Optimal Levels of Spending and Taxation in Canada

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Editor's Note: At the conference, How to Spend the Fiscal Dividend: What is the Optimal Size of Government? *(Ottawa, December 3, 1997), Professor Gerald Scully discussed his work, based on data from the United States and New Zealand, on the optimal level of government spending and taxation. His theoretical analysis as well as his empirical findings for these two countries provided an important and useful background for the day's discussion about the use of Canada's future fiscal surpluses but he does not have a written paper or empirical results based on Canadian data.*

The following chapter was prepared in order to ensure that Canadians have access to Professor Scully's ideas. It uses Scully's theoretical model and econometric approach as the basis for estimates of an optimal rate of taxation and government spending in Canada. This chapter draws upon The Optimum Levels of Spending and Taxation in Canada *by Johnny C.P. Chao and upon* The Growth Tax in Canada *by Joel Emes, Research Economist, and Dexter Samida, Research Assistant, at The Fraser Institute. Mr. Emes and Mr. Samida also provided assistance with the data and exposition of the final version.*

In recent years, many academic studies have examined both theoretically and empirically the relationship between government spending and economic growth. One approach considers factors known to influence economic growth—labour, education, capital, technology, price stability, and natural resources—for a set of countries and through time. The existence of systematic relationships between a country's growth rates and these variables has been established statistically. Some studies have

Notes will be found on page 67.

added the size of government to the more traditional list of determinants of economic growth. These studies have commonly found that the size of government matters but it is difficult to generalize from their results and to draw conclusions for individual countries because the data has been drawn from a number of countries.[1]

A second approach to the study of the role of government in economic growth concentrates on the experience of individual countries. It does not consider the types of determinants of economic growth but assumes instead that, whatever the determinants of economic growth, the size of government has an additional role to play. One of the pioneers in this field has been Gerald Scully, who has published his analyses of data from the United States and New Zealand as well as cross-country surveys of data from about 100 countries.[2] Professor Scully's methodology allowed him to give relatively precise estimates of the optimal size of government, finding it to be about 19 to 23 percent for the United States and New Zealand.

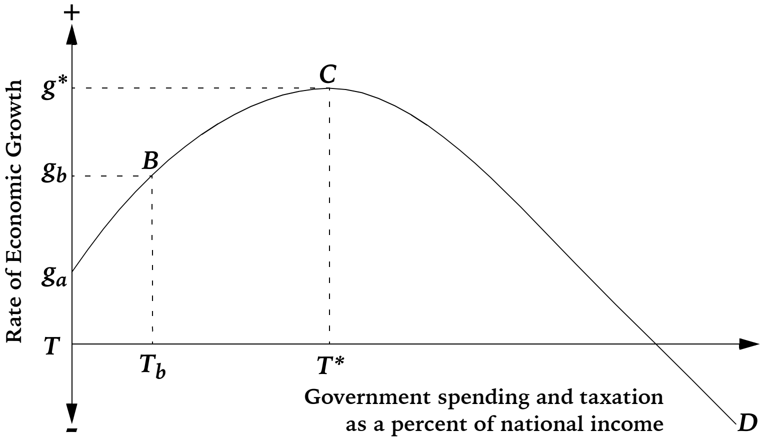
In this chapter we shall use Professor Scully's method to estimate the optimal size of government in Canada. In Part 1, we present a simple model to explain the economic forces that come into play at different levels of government spending and taxation. In Part 2, we present some historic data about spending by Canadian governments between 1929 and 1996. This data set is then used in econometric estimates using Professor Scully's model. The chapter closes with a discussion of the policy implications of our findings.

The concept of optimally sized government

In figure 1, the vertical axis measures the rate of economic growth and the horizontal axis measures government spending as a percent of national output. We assume that spending is equal to taxation. The line with the shape of an inverted U— the Scully curve—shows a postulated functional relationship between economic growth and the level of government spending in a given country.

The shape of the Scully curve g_aD in figure 1 can be explained using a simple analogy. Consider a piece of land in an arid region. The yield of corn planted on this land is increased by the initial application of water and fertilizer in small doses. Increasing the amount of water and fertilizer raises yields further but at a decreasing rate until ultimately the yield is maximized. Further application of water and fertilizer decreases yields and there comes a point where additional applications reduce output below the level at which it was before any water and fertilizer was applied. This relationship between inputs and outputs is described by the Scully curve in figure 1, assuming that the quantity of water and fertilizer are measured on the horizontal axis and yield on the vertical axis.

Figure 1: The Scully Curve



The economic analysis underlying the shape of the Scully curve is as follows. Consider first a zero level of government spending and taxation (T) associated with a growth rate g_a. This growth rate is low because the economy is inefficient when government supplies no services. Under these conditions, private agents have to provide for their own security, enforce contracts, set standards of measurement, and, generally, operate without the aid of the many public goods and services provided by modern states.

Now consider that, in this country with unchanged private sector supplies of capital, labour, and other resources, the government spends and taxes T_b percent of national income. It is postulated that this level of government activity brings about a growth rate of g_b. The higher growth is the result of the government's provision of public goods and services, which increase the overall economic efficiency of the private sector.

The higher efficiency is due to positive externalities (*i.e.* unpriced benefits) accruing to the private sector from the production of government services such as internal and external security, elementary schools, the judiciary, control of disease, roads, water supply, sewers, and a monetary authority assuring a monetary standard and monetary stability. At the low levels of taxation required for this level of spending, the disincentive effects of taxes on work, investment, and risk-taking are small.

Consider now a higher level of government spending and taxation, T^*, that yields a higher rate of economic growth, g^*. However, the curvature of the Scully line between B and C is such that the proportional increase in spending and taxation is less than the proportional increase in economic growth. This property of the curve suggests that government spending is subject to decreasing marginal returns.

Decreasing marginal returns characterize all economic activity. In the present case, they arise as government spending on individual projects at first meets the most pressing needs and exploits the most suitable opportunities for the replacement of inefficient private activities. As spending rises, additional projects financed by government become increasingly less productive. At some point, the marginal benefits from increased government spending become zero. This point is reached at T^* in figure 1, where spending by government produces the highest rate of economic growth the economy is capable of creating. Further increases in spending beyond T^* produce negative marginal effects on economic growth; the Scully curve turns down. In figure 1, we show economic growth falling to zero at a level of government spending, T_m. Higher spending beyond that point can produce negative rates of economic growth.

It is important to consider in more detail the forces that shape the Scully curve. First, there is the law of diminishing returns to additional government spending described in the preceding paragraph. Second, the withdrawal of resources from the private sector initially occurs at the cost of projects with low returns. But the more private spending is reduced, the higher the yield being sacrificed. So economic growth slows or turns down because of decreasing private sector output at growing marginal rates. Third, to raise revenue with which to finance government spending, governments have to impose taxes. Such taxation reduces the private sector's incentives to work, save, invest, and take risks. This, in turn, lowers economic growth.[3]

Finally, some of the spending programs can have additional and somewhat different disincentive effects if they lower the risk of economic life. For example, social security programs protecting workers from the adverse effects of unemployment, illness, and retirement cause them to change their behaviour and reduce work-effort, savings, and risk-taking. Such changes in economic behaviour decrease the effective supply of the traditional factors of production, labour, capital, and entrepreneurship, and therefore reduce economic growth.

Most economists would accept that the preceding analysis is valid and believe that the inverted-U shape of the Scully curve in figure 1 is a realistic description of the world. However, much less agreement exists about the precise curvature of the line and, especially, about the level of government spending at which the optimum growth rate g^* is attained.

Until recently, there were some who believed that the Scully curve rises over a wide range, levels off, and never turns down. These were supporters of communism, socialism and democratic socialism of the sort practised in Sweden and other countries of western Europe. Supporters of these economic systems believed that economic planning and command economies could operate efficiently and achieve rapid economic growth through large planned investment. They also believed that through education it would be possible to create "social man," who was immune to the disincentive effects of taxation and the availability of a wide range of government services. In fact, for a long time these people believed that countries with large governments could have higher rates of economic growth than those with mixed economies and small governments. After the fall of communism and the dismal economic record of social democracies like Sweden, the rank of such believers has shrunk greatly.

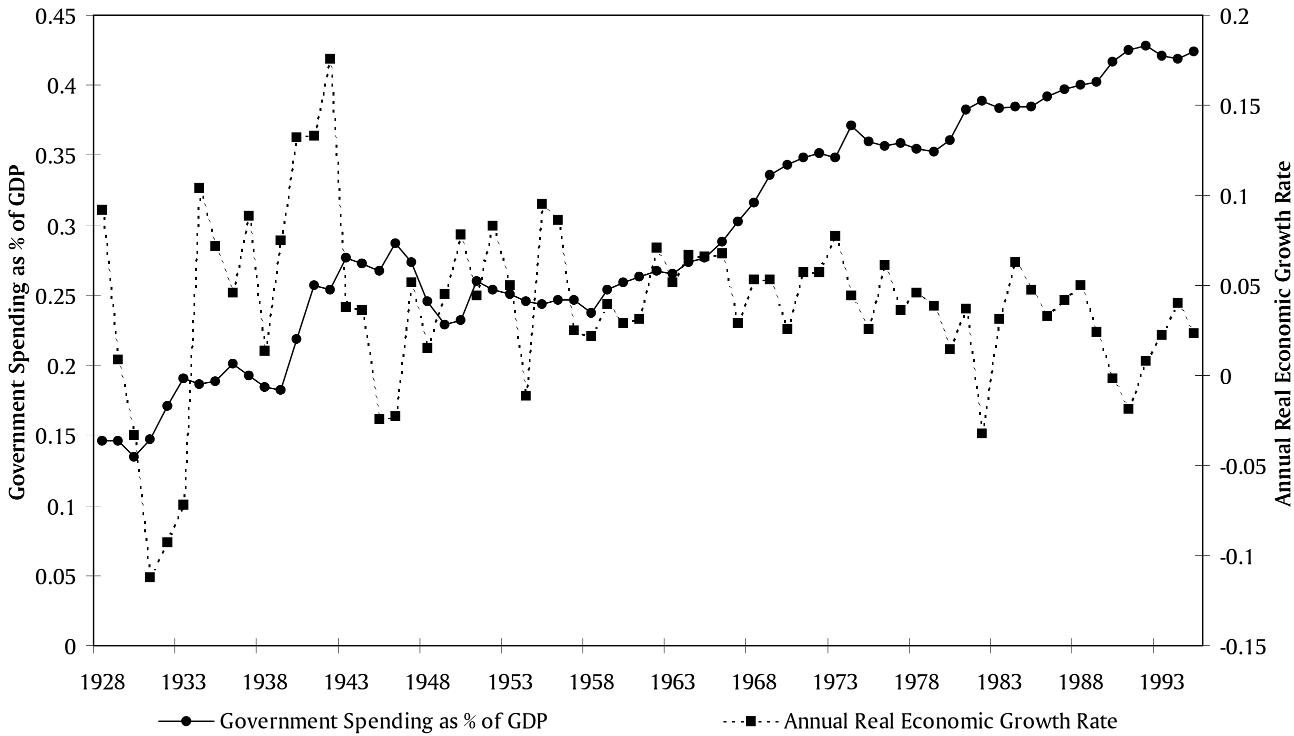
Gerald Scully estimated that, for the United States and New Zealand, the optimal level of government spending and taxation is in the range of 19 to 23 percent. Ludger Schuknecht and Vito Tanzi suggest in *Can Small Governments Secure Social and Economic Well-Being?* (this volume) that government spending in excess of 30 percent reduces economic growth and produces practically no additional improvement in social measures of well-being. What might the optimal rate be for Canada.

Evidence from Canadian data

In figure 2, we show for the years from 1929 to 1996 annual rates of real economic growth and government spending as a percent of national income for Canada. This graph shows that in the prewar period, rising from a low in 1933 during the Great Depression, Canada had both a high rate of economic growth and low levels of government spending. Growth remained high during and after World War II while spending remained around 25 percent of GDP. After about 1960, the size of government began to increase and continued to climb until 1996. During this period, the rate of economic growth was on a distinct downward trend. These data suggest at a simple and intuitive level that Canada around 1960 had reached its optimal level of spending and taxation—about 27 percent. Since in 1996 government spending was 48 percent of national income, Canadian governments clearly spent much more than the optimal amount.

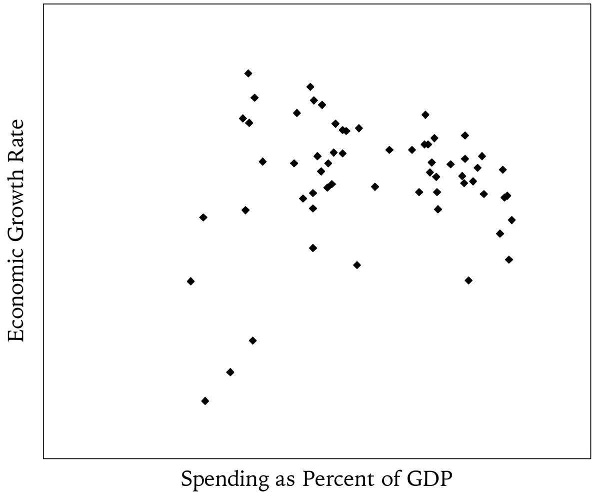
The same impression is conveyed by figure 3, which presents in a different fashion the data underlying figure 2. Figure 3 measures the rate of economic growth on one axis and government spending as a percent of GDP on the other. The individual points represent annual observations of these two variables for the period from 1929 to 1996. It is not too difficult to visualize a Scully line in the shape of an inverted U running nicely through the thickest cluster of points in the graph.

Figure 2: Government spending and economic growth in Canada, 1928–1996



Source: Statistics Canada.

Figure 3: Government spending and economic growth in Canada: scatter of annual observations



Source: Statistics Canada.

Fitting a quadratic equation

To estimate an optimal rate of government spending statistically Gerald Scully (1996) used a very simple and direct approach: he assumed that the data points fit a function described by the following equation:

$$x = a + bY = cY^2 \qquad (1)$$

This equation has been found to describe many empirical phenomena in the world. It also is consistent with the law of diminishing returns since it approximates a line with the shape of an inverted U. Differentiating x in equation (1) with respect to Y and setting it zero shows the maximum point of the curve at $b/2c$.

Following Professor Scully, we substitute the economic growth rate g for x and the level of government spending and taxation τ for Y, we derive equation (2):

$$g = \alpha + \beta\tau + \gamma\tau^2 \qquad (2)$$

Using a nonlinear regression, the results of which are given in the Appendix, we find that for Canada the optimal rate of spending and taxation is approximately 34 percent of national income.

A different model

Following Professor Scully again (1989, 1996) we can give a more sophisticated specification of the econometric model by assuming that economic growth is dependent upon the relative shares of national income spent by the government and the private sector. The mathematical formulation of the relationship uses a specific functional form known as the Cobb-Douglas production function. This production function is used widely in economics both because it describes accurately many empirical phenomena and because it has some convenient mathematical properties.

The economic growth rate is equal to output at time t divided by output in the preceding period: Y_t/Y_{t-1}, which can also be written as $1 + g$, where g is the percentage rate of economic growth. The growth rate is assumed to be determined by government spending in the preceding period G_{t-1} and by the amount spent by the private sector. The latter is determined by the rate of taxation τ and equal to $1 - \tau$ multiplied by that period's total national output Y_{t-1}. The Greek letters in equation (3) represent the relative magnitude that each of the elements contributes to economic growth; their magnitude is estimated econometrically from the data for Canada.[4]

$$\frac{Y_t}{Y_{t-1}} = 1 + g = \alpha\,(G_{t-1})^{\beta}\,(1 - \tau)^{c}\,(Y_{t-1})^{c-1} \tag{3}$$

In the Appendix, we present equation (3) differentiated once and twice with respect to the tax rate. The interpretation of these equations is that the basic function assumed to determine the growth rate has the properties postulated above, *i.e.*, government spending increases growth but at a decreasing rate until it reaches a maximum beyond which the growth rate is lowered.

We now simplify equation (3) by assuming that government spending G equals the amount of national income collected through taxes τY and derive the following equation:

$$1 + g = \alpha\tau^{\beta}(1 - \tau)^{c}\,(Y_{t-1})^{\beta+c-1} \tag{4}$$

Differentiating g with respect to τ and setting it equal to zero we find equation (5), where τ^* is the growth maximizing rate of taxation.

$$\tau^* = \frac{\beta}{(\beta + c)} \tag{5}$$

Following normal procedures, we impose the restriction that the parameters represented by Greek letters in equation (4) sum to 1: $\beta + c = \beta + (1 - \beta) = 1$. This results in the simplified equation (6):

$$1 + g = \alpha\tau^{\beta}(1 - \tau)^{(1-\beta)} \tag{6}$$

Econometric estimates of this equation showed a high degree of collinearity between the dependent and independent variables. To deal with this problem, Gerald Scully (1996) divided both sides of the equation by $1 - \tau$ and obtained equation (7):

$$\frac{(1 + g)}{(1 - \tau)} = a\left[\frac{\tau}{(1 - \tau)}\right]^{\beta} \tag{7}$$

the log form of which gives equation (8):

$$ln\left[\frac{(1 + g)}{(1 - \tau)}\right] = ln\alpha + ln\left[\frac{\tau}{(1 - \tau)}\right]^{\beta} \tag{8}$$

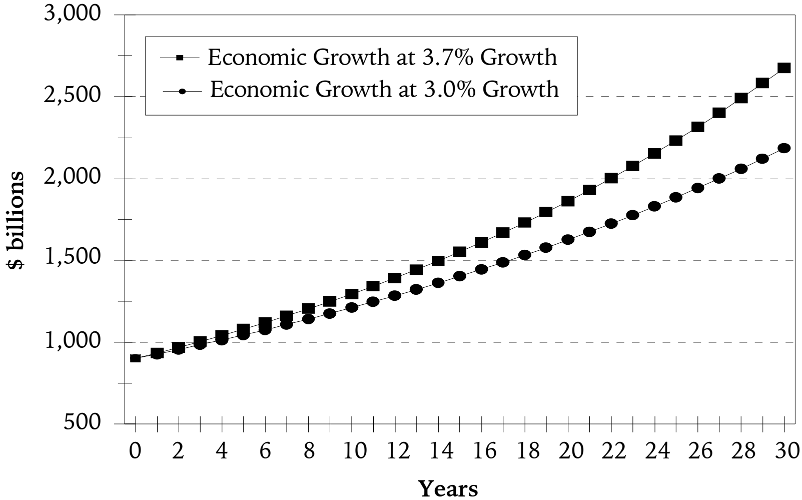
We used this equation and the annual data for Canada from 1926 to 1996. The results are presented in the Appendix for the simple ordinary least square regression. Several, more sophisticated, estimation techniques were used to correct for certain statistical problems associated with these original results.[5] These experiments improved the statistical reliability of the econometric results but did not affect the key result that the optimal rate of taxation and government spending in Canada is about 34 percent.

Conclusions and policy implications

The preceding analysis has some important implications for Canadian economic policy. In 1996, total spending by the governments of Canada was 48 percent of national income. The optimum rate of spending was estimated to be 34 percent. If spending were lowered by 29 percent to that optimum level, the rate of economic growth would increase. Our empirical study allows us to calculate by how big this increase would be.

The econometric results reported in Appendix 1a show that every one percent change in the ratio of spending to national income results in a .74 percent increase in the rate of economic growth.[6] The reduction in the spending ratio of 29 percent due to the movement to the optimal level results, therefore, in an increase in economic growth of 22 percent.

Figure 4: Economic growth at 3.0 percent and 3.7 percent



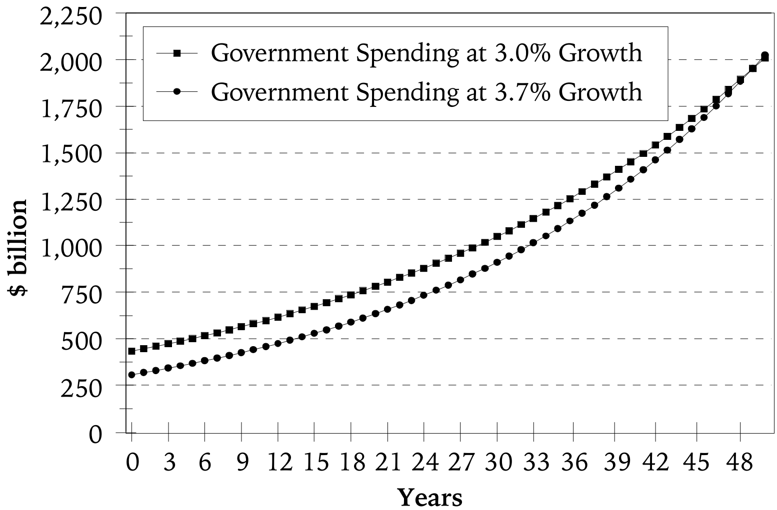
Source: Calculations by authors.

During the period 1990 to 1997, Canada's economy grew 3 percent annually. An increase of 22 percent of this rate brings it to 3.7 percent. The effects of such an increase in the rate of economic growth on national income can be seen in figure 4. At $900 billion in year zero (say 2000), 30 years later (in 2030) national income will be $2,677 billion if it grows at 3.7 percent and only $2,185 billion if it grows at 3.0 percent.

Figure 5 shows what happens to the absolute level of government spending under the two scenarios. The lower line shows that at time zero government spending is always equal to 34 percent of national income. Initially, government spending is at $306 billion, equal to 34 percent of national income of $900 billion. It grows 3.7 percent per year. The top line shows government spending at $432 billion or 48 percent of national income, growing at 3 percent annually. The graph shows that 51 years later the absolute levels of government spending would be the same under the two scenarios. Not shown is the important fact that thereafter government spending at 34 percent of national income would always be higher than under the assumption that it is 48 percent of national income.

Figure 6 shows what happens to private income under the two scenarios. The bottom line represents an initial private income of $468 billion, equal to 52 percent of total national income. It grows at 3 percent and reaches a level of $2,177 billion in 51 years. The top line shows that,

Figure 5: Government spending at 3.0 percent and 3.7 percent growth



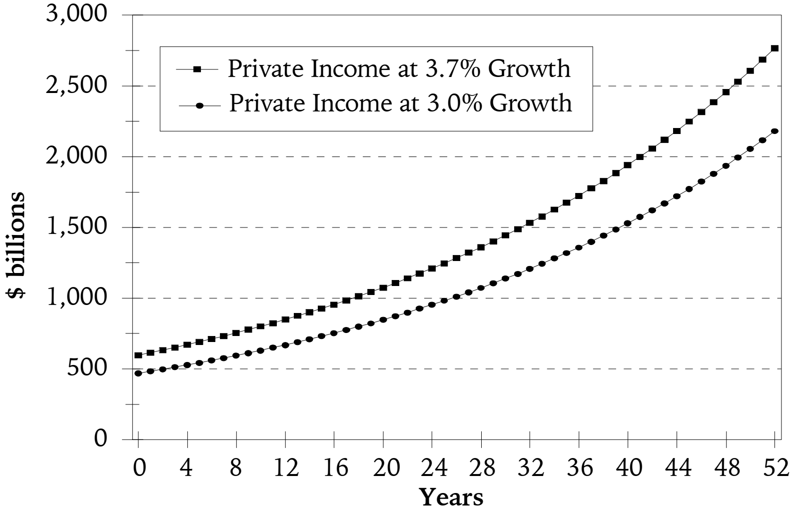
Source: Calculations by authors.

if private spending were raised to $586 billion, equal to 66 percent of total national income, the accompanying growth rate of 3.7 percent in 51 years would yield an income of $2,763 billion, or $586 billion more than under the first scenario. It is important to remember that, in this fifty-first year under the optimum government spending strategy, the absolute level of government spending would also be the same as it would have been had it stayed at its present sub-optimal level.

The preceding figures are only illustrative and assume that all other influences on economic growth remain the same. But they do indicate that reductions in the size of government relative to total national income would significantly raise the private income of future generations and eventually permit greater government spending without impingement on private spending.

The facts brought out by the preceding analysis should be given serious consideration when decisions are made about the use of the fiscal surpluses expected in the future. To reduce government spending from 48 to 34 percent of national income, spending increases have to be below the growth in national income. The remaining surpluses must go to the reduction of taxes and debt. The greater the share of the surpluses going to these expenditure reductions, the more rapidly the country will reach its optimum level of spending and enjoy a corresponding increase in the rate of economic growth.

Figure 6: Private income at 3.0 percent and 3.7 percent growth



Source: Calculations by authors.

Appendix 1A

Summary estimates for

$$ln\left[\frac{(1+g)}{(1-\tau)}\right] = ln\alpha + ln\left[\frac{\tau}{(1-\tau)}\right]^{\beta}$$

Ordinary least squared regression summary statistics

R	.919
R Square	.844
Adjusted R Square	.841
Standard Error of the Estimate	.07032
Mean LN_DPVR1	.4844
Mean LN_IPVR1	–.7470
Standard Deviation LN_DPVR1	.1766
Standard Deviation LN_IPVR1	.4804

Appendix 1B

Summary estimates for

$$1 + g = \alpha + \beta_1\tau + \beta_2\tau^2$$

Constrained non-linear regression summary statistics

Source	DF	Sum of Squares	Mean Square
Regression	3	80.10837	26.70279
Residual	66	.33283	5.042917E-03
Uncorrected Total	69	80.44120	
(Corrected Total)	68	.35580	

R squared = 1 – Residual SS/Corrected SS = .06454
Asymptotic 95%

Asymptotic Confidence Interval

Parameter	Estimate	Standard Error	Lower	Upper
A	.864523201	.100132568	.664602078	1.064444323
B	1.326296262	.625955843	.076535099	2.576057425
C	-1.885825758	.912990020	-3.708669147	-.062982369

Appendix 1C

Summary estimates for

$$1 + g = \alpha\tau^{\beta}(1 - \tau)^{(1-\beta)} \qquad (9)$$

Nonlinear Regression Summary Statistics

Source	DF	Sum of Squares	Mean Square
Regression	2	80.09560	40.04780
Residual	67	.34561	5.158311E-03
Uncorrected Total	69	80.44120	
(Corrected Total)	68	.35580	

R squared = 1 – Residual SS/Corrected SS = .02864
Asymptotic 95%

Asymptotic Confidence Interval

Parameter	Estimate	Standard Error	Lower	Upper
A	2.092074523	.031599164	2.029002327	2.155146720
B	.337247995	.017251433	.302813992	.371681999

Appendix 2A

First and second degree derivatives of

$$\frac{Y_t}{Y_{t-1}} = 1 + g = \alpha\,(G_{t-1})^{\beta}\,(1-\tau)^{c}\,(Y_{t-1})^{c-1}$$

Taking the derivatives of *g* with respect to *G*, the marginal productivities of increasing government expenditures at a positive but diminishing rate may be revealed. Conversely, for τ denotes the average tax rate, increasing taxation levels negatively affects the rate growth at an increasing rate. Hence, with respect to *G*,

$$\frac{\partial g}{\partial G} = \alpha G^{\beta-1}\, Y^{c-1}\, \beta(1 - \tau)^{c}$$

$$\frac{\partial^2 g}{\partial G^2} = \alpha\beta G^{\beta-2}\, Y^{c-1}\, (1 - \tau)^{c}\, (\beta - 1)$$

where $\partial g/\partial G > 0$ and $\partial^2 g/\partial G^2 < 0$. Further, with respect to τ,

$$\frac{\partial g}{\partial \tau} = \alpha G^{\beta}\, Y^{c-1}\, (1 - \tau)^{c-1} c$$

$$\frac{\partial^2 g}{\partial \tau^2} = \alpha c G^{\beta}\, Y^{c-1}\, (1 - \tau)^{c-2}\, (c - 1)$$

where $\partial g/\partial \tau > 0$ and $\partial^2 g/\partial \tau^2 < 0$. These transformations charts out the curvature approximation akin to those depicted in figure 3, and forms the empirical basis behind both the Laffer and Scully Curves.

Notes

1 One of the most respected efforts using this approach is by Barro (1990, 1991, 1996). Others are Grier and Tullock (1980); Tanzi and Schuknecht (1995).
2 See Scully 1989, 1995, 1996.
3 The similarity between the preceding Scully curve and the well-known Laffer curve is no coincidence. The Laffer curve (named after the American economist who developed it in the late 1960s) shows the relationship between total government revenue and rates of taxation. It is also drawn as an inverted U for the following reasons. At zero tax rates, revenues are zero; at 100 percent tax rates, revenues are also zero because incentives to work are totally destroyed if the government confiscates all of the income earned. As tax rates rise from zero, revenues increase initially. However, as a matter of logical necessity, since at a rate of 100 percent they are zero, at some level of rates they must reach a maximum and then decline.
4 As will be discussed below, the basic assumptions used to justify the existence and shape of both the Laffer and the Scully curves are accepted by most analysts. The central question about the Laffer curve is empirical and often heatedly debated. At what level of taxation is revenue maximized in Canada? Are current rates above or below that point of maximization? The same issue surrounds the Scully curve. What is the optimal size of government?
5 Additional statistical inferences were made based on the testing model as proposed by equation (8). These tests included both constrained and unconstrained nonlinear regressions on equations (1) and (6), with insignificant differences in the imputed results. As it is common in economics that there may be several competing theories that attempt to explain the same set of variables, a non-nested hypothesis was conducted to evaluate the statistical validities of equations (1)and (8). Non-nested hypotheses work through the exploitation of the falsity of other models, such that one specification cannot contribute any more explanatory power on the independent variable than the 'true' model. Again, the variance in the value of the optimal level of government spending and taxation as derived was found to be insignificant, and our approaches here remain statistically valid.
6 The slope of the independent variable in log form in equation (8) can be interpreted directly as the elasticity.

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