally, if the $MCF_\tau < 1$, then a tax increase will generate more revenues than the tax increase "costs" taxpayers. This could occur if, for example, an increase in one tax rate causes taxpayers to shift to other tax bases which generate more tax revenues. For example, a lump-sum tax in the presence of a distortionary wage tax will have an MCF that is less than one if leisure is a normal good because the lump-sum tax will induce an increase in the supply of labour and an increase in wage tax revenues.

(Insert Table 5 about here)

The results of our computations are reported in Table 5. The shares of total tax revenues are the 1977-2001 averages for the CIT, PIT, and sales tax in BC. The values for ρ_τ are based on the parameter estimates in column (4) of Table 4. The γ_τ parameters are based on the calculations of the growth effects of the tax rate changes in section 3. The calculations indicate that the short-term MCFs for the PIT and the CIT are broadly similar to previous estimates of the MCFs for these taxes using simulation models. (See Dahlby (1996), Sillamaa and Veall (2001), and Baylor and Beausejour (2004).) However, our computations indicate that the MCF for the PIT is lower than the MCF for the CIT. Our computations also indicate that the MCF for the sales tax is less than one, a result that could arise if a higher sales tax rate leads to increased labour supply.

Since our empirical analysis do not indicate that the sales tax affect the growth rate of the economy either directly, or indirectly through the level of investment, the long-term MCF for the sales tax is the same as the short-term MCF, 0.958.[20] Incorporating the growth rate effects of the tax rate changes increases the MCF for the PIT from 1.009 to 1.137 with a 10 percent public sector discount rate or to 1.272 with a 4 percent discount rate. These computations indicate that including the growth rate effects substantially raises our view of the MCF for a PIT. Our computations therefore support previous analysis which indicates that it is much more costly to raise revenue through a PIT rate increase than through a sales tax rate increase and that there are potentially large efficiency gains if a province switches from an income tax to a sales tax.[21]

When the growth rate effects of the CIT are included in the analysis, the MCF does not have a well-defined meaning because a CIT rate reduction would increase the present value of the government's tax revenues. A CIT rate cut would make taxpayers better off and the government would have more funds to spend on public services or cut other taxes. Therefore our computations provide strong support for cutting corporate income tax rates. Unfortunately, our analysis does not indicate how low the optimal CIT rate for BC is or indeed whether the optimal CIT rate is zero.

5. Conclusions

This paper examines the impact of tax rates on economic growth rate using panel data from Canadian provinces over the period 1977 to 2006. Our empirical analysis indicates that higher CIT and PIT rates are associated with lower private investment and slower economic growth. The estimation results appear to be robust to changes in estimation methods and sample

[20] See Mendoza, et al. (1997) and Milesi-Ferretti and Roubini (1998)
[21] See McKenzie (2000) and Dahlby (2000).

period. While the PIT rate affects growth through private investment, the CIT rate seems to influence growth through both private investment and productivity channels. Moreover, the CIT rate tends to have a stronger negative relationship with both private investment and per capita growth rate. Our empirical estimates suggest that a 10 percentage point cut in the CIT rate is related to 1 to 2 percentage point increase in transitional growth rate.

We use the empirical results to assess the impacts of BC's 2001 tax cuts on the province's output and growth rate. The results indicate that in the long run the BC's per capita GDP with the CIT tax cut will be about 11 percent higher than in the absence of the tax cut. Equivalently, at a discount rate of 10 percent, the present value of the output gain from the 2001 CIT rate cut is about 41 percent of current output. Qualitatively similar results are also found for the PIT cut, although the total impact of the PIT cut was smaller than the CIT cut. Thus, in the long-run, the small "temporary" increase in the per capita growth rate translates into a significant long-run output gain for the province. An important implication of this is that Canadian provincial governments will see higher output gains if they adopt pro-growth tax policies.

One concern that policy makers often voice in cutting tax rates is the implication of tax reform for government tax receipts. We have estimated the elasticities of total tax revenue with respect to CIT, top marginal PIT, and sales tax rates. We then use the results from the revenue regressions to calculate the marginal cost of funds for BC. We find that the marginal cost of funds from the PIT and CIT are higher than from the sales tax. In other words, raising revenue through the PIT or the CIT has a higher economic cost than through a sales tax. The simulation analysis conducted for BC also shows that the present value of total tax revenue actually increases when the CIT rate is cut.

Finally, an important contribution of this study is that it fills the gap in empirical literature on taxation and growth in Canada. The revenue estimations and the associated marginal cost of funds calculations included in the analysis also provide a good starting point for future empirical research on static and dynamic revenue effects of tax cuts.

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Appendix 1: Definitions of variables and data sources

Variable	Description	Source
Nominal GDP	Gross Domestic Product (GDP) in current prices	CANSIM Table 384-0014 (1972-1988) and Table 384-0001 (1989-2006)
Real GDP	Gross Domestic Product in 1997 dollars	Statistics Canada, *Provincial Economic accounts*
Investment	Total private investment in 1997 dollars	Statistics Canada, *Provincial Economic accounts*
Population	Total provincial population	CANSIM Table 051-0001.
Corporate marginal tax rate	Provincial statutory top marginal corporate income tax rate (General rate)	*Finances of the Nation* (formerly *National Finances*)
Top personal marginal tax rate	Provincial income tax rate of the top income bracket	*Finances of the Nation* (formerly *National Finances*)
Sales tax rate	Provincial sales tax rate (PST)	*Finances of the Nation* (formerly *National Finances*)
Federal CIT rate	Federal government Corporate income tax rate	*Finances of the Nation* (formerly *National Finances*)
Federal PIT rate	Federal government top personal income tax rate	*Finances of the Nation* (formerly *National Finances*)
Total tax revenue	The sum of provincial income, consumption, property and related, and other tax revenues	Statistics Canada, *Public Finance Historical Data* 1965/66-1991/92, catalogue no. 68-512 (1972-1988) and CANSIM (1989-2006).
Export price	Export price index of provinces' major exporting commodities.	CANSIM Table 176-0006 and Table 228-0044)
Government expenditure to GDP ratio	Provincial and local government expenditures to GDP ratio	CANSIM Table 385-0001
US growth rate	Growth rate of US GDP in 2000 dollars	CANSIM II, Table 451-0010

Appendix 2: Derivation of Equation (4)

The growth equation that includes private investment is given as:

$$g_{it}= \Delta \ln y_{it}=\alpha_Y \ln y_{it-1}+\alpha_{CIT}CIT_{it}+ \alpha_{PIT}PIT_{it} + \alpha_{INV}INV_t + \text{other terms} + \varepsilon_{it}, \quad (2.1)$$

where, y_{it} is real GDP per capita, and other variables are as defined in the text. The estimated aggregate private investment equation is given as:

$$INV_{it}= \beta_Y ln\ y_{it-1}+\beta_{CIT}CIT_{it}+ \beta_{PIT}PIT_{it} + other\ terms + \varepsilon_{it}\ , \quad (2.2)$$

Combining equations (2.1) and (2.2) and noting that in the initial period that $ln\ y_{t-1}$ is predetermined we obtain:

$$\Delta \ln y_t = (\alpha_{CIT} + \alpha_{INV}\beta_{CIT})\Delta CIT\ . \quad (2.3)$$

The percentage gain in per capita GDP growth rate (Δg_t) due to a change in the CIT rate is given as:

$$\Delta g_t = (\alpha_Y + \alpha_{INV}\beta_Y)\Delta \ln y_{t-1} + (\alpha_{CIT} + \alpha_{INV}\beta_{CIT})\Delta CIT \quad (2.4.)$$

$$\Delta g_{t+1} = (\alpha_Y + \alpha_{INV}\beta_Y)\Delta \ln y_t + (\alpha_{CIT} + \alpha_{INV}\beta_{CIT})\Delta CIT = (1 + \alpha_Y + \alpha_{INV}\beta_Y)(\alpha_{CIT} + \alpha_{INV}\beta_{CIT})\Delta CIT$$
$$\Delta g_{t+2} = (1 + \alpha_Y + \alpha_{INV}\beta_Y)^2(\alpha_{CIT} + \alpha_{INV}\beta_{CIT})\Delta CIT$$

$$\Delta g_{t+3} = (1 + \alpha_Y + \alpha_{INV}\beta_Y)^3(\alpha_{CIT} + \alpha_{INV}\beta_{CIT})\Delta CIT\ ,\ldots$$

$$\Delta g_{t+j} = (1 + \alpha_Y + \alpha_{INV}\beta_Y)^j[\alpha_{CIT} + \alpha_{INV}\beta_{CIT}]\Delta CIT \quad (2.5)$$

Table 1: Summary Statistics for the Growth Regressions, 1977-2006

Variables	Mean	Std Dev	Minimum	Maximum
Top corporate tax rate (%)	14.26	2.64	6.05	17.00
Top personal income tax rate (%)	19.39	4.04	10.00	32.00
Government consumption to GDP ratio (%)	29.88	5.55	17.28	41.59
Private investment to GDP ratio (%)	17.53	4.41	11.99	33.40
Population growth rate (%)	0.72	0.89	-1.39	4.18
Export price growth rate (%)	-0.52	7.47	-19.11	19.09
US GDP growth rate (%)	3.14	0.33	2.55	3.51
GDP per capita growth rate (%)	1.73	1.15	-1.00	5.24
Initial GDP per capita (1997 dollars)	23884	6186	12491	40408

Notes: The number of observations is 60.

Table 2: Growth Regressions (1977-2006)

Dependent variable: average growth rate of GDP per capita for the 5-year periods, 1977-2006.

Estimation method	OLS	Robust	IV	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Corporate marginal tax rate	-0.108**	-0.119***	-0.115**	-0.132**	-0.158**	-0.155**	-0.133**
	(-2.064)	(-2.980)	(-2.523)	(-2.081)	(-2.482)	(-1.994)	(-2.138)
Top Personal marginal tax rate	-0.047	-0.065**	-0.054*	0.026	-0.064*	-0.025	
	(-1.401)	(-2.290)	(-1.929)	(0.492)	(-1.654)	(-0.518)	
Log of initial GDP per capita	-2.731**	-3.015***	-3.233***	-1.753*	-4.114*	-3.968**	-3.845**
	(-2.478)	(-5.616)	(-3.143)	(-1.736)	(-1.897)	(-2.201)	(-2.147)
Government expenditure to GDP	-0.124*	-0.136***	-0.144**	-0.107**	-0.218*	-0.242**	-0.233**
ratio	(-1.926)	(-4.438)	(-2.507)	(-2.397)	(-1.926)	(-2.092)	(-2.041)
Population growth rate	-0.457*	-0.420***	-0.496**	-0.264	-0.979**	-1.250***	-1.174**
	(-1.840)	(-3.01)	(-2.523)	(-0.925)	(-2.019)	(-2.597)	(-2.558)
Export price growth rate	0.045**	0.038***	0.046***	0.036**	0.051**	0.061**	0.061**
	(2.358)	(3.145)	(2.846)	(2.207)	(2.139)	(2.283)	(2.439)
US growth rate	1.262***	1.429***	1.231***	1.279***			
	(3.364)	(5.290)	(3.527)	(3.961)			
Investment to GDP ratio						0.087*	0.094**
						(1.805)	(2.152)
Constant	32.712**	34.896***	37.721***	20.545*	53.683**	50.775**	48.220**
	(2.353)	(5.314)	(3.027)	(1.733)	(2.197)	(2.351)	(2.248)
Observations	60	60	60	60	60	50	50
Adj.R-Squared	0.369	0.360	0.366	0.386	0.280	0.266	0.298

The figures in parentheses are t-ratios calculated from robust standard errors.

*, **, and *** show that coefficients are significant at 10%, 5%, and 1% significance levels, respectively.

Provincial fixed-effects are included in column (4). Tax rates, initial GDP per capita, and population treated as endogenous in (5). Time dummies are included in columns (5) to (7).

Table 3: Investment Regressions, 1977-2006
Dependent variable: average private investment to GDP ratio

Estimation method	OLS	Robust	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Corporate marginal tax rate	-0.509*	-0.409**	-0.513**	-0.584**	-0.494*
	(-1.970)	(-2.532)	(-2.089)	(-2.324)	(-1.719)
Top Personal marginal tax rate	-0.517***	-0.330***	-0.393**	-0.448**	-0.378*
	(-2.768)	(-2.863)	(-1.983)	(-2.351)	(-1.850)
Log of initial GDP per capita	-4.446	-2.790	-17.447***	-0.204***	-20.187***
	(-1.258)	(-1.285)	(-2.919)	(-3.081)	(-2.825)
Government expenditure to GDP ratio	-0.395*	-0.498***	-0.748***	-0.887***	-0.867***
	(-1.774)	(-4.036)	(-3.347)	(-3.389)	(-2.944)
Population growth rate	-0.841	-1.748***	0.023		
	(-0.916)	(-3.095)	(0.026)		
Export price growth rate	0.150	0.094*	0.161		
	(1.606)	(1.928)	(1.568)		
US growth rate	-0.528	-1.013			
	(-0.382)	(-0.928)			
Constant	93.619**	76.312***	225.718***	2.616***	255.789***
	(2.154)	(2.873)	(3.469)	(3.519)	(3.149)
Observations	60	60	60	60	50
Adj.R-Squared	0.260	0.196	0.229	0.198	0.047

The figures in parentheses are t-ratios calculated from robust standard errors.
*, **, and *** show that coefficients are significant at 10%, 5%, and 1% significance levels, respectively.
Tax rates and initial GDP per capita are treated as endogenous in (3). Time dummies are included in columns (3) to (5).

Table 4: Total Tax Revenue Regressions, 1972-2006

Dependent variable: Natural logarithm of total tax revenue. [a]

	(1)	(2)	(3)	(4)
Constant	-3.895***	-4.485***	-2.949***	-2.057***
	(0.128)	(0.331)	(0.389)	(0.554)
Ln (GDP)	1.052***	1.033***	1.020***	1.022***
	(0.004)	(0.004)	(0.004)	(0.004)
ln (CIT)	0.071**	0.045**	0.036*	0.050**
	(0.031)	(0.023)	(0.021)	(0.024)
ln (PIT)	0.253***	0.236***	0.264***	0.295***
	(0.038)	(0.041)	(0.038)	(0.053)
ln (sales tax rate)[b]	0.224***	0.208***	0.188***	0.185***
	(0.015)	(0.014)	(0.012)	(0.011)
Ln(other provinces CIT)		0.719***	0.361***	0.301**
		(0.084)	(0.101)	(0.137)
Ln(Federal CIT)		-0.264***	-0.057	-0.239***
		(0.047)	(0.052)	(0.078)
ln (Federal PIT)			-0.349***	-0.424***
			(0.051)	(0.060)
Observations	350	350	350	250
Adj.R-Squared	0.994	0.996	0.997	0.997

Robust standard errors in parentheses. Significance levels are indicated by * for 10%, ** for 5%, and *** for 1%.

[a] *Total tax revenue* is the sum of income, consumption, property and related, and other tax revenue.

[b] This variable is defined as *ln* (variable + 1).

Table 5: The MCFs for Corporate, Personal, and Sales Taxes in BC

	CIT	PIT	Sales Tax
Shares of Total Tax Revenues (1977-2001)	0.0591	0.2977	0.1773
		MCFs	
Short-Term ($\gamma_\tau = 0$)	1.182	1.009	0.958
Long-Term			
4.0 % Discount Rate	--	1.272	0.958
10.0 % Discount Rate	--	1.137	0.958

Figure 1 The Effect of BC's CIT Rate Cut on Growth

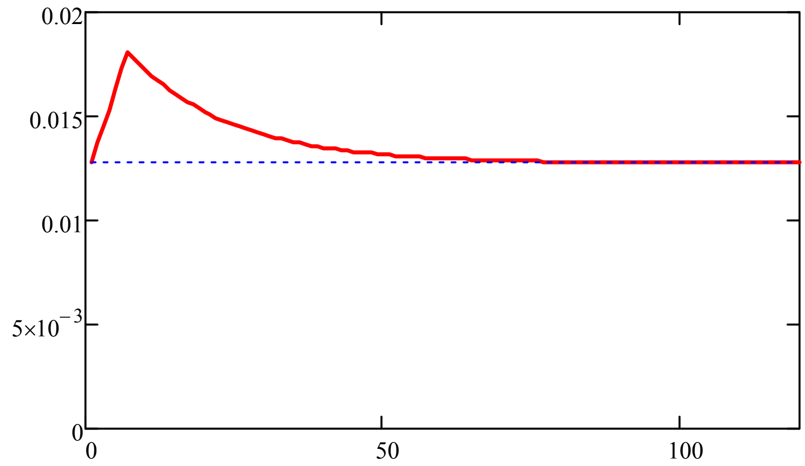


Figure 2 Relative Output with BC's CIT Rate Cut

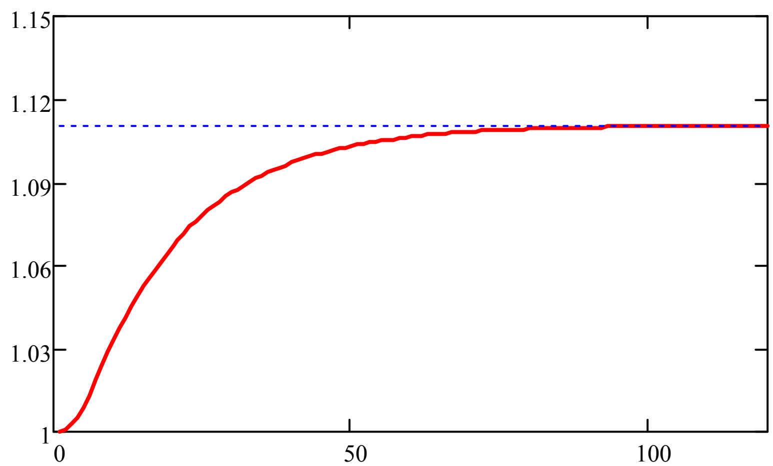
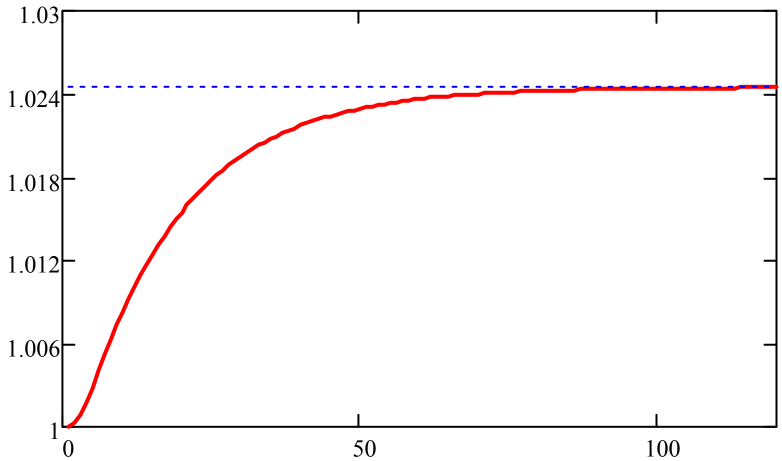


Figure 3 Relative Output with BC's PIT Rate Cut



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Robustness Checks for our preferred growth regression (observations = 50)

Dependent variable	Variable of interest	Federal taxes[a]	Outliers [b]	Alternative Instrument [c]	Resource abundance [d]	National average CIT [e]	Relative CIT rate [f]
Growth rate	CIT rate	-0.135**	-0.138**	-0.135*	-0.159**	-0.122**	-0.020*
		(-1.960)	(-2.308)	(-1.930)	(-2.087)	(-2.095)	(-1.819)
	PIT rate	--					
	Investment	0.101**	0.102**	0.095**	0.045	0.102**	0.095**
		(2.394)	(2.293)	(2.147)	(0.497)	(2.347)	(2.126)
	Adj. R2	0.321	0.404	0.298	0.275	0.337	0.295

a : Federal CIT and PIT rates are included (treated as exogenous). No time dummy but US growth rate is included.
b: Outliers as defined in Mendoza, et al. (1997) are those observations that yield residuals greater than two standard errors of the regression. According to this criterion, New Brunswick (1977) is the outlier.
c: Lagged values of CIT is used as an alternative instrument.
d: we include the fraction of GDP in mining production (at the beginning of each period), as in Barro and Sala-i-Martin (2004), to capture the impact of provincial resource endowment.
e: We control for the national average provincial corporate tax rates. Time dummies are not included but we include US growth rate. The coefficient of this variable is insignificant.
f: Here we use the relative provincial corporate tax rate (i.e. relative to national average). Lagged value of the variable is used as an instrument. Time dummies are also included.