Oxford University Centre for Business Taxation

Debt and tax losses: the effect of tax asymmetries on the cost of capital and capital structure

November 2013

WP 13/24

Matt Krzepkowski
University of Calgary

Working paper series | 2013

SAID BUSINESS SCHOOL

UNIVERSITY OF OXFORD

DEBT & TAX LOSSES: THE EFFECT OF TAX ASYMMETRIES ON THE COST OF CAPITAL AND CAPITAL STRUCTURE

MATT KRZEPKOWSKI*

Abstract. Firms with positive income pay corporate taxes on profits and reduce their total tax burden by claiming various credits and deductions. Firms with negative income and no past profits only claim tax offsets to lower future taxes payable, realizing both taxes on production and investment incentives when they become profitable. This paper looks at the effect of this asymmetric system of partially offsetting losses on the cost of capital. I find changes in marginal effective tax rates depend on the riskiness of investment. Riskless investments see their corporate tax liabilities deferred into the future under a partial-loss system, decreasing their marginal effective tax rate by between 2 and 4%. Risky investments have higher marginal effective tax rates by between 2 and 7%, as they will pay corporate tax immediately if successful and delay receiving investment tax credits and deductions if unsuccessful. Included in these estimates are changes in the effective tax rate due to changes in the capital structure of firms. Loss firms are unable to immediately deduct interest payments, lowering the optimal debt ratio and increasing the cost of financing. I estimate financial decisions under a partial loss system decrease the industry-wide debt-asset ratio between 2-5 percentage points, but these changes have a minimal effect on effective tax rates.

I would like thank Jack Mintz, Ken McKenzie and seminar participants at the University of Calgary and the Oxford University Centre for Business Taxation Annual Symposium for their comments. I am grateful to Miodrag Jovanovic and David Messier from the Department of Finance Canada for their comments, assistance, and access to data. All opinions and errors are my own.
*Department of Economics, University of Calgary, 2500 University Drive NW, Calgary AB Canada T2N 1N4; Email: mkrzepko@ucalgary.ca.

During start-up and business cycles, corporations occasionally go through periods of unprofitability. Symmetric tax treatment would dictate that unprofitable firms would receive a direct government transfer proportional to the size of their loss, just as profitable firms pay taxes relative to their profit. It is clear current corporate tax systems do not work under this principle. Instead, tax systems operate under a partial loss-offset system, where rather than receiving an immediate refund, firms reporting a loss must carry the balance of their losses forward without interest to lower future taxable income.[1] There is a clear basis for treating firm losses in this manner: firms are prevented from immediately claiming losses to prevent tax avoidance issues where firms artificially inflate their losses through increased debt usage (as interest payments are tax deductible) or transfer pricing schemes, or to avoid implicitly encouraging unprofitable businesses.

This deferral of tax payments distorts investment decisions by making the cost of investment differ whether a firm is tax-paying or not. On the plus side, any revenue from additional investment made by non-tax-paying firms only incurs a tax liability when the firm becomes tax paying, discounting the marginal statutory taxes paid on additional revenue. On the downside, these firms must also defer all tax benefits such as investment tax credits and tax allowances for depreciating capital. With substantial tax credits and deductions available for some industries, these benefits may outweigh the corporate tax payments and the change in the marginal cost of capital due to the asymmetric treatment of losses is ultimately ambiguous.

Determining the direction and magnitude of this asymmetric tax treatment on the user cost of capital requires a complete measure of the tax distortion on investment. This is the objective of the marginal effective tax rate, which incorporates the statutory tax rate on the returns from investment, tax depreciation on assets, and other tax credits or deductions to calculate the wedge between the required rate of return from capital with and without taxes.

[1]Canadian firms that paid taxes in any of the past three years are able to carry losses backwards to claim an immediate refund. Also, tax loss offsets eventually expire if they are not used. To lower the amount of expiring losses, Canada has extended the number of years losses can be carried forward from 7 to 10 in 2004 and up to 20 years in 2006.

This asymmetric tax treatment based on a firm's tax status has important implications on the design of tax systems. If firms were able to immediately deduct their losses, it would be irrelevant whether a firm, industry, or country has a low effective tax rate because they have a low statutory rate or because they have significant investment incentives to compensate for a high statutory rate. However, targeted tax credits and deductions may be ineffective if they are only used when firms are in a tax-paying position, and this effect should be accounted for when comparing the competitiveness of tax systems. The more a government relies on using additional tax benefits to spur investment instead of focusing on lowering its statutory corporate tax rate, the greater the distortion between tax-paying and non-tax-paying firms. The direction of the tax distortion also has implications on firm investment behaviour during business cycles. If firms with negative income must forgo significant tax benefits, the cost of capital will increase, further affecting a business' incentive to invest during economic downturns.

Most effective tax rate comparisons focus on tax-paying firms, or implicitly assume the use of a full loss offset system in their calculations. This is not simply an innocuous assumption, as tax losses are a substantial part of the corporate tax system. Total taxable income of Canadian corporations in 2008 was $208.9 billion, while claimed tax losses totalled $103.8 billion (Finance Canada, 2010).[2] The total amount of unused tax losses available to be carried forward in 2008, including the closing balance of unused investment tax credits and capital costs deductions, was $236.2 billion, or more than 13% of Canadian GDP. During the 2001 recession, there were nearly as many tax-paying as non-tax-paying firms in the United States (Altshuler et al., 2008). Moreover, the evidence does not support tax losses being accumulated perpetual loss firms, as over 70% of taxes carryforwards are eventually claimed in Canada.

Using a novel Canadian dataset, I estimate the distortionary effect of this asymmetric tax treatment on firm investment incentives. I first predict the frequency and duration of

[2]This excludes unclaimed tax credits and depreciation allowances.

non-tax-paying firms using data from federal income tax returns. The longer firms are non-tax-paying, the lower the present value of their tax payments and benefits. I combine the estimated probability distribution of firms becoming tax paying in the future with industry-specific measures of profitability and a calculated loss-adjusted marginal effective tax rate for ten industries under a partial loss system. I then compare these results to the marginal effective tax rate under a full loss-offset system, to find the effect a partial loss system has on the cost of capital. I find the direction of the change in the marginal effective tax rate between the two tax systems depends largely on the riskiness of investment. If an investment has a certain positive after-tax rate of return then the marginal effective tax rate will decrease under a partial-loss offset system. As the return is constant, a deferral of tax payments results in effective tax rates to tend toward zero. However, if the return on investment is risky, then the effective tax rate will increase for all industries. In this case, if an investment is profitable then the tax liabilities will outweigh the tax benefits and the firm will have an immediate tax payment; if the investment is not profitable than the tax benefits from investment will outweigh the taxes on additional investment, but the firm will incur a loss and have to delay its receipt of these benefits.

There has been some prior work calculating effective tax rates under a partial loss offset system. Auerbach (1986) calculates the user cost of capital and simulates investment under a partial loss system with hypothetical income and cashflow tax systems. Auerbach and Poterba (1987) calculate effective tax rates for different types of capital in the United States, estimating transition probabilities of a firm's tax status over time. They find the effective tax rate under partial loss system compared to a full loss system are higher for industrial equipment and lower for industrial buildings, as equipment has more generous depreciation rates for tax purposes. Mintz (1988) and Glenday and Mintz (1991) calculate effective tax rates for Canada, using the average time for a tax loss to be used, finding the effective tax rate to be lower under a partial loss system for all industries.

A drawback of these estimates is their treatment of firm financing decisions. Interest from debt financing is deductible for tax purposes, making debt financing less expensive than equity for tax-paying firms. Firms in a loss position are unable to claim deductions on interest payments immediately, diminishing the value of this advantage. This raises the cost of capital and will cause a shift away from debt due to additional costs associated with debt financing, including potential agency costs dealing with conflicts in managerial and investor incentives or expected bankruptcy costs of increased leverage. These previous papers have omitted changes to financing decisions in their effective tax rates estimates. Auerbach and Poterba (1987) abstract from this issue by assuming capital is full equity financed. Mintz (1988) uses the fact that expected tax benefits and bankruptcy costs of debt will offset each other at the margin, making the cost of financing constant between the two tax systems, though this will not hold for large discrete tax changes.

The finance literature, on the other hand, has used the interest deductibility of debt financing and the partial loss offset system as a key factor in optimal capital structure. Firms are expected to increase debt until their taxable income becomes negative, at which point the tax benefit of debt will decrease, and this theory can be used to explain interior solutions of debt-equity ratios. Mackie-Mason (1990) and Graham, Lemmon, and Schallheim (1998) show firms adjust their financial structure due to changes in statutory tax rates and the presence of tax losses, finding firms with higher tax rates increase their use of debt to lower their tax burden. Expanding on this point in a series of papers, Graham (2000) and Graham and Kim (2009) show the presence of tax loss carryforwards are a significant determinant of a firm's debt ratio. In their models, firms estimate the likelihood of having positive profits, and use enough debt to lower their expected taxable income. Using too much debt will cause a firm to delay using some of its interest deductions, decreasing its present value. Still, firms are found to be systematically under-levered in relation to the potential tax savings of debt as bankruptcy and financial distress costs from leverage prevent firms from maximizing their use of debt. After measuring the [tax] benefit of debt, van Binsbergen, Graham, and Yang (2010) attempt to determine these additional costs of debt. They simulate the tax benefit curve of debt and, using shifts in this curve and the U.S. 1986 Tax Reform Act to identify the marginal cost curve of debt. They estimate the costs of debt to be equal to approximately 7% of firm value. Korteweg (2007, 2010) uses a capital asset pricing model and Bayesian MCMC simulations to determine the costs of using debt, finding distress costs are a convex function of leverage, and observed debt levels amount to 11% of firm value.

To account for changes in financial structure due to the tax system, I parameterize a functional form for the bankruptcy costs of debt, calibrating my model so the marginal bankruptcy costs of additional leverage at the observed debt-asset ratio under the current partial-loss offset system are equal to the marginal tax benefits accruing in the future. I then simulate the effective tax rate under a full loss offset tax system offering immediate interest deductibility to predict how far leverage would increase under a symmetric tax system. I calculate the deferral of interest tax deductions results in a decrease in the debt-asset ratio by an average of 0.03 across all industries, equal to 6% of the total debt-asset ratio. Industries with low observed leverage ratios are expected to have the lowest change in their debt ratio as they may already have high costs of financial distress. However, this decrease in debt increases the cost of financing, and accounting for this change in capital structure results in limited increases in the effective tax rate of less 1% across industries. As previewed by these results, though a partial-loss tax system may have significant effects on the financial structure of firms, its effect on the user cost of capital is quite small.

The paper proceeds as follows: Section 2 presents the model for calculating the user cost of capital under the current Canadian income tax system. Section 3 lays out the empirical approach and results estimating the duration of firm tax losses. Section 4 includes the parameterization of the model from section 2 and presents results of simulations analysis of different tax treatments. Section 5 concludes. Proofs for the user cost of capital are included in the appendix.

2. The Model

Consider a risk-neutral firm producing an output good in each period, with total output given by a Cobb-Douglas production function with decreasing returns to scale $F(K_t) = K_t^{\phi}, (0 < \phi < 1)$ where K_t is the capital stock of the firm and ϕ is the output elasticity of capital. The firm is a price-taker in the output market for its good, selling its production at a price P_t, making the total operating revenue of the firm $R_t(P_t, K_t) = P_t K_t^{\phi}$. The firm has uncertainty about the future output price, but it is assumed to follow a simple first order autoregressive (AR(1)) process, with $p_t = ln(P_t)$ and

$$p_t = \nu(\mu - p_{t-1}) + p_{t-1} + \sigma\varepsilon_t \; ; \; \varepsilon_t \sim N(0, 1) \tag{1}$$

where ν is a persistence parameter, μ is the long run price, σ is the variance of the shock, with ε_t being a normally distributed independent shock with a mean of zero and variance of one. The choice of an AR(1) process is consistent with mean-reverting firm profitability (Fama and French, 2000) being explained by competition in output market prices (Bhattacharya, 1978). Under this formulation, all firms move towards a long-run level of profitability. The drift of the process is negative if the last period's price was higher than the long-run mean and positive if the last period's price was below the mean.

The firm has control over capital, K_{t+1}, equal to investment plus the current capital stock net of depreciation at rate δ. Investment in capital is made at a unit cost normalized to 1, which is constant and known with certainty.[3] The firm can fund a portion b_{t+1} of its investment through debt at a cost of the interest rate i_{t+1} in the next period. The equilibrium interest rate will be determined through a capital market equilibrium derived shortly. The per period dividend paid out by the firm is given by the equation

$$D_t = \mathbb{E}(P_t|P_{t-1})R(P_t, K_t) - (K_{t+1} - (1 - \delta)K_t) - b_t(1 + i_t)K_t + b_{t+1}K_{t+1} - T_t \tag{2}$$

The total corporate taxes paid by the firm, T_t, depend on the current tax system. The tax base of the Canadian corporate income tax system is net revenue with allowable deductions

[3]Given the additional shock, the firm has uncertainty about the level of their profits between periods. This is the only source of risk entering the firm's decision problem, known in the literature as 'income risk'. Other authors have noted the importance of other types of risk, such as capital risk, manifesting itself in either uncertainty about the depreciation rate of capital (Bulow and Summers, 1984) or uncertainty over the price of capital (McKenzie, 1994).

for nominal interest payments, economic depreciation and credits for current investment purchases. Under a symmetric, full loss offset system, the tax burden can be written as

$$T_t = u[R(P_t, K_t) - i_t b_t K_t - \alpha UCC_t] - \phi(K_{t+1} - (1-\delta)K_t) \tag{3}$$

where u is the statutory corporate income tax rate, α is the depreciation rate for tax purposes (the capital cost allowance (CCA) rate), and ϕ is the investment tax credit rate. The undepreciated capital stock for tax purposes is given by UCC_t. The transition equation of the undepreciated capital stock is equal to current investment net of the investment tax credit[4], minus claimed depreciation on a declining balance method[5]

$$UCC_{t+1} = (1-\phi)(K_{t+1} - (1-\delta)K_t) + (1-\alpha)UCC_t \tag{4}$$

The firm chooses capital investment and debt ratio to maximize its total value to shareholders at time t. The value of equity is given by the net distribution to shareholders, equal to the net dividend plus any accrued capital gains on the stock of equity. Assuming no new share issues, the total discounted value of equity is given by the discounted stream of dividends,

$$E_t = \mathbb{E}\sum_{s=t}^{\infty}\frac{1}{(1+\rho)^s}[D_s] \tag{5}$$

and ρ being the after-tax rate of return on equity required by shareholders. Investors are concerned with the net of tax rate of return they receive either from equity or debt.[6] Debt

[4]The Canadian tax system deducts the full investment tax credit from the purchase price of capital when determining the eligible depreciation base for investment, allowing the investment tax credit to be fully factored out of the present value of the capital cost allowance. Only half of the investment is eligible for the credit in the first year.

[5]Tax depreciation for most assets follows a declining balance method as shown here. This equation can be adjustment for specific asset classes offering straight-line write-offs. Depreciation is only claimed when an investment becomes operational, and only one half of the value can be claimed for investment that is operational in the middle of the tax year.

[6]For simplification, the model presented here includes corporate taxes but excludes personal taxes, although these are included in later simulations. In reality, investors are taxed at a rate m on nominal interest income, yielding a return of $i(1-m)$. Similarly, the return on equity is $\rho(1-c)$ where c is the effective tax rate on equity, including both the effective tax rate on capital gains and the personal tax rate on dividends. Further, capital gains are taxed on a realization instead of accrual. The effective tax rate on capital gains is the equivalent tax

contracts last one period with the promise of repayment on each unit equal to one plus the negotiated interest rate i_{t+1}, with the remaining cashflow of the firm accruing to equity holders. The required expected return on debt is affected by the stochastic nature of the output price. If the firm turns a profit, it covers all of its debt costs by paying the full interest rate of $1 + i_t$ on its outstanding debt. However, if the firm's revenue becomes too low it will be unable to cover all of its operating costs, including its interest payments on debt. Limited liability on the part of investors means they can never lose more than their initial investment, resulting in a chance the firm is unable to fulfill its contractual obligations to debt holders. In this case the firm will be required to declare bankruptcy. In the event of bankruptcy, equity holders receive nothing from the firm and claim a capital loss, while debt holders claim the remaining assets of the firm. Since the dividend given to equity holders in bankruptcy is equal to zero, the return in bankruptcy states to debt holders is determined by solving for the interest rate after setting equation (2) equal to zero. These assets include all current period revenues, any remaining capital assets, and undepreciated capital cost base, or $(1 - u)R(P_t, K_t) + (1 - \phi)(1 - \delta)K_t + u\alpha UCC_t$, though these remaining assets are less than their initially contracted return. In addition to the decrease in return from debt, debt holders will face additional costs associated with bankruptcy, though they anticipate these costs when negotiating the interest rate. These additional costs can be thought of as the bargaining and transactions costs necessary to split and sell the assets of the firm. A debt holder will spend additional resources to recoup their losses when either the size of the insolvency increases in magnitude or the fraction of the return each debtor will receive from their initial investment decreases. Let these total bankruptcy costs be an increasing, convex function of the debt/asset ratio of the firm, $C_b(b)$,$C_{bb}(b) > 0, C(0) = 0$, and multiplicative in the capital stock of the firm, so total bankruptcy costs are equal to C(b)K. For a given price shock, the return to each debt holder is determined by the state of the firm and the return from each state

rate yielding the same present value of revenues, discounted at a constant personal discount rate, as the tax rate on realizations. See Glenday and Davies (1990) to see the methodology behind converting the tax on realizations to an accrual-equivalent rate.

$$
i(b_t, K_t, p_t) = \begin{cases} i_t & \text{if } p_t > p_B \\ \frac{(1-u)R(P_t,K_t)+(1-\phi)(1-\delta)K_t+u\alpha UCC_t-b_tK_t}{(1-u)b_tK_t} - \frac{C(b_t)K_t}{b_tK_t} & \text{if } p_t < p_B \end{cases} \tag{6}
$$

where p_B is the threshold price where the firm is bankrupt.

All investors are assumed to be risk neutral, so a bond market equilibrium indicates the expected return on risky bonds must be equal to the riskless return, ρ,

$$
\rho = (1 - q_B)i_t + \int_{-\infty}^{p_B} q(p_t|p_{t-1})i(b_t, K_t, p_t)\mathrm{d}p_t \tag{7}
$$

with q_B being the probability of the firm going bankrupt, and the integral indicating the probability distribution of the price in bankruptcy states. If the firm is not bankrupt, which occurs with probability $(1 - q_B)$, the firm gets the full interest rate, while in bankruptcy states the return depends on the actual shock to determine the remaining revenue. Taking the derivative of equation (7) with respect to the debt-asset ratio b_t, shows an increase in leverage causes bond owners to demand a higher interest rate on debt,

$$
(1 - q_B)\tfrac{\partial i}{\partial b} = \frac{1}{b}\int_{-\infty}^{p_b} q(p_t|p_{t-1})[i(b_t, K_t, p_t) + \tfrac{\partial C(b)}{\partial b} + \tfrac{1}{1-u}]\mathrm{d}p_t \quad (> 0) \tag{8}
$$

The optimal debt-asset ratio of the firm will come from the firm trading off the tax benefit from issuing debt (as debt financing is deductible for tax purposes) against the increased required returns from increasing leverage. To see this, note the intertemporal first-order condition of equation (2) with respect to the debt asset ratio b_t after including bankruptcy is equal to

$$
(1 + \rho) = (1 - q_B)[1 + (1 - u)(i_t + \tfrac{\partial i(b_t,K_t,p_t)}{\partial b}b_t)] \tag{9}
$$

and substituting in equation (7) for the partial derivative of the interest rate with respect to b_t and simplifying gives

$$
\rho u = \int_{-\infty}^{\infty} q(p_t|p_{t-1})[(1 - u)\tfrac{\partial C(b)}{\partial b}]\mathrm{d}p_t \tag{10}
$$

The left-hand side of the equation is the marginal tax benefit of increasing debt. The right hand side is the tax-adjusted marginal bankruptcy costs of debt (as any increase in the interest rate on debt is also tax deductible) which is increasing in the debt ratio. While the interest rate itself is a function of the capital stock,[7] the first order condition with respect to the interest rate is not. This allows the optimal capital and financing decisions to remain separable from each other. This allows the firm to effectively operate in two stages, first choosing an optimal debt ratio, and then a level of investment. Taking the first order conditions of the firm maximization problem including the interest rate being a function of the debt ratio, capital stock, and undepreciated capital cost, after simplification, yields the user cost of capital expression

$$\mathbb{E}(P_{t+1}|P_t)F_K(K_{t+1}) = [(\rho + C(b))(1-u) - \rho)b + (\rho+\delta)(1-\phi)(1-\tfrac{u\alpha}{\rho+\alpha})]/(1-u) \qquad (11)$$

The combined first term on the right hand side is the benefit of debt and $u\alpha/(\rho+\alpha)$ is the present value of the total tax depreciation allowances from of a unit of depreciable capital. This user cost of capital is related to the weighted average cost of capital (WACC) from the finance literature. The WACC is the appropriate discount rate for the cashflow of a firm, and can be constructed by calculating the total value of the unlevered firm (a fully equity-financed firm) and the value of the debt tax shield. If the firm uses no debt then the rightmost term in equation (11) is the user cost of capital, and the first term is the tax benefit of debt.

The effect of taxes on this cost of capital can be split into three components. The first is the statutory tax rate $(1-u)$, imposed on additional revenue and increases the required pre-tax rate of return. The second is the financial cost of capital, which affects the debt/equity decision as defined above in the capital market equilibrium. An increase in the statutory rate will increase the marginal benefit of using debt, and a shift towards debt, lowering the user cost of capital. The third effect of the tax system is the combination of the investment

[7]If the firm exhibits constant returns to scale in production, and the undepreciated capital cost base is proportional to the capital stock, as is true in a non-stochastic case, then the interest rate would be independent of the capital stock, as the returns to debt holders and bankruptcy costs would all be rising at the same rate.

tax credit and CCA deductions on depreciating capital, appearing as the last terms of the numerator on the right hand side of equation (11). A higher tax credit, ϕ, a more generous tax depreciation rate, α, or a higher statutory tax rate will each increase the value of these investment incentives.[8]

The cumulative effect of the tax system on the cost of capital can be shown through the marginal effective tax rate on capital. The marginal effective tax rate is given as the wedge between the gross of tax user cost of capital r_g, given as the right hand side of equation (11), minus the depreciation rate, against the cost of capital without taxes, as a ratio of the gross rate of return. This can be written as

$$METR = \frac{r_g - \rho}{r_g} \tag{12}$$

The cost of capital without taxes is defined in this model as the risk-free interest rate ρ. If there is no tax benefit from issuing debt, equation (10) cannot hold, making the choice of debt equal to zero.[9] The extent to which the tax system distorts investment depends on the value of the statutory corporate tax rate versus the other tax investment incentives. If these incentives are large enough relative to the statutory income tax rate, the tax system may actually subsidize investment.

Under a symmetric, full loss offset tax system, whether the taxable income of a firm is positive or negative has no effect on the user cost of capital. If a firm is in a tax-paying position, it pays corporate taxes on its production and deducts its interest payments, investment tax credits, and depreciation allowances as described above. In the event the firm's taxable income is negative, all of these conditions still hold. The firm is able to claim all of its deductions and the profit generated from an additional unit of capital only decreases the size of a loss and the user cost of capital is unchanged.

[8] The investment tax credit reduces the capital cost eligible for capital cost allowances but the net effect still lowers the user cost.

[9] This is true in a world without personal taxes. If the corporate tax rate on interest is less than the tax rate on dividends and capital gains, the interest rate on debt may still be lower than the tax rate on equity even without the corporate deduction for interest. In this case, there would still be an interior solution for the debt ratio.

In actuality, firms only pay taxes if their net income is positive, and are only able to claim all of their available deductions and credits provided they do not exceed the total tax base, $R(P_t, K_t)$. If their tax burden is negative then firms only accumulate offsets to lower future (or past) payable taxes. In Canada, this offset, known as a tax loss carryforward (or carry-back) can be used in any of the past 3 years if the firm has previously paid taxes, or can be used in any of the future 20 years to lower the taxable income of a firm. This has two main effects on the marginal investment decisions of firms. On the revenue side, if a firm is in a loss position the additional revenue from a current investment is sheltered from taxes until the firm has positive net income. The additional revenue decreases the stock of tax loss carryforwards the firm has, but this only affects the tax liability of the firm in the period it would have used the tax offset. This means the true value of corporate taxes on a marginal current investment is the present value of taxes paid in the future when the firm becomes tax-paying.

On the tax benefit side, a firm is only able to use interest and investment deductions and credits to lower its taxes payable, and is therefore unable to use them while it is in a loss position. The value of the tax credits and deductions increase the size of a loss but can be only used to lower future taxes, making their value only equal to their discounted present value. Whether the current period's tax benefits outweigh the statutory tax payments will dictate whether the cost of capital increases or decreases.

To add complexity to the tax system, Canadian firms carry forward separate balances of tax loss carryforwards, investment tax credits, capital cost allowances, and various other credits such as research and development tax credits. This is because a firm is only eligible to claim tax credits if their taxable income remains positive after all other deductions and because Canadian firms are not required to claim their capital depreciation for tax purposes in each available year. If they do not claim their full deduction, the undepreciated capital carries forward indefinitely, without interest, and the firms can claim the deduction in any future year. A firm in a tax-paying position has no reason not to claim the full depreciation in the current year and lower their current tax burden. Non-tax-paying firms can either claim the deduction and receive tax loss offsets for future years or they can elect not to claim the full deduction and keep a higher undepreciated capital cost for the next period. The trade-off is that tax loss offsets expire after 20 years while the undepreciated capital cost base can be carried forward indefinitely. However, if a firm becomes tax-paying in a future period they are only able to claim depreciation allowances at the current rate (except in the case of assets which depreciate on a straight-line basis). It may be in the best interest of the firm to claim tax loss offsets if it anticipates becoming highly profitable in the next few years. Firms would also be more likely to claim full depreciation even if they are in a loss position with assets with low depreciation rates (e.g. buildings), and choose to keep assets with higher write-off rates undepreciated. For simplicity in showing how the cost of capital is affected by the tax loss system, I assume firms have a mandatory deduction on depreciation allowances, interest payments, and investment tax credits (at its deduction equivalent rate of ϕ/u), and these are claimed when the firm becomes tax-paying. This is similar to the system of the United States that has forced deductions that increase the size of losses carried forward. With only 11% of tax losses actually expiring with a 10 year limit (Finance Canada, 2010) and with the limit being extended to 20 years in 2006, the effect of this simplification is likely to be small. For a stock of carryforwards, capital, investment, and undepreciated capital cost for tax purposes there is a threshold price, for each period, that enables a firm to use up all of its tax deductions and credits to become tax-paying. Defining the total stock of losses available to be used in the current period $TLCF_t$, this threshold price is denoted $\bar{P}$, and is equal to

$$\bar{P} = (TLCF_t + i_t b_t K_t - \alpha UCC_t + \frac{\phi}{u}(K_{t+1} - (1-\delta)K_t))/[R(P_t, K_t)] \tag{13}$$

If the price is below this threshold then the firm is non-tax-paying and will change its stock of loss carryforwards (though the stock may decrease). Above this value, the firm will be able to use all of its tax losses and pay tax on any remaining taxable income. As the investment tax credits and capital cost allowances are assumed to either be claimed immediately or added to the claimed loss, the total after-tax profit of the firm can be written as

$$\int_{\infty}^{\bar{P}} R(P_t, K_t)q(p_t|p_{t-1})\mathrm{d}p_t + \int_{\bar{P}}^{\infty} (1-u)((R(P_t, K_t)q(p_t|p_{t-1})\mathrm{d}p_t + uTLCF_t - (1-\phi)(K_{t+1} - (1-\delta)K_t)$$
$$- b_t(1 + i_t(1-u))K_t + u\alpha UCC_t + b_{t+1}K_{t+1} \quad (14)$$

with the first integral being when the firm is non-tax-paying and the second when the firm uses up its losses and becomes tax-paying. The transition equation for the stock of tax loss carryforwards is

$$TLCF_{t+1} = \begin{cases} 0 & \text{if } P_t > \bar{P} \\ TLCF_t - R(P_t, K_t) + \dfrac{\phi}{u}(K_{t+1} - (1-\delta)K_t) + & \\ \qquad i_t b_t K_t + \alpha UCC_t & \text{if } P_t < \bar{P} \end{cases} \quad (15)$$

Unfortunately, it is not possible to reach a simplified expression for the user cost of capital for this problem. Simplifying the cost of capital requires knowledge when the firm will be tax-paying in all periods in order to calculate the present value of all future tax liabilities and benefits. As the firm's decisions at time t will affect its stock of tax losses carried forward into period $t+1$, this will affect the probability of the firm being tax-paying in each subsequent period. The user cost of capital will therefore hinge on how an additional investment will affect the integrals around whether the firm is tax-paying or not. Though this complete user cost of capital is saved for the appendix, some assumptions can lead to a more compact user cost of capital equation for marginal investments. As the purpose of this paper is to estimate the effect of the partial loss offset system on the marginal user cost of capital, the key variable of interest is the amount of time it takes a firm to use the marginal loss once it is incurred, even if the firm may have some control of whether it is tax-paying or not. This has been the standard approach in this strand of literature. Mintz (1988) assumes the tax status of the firm is determined after a firm commits to an investment plan. Auerbach and

Poterba (1987) make a similar assumption by assuming the transition probabilities of firms in and out of tax-paying status are exogenous when determining the marginal effective tax rate. This approach is also implicitly used by Graham (1996), who is more concerned with financing decisions, as he takes the taxable income of a firm as exogenous. If a marginal loss will be used in period $S > t+1$, its user cost of capital is given by the equation

$$F_K(K_{t+1}) = \frac{([\rho + C(b)][1 - \frac{u}{(1+\rho)^S}] - \rho)b + (\rho + \delta)[(1-\phi)(1 - \frac{u\alpha}{\rho+\alpha}) + \tilde{A}]}{(1 - \frac{u}{(1+\rho)^S})P_s} \tag{16}$$

where

$$\tilde{A} = \phi(1 - \frac{1}{(1+\rho)^S}) + (1-\phi)u\alpha \sum_{s=1}^{S} (1-\alpha)^s (1 - \frac{1}{(1-\rho)^{S-1-s}}) \tag{17}$$

This equation is similar to the previous user cost with additional terms to show the effect of the partial loss system on different tax parameters. First, the firm does not immediately deduct its investment tax credit in the current period, and is discounted at the rate ρ until period S. The summation term is over the period until the firm is able to use the marginal tax losses at time S. The firm would normally claim $u\alpha$ in the first period, $u\alpha(1-\alpha)$ in the next, and so on, but is only able to claim a discounted version of these. The entire stream of deductions is not pushed entirely in the future, as the firm will expect to be able to deduct any remaining tax depreciation allowances immediately in the periods after it becomes tax-paying. On the revenue side, the firm does not have to pay corporate taxes in period $t+1$, but in period $t+1+s$, so this delay is shown in the denominator. The actual amount of corporate taxes paid on the additional investment is correlated with the amount of time it takes the firm to become tax-paying. When a firm incurs a loss it must have received a low price shock, so the marginal return on investment is lower than if the firm received a large shock and was immediately tax-paying.

Finally, this potential delay in tax payments further complicates the financing decisions of firms. Though the firm must still trade off against the increased marginal bankruptcy costs from increasing leverage, it must also weight the potential for the marginal benefit of leverage to be discounted. Once tax deductions on interest are deferred because a firm is non-tax-paying, the costs of using debt will outweigh the present value of benefits of debt at the same debt ratio. Moving from a full loss system to a partial loss system should therefore coincide with a decrease in debt usage. With higher costs of finance, the firm should move down its cost of debt curve to the new point where the marginal costs of increased leverage are equal to the discounted marginal benefits of interest deductibility.

Investment in capital will increase the amount of losses carried forward in the next period as in equation (15), which in turn will affect the expected amount of time the firm is expected to wait to use any deductions on interest payments.

The equivalent optimal condition for the cost of capital under a partial loss offsetting system is equal to

$$\rho \tfrac{u}{(1+\rho)^S} = \int_{-\infty}^{\infty} q(p_t|p_{t-1})[(1 - \tfrac{u}{(1+\rho)^S})\tfrac{\partial C(b)}{\partial b}]\mathrm{d}p_t \tag{18}$$

As the delayed corporate taxes lower the marginal cost of capital while the other three effects increase it, the effect of the tax asymmetric treatment is ultimately ambiguous. Generous early tax deductions and the investment tax credit likely initially outweigh the revenue generated from the marginal unit of capital, lowering the taxable income from inframarginal investments, and as these expire the firm will begin to pay taxes on its investment. The duration of its tax loss and the profitability in loss states will affect whether the effective tax rate increases or decreases.

Rather than assuming a firm knows how long it may take to become tax-paying, the user cost of capital can be calculated by multiplying the user cost of capital from equation (18) by the probability of a firm using a tax loss in each future year. This estimate can then be used to determine the difference between the cost of capital between the full loss offset and the partial loss system.

3. Estimating the Use Rate of Tax Losses

Estimating the amount of time it takes firms to use a tax loss is done through a duration analysis. The dataset used for estimation is the entire universe of incorporated Canadian businesses for the period 2000-2010 obtained from the Department of Finance Canada. The data comes from the standard T2 business income tax forms and the General Index of Financial Information (GIFI), providing additional corporate information on businesses on a largely voluntary basis, though a number of fields are mandatory for tax filing. The use of tax data has advantages over other financial datasets as it provides information on all Canadian firms, including small private corporations that make up a majority of the population of firms, which may have different volatility than publicly traded corporations (Davis et al., 2006). Using tax data also allows for an accurate measurement of the true use of losses and a schedule of when these losses are used. No financial dataset reports the true amount of tax loss carryforwards, but must be imputed from the tax code and observation of firm tax payments. Also, as financial datasets do not monitor the firm from its incorporation but from an arbitrary time period, the stock of losses at the beginning of observation is unknown, and just set to zero. This particular tax dataset can observe the stock of losses carried forward from a previous period, the amount of losses that have expired, losses that have been carried backward to offset past taxable income, and the precise number of losses that have been carried forward to be used at a later date.

The total losses by a firm may fluctuate over time, with firms using some of their losses, claiming more losses in the next period, and then finally depleting their stock sometime in the future. As a firm is able to use any of their past losses to reduce their current taxable income it is still impossible to follow the lifetime of each particular loss. However, a firm has an incentive to use the oldest tax loss first, as they have the greatest probability of expiring. Since this paper is concerned about the use of the marginal loss in any given period, some accounting can follow when a particular loss should be used.

Table 1. Firm Tax Loss Example

Time	Firm Profit	Stock of Losses	Initial Loss Duration
0	10,000	0	-
1	- 60,000	50,000	50,000
2	10,000	40,000	40,000
3	-30,000	70,000	40,000
4	50,000	20,000	0
5	30,000	0	-

Once a firm incurs a loss, the total amount of losses carried forward becomes the stock of losses needed to expire sometime in the future for the marginal investment to be taxable. The time period when the firm has used enough losses to deplete this initial stock of losses is then reported as the total duration. This is shown most easily through the example in Table 1. The hypothetical firm below claims losses in period $t = 1$, uses a portion of these losses backwards in $t = 0$, some more in $t = 2$, claims additional losses in $t = 3$, and uses its claimed losses through periods $t = 4$ and $t = 5$. In period $t = 3$ when the firm claims more losses, the stock of initial losses will remain the same. In period $t = 4$ the firm uses 50,000 past tax losses, enough to deplete the first stock of losses incurred in period 1 but not its entire stock. Thus the duration of the stock of losses is 3 periods while the firm is actually tax-paying in period 5.

The additional stock of losses incurred in period 3 will not be recorded as an additional stock of losses. This is done in order to measure the time it takes a firm to begin using tax losses from the time it enters a loss position. A large majority of firms experience losses for several periods and then become tax-paying and use all of their accumulated losses in a single period. If a firm incurs losses for five consecutive periods and then uses all of its losses in the sixth period then the average time to use a loss would be 2.5 though the full length of 5 years the firm is non-tax-paying is more useful in analysis that follows. Cooper and Knittel (2006) use a similar approach to determine the duration of net operating losses for the United States, though they are interested in the use rate of all losses and include all new losses, even when a firm has outstanding losses.

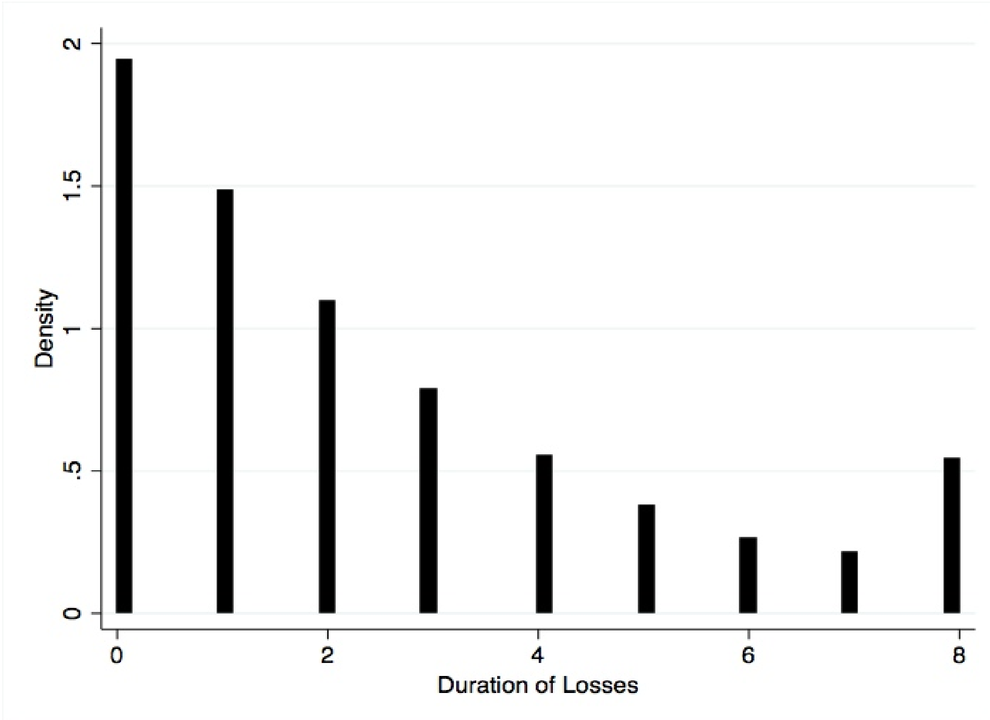

FIGURE 1. Probability Density of Tax Loss Duration

A histogram of the duration of losses incurred between 2000 and 2004 is shown in Figure 1. As the observation window ends in 2010 losses incurred after this point would have varying levels of censoring if the losses are incurred closer to 2010 and not shown in the figure. Losses incurred prior to 2004 still have some censoring compared to the tax system. Prior to 2004 the maximum period of time a loss could be carried forward was 7 years, which was extended to 10 years in 2004 and 20 years in 2006. This explains the jump in the probability density at 8 years as these losses are shown to have duration of eight years as that is the year they will appear as expired. Otherwise, the density follows a predictable pattern. A significant proportion of losses are used immediately for firms that had previous profits giving the firm the ability to carry their losses backwards, and the density of loss duration is decreasing as time passes.

Several additional covariates are included that may affect the length of time it takes a firm to use a loss. The age of the firm may affect the nature of the loss incurred, with new firms starting up and suffering losses due to large fixed initial costs while older firms may experience losses due to economic conditions. Larger firms may also have greater (absolute) swings in revenue and their losses may be relatively small compared to their overall size. Other control variables include the particular year and most importantly the industry code of the firm suffering the loss.[10]

Estimation of the duration of losses is done using a full parametric approach. The variable of interest in this particular paper is the baseline probability distribution of tax losses, as well as the effect of provincial and industry dummy covariates that may influence its shape. Non-parametric or semi-parametric approaches are able to estimate the effect of these covariates without specifying the shape of the actual hazard function. Though a Kaplan-Meier step estimate of the probability distribution can be backed-out through these procedures, a continuous probability distribution is much more valuable here. The presence of numerous censoring issues is also accommodated more easily through the use of a full parametric approach.

A parametric approach requires assuming the shape of the probability density function of the data generating process. The functional form here is taken as the Weibull continuous probability distribution, given by

$$f(t_i, x_i, \beta) = \kappa t^{\kappa-1} \exp(-\mathbf{x_i}\beta t)^{\kappa}$$

A shape parameter κ allows for adjustments to whether firms that have not used a loss after some time have a greater or lesser probability of using the loss in the future, which is not possible under a simpler exponential function.[11] The distribution function shows the probability that failure occurs at any time t in the future, given a vector of variables x and coefficients β, looking from time 0. Vectors x and β denote the variables and coefficient estimates.

[10]See Altshuler et al. (2009) on how these variable affect the number of firms experiencing losses in the United States

[11]The observed usage of losses under a relatively short window with discrete time periods makes it impossible to identify the shape of a more flexible function form such as a generalized gamma distribution.

The model is estimated using a standard maximum likelihood estimator (MLE), which lends itself well to the use of censored data present here and in all duration models. The maximum likelihood estimator aims to choose parameter values that maximize the probability (or likelihood) the observations come from the estimating equation. We are interested in the probability density of time to use a loss t, conditional on a set of parameters, or $f(t|x,\beta)$. The maximum likelihood estimator requires the joint density of observations to be independent of each other, so $f(t_{1,2....n}|\beta, x)$ can be written as the product of individual probability densities, which yields the likelihood function $L(\beta|x_i, t_i)$.

The likelihood function must also be adjusted for censored data. In this dataset there is the standard problem of not being able to observe when firms will use a loss if they have not used their loss by the end of the observation window of 2010. There is also a further issue with right censoring of variables in the first few years of the dataset. Losses incurred prior to 2004 were only eligible to be carried forward for seven years instead of the current 20 years. Rather than treating these losses as surviving seven years when they expire they are treated as being censored. Coding duration is made more difficult by the fact there are a number of ways for losses to be used. Losses can either be carried backwards to offset previous taxes paid, they can expire because the firm was non-tax-paying for many years, or the firm can exit the market. An exit in this sense can mean the firm truly goes bankrupt, stops reporting income, or was acquired by another firm where it will become impossible to follow the trail of losses. This leads to additional censoring easily controlled for during estimation.

Adjusting the likelihood function for censoring is done by rewriting the probability density as the multiplication of two related functions, the hazard function $h(t|x,\beta)$ and the survival function $S(t|x,\beta)$. The hazard function is the probability of failure at a specific period, given that the agent has survived until then. The survival function gives the probability of having survived until a specific period. The probability density of failing at a time t is the probability of surviving until that period, which is the survival function, multiplied by the probability of failing at time t after reaching time t, or the hazard function. The hazard and survival functions for the Weibull distribution are

$$h(t_i|x_i,\beta) = \exp(-\mathbf{x_i}\beta)\kappa(t)^{\kappa-1} \qquad S(t_i|x_i,\beta) = \exp[-(\exp(-\mathbf{x_i}\beta)t)^{\kappa})]$$

The likelihood function can then be written as

$$L(\beta|x_i,t_i) = \prod_{i=1}^{n} S_i(t_i|x_i,\beta)h_i(t_i|x_i,\beta)^{\Psi} \tag{19}$$

The indicator Ψ is equal to 1 when the firm becomes taxpaying and is equal to zero when the observation is censored because the timing of the usage of losses is not known. If the loss observed to be used, then the observation is able to provide insight into the probability of duration ending at time $t+1$ if it has not used the tax loss in period t. If this time is unobserved, then all the observation is able to provide is the probability of duration lasting, or surviving, until time t.

This equation is maximized using the Newton-Raphson algorithm, taking a vector of the first and second derivatives of the log-likelihood function and iterating on

$$\beta_{j+1} = \beta_j - \left[\frac{\partial^2 \ln(L)}{\partial\beta\,\partial\beta'}\right]^{-1}\left[\frac{\partial \ln(L)}{\partial\beta}\right] \tag{20}$$

The iteration process requires some initial coefficient values, which are estimated using a naive ordinary least squares regression using all observations as if they were uncensored and normally distributed. The result for β_{j+1} is then taken as the starting value for the next iteration. This process is iterated on until the change in parameter estimates between iterations is less than a threshold value of $10e^{-8}$.

The results of the estimation are shown in Table 2. Each coefficient can be interpreted by including it as the exponent of e and compared to 1 to determine the percentage change in time for a firm to use a loss. Negative values imply a faster use of losses while positive coefficients imply a slower use of losses. As expected, older firms use losses at a slightly faster rate than newer firms, but there is an insignificant effect of the size of firms and their expected time to use losses. There is also a significant difference, some positive, some negative, for each of the provinces and for each of the industries that effective tax rates will be estimates for.

4. The Marginal Effective Tax Rate and Calibration

The marginal effective tax rate is given as the tax wedge between the gross of tax cost of capital net of depreciation as before,

$$METR = (r_g - \rho)/r_g$$

with r_g taken from to either equation (11) or (18). These equations are derived for a specific type of capital, while each industry uses a variety of capital inputs that have different tax and economic depreciation rates: computers depreciate faster than some types of heavy machinery, and land does not depreciate at all. To calculate the effective tax rate of an industry, economic depreciation (δ) for 177 different assets classes was taken from Patry (2007), assuming geometric depreciation and assumed to be constant across industries and provinces. Each asset class was then matched with its corresponding tax depreciation rate (α) taken from the Canada Income Tax Act, and weighted by its capital stock for each industry also estimated from Patry (2007).

Both statutory corporate tax rates and credit rates vary across provinces. All Atlantic provinces have eligible investment tax credits, as do Quebec, Manitoba and Saskatchewan. The combined statutory rate varies between provinces, from 25% in Alberta, British Columbia and New Brunswick, and up to 31% in Nova Scotia and Prince Edward Island. Only Ontario, Saskatchewan, and Newfoundland and Labrador offer preferential statutory tax rate deductions for specific industries. The capital stock weight of each industry across the Canadian provinces determines the weight of province-specific tax rates and deductions.

To combine different assets for an industry, the METR for each input is calculated and then multiplied by the estimated weight of each capital type for a particular industry. This methodology assumes capital stocks will not change with tax changes, or that there is zero substitution between capital types. This lack of substitution means the effective tax rates presented here are overstated in the full loss-offset case, as firms may substitute to goods with faster capital cost allowance rates under a full loss offset if they are certain they would be eligible to claim these deductions.

Finally, the net of tax risk free interest rate on debt and equity is taken as the yield on a Government of Canada 10-year bond, and the inflation rate is taken as the midpoint of the Bank of Canada's targeted inflation band of 2%. Personal taxes on interest and combined tax rate on dividends and capital gains are estimated by Finance Canada as being 28.44% and 16.5%. These personal taxes lead to a difference in the risk-free required rates between equity and debt. It is assumed that each asset is financed in the same proportion of debt and equity, though it is possible that different types of assets may be funded in different proportions of debt and equity (Auerbach, 1983). The debt ratio, under a partial-loss system, is taken as the total debt-asset ratio for each industry from Statistics Canada's Financial and Taxation Statistics for Canadian Enterprises. By taking the simple average as the debt asset ratio this assumes that the marginal investment is financed at the same proportion of debt and equity as the average investment. It also assumes that each capital type is financed in the same proportion of debt and equity, but as the discount rate between periods when the firm is non-tax-paying is the risk-free return, and by multiplying each type of capital by its industry-specific capital weight, this does not affect the calculation of the industry-specific marginal user cost of capital.

4.1. **Statutory Corporate Taxes.** Calculating the effect of the partial-loss system is primarily done by calculating the new present value of tax credits and interest deductions. However, the tax base subject to the statutory corporate taxes paid depends not only on how long it takes a firm to become tax-paying, but the return on investment in states where the firm enters a loss position. If a firm receives a very low price shock they will not be tax-paying for a long period of time but this low price shock will also be associated with a very low return on additional investment. Calculating the marginal effective tax rate requires pairing not only the probability of entering a loss, but also the marginal return in each state to determine the expected statutory corporate tax rate. Under a full loss offset (or if the firm would always be tax-paying) the firm will always pay additional corporate taxes, even if its taxable income is negative, and so its corporate taxes will be equal to the simple expected value of the price shock. Under a partial-loss offset, the firm will immediately pay taxes if its return is high and will defer taxes if the shock is low, which decreases the expected corporate taxes paid, but not at the same rate as other tax credits which have a fixed value based on the size of investment and amount of debt.

Determining the expected profitability is done by parameterizing the distribution of firm profitability within a given industry. From the model in the first section the firm price shock is assumed to follow a lognormal distribution. This distribution is approximated by taking the log of the ratio of firm operating profits to total tangible capital to get the distribution of firm profitability. The distribution is assumed to have a normal distribution with a mean of zero and an industry-specific standard deviation. Combining the distribution and the average number of firms incurring a loss each year from 2000 to 2010 gives the critical value price shock where the firm will become tax-paying and non-tax-paying. This gives the probability the firm is tax-paying, and can be multiplied by the expected value of the price shock to the right of the tax-paying cutoff to give the expected tax base if the firm will be tax-paying. The process is repeated for the truncated distribution of firms that are non-tax-paying. Of the firms that are non-tax-paying, the survival analysis above measures the number of firms that will be tax-paying after one year, two years, and so on. Assuming that firms will becoming tax-paying sooner the closer their price shock was to the tax-paying threshold, I segment the entire profitability distribution into sections of how long the firm will take to become tax-paying, and calculate the expected profitability for each of these areas.

4.2. **The Cost of Debt.** Estimating the marginal effective tax rate requires calibrating the cost of debt function for each industry. To calibrate the cost of debt function, the average debt-asset ratio for each industry is taken as the optimal debt-asset ratio under a partial loss offset system. In addition to the weighted cost of capital term, I add an additional term, $i(b)$, the additional bankruptcy costs from increasing leverage, assumed to be a convex function of leverage. Parameterization of the cost of debt function is done in a manner similar to van Binsbergen, Graham, and Yang (2010) and Korteweg (2010). Both of these papers assume the additional costs of debt are a quadratic function of debt, with van Binsbergen, Graham, and Yang (2010) focusing on the marginal costs of debt and Korteweg (2010) explicitly estimating a quadratic functional form. Furthermore, both find the linear term to be virtually zero. The estimating equation from van Binsbergen, Graham, and Yang (2010) has an predicted intercept to be 1/42 of their slope coefficient on debt or even negative. Korteweg (2010) estimates the total costs or benefits of leverage, including the tax benefits, finding the linear term approximates the tax benefits of leverage. Using this functional form, the increase in the interest rate on debt due to additional bankruptcy costs is written as

$$i(b) = \xi_i b^2 \tag{21}$$

Using this equation for the relationship between leverage and interest rates, it is then possible to estimate changes in debt structure and effective tax rates between a partial loss system and a full loss system for corporate taxes.

The effective tax rates are calculated following a number of steps. The probability distribution of losses from the previous section is used to determine the present value of corporate taxes. This present value is taken to identify the parameter value ξ_i for each industry so the optimal debt-ratio is equal to the observed debt ratio. The parameter value is taken to be constant across provinces, while the debt ratio varies due to differences in the present value of corporate taxes. The capital-stock-weighted average debt ratio must then be equal to the observed debt ratio.

After parameterizing this cost of debt, it is possible to estimate the expected benefits of leverage and compute the marginal effective tax rate under a partial-loss system. It is also possible to calculate the marginal effective tax rate under a full-loss offset system allowing adjustments in the debt-asset ratio. If firms do not change their debt ratio moving from a partial-loss to a full-loss offset system then firms would be able to obtain the same interest rate on debt and greater interest deductibility from interest. More likely, with immediate interest deductibility of debt, the marginal benefit of leverage increases, and the firm would increase its debt ratio. The value of the ξ_i parameter allows for a matching of the new marginal benefits of leverage to the marginal bankruptcy costs of debt. With this new debt-asset ratio and interest rate, the marginal effective tax rate can then recalculated.

The main results are presented in Tables 3 and 4. Table 3 shows the calculated marginal effective tax rate under different potential tax systems and assumptions on returns. The first column shows the estimated marginal effective tax rates under a partial loss system for an investment with a constant return. Regardless of whether a firm enters a loss or not, the return on investment is always the same. This is similar to the case of 'continuing investment' in Mintz (1988). The second column shows the estimated effective tax rate under a risky investment, where low shocks will be associated with a longer period of a loss and a low return on investment. All of these tax rates are higher than for a fixed return as the benefit of deferring corporate taxes is lower while the cost of deferred tax credits remains the same. The third and fourth columns show the marginal effective tax rate under a full loss system, first without any changes in the debt asset ratio, and then with an increase in the debt ratio associated with the additional benefits of leverage.

Omitting changes in debt usage, the marginal effective tax rate is higher under a full loss offset system than under the partial loss offset system for all industries in the case of riskless investments. This is not entirely surprising given features of the Canadian tax system. With a relatively small number of provinces with investment tax credits, much of the tax benefit come from tax depreciation allowances which only serve to reduce income taxes paid. These investment incentives are much larger than the tax benefits of leverage, driving a majority of the marginal effective tax rate. This results in all of the industry-specific marginal effective tax rates to be positive under a full loss offset system, and tend towards zero if a firm takes longer to become tax-paying.[12] The difference between marginal effective tax rates between the two tax systems is between 1.2% for utilities and close to 4% for communications. With the relative size of the tax rates, the percentage difference between the tax systems would actually be highest for the forestry industry due to its already very low tax rate. Risky investments have predictably higher marginal effective tax rates under a partial loss offset system than compared to a full loss system. The tax rates are higher by between 1% for utilities to over 7% for forestry. The lowest effective tax rate under a full loss system, in forestry, is primarily due to the use of capital which depreciates quickly and has preferential tax treatment, and the deferral of these benefits drives up the effective tax rate substantially.

The final column shows the results including changes in the effective tax rate after including changes in the debt ratio. Table 4 looks at changes in the debt ratio directly. The results make it clear that although the switch to a full loss offset system has a significant effect on the debt-asset ratio, this causes a very limited change in the overall cost of capital. The increased present value of interest rate tax deductions are largely offset by increases in the interest rate leading to small decreases in the marginal effective tax rate between the two full loss offset estimates. The debt asset ratios show a sizeable change in the debt ratio from a move to a full loss offset from a partial loss offset, with the debt-asset ratio increasing by between 2 to 5 percentage points, accounting for between a 4% to 8% increase in the overall debt-asset ratio of firms. These estimates are relatively high compared to previous estimates from Gordon and Lee (2001), who found that a change in the statutory tax rate of 10% would lead to a change in the debt-asset ratio of close to 5 percentage points. This

[12]Excluding changes in debt, the marginal effective tax rate will only increase under a partial loss-offset system if it is initially negative.

is potentially due to the fact that the sample used by Gordon and Lee had an average debt-asset ratio of only around 30% (as opposed to the debt-asset ratio here of around 50%), and significantly higher corporate tax rates. Thus their sample had a potentially greater incentive for firms to increase debt as firms had lower observed debt-asset ratios, which would suggest a higher risk involved in increasing the debt-asset ratio than in the estimation here.

These results are still comforting on two fronts. The finance literature has been concerned with effect partial loss-offsetting may have on optimal financial structure, whereas the taxation literature has largely assumed fixed debt-asset ratios in simulations to avoid additional endogenous variables. The results here show that both may be valid. The debt-asset ratio would appear to have much room to fluctuate due to tax-loss provisions, but these effects may have limited economic significance for those interested in the use of effective tax rate simulations.

Given the assumptions on the tax status of the firm, this is the only valid comparison between capital structure and the tax system. When measuring the discounted value of the statutory rate and deductions, it was assumed the marginal investment had no effect on the tax status of the firm. This assumption carries over to the use of debt. Any comparisons between different debt ratios or tax rate changes under intermediate systems between a partial and full loss offset system should take into account potential changes in the tax status that go along with these changes. Whether the choice of capital structure had an effect on the tax status of the firm at the equilibrium level of debt under the partial loss-offset system is included when calculating the tax rates. Under a full loss system, the choice of debt will not have any effect on the tax status of the firm, as firms can always receive a refund or a deduction even if their taxable income is negative.

5. Conclusions

This paper has considered the effect of partial loss offsetting on the marginal effective tax rate and capital structure. I find the marginal effective tax rate either increases or decreases for non-tax-paying firm based on the riskiness of investments. This may have important consequences on the distribution of capital investment firms based on their profitability, while limiting the effectiveness of investment incentives targeted for particular industries. With respect to financing decisions, the deferred interest deductibility of debt financing is estimated to have a significant effect on the capital structure of firms. Though not the main driver of capital structure, the difference in debt-asset ratios between a partial and full loss offset system is approximately 0.03, constituting around 6% of the total debt usage of firms. This is a substantial shift in the debt-asset ratio associated with relatively small changes in the present value of tax payments, but has limited effects on the marginal effective tax rate, as interest rate changes offset benefits of increased interest deductibility.

Appendix A. Proofs for the User Cost of Capital

Full Loss Offset. The complete dynamic problem of the firm is given by

$$V_t(P_t, UCC_t, K_t, b_t) = \max_{\{K_{t+1}, b_{t+1}\}} \{R(P_t, K_t) - (K_{t+1} - (1-\delta)K_t) - b_t(1+i_t)K_t - T_t + b_{t+1}K_{t+1} + \tfrac{\mathbb{E}V_{t+1}(P_{t+1}, UCC_{t+1}, K_{t+1}, b_{t+1})}{1+\rho}\} \quad (22)$$

subject to

$$p_{t+1} = \nu(\mu - p_t) + p_t + \sigma\varepsilon_t\ ;\ \varepsilon_t \sim N(0,1) \quad (23)$$

$$T_t = u[R(P_t, K_t) - i_t b_t K_t - \alpha UCC_t] - \phi(K_{t+1} - (1-\delta)K_t) \quad (24)$$

$$UCC_t = (1-\phi)(K_t - (1-\delta)K_{t-1}) + (1-\alpha)UCC_{t-1} \quad (25)$$

The solution of the problem depends on three first order conditions, three envelope conditions and the transition equations for the UCC. Denoting the partial derivative of the value function with a particular argument as $V(\cdot)^j$ with $j \in (2,3,4)$ for UCC_t, K_t, b_t respectively, the seven additional equations are

$$\frac{\partial V(\cdot)}{\partial K_{t+1}} = 0 = -(1-\phi) + b_{t+1} + \tfrac{1-q_B}{1+\rho}(\mathbb{E}V^2_{t+1}(\cdot)(1-\phi) + \mathbb{E}V^3_{t+1}(\cdot)) \quad (26)$$

$$\frac{\partial V(\cdot)}{\partial b_{t+1}} = 0 = K_{t+1} + \tfrac{(1-q_b)V^4_{t+1}(\cdot)}{1+\rho} \quad (27)$$

$$\frac{\partial V(\cdot)}{\partial K_t} = (1-u)R_K(\cdot) + (1-\phi)(1-\delta) - b_t(1+i_t(1-u)) - \tfrac{\partial i}{\partial K_t} b_t K_t (1-u) + \tfrac{(1-\phi)(1-\delta)}{1+\rho} V^2_{t+1}(\cdot) \quad (28)$$

$$\frac{\partial V(\cdot)}{\partial b_t} = -(1+i_t(1-u))K_t - b_t K_t \tfrac{\partial i}{\partial b_t} \quad (29)$$

$$\frac{\partial V(\cdot)}{\partial UCC_t} = u\alpha + u\alpha(1-\alpha)q_B + \tfrac{(1-q_B)(1-\alpha)}{1+\rho} V^2_{t+1}(\cdot) \quad (30)$$

Following the proof in the text, the two debt equations (27) and (29) are combined to immediately give the firm's financing condition (equation (10) in the text) as

$$(1+\rho) = (1-q_B)[1+(1-u)(i_t + \tfrac{\partial i(b_t,p_t)}{\partial b} b_t)] \tag{31}$$

Using the fact that

$$(1-q_B)i = \rho - \int_{-\infty}^{p_B} q(p_t|p_{t-1})(i(b_t,K_t,p_t)\mathrm{d}p_t \tag{32}$$

and

$$(1-q_B)\tfrac{\partial i}{\partial b} = \frac{1}{b}\int_{-\infty}^{p_b} q(p_t|p_{t-1})[i(b_t,K_t,p_t) + \tfrac{\partial C(b)}{\partial b} + \tfrac{1}{1-u}]\mathrm{d}p_t \tag{33}$$

solves for the first order condition for the debt ratio that is independent of the capital stock as in the text. To solve for the user cost, taking the first order condition of K_{t+1} (26) and the envelope condition of capital (28) together gives

$$(1-u)\mathbb{E}(P_{t+1}|P_t)F_K(K_{t+1}) = [(\{\rho+C(b)\}(1-u)-\rho]b-(1-\phi)(\rho+\delta)[1-V_{t+2}^2(\cdot)/(1+\rho)] \tag{34}$$

which relies on a similar substitution of the interest rate. Note here that all tax liabilities and benefits are discounted by the risk-free interest rate and the value function with respect to the undepreciated capital cost is still present. With a full loss offset, the firm may be uncertain about the revenue their capital will generate, but is always able to claim their deductions and credits or are transferred to debt holders. To get to the user cost of capital to be equivalent to the one presented in the text is to calculate the present value of the full stream of tax depreciations allowances over time. The equation for the transition of the undepreciated capital cost (30) can be moved forward infinitely to get the present value of additional investment, $u\alpha(1+\rho)/(\rho+\alpha)$, reducing this equation to

$$\mathbb{E}(P_{t+1}|P_t)F_K(K_{t+1}) = [(\{\rho+C(b)\}(1-u)-\rho)b+(\rho+\delta)(1-\phi)(1-\tfrac{u\alpha}{\rho+\alpha})]/(1-u) \tag{35}$$

□

Partial Loss Offset. Separating the revenue of the firm between tax-paying and non-tax-paying components, the problem of the firm becomes

$$
\begin{aligned}
V_t(P_t, UCC_t, K_t, b_t, TLCF_t) = \max_{\{K_{t+1}, b_{t+1}\}} \{ \int_{\infty}^{\bar{P}} R(P_t, K_t) q(p_t | p_{t-1}) \mathrm{d}p_t \\
+ \int_{\bar{P}}^{\infty} [(1-u)(R(P_t, K_t) + uTLCF_t] q(p_{t+1} | p_t) \mathrm{d}p_t \\
- (1-\phi)(K_{t+1} - (1-\delta)K_t) - b_t(1 + i_t(1-u))K_t + u\alpha UCC_t \\
+ b_{t+1}K_{t+1} + \tfrac{\mathbb{E}V_{t+1}(P_{t+1}, UCC_{t+1}, K_{t+1}, b_{t+1}, TLCF_{t+1})}{1+\rho} \}
\end{aligned}
\tag{36}
$$

subject to

$$p_{t+1} = \nu(\mu - p_t) + p_t + \sigma\varepsilon_t \ ; \ \varepsilon_t \sim N(0, 1) \tag{37}$$

$$T_t = u[R(P_t, K_t) - i_t b_t K_t - \alpha UCC_t] - \phi(K_{t+1} - (1-\delta)K_t) \tag{38}$$

$$UCC_t = (1-\phi)(K_t - (1-\delta)K_{t-1}) + (1-\alpha)UCC_{t-1} \tag{39}$$

$$\bar{P} = (TLCF_t + i_t b_t K_t - \alpha UCC_t + \phi(K_{t+1} - (1-\delta)K_t))/F(K_t) \tag{40}$$

$$
TLCF_{t+1} = \begin{cases} 0 & \text{if } P_t > \bar{P} \\ TLCF_t - R(P_t, K_t) + \dfrac{\phi}{u}(K_{t+1} - (1-\delta)K_t) + \\ \qquad i_t b_t K_t + \alpha UCC_t & \text{if } P_t < \bar{P} \end{cases}
\tag{41}
$$

The solution of the problem depends on similar first order conditions, with additional transition equations for the tax loss carryforward.

$$\frac{\partial V(\cdot)}{\partial K_{t+1}} = 0 = -(1-\phi) + b_{t+1} + \tfrac{1-q_B}{1+\rho}\mathbb{E}[V^2_{t+1}(\cdot)(1-\phi) + V^3_{t+1}(\cdot) + V^5_{t+1}(\cdot)\tfrac{\phi}{u}] \tag{42}$$

$$\frac{\partial V(\cdot)}{\partial b_{t+1}} = 0 = K_{t+1} + \tfrac{(1-q_B)\mathbb{E}V^4_{t+1}(\cdot)}{1+\rho} \tag{43}$$

$$\frac{\partial V(\cdot)}{\partial K_t} = \begin{array}{c} \int_{-\infty}^{\bar{P}} R_K(\cdot)q(p_{t+1}|p_t)\mathrm{d}p_t + \int_{\bar{P}}^{\infty}(1-u)R_K(\cdot)q(p_{t+1}|p_t)\mathrm{d}p_t + (1-\phi)(1-\delta) \\ -b_t(1+i_t(1-u)) - \frac{\partial i}{\partial K_t}b_tK_t(1-u) + \frac{1-q_B}{1+\rho}\mathbb{E}[(1-\phi)(1-\delta)V^2_{t+1}(\cdot) \\ +(\frac{\phi}{u}(1-\delta) - R_K(\cdot) + ib)V^5_{t+1}(\cdot)] \end{array} \tag{44}$$

$$\frac{\partial V(\cdot)}{\partial b_t} = -(1+i_t(1-u))K_t - (1-u)b_tK_t\tfrac{\partial i}{\partial b_t} + \tfrac{(iK_t + b_tK_t\frac{\partial i}{\partial b_t})(1-q_B)\mathbb{E}V^5_{t+1}(\cdot)}{1+\rho} \tag{45}$$

$$\frac{\partial V(\cdot)}{\partial UCC_t} = u\alpha + u\alpha(1-\alpha)q_B + \tfrac{1-q_B}{1+\rho}\mathbb{E}((1-\alpha)V^2_{t+1}(\cdot) + \alpha V^5_{t+1}(\cdot)) \tag{46}$$

$$\frac{\partial V(\cdot)}{\partial TLCF_t} = -[u(R(P_t,K_t) + uTLCF_t] + \int_{\bar{P}}^{\infty} uq(p_{t+1}|p_t)\mathrm{d}p_{t+1} \tag{47}$$

This is similar to the form of the full loss offset, with the introduction of the probability of the firm paying taxes and the probability of marginally increasing the size of a loss with $V^5_{t+1}(\cdot)$. If the firm is tax-paying in the next period the value of this equation is equal to zero as the firm will not have any losses to carry forward. As the probability of being tax-paying increases, the user cost of capital tends towards the equivalent equation from the full loss offset. These equations can also be combined in a similar manner to arrive at a modified optimality conditions.

A similar set of substitutions as above give the first order condition for the optimal debt decision,

$$(1+\rho) = [1 + (1-u+V^5_{t+1}(\cdot))(i_t + \tfrac{\partial i(b_t,p_t)}{\partial b}b_t)] \tag{48}$$

However, note that the return to debt holders in the event of bankruptcy is affected by whether the firm is tax-paying or not and on the value of the tax loss carryforward stock. The return to debt holders is therefore

$$i(b_t, K_t, p_t) = \begin{cases} i_t & \text{if } p_t > p_B \\ \int_{\infty}^{\bar{P}} R(P_t, K_t) q(p_t | p_{t-1}) \mathrm{d}p_t & \\ \quad + \int_{\bar{P}}^{P_B} [(1-u)(R(P_t,K_t) + uTLCF_t] q(p_{t+1|p_t}) \mathrm{d}p_t & \text{if } p_t < p_B \\ \quad\quad +(1-\phi)(1-\delta)K_t + u\alpha UCC_t - b_t K_t]/[(1-u)b_t K_t] - \frac{C(b_t)K_t}{b_t K_t} & \end{cases} \tag{49}$$

Substituting the identity of the interest rate yields the condition for the optimal debt ratio.

$$\rho u - V_{t+1}^5(\cdot) = \int_{-\infty}^{\infty} q(p_t | p_{t-1}) [(1 - u + V_{t+1}^5(\cdot)) \tfrac{\partial C(b)}{\partial b}] \mathrm{d}p_t \tag{50}$$

This equation is now indirectly affected by the investment decision, since investment affects the size of $V_{t+1}^5(\cdot)$, which is the effect of the loss carried forward when the first is non-tax-paying. When the firm is in a loss position an increase in investment will increase the size of the loss, decreasing the probability of the firm being tax-paying in the next period, which decreases the benefit of increasing debt. Higher investment would increase the delay in using interest deductions, so the debt ratio should be decreasing in the future capital stock. Combining these terms for the debt ratio and the choice of capital leads directly to the user cost of capital, similar to equation (34) above,

$$\begin{aligned} F_K(K_{t+1}) = \{ & [(\rho + C(b))(1 - u + V_{t+1}^5(\cdot)) - \rho] b + (1-\phi)(\rho+\delta)[1 - V_{t+2}^2(\cdot)/(1+\rho)] \\ & + V_{t+1}^5(\cdot)(\frac{\phi}{u} + (1-\phi)\alpha)(1+\rho) - V_{t+2}^5(\cdot)[(\frac{\phi}{u} + (1-\phi)\alpha)(1-\delta) - R_K(\cdot)]\} \\ & / \{\mathbb{E}(P_{t+1}|P_t) - \int_{\bar{P}}^{\infty} u P_{t+1} q(p_{t+1}|p_t) \mathrm{d}p_{t+1} + V_{t+1}^5(\cdot)\} \end{aligned} \tag{51}$$

While quite involved, each term has a natural interpretation and relationship to the user cost of capital under the full loss-offset system. By assuming all deductions and credits are claimed immediately and instead contribute to the size of the loss carried forward, the first sections of the numerator and denominator are identical to the user cost of capital for the full-loss offset case, with the additional terms at the end showing how investment and debt decisions affect the future loss over time. Capital investment affects future losses in a number of ways. It increases the amount of the loss by the deduction equivalent investment tax credit rate and the UCC in period $t+1$ but affects period $t+2$ as well. If the firm is in a loss position and chooses to invest in period $t+2$, the value of the investment tax credit and UCC will be smaller due to the additional undepreciated capital from previous investment. These terms are shown in the second line of the above equation. Finally, increased investment will increase future revenue, which would serve to lower the total loss carried forward into period $t+2$. The denominator of this equation includes the probability of the firm being tax-paying, increasing the value of loss when it is non-tax-paying. It is possible to expand the term on the undepreciated capital cost infinitely forward, but this only serves to complicate the expression further. As the UCC decreases over time, it still has an effect on the future tax status of the firm in every future period, at a decreasing rate. In an arbitrary period $t+s$, there will be $(1-\alpha)^{t+s}$ remaining of the initial investment in the undepreciated capital stock for tax purposes, which will increase the size of the loss of the firm by $u\alpha(1-\alpha)^{t+s}$ in any future period the firm is non-tax-paying. By assuming the firm knows in what period it will become tax-paying, additional investment or debt will not affect the value of $V^5_{t+1}(\cdot)$, and it is then possible to simplify the user cost of capital as in the main text.

$\square$

Table 2. Regression Results

Regression Statistics		Coefficient	b/se	Coefficient	b/se
No. of subjects	1377408	Agriculture	-0.036***	B.C.	.
No. of failures	786152		(0.011)		
Time at risk	4416061	Forestry	-0.115***	Alberta	-0.098***
Log likelihood	-1557098.3		(0.011)		(0.003)
		Utilities	0.260***	Saskatchewan	-0.108***
			(0.031)		(0.006)
		Construction	-0.182***	Manitoba	-0.035***
			(0.003)		(0.006)
Coefficient	b/se	Manufacturing	-0.017***	Ontario	0.126***
Firm Age	-0.001***		(0.005)		(0.003)
	(0.000)	Wholesale Trade	0.018***	Quebec	0.101***
Firm Assets	0.000		(0.004)		(0.003)
	(0.000)	Retail Trade	0.089***	New Brunswick	0.058***
Constant	1.498***		(0.003)		(0.008)
	(0.003)	Transportation	-0.113***	Nova Scotia	0.072***
κ	1.233549		(0.004)		(0.007)
	-0.0011254	Communications	0.062***	Newfoundland	0.052***
			(0.008)		(0.009)
		Other Services	0.088***	P.E.I.	0.082***
			(0.004)		(0.016)

Note: Dependent variable is the duration of a tax loss offset. Standard errors are in parentheses. Statistical significance at the 10%, 5% and 1% levels are shown by an increasing number of asterisks. All regressions include year dummy variables that have been omitted from the regression results but were each significant at a 99% significance level in all specifications.

Table 3. Marginal Effective Tax Rates

Industry	Partial Loss Offset Riskless Investment	Partial Loss Offset Risky Investment	Full Loss Offset	Full Loss Offset +Debt Adjustment
Agriculture	23.75%	26.96%	25.69%	25.69%
Forestry	3.95%	13.14%	5.86%	5.76%
Utilities	23.58%	25.64%	24.80%	24.78%
Construction	22.16%	27.76%	25.11%	25.02%
Manufacturing	13.46%	19.89%	15.99%	15.84%
WholesaleTrade	23.54%	27.33%	25.52%	25.49%
RetailTrade	25.26%	28.41%	27.17%	27.14%
Transportation	22.49%	27.41%	25.33%	25.28%
Communication	25.28%	31.45%	29.03%	29.00%
OtherServices	30.15%	33.81%	32.57%	32.55%

Table 4. Effects of Bankruptcy Costs

Industry	Observed Debt	Adjusted Debt	ξ_i	Effect on Interest Rate (Percentage Points)
Agriculture	53.01%	55.93%	0.007927	0.2227
Forestry	53.01%	57.27%	0.007599	0.2135
Utilities	56.26%	58.82%	0.006999	0.2215
Construction	59.69%	64.92%	0.006111	0.2178
Manufacturing	40.48%	43.29%	0.01334	0.2185
Wholesale Trade	44.54%	47.59%	0.01095	0.2172
Retail Trade	45.15%	48.01%	0.01064	0.2169
Transportation	56.54%	61.22%	0.006594	0.2108
Communications	55.12%	58.71%	0.007127	0.2165
Other Services	51.20%	54.02%	0.008191	0.2147

References

Altshuler, Rosanne, Alan J Auerbach, Michael Cooper, and Matthew Knittel. 2009. "Understanding US Corporate Tax Losses." In *Tax Policy and the Economy, Volume 23*. University of Chicago Press, 73–122.

Auerbach, Alan. 1983. "Taxation, Corporate Financial Policy and the Cost of Capital." *Journal of Economic Literature* 21 (3):905–40.

———. 1986. "The Dynamic Effects of Tax Law Asymmetries." *Review of Economic Studies* 53 (2):205–25.

Auerbach, Alan and James Poterba. 1987. "Tax Loss Carryforwards and Corporate Tax Incentives." In *The Effects of Taxation on Capital Accumulation*. National Bureau of Economic Research, 305–342.

Bhattacharya, Sudipto. 1978. "Project Valuation with Mean-Reverting Cash Flow Streams." *Journal of Finance* 33 (5):1317–31.

Bulow, Jeremy I. and Lawrence H. Summers. 1984. "The Taxation of Risky Assets." NBER Working Papers 0897, National Bureau of Economic Research, Inc.

Cooper, Michael and Matthew Knittel. 2006. "Partial Loss Refundability: How Are Corporate Tax Losses Used?" *National Tax Journal* 59 (3):651–663.

Davis, Steven J., John Haltiwanger, Ron S. Jarmin, and Javier Miranda. 2006. "Volatility and Dispersion in Business Growth Rates: Publicly Traded versus Privately Held Firms." NBER Working Papers 12354, National Bureau of Economic Research, Inc.

Fama, Eugene F. and Kenneth R. French. 2000. "Forecasting Profitability and Earnings." *The Journal of Business* 73 (2):161–75.

Glenday, Graham and James Byron Davies. 1990. "Accrual Equivalent Marginal Tax Rates for Personal Financial Assets." *Canadian Journal of Economics* 23 (1):189–209.

Glenday, Graham and Jack M. Mintz. 1991. "The Nature and Magnitude of Tax Losses of Canadian Corporations." In *Policy Options for the Treatment of Tax Losses in Canada*. Toronto: Clarkson Gordon Foundation.

Gordon, Roger H. and Young Lee. 2001. "Do Taxes Affect Corporate Debt Policy? Evidence From U.S. Corporate Tax Return Data." *Journal of Public Economics* 82 (2):195–224.

Graham, John R. 2000. "How Big Are the Tax Benefits of Debt?" *Journal of Finance* 55 (5):1901–1941.

Graham, John R. and Hyunseob Kim. 2009. "The Effects of the Length of the Tax-Loss Carryback Period on Tax Receipts and Corporate Marginal Tax Rates." NBER Working Papers 15177, National Bureau of Economic Research.

Graham, John R., Michael L. Lemmon, and James S. Schallheim. 1998. "Debt, Leases, Taxes, and the Endogeneity of Corporate Tax Status." *Journal of Finance* 53 (1):131–162.

Korteweg, Arthur. 2007. "The Costs of Financial Distress Across Industries." Tech. rep.

———. 2010. "The Net Benefits to Leverage." *Journal of Finance* 65 (6):2137–2170.

Mackie-Mason, Jeffrey. 1990. "Do Taxes Affect Corporate Financing Decisions?" *Journal of Finance* 45 (5):1471–93.

McKenzie, Kenneth J. 1994. "The Implications of Risk and Irreversibility for the Measurement of Marginal Effective Tax Rates on Capital." *Canadian Journal of Economics* 27 (3):604–19.

Mintz, Jack M. 1988. "An Empirical Estimate of Corporate Tax Refundability and Effective Tax Rates." *The Quarterly Journal of Economics* 103 (1):225–31.

Patry, Andre. 2007. *Economic Depreciation and Retirement of Canadian Assets: A Comprehensive Empirical Study and Retirement of Canadian Assets: A Comprehensive Empirical Study*. Statistics Canada. Catalogue No. 15-549-XIE.

van Binsbergen, Jules H., John R. Graham, and Jie Yang. 2010. "The Cost of Debt." *Journal of Finance* 65 (6):2089–2136.

Oxford University Centre for Business Taxation
Working Paper series recent papers

WP13/23 Jennifer Blouin, Harry Huizinga, Luc Laeven, Gaëtan Nicodème *Thin capitalization rules and multinational firm capital structure*

WP13/22 Danny Yagan *Capital tax reform and the real economy: the effects of the 2003 dividend tax cut*

WP13/21 Andreas Haufler and Christoph Lülfesmann *Reforming an asymmetric union: on the virtues of dual tier capital taxation*

WP13/20 Michael Blackwell *Do the haves come out ahead in tax litigation? An empirical study of the dynamics of tax appeals in the UK*

WP13/19 Johannes Becker and Ronald B Davies *Learning and international policy diffusion: the case of corporate tax policy*

WP13/18 Reuven S Avi-Yonah *And yet it moves: taxation and labour mobility in the 21st century*

WP13/17 Anne Brockmeyer *The investment effect of taxation: evidence from a corporate tax kink*

WP13/16 Dominika Langenmayr and Rebecca Lesterz *Taxation and corporate risk-taking*

WP13/15 Martin Ruf and Alfons J Weichenrieder *CFC legislation, passive assets and the impact of the ECJ's Cadbury-Schweppes decision*

WP13/14 Annette Alstadsæter and Martin Jacob *The effect of awareness and incentives on tax evasion*

WP13/13 Jarkko Harju and Tuomos Matikka *The elasticity of taxable income and income-shifting between tax bases: what is "real" and what is not?*

WP13/12 Li Liu and Andrew Harper *Temporary increase in annual investment allowance*

WP13/11 Alan J Auderbach and Michael P Devererux *Consumption and cash-flow taxes in an international setting*

WP13/10 Andreas Haufler and Mohammed Mardan *Cross-border loss offset can fuel tax competition*

WP13/09 Ben Lockwood *How should financial intermediation services be taxed?*

WP13/08 Dominika Langenmayr, Andreas Haufler and Christian J bauer *Should tax policy favour high or low productivity firms?*

WP13/07 Theresa Lohse and Nadine Riedel *Do transfer pricing laws limit international income shifting? Evidence from European multinationals*

WP13/06 Ruud de Mooij and Jost Heckemeyer *Taxation and corporate debt: are banks any different?*

WP13/05 Rita de la Feria *EU VAT rate structure: towards unilateral convergence?*

WP13/04 Johannes Becker and Melaine Steinhoff *Conservative accounting yields excessive risk-taking - a note*

WP13/03 Michael P.Devereux, Clemens Fuest, and Ben Lockwood *The Taxation of Foreign Profits: a Unified View*

WP13/02 Giorgia Maffini *Corporate tax policy under the Labour government 1997-2010*

WP13/01 Christoph Ernst, Katharina Richter and Nadine Riedel *Corporate taxation and the quality of research & development*

WP12/29 Michael P Devereux and Simon Loretz *What do we know about corporate tax competition?*

WP12/28 Rita de la Feria and Richard Krever *Ending VAT Exemptions: Towards A Post-Modern VAT*

WP12/27 Theresa Lohse, Nadine Riedel and Christoph Spengel *The Increasing Importance of Transfer Pricing Regulations – a Worldwide Overview*

WP12/26 Harry Huizinga, Johannes Voget and Wolf Wagner
Capital gains taxation and the cost of capital: evidence from unanticipated cross-border transfers of tax bases

WP12/25 Harry Huizinga, Johannes Voget and Wolf Wagner
International taxation and cross border banking

WP12/24 Johannes Becker and Nadine riedel
Multinational Firms Mitigate Tax Competition

WP12/23 Michael Devereux, Li Liu and Simon Loretz
The Elasticity of Corporate Taxable Income: New Evidence from UK Tax Records

WP12/22 Olivier Bargain, Mathias Dolls, Clemens Fuest, Dirk Neumann, Andreas Peichl, Nico Pestel, Sebastian Siegloch
Fiscal Union in Europe? Redistributive and Stabilising Effects of a European Tax-Benefit System and Fiscal Equalisation Mechanism

WP12/21 Peter Egger, Christian Keuschnigg, Valeria Merlo and Georg Wamser *Corporate taxes and internal borrowing within multinational firms*

WP12/20 Jarkko Harju and Tuomos Kosonen *The impact of tax incentives on the economic activity of entrepreneurs*

WP12/19 Laura Kawano and Joel slemrod *The effects of tax rates and tax bases on corporate tax revenues: estimates with new measures of the corporate tax base*

WP12/18 Giacomo Rodano, Nicolas Serrano-Velarde and Emanuele Tarantino *Bankruptcy law and the cost of banking finance*

WP12/17 Xavier Boutin, Giacinta Cestone, Chiara Fumagalli, Giovanni Pica and Nicolas Serrano-Velarde *The Deep pocket effect of internal capital markets*

WP12/16 Clemens Fuest, Andreas Peichl and Sebastian Siegloch *Which workers bear the burden of corporate taxation and which firms can pass it on? Micro evidence from Germany*

WP12/15 Michael P. Devereux *Issues in the Design of Taxes on Corporate Profit*

WP12/14 Alan Auerbach and Michael P. Devereux *Consumption Taxes In An International Setting*

WP12/13 Wiji Arulampalam, Michael P. Devereux and Federica Liberini *Taxes and the location of targets*

WP12/12 Scott Dyreng, Bradley Lindsey and Jacob Thornock *Exploring the role Delaware plays as a tax haven*

WP12/11 Katarzyna Bilicka and Clemens Fuest *With which countries do tax havens share information?*

WP12/10 Giorgia Maffini *Territoriality, Worldwide Principle, and Competitiveness of Multinationals: A Firm-level Analysis of Tax Burdens*

WP12/09 Daniel Shaviro *The rising tax-electivity of US residency*

WP12/08 Edward D Kleinbard *Stateless Income*

WP12/07 Vilen Lipatov and Alfons Weichenrieder *Optimal income taxation with tax competition*

WP12/06 Kevin S Markle *A Comparison of the Tax-motivated Income Shifting of Multinationals in Territorial and Worldwide Countries*

WP12/05 Li Liu *Income Taxation and Business Incorporation: Evidence from the Early Twentieth Century*

WP12/04 Shafik Hebous and Vilen Lipatov *A Journey from a Corruption Port to a Tax Haven*

WP12/03 Neils Johannesen *Strategic line drawing between debt and equity*

WP12/02 Chongyang Chen, Zhonglan Dai, Douglas A. Shackelford and Harold H. Zhang, *Does Financial Constraint Affect Shareholder Taxes and the Cost of Equity Capital?*

WP12/01 Stephen R. Bond and Irem Guceri, *Trends in UK BERD after the Introduction of R&D Tax Credits*

WP11/24 Athiphat Muthitacharoen George R. Zodrow *Revisiting the Excise Tax Effects of the Property Tax*

WP11/23 Krautheim, Sebastian and Tim Schmidt-Eisenlohr *Wages and International Tax Competition*

WP11/22 Haufler, Andreas, Pehr-Johan Nörback and Lars Persson *Entrepreneurial innovation and taxation*

WP11/21 Mancini, Raffaele, Paolo M. Panteghini and Maria laura Parisi *Debt-Shifting in Europe*

WP11/20 Xing, Jing *Does tax structure affect economic growth? Empirical evidence from OECD countries*

WP11/19 Freedman, Judith *Responsive regulation, risk and rules: applying the theory to tax practice*

WP11/18 Devereux, Michael P. and Simon Loretz *How would EU corporate tax reform affect US investment in Europe?*

WP11/17 Vella, John, Clemens Fuest and Tim Schmidt-Eisenlohr *Response on EU proposal for a Financial Transaction Tax*

WP11/16 Loretz, Simon and Socrates Mokkas *Evidence for profit-shifting with tax sensitive capital stocks*

WP11/15 Weisenbach, david A. *Carbon taxation in the EU: Expanding EU carbon price*

WP11/14 Bauer, Christian, Davies, Ronald B. and Andreas Hauer *Economic Integration and the Optimal Corporate Tax Structure with Heterogeneous Firms*

WP11/13 Englisch, Joachim *National Measures to Counter Tax Avoidance under the Merger Directive*

WP11/12 de la Feria, Rita and Clemens Fuest *Closer to an Internal Market? The Economic Effects of EU Tax Jurisprudence*

WP11/11 Englisch, Joachim *EU Perspective on VAT Exemptions*

WP11/10 Riedel, Nadine and Hannah Schildberg-Hörisch *Asymmetric Obligations*

WP11/09 Böhm, Tobias and Nadine Riedel *On Selection into Public Civil Service*

WP11/08 Auerbach, Alan J. and Michael P. Devereux *Consumption and Cash-Flow Taxes in an International Setting*

WP11/07 Becker, Johannes and Clemens Fuest *Tax Competition: M&A versus Greenfield Investment*

WP11/06 Riedel, Nadine *Taxing Multinationals under Union Wage Bargaining*

WP11/05 Liu, Li and Rosanne Altshuler *Measuring the Burden of the Corporate Income Tax under Imperfect Competition*

WP11/04 Becker, Johannes and Clemens Fuest *The Taxation of Foreign Profits - The Old View, the New View, and a Pragmatic View*

WP11/03 Konrad, Kai *Search Costs and Corporate Income Tax Competition*

WP11/02 Hellerstein,Walter *Comparing the Treatment of Charities Under Value Added Taxes and Retail Sales Taxes*

WP11/01 Dharmapala, Dhammika and Nadine Riedel *Earnings Shocks and Tax-Motivated Income-Shifting: Evidence from European Multinationals*