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The Effect of Corporate Taxes on Canadian Investment: An Empirical Investigation

by

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Abstract

This study examines the sensitivity of industry-level investment in Canada to a reduction in the corporate tax burden over the 2001 to 2004 period. The analysis exploits the fact that the seven-point reduction in the federal corporate income tax rate did not apply to manufacturing industries. The selective nature of the tax reductions provides “treatment” and “control” groups, making it easier to identify the effect of lower taxes on business investment.

Employing a neoclassical model of investment and a difference-in-differences approach, the impact of the tax component of the user cost on investment in 43 manufacturing and service industries is estimated. Both approaches suggest that the corporate tax reductions led to higher investment. A 10 per cent reduction in the tax component of the user cost of capital is associated with an increase in the capital stock in the 3 to 7 per cent range, with the latter being the preferred estimate, since it is obtained using a more robust methodology.

Résumé

L’auteur étudie la sensibilité de l’investissement des entreprises au Canada à un allégement du fardeau fiscal des sociétés durant la période de 2001 à 2004. L’analyse tire parti du fait que la réduction de sept points du taux d’impôt fédéral sur le revenu des sociétés ne s’appliquait pas à toutes les industries manufacturières. Le caractère sélectif de la réduction d’impôt a permis de cibler des groupes « traités » et « témoins », et d’expliquer ainsi plus facilement l’incidence d’une réduction d’impôt sur l’investissement des entreprises.

En se servant d’un modèle néoclassique d’investissement et d’une approche de l’écart des différences, l’auteur évalue l’incidence de la composante fiscale du coût du capital sur l’investissement de 43 entreprises de l’industrie manufacturière et des services. Les deux méthodes révèlent que la réduction de l’impôt des sociétés favorise des investissements supérieurs. Une réduction de 10 % de la composante fiscale du coût du capital se traduit par une croissance du stock de capital de 3 à 7 %, ce dernier chiffre représentant l’estimation privilégiée, parce qu’il est obtenu avec une méthodologie plus robuste.

1. Introduction

In the early 2000s the corporate tax burden was significantly reduced in Canada. The most significant tax policy measure saw the general federal corporate income tax (CIT) rate fall seven percentage points – or about 24 percent – over four years, beginning with a one-point reduction in 2001 followed by three consecutive two-point reductions (see Box 1). This study exploits the variation in the tax wedge – the difference between cost of capital with and without corporate taxes – created over this period by these tax reductions. In particular, it examines the responsiveness of investment to changes in the tax component of the user cost among industries that were affected by the tax reductions (i.e. the service sector) and those that were not (i.e. the manufacturing sector).

This paper employs two methodologies to assess the impact of corporate taxes on investment. First, the response of investment to the tax and non-tax components of the user cost is examined using a panel data set of 43 industries between 1998 and 2004. Second, a difference-in-differences estimation of the corporate tax reductions is performed by examining growth in the capital stock before and after the tax reductions. In section 2 and 3, the cost of capital theory is reviewed, including a description of how different taxes, particularly the CIT, affect the cost of capital. Section 4 reviews the literature on the empirical relationship between investment and the cost of capital. Section 5 describes the data used for estimation. Finally, in sections 6 and 7, two approaches used to estimate the impact of tax reductions on Canadian investment are described followed by a discussion of the empirical results.

Box 1: The Federal Corporate Income Tax Cuts, Budget 2000

The federal government announced major corporate tax reductions in its 2000 Budget and set out a timetable for these reductions in the 2000 Economic Update. The most significant change was a seven-point reduction in the general CIT rate – from 28 to 21 percent – phased in over four years, beginning with a one-percentage point cut in 2001 followed by three consecutive years of two point reductions. The tax cuts were applied to business income not already subject to a reduced tax rate or special allowances, which thereby excluded small business, manufacturing and resource income. Therefore, for the purpose of this analysis, we assume that firms in the service sector were most likely to react to the tax cuts. In this study, the service sector is broadly defined to include all industries that are outside manufacturing, agriculture, oil and gas, and public or quasi-public industries, such as public administration, education services, healthcare services and utilities. Due to data limitations, we also exclude finance, insurance and real estate and leasing service industries.

2. Theoretical Link between Investment and the Cost of Capital

Corporate taxes reduce the financial returns on capital projects, causing fewer projects to be undertaken. This section reviews the neoclassical user cost theory to formally show how taxes can affect investment decisions. Pioneered by Jorgenson (1963), the neoclassical theory of investment predicts that a profit-maximizing firm will acquire capital up to the point where the marginal product of capital ($f^1(K)$) equals its user cost (UC):

$$f^1(K) = UC \qquad (1)$$

The UC is the cost of acquiring an additional unit of capital. It includes the price of capital relative to output (q), the opportunity cost of financing capital (r_f), the inflation rate (π) and the rate of depreciation (δ). Therefore, on a pre-tax basis, the UC is given by:

$$UC \equiv q(r_f - \pi + \delta) \qquad (2)$$

Equation (1) and (2) imply that a firm will acquire capital up to the point where it is compensated for the real opportunity cost of funds (r_f - π) plus the cost of replacing depreciated capital.

Taxes also affect the cost of capital. The corporate income tax rate (τ) lowers after-tax returns by a factor of 1-τ . This is equivalent to an increase in the cost of capital by a factor of 1/(1-τ). At the same time, other tax measures encourage capital formation. For example, depreciation allowances, investment tax credits and interest deductibility all reduce the cost of capital. Including all the effects of taxes, equation (2) becomes:

$$UC \equiv \frac{q(r_f - \pi + \delta)(1-\varphi)\left(1 - A + \dfrac{\eta(1-\tau)}{r_f + \delta}\right)(1+ST)}{1-\tau} \qquad (3)$$

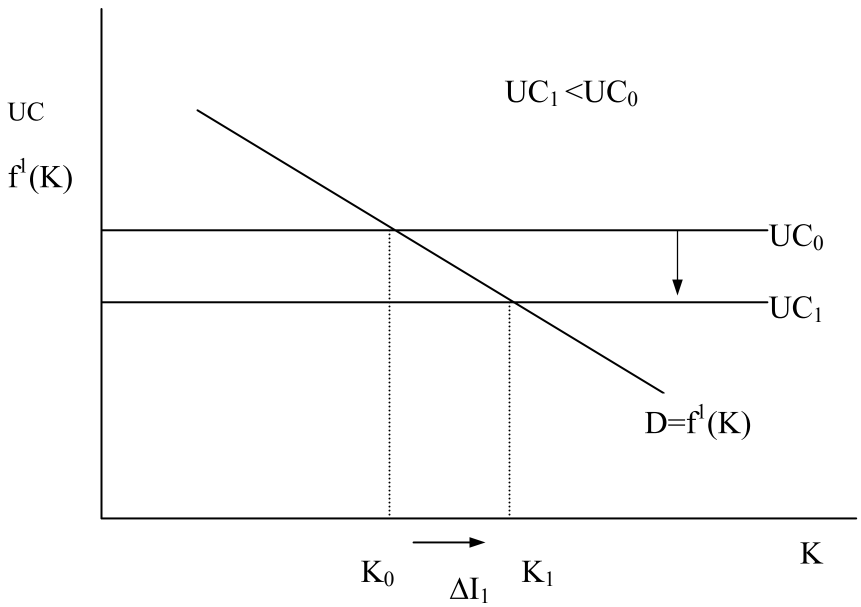
where φ is the investment tax credit (ITC) rate, A is the present value of depreciation allowances, η is the capital tax rate, τ is the corporate tax rate and ST is the sales tax applied to capital inputs. Explicitly, the opportunity cost (r_f) of funds in equation (2) is the weighted average of debt and equity financing:

$$r_f = \beta i(1-\tau) + (1-\beta)\rho \qquad (4)$$

where, β is the debt to asset ratio, i is the real interest rate on borrowed funds (reduced by interest deductibility), and ρ is the required return on equity capital.

According to equations (1) and (3), any factor that lowers the user cost, such as a reduction in the corporate income tax rate or an increase in depreciation allowances, will encourage capital formation. As firms acquire more capital, the marginal product falls until it converges to the new lower value of the user cost. Figure 1 illustrates this process. Suppose the government introduces an investment tax credit, bringing the user cost down from UC_0 to UC_1, thereby shifting the supply curve down. At K_0, the firm's marginal product is higher than the new user cost, UC_1, so the profit-maximizing firm will increase investment (ΔI_1) up to the point where the marginal product equals the new user cost (K_1). Although Figure 1 treats the move to the higher optimal capital stock as immediate, in reality the process is dynamic, with firms gradually increasing K as a result of adjustment costs.

Figure 1: A Reduction of UC on Optimal K



The preceding analysis applies to taxable firms. For non-profitable firms, the value of tax credits and deductions diminishes and the effect of taxes on the user cost becomes more complicated (see Mintz, 1988). Another limitation of the user cost theory is that it assumes perfect capital markets, so that firms can borrow and lend freely to reach their optimal capital stock. This assumption has been called into question in the recent literature that shows asymmetric information between a firm's insiders and outside investors may constrain the financing of profitable projects.[1] As a result, tax reductions may not only affect investment by raising after-tax returns, as emphasized in the user cost theory, they may also have a stimulatory impact by raising the supply of after-tax cash flow available to financially-constrained, profitable firms. By ignoring the cash flow effect, this assessment using the user cost approach may understate the total impact of the CIT cuts on investment.

[1] The empirical work by Hall(1992), Hubbard and Frezzari (1987), Schaller (1993) and others provide evidence that information asymmetries leads to financing constraints, which in turn causes some firms to rely on internal funds (i.e. cash flow) to finance investment.

3. Impact of Taxes on the Cost of Capital

The effect of taxes on the cost of capital depends, in part, on the type of tax in question. From equation (3) it is clear that some tax measures reduce the user cost of capital: investment tax credits lower the purchase price of investment by $q\varphi$, depreciation allowances decrease the taxes on new capital purchases by $qA\tau$, and interest deductibility results in a tax saving of $qiB\tau$.

But other tax measures clearly make it more costly for firms to acquire capital. For example, the retail sales tax (ST), which is applied to new capital purchases in Ontario, Manitoba, Saskatchewan, British Columbia and Prince Edward Island, raises the cost of capital. The capital tax, which applies to a firm's capital stock above a certain threshold, also increases the user cost of purchasing capital.[2]

The effect of the corporate tax rate (τ) on the user cost is more complex given its interaction with the other tax parameters. On the one hand, a CIT reduction directly increases the profits earned on a marginal investment project, causing the UC to fall. But on the other hand, a lower CIT rate reduces the benefits arising from interest and capital tax deductibility as well as depreciation allowances, all of which cause the UC to rise.

To estimate the net impact of the Budget 2000 CIT cuts on the cost of capital, the user cost formula given by equation (3) is parameterized at pre-tax cut levels for the service sector. Holding all other variables fixed, the marginal effect of the CIT rate on the UC is simulated (i.e. $\partial UC / \partial \tau$), allowing for all interaction between the CIT rate and other tax measures, such as interest and capital tax deductibility and depreciation allowances. This analysis shows that a decline in the CIT rate leads to a lower user cost. Specifically, the seven-point reduction announced in 2000 reduced the cost of capital for large firms with service income by 2.4 percent.

A key consideration is the timing of the tax cuts. It is likely that phased-in tax cuts, such as the budget 2000 reductions, have a larger impact on the incentives to invest than immediate tax reductions, mainly because phased-in tax cuts increase future after-tax returns and therefore provide a gain to new capital, while immediate tax cuts provide a large windfall gain to existing capital (House and Shapiro, 2004). Further, phased-in cuts give an incentive for firms to build up investment related expenses (i.e. interest deductions, CCA) in an effort to maximize the tax value of these deductions before the tax cuts come into effect. These results are predicated on the credibility of a government's phase-in strategy. To the extent that governments negatively modify their initial announcements, the credibility of any future announcements would be reduced. In this study, it is assumed that firms viewed the one percentage point tax reduction announced in Budget 2000 as credible but remained sceptical about the remaining six percentage-point reduction until the schedule was set out in legislation in the October 2000 Economic Statement.

[2] The capital tax was eliminated by the federal government in 2006, but remains in place in Manitoba, New Brunswick, Nova Scotia, Ontario, Québec and Saskatchewan.

While it is necessary to demonstrate that the tax cuts lowered the user cost, it is not sufficient in itself to conclude that the tax cuts encouraged investment. This requires evidence that investment was sensitive to taxes imbedded in the user cost. The next section reviews studies that test the sensitivity of investment to the user cost, which is followed by an empirical test using a panel data set for Canadian service and manufacturing industries during the period surrounding the tax cuts.

4. Review of Empirical Literature

Knowledge of the user cost and its role in investment behaviour is central to our understanding of the effect of tax policy. Indeed, the conclusions from many general equilibrium models used to simulate the impact of corporate tax policy are sensitive to the estimate of the user cost behavioural parameter.[3]

Since Jorgenson (1963), an extensive empirical literature has emerged to explain the relationship between the user cost of capital and investment. Earlier studies, largely based on macro-investment data, failed to find an economically significant relationship. Chirinko (1993) reviews this literature and finds that the response of investment to the user cost is small and insignificant relative to output variables.

More recent empirical work has attempted to overcome aggregation problems using micro data.[4] Chirinko, Fazzari and Meyer (1999) employ a large U.S. firm-level data set containing 26,000 observations and find a statistically significant user cost elasticity with respect to capital of -0.25. In a later study, Chirinko, Fazzari and Meyer (2002) estimate a higher elasticity of -0.4 using a smaller U.S. firm-level data set and a long-panel estimation strategy.

An ongoing challenge in the empirical literature is measuring the expected user cost – the key decision variable for a forward-looking firm. To reduce the likelihood of measurement error and therefore potential bias to the user cost elasticity estimates, some economists have studied investment during periods of tax reform. The key advantage of tax reform periods is that they represent discernable changes in tax rates, allowing the researcher to minimize the error associated with measuring expected tax prices. Cummins, Hasset and Hubbard (1995) apply this approach to tax reforms in 14 OECD countries. They find evidence of significant investment responses to taxes in 12 of the 14 countries studied, including in Canada during the 1987 tax reform.

Two of the more extensively studied tax reforms have been those of 1991 in Sweden and 1986 in the U.S. The Swedish reform, labelled by Agell, England and Soderstein (1996) as the most "far-reaching reform in any industrialized country in the post-war period" (p. 643), saw a major broadening of the value-added sales tax,

[3] Chirinko (2002) examines the sensitivity of general equilibrium results to user cost elasticities. He finds that a one percent increase in the user cost elasticity translates into an increase in welfare due to a tax reform of between 0.5-0.94 percent.

[4] ab Iorwerth and Danforth (2004) provide a more recent review of the literature.

combined with significant reductions in the corporate and personal tax rates for middle- to high-income individuals. Auerbach, Hasset and Sodersten (1995) examine whether these tax changes had any effect on investment and conclude that the impact was likely minor. The U.S. tax reform of 1986 also introduced sweeping changes to the tax code. On the corporate side, the CIT rate was reduced from 46 percent in 1985 to 34 percent in 1988, depreciation lives were lengthened and the investment tax credit was repealed. Cummins and Hasset (1992) study investment behaviour after the 1986 U.S. tax reform and estimate user cost elasticity of –1.1 for equipment and –1.2 for structures. The authors argue that their exploitation of the tax reform period as well as their use of firm level data, allowed them to overcome measurement errors common in earlier macro-level studies.

Despite the importance of user cost elasticity estimates in developing tax policy, few empirical studies have been conducted using Canadian firm-level or industry-level panel data.[5] Chirinko and Meyer (1997) attempt to infer Canadian elasticities by organizing their U.S. firm-level sample into sectors comparable to those in Canada. However, given the unique industrial structure of the Canadian economy combined with the relative complexity of its tax code, Chirinko and Meyer admit that it may not always be appropriate to apply the U.S. results in a Canadian context.

Based on the above studies, the user cost does have a significant impact on investment, although the range of estimates tends to vary widely. Reviewing the literature, Hasset and Hubbard (1997) conclude that "recent studies appear to have reached a consensus that the elasticity of investment with respect to the user cost of capital is between -0.5 and -1.0" (p.34). Table 1 summarizes the recent empirical findings in this area.

[5] Two recent studies have used Canadian aggregate time series data on M&E. ab Iorwerth and Danforth (2004) estimate a user cost elasticity of -0.97, while Schaller (2007) reports an elasticity of -0.9 with respect to tax variables . (on re-reading this section, it does seem odd to relegate these studies to a footnote.)

Table 1: Long-Run User Cost Elasticity Estimates

Study	**Estimate**	**Nature**
Chirinko (1993)	0 to -0.3	Survey of Econometric Studies[1]
Cummins and Hasset (1992)		
- Equipment	-1.1	U.S. 1986 Tax Reform
- Structures	-1.2	- firm-level data, 1987
Cummins, Hasset and Hubbard (1996)	-0.66[2]	Years of Major Tax Reforms in Several Countries[3] -firm-level data, 1987-1992
Caballero, Engel and Haltiwanger (1995)	-0.72[2]	U.S. manufacturing plant-level data, 1972-1988.
Chirinko, Fazzari and Meyer (1999)	-0.25	U.S. firm-level panel data, 1981-1991
Chirinko, Fazzari and Meyer (2002)	-0.4	U.S. firm-level panel data, 1974-1992
ab Iorwerth and Danforth (2004)	-0.97	Canadian macro time series data on M&E, 1984-2002.
Schaller (2007)	-0.9[4]	Canadian macro time series data on M&E, 1962-1999.

[1] Based on mainly U.S. studies between the ear1y 1960s and late 1980s
[2] Calculated by Chirinko (2002)
[3] Includes Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, The Netherlands, Norway, Spain, Sweden, United Kingdom and the United States.
[4] Based on the tax component of the user cost of capital

As a result of structural differences between Canada and the U.S., it may not be appropriate to apply the same elasticities found in U.S. firm-level studies to a Canadian setting. In particular, it is well known that Canada, relative to the U.S., has a greater degree of foreign ownership.[6] Recent empirical evidence suggests that real investment coming from foreign sources is particularly sensitive to the effective corporate tax rates. For example, Grubert and Mutti (2000) found that the amount of real capital invested by U.S. MNEs in a given country is highly responsive to the effective host country corporate tax rate, reporting an elasticity of –3 for countries open to free trade. For this reason, it may be more reasonable to expect that the upper range of the U.S. user cost elasticity estimates would apply to Canada.

[6] As an indication, between 1990 and 2000, inward FDI flows as a share of fixed capital formation averaged 12.5% in Canada compared to 7.0% in the United States. (source: United Nations Investment Database,).

5. Investment Model and Empirical Approach

There are, in general, two main types of models used to explain investment behaviour. The first category is based on Jorgenson's (1963) neoclassical theory of investment, or user cost theory, which has been widely used to study the behavioural effect of tax policy. As outlined in section 2, this theory predicts that a profit-maximizing firm will invest in capital up to the point where the revenue generated from the last unit of capital is equal to the UC, or the cost of employing that unit. Different variations of the user cost model, relating investment to current and lagged values of the user cost, sales and other variables, have performed well empirically.[7] More recently, econometricians have included liquidity variables (e.g. cash flow) to the neoclassical investment equation to capture the impact of financing constraints caused by asymmetric information between the investor and firm as discussed in section 2.[8]

Another popular approach is the q-theory of investment. Developed by Tobin (1969), the q-theory suggests that investment should depend on the market value of capital, which is based on future streams of profits, relative to its replacement cost. Building on this idea, Hayashi (1982) and others formally show that a representative firm with convex adjustment costs will invest if the present value of profits from an additional unit (shadow value) of capital exceeds its replacement value. The shadow to replacement value ratio, known as Tobin's marginal q, summarizes all information relevant to a firm's investment decision under the assumption of perfect capital markets. For examples of investment equations using a tax-adjusted q see Summers (1981) for the U.S. and Schaller (1993) for Canada. A major problem with the q-theory is that it is difficult to test empirically since a firm's marginal q is unobservable. Studies instead rely on a firm's average q, which, according to Hayashi, only equals the marginal q under fairly restrictive assumptions.

This paper employs the user cost theory to estimate the impact of corporate taxes on Canadian investment. In Annex A, a model of investment demand is formally developed that expresses investment as a function of the user cost and output. An estimable version of this model is as follows:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_0 + \alpha_1 \frac{\Delta UC_{i,t}}{UC_{i,t-1}} + \alpha_2 \frac{\Delta Y_{i,t}}{Y_{i,t-1}} + \alpha_3 f_i + \alpha_4 T_t + \varepsilon_{i,t} \qquad (5)$$

where i indexes industries, and f_i and T_t represents industry and time dummies, respectively. The coefficient α_1 represents the elasticity of capital with respect to the user cost.[9] Equation (5) is similar to many user cost models estimated in the literature

[7] See Chirinko (1993) for a detailed review of investment models used for econometric analysis. Examples of studies using the user cost approach include Cummins and Hasset (1992) for the U.S. and ab Iorwerth and Danforth (2004) for Canada.

[8] See Hubbard (1998) for a review of the literature on investment and financing constraints.

[9] Chrinko et al (1999) show why this coefficient represents the user cost elasticity.

(see Hall, Mairesse and Mulkay, 1998) and represents the base model for evaluating the responsiveness of investment to the user cost of capital.[10] The inclusion of industry fixed effects is justified on the basis that depreciation rates vary by industry so that certain industries may have higher investment to capital ratios than others.

From equation (5) it is impossible to determine whether investment reacts to changes in tax policy, changes in the economic parameters or a combination of both. To identify the separate impact of taxes on investment, the user cost is decomposed into its tax and non-tax components. First, equation 3 can be rewritten as:

$$UCC = \frac{q(r-\pi+\delta)(1-\varphi)\left(1-A+\frac{\eta(1-\tau)}{r_f+\delta}\right)(1+ST)}{1-\tau}\left\{1-\frac{Bi\tau}{r-\pi+\delta}\right\}$$

where r =Bi+(1-B)p. Taking the natural logs:

$$\ln UC = \ln q(r-\pi+\delta) + \ln\left\{\frac{(1-\varphi)\left(1-A+\frac{\eta(1-\tau)}{r_f+\delta}\right)(1+ST)}{1-\tau}\left\{1-\frac{Bi\tau}{r-\pi+\delta}\right\}\right\}. \tag{6}$$

The first term of the right-hand-side in equation (6) gives the log of the cost of capital without taxes (UC^{nt}) while the second term gives the log of the tax wedge (TW), or the log difference between the UC and UC^{nt}. Adding time subscripts and taking the first differences of equation (6) gives:

$$\ln UC_t - \ln UC_{t-1} = \left(\ln UC_t^{nt} - \ln UC^{nt}{}_{t-1}\right) + \left(\ln TW_t - \ln TW_{t-1}\right) \tag{7}$$

which approximates:

$$\frac{\Delta UCC_t}{UCC_{t-1}} = \frac{\Delta UC^{nt}{}_t}{UC^{nt}{}_{t-1}} + \frac{\Delta TW_t}{TW_{t-1}}. \tag{8}$$

According to equation (8), the percent change in TW is equivalent to the percent change in UC caused by changes in the tax parameters. Isolating the impact of taxes, the regression model becomes:

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[10] Firm-level studies typically include cash flow divided by the lagged capital stock as an additional variable to proxy the effect of financing constraints. This study, like other industry-level studies, does not use cash flow in the regression since it is unavailable at the detailed industry level.

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_0 + \alpha_1 \frac{\Delta UC^{nt}{}_{i,t}}{UC^{nt}{}_{i,t-1}} + \alpha_2 \frac{\Delta TW_{i,t}}{TW_{i,t-1}} + \alpha_3 \frac{\Delta Y_{i,t}}{Y_{i,t-1}} + \alpha_4 f_i + \alpha_5 T_t + \varepsilon_{i,t} \cdot (9)$$

This study takes advantage of the fact that certain industries, namely in the service sector, saw a significant reduction in their corporate income tax rates over the sample period, while others did not. Therefore, we include in our sample both private services industries, the so-called treatment group, and manufacturing industries as the control group.[11] To exploit the "natural experiment" nature of the tax cuts, two regression methodologies are employed. The first approach captures the impact of tax reductions by examining year-to-year changes in investment by industry using equation (9), while the second compares investment by industry in two periods, before and after the "treatment" of lower taxes. In both cases, additional variables are included in the regression to control for other influences by the treatment and control group.

6. Data

The panel data set consists of Canadian real investment, real capital stock, and real GDP as well as output and input prices by industry and year, all available from Statistics Canada. Depending on data availability, the industry data are at the two to four digit North American Classification System (NAICS) level. The user cost variables, UC^{nt} and *TW*, were constructed at Finance Canada by David Lemay. A substantial amount of data was required to calculate these variables, e.g. output and investment goods prices, interest rates, depreciation rates, capital cost allowance rates, investment tax credit rates, CIT rates, capital tax rates, sales tax rates. Some of these tax and economic variables are asset and time specific. For example, depreciation rates differ by type of asset, investment tax credits are available in some provinces but not in others, and tax rates change over time. Thus these inputs to the user cost variables were assembled on an industry-by-industry and year-by-year basis using information on the provincial location and asset mix of each industry. This bottom up approach increases the precision of the user cost variables and therefore reduces the likelihood of measurement error bias in the regression results. The method used to calculate industry user costs is outlined in detail in Annex A.

The fact that firms formulate their investment plans by discounting future expected cash flows is accounted for in calculating the user cost variables. In most cases, user cost parameters, such as inflation or interest rates, are uncertain so we assume that firms formulate their expectations based on current values. But in the case of tax changes that were phased in and viewed as both credible and permanent, the present value of the tax change is used. For example, in the February 2000 federal budget, a one-percentage point reduction in the CIT rate, effective January 1, 2001, was announced. The TW variable was updated therefore starting March 2000 to reflect the present value of the

[11] Resource industries are excluded from the analysis in part because the benefited from the tax reductions over a different time horizon than other industries and also because investment in resource industries is affected by different factors than other industries.

coming tax reduction. The same approach was applied for October 2000 to reflect the impact of the additional six percentage point CIT reductions to be phased in from January 1, 2002 to January 1, 2004.[12] As a result, although the major reductions became effective from 2002 to 2004, the largest impact on the user cost occurs in late 2000, when the announcement took place. Since the announcement was made late in the year, only a small portion of these discounted reductions are captured in the annual user cost for 2000, with much of the adjustment coming in 2001.

We merge the calculated user costs with the data from Statistics Canada by NAICS code and year. After deleting observations with missing data and computing necessary lags, our final sample consists of a balanced (equal number of observations per industry) panel of 43 manufacturing and service industries over seven years (1998 to 2004), resulting in 301 observations. The sample covers the period before and after the tax reductions were announced, allowing the regression estimates to reflect the underlying investment process during the period of tax changes.

7. Empirical Estimates

7.1 Tax Wedge Regression Using Annual Panel Data

Table 2 presents the OLS regression results using annual investment in 43 industries over the period 1998 to 2004. Five variations of equation (9) were estimated. The equation performs best with the addition of fixed and time specific dummies. A Breusch-Pagan test strongly rejects the hypothesis of random effects, supporting the use of industry dummies, while an F-test confirms the joint significance of the time dummies. However, when time dummies are included, the coefficient on output growth declines in size and is no longer statistically significant. This likely reflects the fact output growth is highly correlated to macroeconomic events (such as the collapse of the high-tech bubble in 2001), which are captured by the time dummies. Results of this regression model suggest that the tax reductions are significantly related to an increase in investment. Specifically, a ten per cent reduction in the user cost arising from changes in the tax parameters is associated with about a three per cent increase in the real capital stock. The non-tax component of the user cost has roughly the same impact on investment activity.[13] These results provide evidence that, over the sample period, investment sensitivity to the user cost was driven by both tax policy, namely the Budget 2000 tax cuts, and changes in the economic parameters, such as real interest rates and the relative price of capital.

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[12] To allow for tax reductions being phased in at different dates, we prepare a table of the corporate tax rate by month. We then discount the reductions beginning at the announcement month over a ten-year period at a rate of five per cent, equivalent to the prime business-lending rate between 2000 and 2004. To convert to annual data, a 12-month average is taken. While discounting puts the bulk of the reduction in 2001 and 2002, the full impact of the seven-point reduction does not occur until January 2004.

[13] By comparison, this estimate is roughly similar to the –0.4 user cost elasticity found by Chirinko, Fazzari and Meyer (2002) and the –0.25 estimate by Chirinko, Fazzari and Meyer (1999) using U.S. firm-level data. Note that these user cost elasticity estimates, as well as our output elasticity estimate, call into question the theoretical use of the Cobb-Douglas production function, which assumes unitary elasticities on both output and the user cost.

Table 2: User Cost Regression Results

Explanatory Variables	R(1)	R(2)	R(3)	R(4)	R(5)
$\Delta UC^{nt}_t/UC^{nt}_{t-1}$	-0.072	-0.118	-0.012	-0.331**	-0.327*
	(0.075)	(0.074)	(0.066)	(0.131)	(0.112)
$\Delta TW_t/TW_{t-1}$	-0.135	-0.164	-0.157***	-0.319**	-0.313**
	(0.104)	(0.107)	(0.094)	(0.147)	(0.151)
$\Delta Y_t/Y_{t-1}$		0.569*	0.459*		0.104
		(0.168)	(0.146)		(0.135)
Fixed Industry Effects	No	No	Yes	Yes	Yes
Fixed Time Effects	No	No	No	Yes	Yes
N	301	301	301	301	301
R^2	0.06	0.11	0.12	0.27	0.28

Note : Robust standard errors in parenthesis. Dependant variable is I_t/K_{t-1}.
*Significant at 1 percent level **Significant at 5 percent level ***Significant at 10 percent level

The transformation of investment by dividing by the beginning of period capital stock is expected to make the series more stationary. Formal testing for non-stationarity (e.g. using standard Dickey-Fuller tests) would have low power given the short time span of our panel data set (see Karlsson and Löthgren, 2000). However, based on an observation of the data, there appears to be no evidence of a unit root in the investment to capital ratio. To account for nonspherical disturbances in our model, coefficient standard errors that are robust to the presence of serial correlation and heteroskedasticity are computed.[14]

Tests for the possibility that the tax wedge estimate may be biased due to correlation with the error term are performed. A bias could arise if the tax wedge were endogenous, measured with error, or if it were correlated with a relevant omitted variable. A Hausman test for the regression R(4) supports the hypothesis of no correlation between error term and the tax wedge variable.[15] Performing a Hausman test on the non-tax component of the user cost yields the same conclusion.

[14] See Arellano(1987) for the computation of robust standards errors in panel data. Heteroskedastiscty is detected at the 5 percent level using a White test. We also find evidence of serial correlation using an approach proposed by Wooldridge (2002, pg. 275).

[15] The Hausman test is the F-statistic on the predicted change in the tax wedge when added to the regression. Changes in the tax wedge were instrumented using its lagged value, lagged investment to capital, output and time and firm dummies.

Given that the industries vary substantially by size, it is possible that only a subset of smaller industries are driving the result that investment is responsive to tax cuts. In this case, it would be imprudent to draw the conclusion that the tax change had a significant impact on aggregate investment. The possibility was tested by including small and large industry interaction variables on the tax wedge in the regression equation.[16] The estimated coefficients were not statistically different for large and small industries, ruling out the possibility that the tax cuts were isolated among a group of smaller industries.

It is also possible that the economic parameters imbedded in the tax wedge (e.g. to discount depreciation allowances) are influencing the tax wedge elasticity estimates. To explore this issue, all economic parameters used in the calculation of the tax wedge are fixed at 1997 levels for the entire sample period and the equations are re-estimated. The impact of holding the economic parameters in the tax wedge fixed is negligible, with the tax wedge elasticity equaling -0.30 for regression R(4) (vs. -0.32 in Table 2) and significant at the 5% level.

7.2 Difference-in-Differences Approach

Investment is a dynamic process, with firms taking several years to reach their new capital stock. The potential benefit of specifying an annual investment model is the ability to capture the short-term dynamics of investment decisions. In practice, however, specifying the dynamic structure with lags is difficult in general and not feasible given the short time period of our sample.[17]

One way to address this problem is to employ a "long panel" estimation strategy that considers the full pre- and post-tax cut period during which firms are expected to respond to the tax reductions. Chirinko, Fazzari and Meyer (2002) follow a similar approach, dividing a 19-year sample into three different intervals, thereby eliminating the need to model adjustment costs. While this type of estimation is based on fewer observations, it better captures the long-run adjustment of investment to its new capital stock.

In this section, growth in the capital stock in the pre- and post-tax cut periods is examined using a difference-in-differences (DD) estimation strategy.[18] In its simplest application, one could compare growth in the capital stock in the treatment group relative to the control group before and after the tax cuts. If growth in the capital stock accelerated in the treatment group accelerated relative to the control group, this would provide evidence that the tax reductions stimulated investment. However, in this study,

[16] In this case, an industry is considered small if average real capital stock averaged less than $10 billion over the sample period. A cut-off of $5 billion was used with the same result.
[17] See Chirinko, Fazzari and Meyer (2002) for a discussion of the difficulties associated with estimating an investment equation with a dynamic structure.
[18] A DD approach refers to the changes in the outcome variable following an event in the treatment group relative to changes in the control group. In our case, we are isolating changes stemming from tax changes on the capital stock, controlling for industry specific and other effects. For an overview of the DD approach see Angrist and Krueger (2001).

the DD approach must be carried out in a regression framework in order to control for other non-tax factors which may have led to varying rates of capital accumulation between the two groups.

To perform the DD analysis, the sample is divided into two periods: a pre-tax cut period (1997-1999) and a post-tax cut period (2000-2004) during which the tax cuts were announced and phased-in. Annualized percent changes in each component of the user cost and the real capital stock are calculated for each period. The goal is to examine changes in the real capital stock among the 22 service industries that saw large reductions in their tax burden in the tax cut period against 21 manufacturing industries that saw no or little change, after controlling for other factors that also vary between industries (i.e. output growth, relative price of capital, industry specific effects). The impact of the tax changes on the real capital stock is represented by the tax wedge coefficient estimate, which gives the DD estimate of the impact of the tax reductions on the real capital stock.

Estimation results are reported in Table 3. A version without the relative price of capital and output growth is also estimated given that these variables are statistically insignificant. Results suggest that corporate tax reductions after 2000 led to a higher level of capital stock. The DD estimate of tax changes on the capital stock is highly significant and negative. Results also indicate that growth in the capital stock was, on average, higher after the corporate tax cuts. A 10 per cent reduction in the user cost arising from changes in the tax parameters is associated with an approximately 7 per cent increase in the capital stock.[19]

[19] As tested in section 7.2, this result is robust to the inclusion of small/large industry interaction dummies. A similar result is found when the economic parameters used to calculate the tax wedge are held fixed at 1997 levels, with the tax wedge elasticity in regression D(2) estimated at -0.68 (vs. 0.73 in Table 5), significant at the 1% level.

Table 3: DD Fixed Effects Regression Results

	D(1)	D(2)
Tax Wedge[1]	-0.708**	-0.727*
	(0.266)	(0.218)
Post-tax cut period dummy	0.016	0.024**
	(0.025)	(0.013)
Output Growth	-0.099	
	(0.391)	
Relative Price of Capital	-0.027	
	(0.232)	
N	86	86
R^2	0.58	0.58

[1]Represents annualized per cent change in the tax component of the user cost over pre- (1997-99) and post-tax cut periods (2000-04)
Dependant variable is annualized per cent change in the real capital stock over pre- (1997-99) and post-tax cut periods (2000-04).
Fixed Effect estimates not reported
Robust standard errors are in parenthesis.
* Significance at 1 percent level, **Significant at 5 per cent

Conclusion

Over the period the 2001-2004, significant federal corporate income tax cuts were introduced. The fact that these tax cuts were selective provided a "treatment" and "control" group, making it easier to identify the effect of lower taxes on business investment**.** This paper used two econometric approaches to investigate the impact of taxes on investment. First, employing an annual panel data set of 43 service and manufacturing industries, strong evidence is found that the corporate tax reductions led to higher investment. The disadvantage of this approach is that it assumes that investment only responds in the year the tax change occurs. Given that firms may take several years to respond to the tax cuts, the regression equation may understate the true impact of tax changes on investment. This issue is addressed in the second approach, which examines the investment response over the entire tax reduction period using a difference-in-differences (DD) estimation strategy. As a result, while our tax wedge elasticity estimates range from about -0.3 under the annual approach to -0.7 under the DD approach, a higher weight should be placed on the latter estimate.

Annex A: Deriving an Investment Equation

To develop an equation of investment demand, a representative firm with a single type of capital (K) and no adjustment costs maximizes profits over T time periods is assumed:[20]

$$Max\sum_{t=0}^{T} B^t\left[P_t f\left(K_t\right)-P_t^I I_t\right], \tag{A1}$$

subject to the capital constraint:

$$K_{t+1} = (1-\delta)K_t + I_t , \tag{A2}$$

where $B^t = (1+r)^{-t}$ is the discount rate, $f(K_t)$ is the production function, K_t is capital at the beginning of period t, I_t is investment during period t, r is the interest rate, δ is the depreciation rate, and P_t and P_t^I are the price of output and investment, respectively. The Lagrangian for this problem is

$$L = \sum_{t=0}^{T}\left\{B^t\left(P_t f\left(K_t\right)-P_t^I I_t\right)+\lambda_t\left[K_{t+1}-(1-\delta)K_t-I_t\right]\right\} . \tag{A3}$$

Assuming prices are constant across time, maximizing this Lagrangian by choosing I_t and K_t at time t gives:

$$\frac{\partial L}{\partial I_t}:\lambda_t = B^t P^I , \tag{A4}$$

$$\frac{\partial L}{\partial K_t}: B^t P f^1(K_t)+\lambda_{t-1} = \lambda_t(1-\delta). \tag{A5}$$

Substituting (A4) into (A5) and simplifying yields:

$$f^1(K_t) = \frac{P^I}{P}(r+\delta) = UC \tag{A6}$$

Equation (6) shows that a firm maximizes profits by choosing K_t so that the marginal product of capital equals the user cost (UC) at t. Assuming the production function is Cobb-Douglas, $Y_t = A_t K_t^{\alpha}$, gives:

[20] A similar maximization problem is presented in Hall, Mairesse and Mulkay, 1998

$$K_t = \alpha \frac{Y_t}{UC_t}. \tag{A7}$$

In log form equation (A7) can be written:

$$\ln K_t = \ln \alpha + \ln Y_t - \ln UC_t \tag{A8}$$

Taking the first differences of (A8) approximates:

$$\frac{dK_t}{K_t} = \frac{dY_t}{Y_t} - \frac{dUC_t}{UC_t}. \tag{A9}$$

The growth in capital in (A9) can be written,

$$\frac{dK_t}{K_t} = \frac{I_t - \delta K_t}{K_t} = \frac{I_t}{K_t} - \delta \tag{A10}$$

Substituting (A10) into (A9) gives:

$$\frac{I_t}{K_t} = \frac{dY_t}{Y_t} - \frac{dUC_t}{UC_t} + \delta \quad ,$$

which implies an investment equation of the form:

$$\frac{I_t}{K_t} = \frac{dY_t}{Y_t} - \frac{dUC_t}{UC_t} + \delta \, . \tag{A11}$$

Note that since equation (A11) is specified using a Cobb-Douglas function, it assumes an elasticity of capital stock with respect to the user cost and sales growth of one (in absolute terms).

Annex B: Calculating the User Cost of Capital

To construct industry specific user costs, user costs are calculated for about 150 types of assets for each of the thirteen provinces and territories. This approach captures many asset and province specific tax parameters, such as capital cost allowances, investment tax credits, retail sales tax, corporate tax rates and the rate of economic depreciation. Economic depreciation rates are from Patry (2007), while tax parameters for each year and province are from Finance Canada. The underlying user costs can be represented as:

$$UC_{g,p,i,t} \equiv \frac{q_{i,t}(r^{f}{}_{i,t} - \pi_t + \delta_{g,i,t})(1-\varphi_{p,i,t})\left(1 - A_{g,t} + \dfrac{\eta_{p,t}(1-\tau_{p,i,t})}{r^{f}{}_{i,t} + \delta_{g,i,t}}\right)(1+ST_{p,g,t})}{1-\tau_{p,i,t}} \qquad \text{(B1)}$$

where g denotes asset type, p province, i industry and t time. The notation of each variable is defined in section 2. To convert asset user costs into industry user costs, Statistics Canada data on the asset composition of each industry is used. Industry user costs are a weighted average of the asset-specific user costs, with capital stocks used as the weight. Corporate tax rates for each industry are a weighted average of general and manufacturing and processing tax rates based on taxable income.

Annex C: Description of Variables

Investment (I): Real gross investment in non-residential assets, 1997$. CANSIM table 031-0002

Capital (K): Real net capital stock of non-residential assets, 1997$. Calculated using straight-line depreciation. CANSIM table 031-0002.

Output (Y): Real gross domestic product, 1997$. CANSIM table 379-0017.

Components of User Cost (UC):

1) $q = \frac{P^I}{P^Y}$: Relative price of capital

    Price of Output (P^I) derived from CANSIM table 031-0002.

    Price of Output (P^Y) calculated from CANSIM table 383-0015 and 383-0014 for output prices (note: only available to 2003). Output prices in 2004 are forecast using the average annual growth rate in output prices between 1997 and 2003.

2) τ : Federal-provincial corporate income tax (CIT) rate.

3) $r^f = \beta(1-\tau)i + (1-B)\rho$: Cost of finance

    β : debt to asset ratio. Derived from Quarterly Financial Statistics, Statistics Canada.
    i : cost of debt financing. Based on Scotia Bank mid-term corporate bond yields (source: Statistics Canada).
    ρ : cost of equity financing, risk adjusted. Based on the arbitrage condition: $\rho(1-t_E) = i(1-t_p)$, where t_E is a weighted average of the personal income tax rate on dividends and personal tax rate on capital gains, and t_p is the personal income tax rate on ordinary income.

4) ϕ : investment tax credit (ITC).

5) A : present value of depreciation or capital cost allowances (CCAs)

6) δ : rate of economic depreciation. Based on Patry (2004).

7) η : capital tax

8) ST : retail sales tax (RST) on capital inputs.

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