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Measuring Effective Tax Rates in the Presence of Multiple Inputs: A Production Based Approach

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Abstract

We suggest a new method for comparing tax regimes across jurisdictions. The approach aggregates taxes on inputs by focussing on production, rather than investment, decisions. Taxes on various inputs affect production decisions by increasing marginal costs. By calculating the difference between the tax-inclusive and tax-exclusive marginal cost of production, we determine the effective excise tax rate on marginal costs implied by all of the various taxes imposed upon the firm's inputs. The *effective tax rate on marginal costs* provides a convenient summary measure of the potential impact of taxes on all inputs on production location decisions.

I. Introduction

Policy issues often turn to questions related to the overall tax burden faced by companies, especially across sectors and jurisdictions. Two related partial equilibrium approaches are typically used to analyze this burden. The first involves measuring the effect of corporate income and other taxes on the return to capital, as in the case of project analysis. The second involves measuring the marginal effective tax rate on capital, which employs the concept of the user cost of capital. Using these approaches, tax burdens faced by firms in different jurisdictions are compared to see how investment might be influenced by the tax system.

Although commonly used, these approaches are inadequate for some important policy questions. For instance, some taxes do not fall on capital but could nonetheless influence the decision of a business to operate in a particular jurisdiction. Non-capital taxes on businesses that may influence production and location decisions include excise and sales taxes, export taxes, import duties, payroll taxes, etc. Moreover, different jurisdictions rely to varying degrees on different types of taxes. For example, in Canada, the province of Quebec relies more on employer payroll taxes than corporate income taxes compared to the province of Ontario. Similarly, Northern Ireland has a higher corporate income tax rate but lower payroll taxes compared to the Republic of Ireland. Currently, the public economist's "tool kit" does not contain the appropriate framework to evaluate how the tax system in general, rather than taxes on capital in particular, may influence the location of production facilities across jurisdictions. In this paper we attempt to fill this lacunae by developing an effective tax rate concept which incorporates taxes on both capital and other factors of production. In this way we are able to evaluate how the tax system might influence the choice of production across jurisdictions using a summary statistic that can, in principle, incorporate all of the relevant taxes levied on businesses.

Attempts have been made to incorporate these considerations into the two approaches mentioned above. Typically, this has involved aggregating all of the taxes on different inputs—for example, corporate income taxes, sales taxes on business inputs, property taxes on real estate and payroll taxes—and expressing them as a percentage of the return on capital. Our view is that this approach is problematic because it tends to overestimate the effective tax rate on capital for noncapital-intensive firms. To see this, we provide a simple example of the typical project analysis and marginal effective tax rate approaches to measuring the burden of taxes in the presence of multiple inputs, and compare them to our approach.

We begin with the project analysis approach, which is exemplified by a recent analysis undertaken by KPMG (1994).[1] Consider two firms that differ in terms of their labour/capital intensities. Both of these firms are presumed to earn an after-tax rate of return on capital of 5%, which is the rate of return required to just satisfy shareholders. Therefore, both projects are assumed to be marginal in the sense that they do not generate rates of return in excess of the "hurdle" rate required by shareholders. Say the labour-intensive firm has capital of $500, annually earns $130 in revenues and incurs $70 in salary costs and an additional $10 in payroll taxes (14.28% of salaries).[2] Profits prior to the payment of corporate income taxes are $50 which are taxed at a 50% rate. Therefore, $25 is left in after-tax profits to pay shareholders. The rate of return on the $500 of capital in the absence of payroll and corporate taxes is 12% and the after-tax rate of return is 5%.[3] The firm pays $10 in payroll taxes and $25 in corporate income taxes, for a total tax bill of $35. Employing the methodology typically used in project analysis, the effective tax rate on profits is calculated as $35 in corporate and payroll taxes divided by $60 dollars of profits gross of corporate income and payroll taxes, or 58.33%. Now suppose that a capital-intensive firm with $1900 in capital earns $190 in revenues, incurs no labour costs and pays $95 in corporate income taxes (at the 50% rate), leaving $95 in after-tax profits paid to shareholders, for pre- and post-tax rates of return on capital equal to 10% and 5% respectively. The effective tax rate measured for the capital-intensive firm is 50%, which is less than the 58.33% rate for the labour-intensive firm.

Similar reasoning underlies cost of capital approaches. Under the standard user cost of capital approach (Jorgenson, 1963), the marginal revenue product on capital is equal to the user cost of capital, adjusted for depreciation, financing costs and taxes. A common method of incorporating payroll taxes into this framework, see for example Boadway, Chua and Flatters (1995) and Gerard, Jamaels and Valenduc (1996), is to express the gross of labour marginal return to capital as the standard user cost of capital plus the incremental labour costs per dollar of capital. The difference between the cost of capital measured in this way and the modified cost of capital in the absence of taxes is then used to compute an effective tax rate. In terms of the example above, for the labour-intensive firm the before tax rate return to capital is 12% and the after corporate and payroll tax rate of return is 5%, again implying an effective tax rate on capital of 58.33% $((.12 - .05)/.05)$; similarly, with a pre-tax rate of return of 10% and a post-tax rate of return of 5%, the capital-intensive firm faces an effective tax rate on capital of 50%.[4]

The conclusion reached under both of the standard approaches is that the labour intensive firm is taxed at a higher rate than the capital intensive firm, and is therefore disadvantaged by the tax system. We question this conclusion. The crux of our argument is that both of these approaches inappropriately view payroll taxes as a tax imposed on capital.

As such, we suggest a new method for aggregating taxes on different inputs (and outputs), one that focuses on *production*, rather than *investment*, decisions. We develop an effective tax rate concept that is based on the simple and well known idea that firms product output until marginal revenue is equal to the marginal cost of production. Taxes on outputs and inputs affect production decisions by increasing the marginal cost of production. The *effective tax on marginal production costs* is then computed as the difference between the tax-inclusive and tax-exclusive marginal cost of production. By dividing this difference by the net-of-tax marginal cost of production, we determine the effective excise tax rate on marginal costs implied by all of the various taxes imposed upon the firm's inputs.

In terms of the example given above, our approach works as follows. Both the labour and capital-intensive firms have tax-exclusive costs of \$95. For the labour-intensive firm this consists of \$70 in wages plus \$25 in required return to capital (with a required rate of return to capital of 5%, this is determined by $.05 \times \$500 = \$25$). For the capital-intensive firm, with no wages the only cost is the required return to capital of \$95 ($.05 \times \$1900$). The labour intensive firm pays a total of \$35 in payroll and corporate income taxes, while the capital intensive firm pays \$95. The effective tax rate on costs is therefore 38.84% for the labour-intensive firm and 100% for the capital intensive firm.[5] Contrary to the conclusion reached above using the approaches where all taxes are treated as impinging upon the return to capital, when we convert taxes on both inputs into an effective excise tax rate on costs we conclude that the labour-intensive firm is favoured by the tax system, because taxes lead to a lower percentage increase in its costs of production. The reason for this, of course, is that the labour-intensive firm relies more heavily on the factor of production that is taxed at the lower rate.

Our measure of the effective tax rate on the marginal cost of production depends on the factors of production used by firms, the production technology, the types of taxes imposed, and the incidence of these taxes. It provides an economically meaningful and intuitive "summary statistic" of how taxes impose upon "the cost of doing business." We claim no new or unique insight into the linkage between input prices and costs—indeed, the basic idea behind our measure is rooted in elementary price theory going back to Marshall, if not earlier—rather our contribution is to exploit these well recognized linkages to provide a summary measure of the impact of taxes on production costs. By computing effective tax rates on marginal production costs, we may speculate not only on how the tax system may influence decisions to produce in different jurisdictions, but also on how the tax regime as a whole, not just taxes on capital, may act to to encourage some types of production vis-a-vis other types within a particular jurisdiction.

As an illustration of the methodology we compute effective tax rates on production costs for various industries and provinces in Canada, taking account of income, sales, capital and payroll taxes. Given the fact that some provinces rely more heavily on payroll compared to capital taxes, or sales compared to income taxes, it has traditionally been difficult to compare the business tax regimes across the jurisdictions. Using our approach we are able to do just that. The effective tax rate on the marginal cost of production allows us to determine how taxes may affect production decisions across different provinces for particular industries, and across industries for particular provinces.

II. The Basic Methodology

In order to move quickly onto the results, we proceed by presenting a simple, intuitive explanation of the basic idea behind the methodology, which is grounded in the fundamentals of elementary price theory. A formal derivation based upon the dynamic value maximizing decisions of individual firms is provided in Appendix A.

To begin, it is useful to think in terms of perfectly competitive input and output markets. The assumption of perfect competition is for expositional purposes only, as the analysis also applies to non-competitive markets (with minor modifications).

Consider the output market for some good. Figure 1 illustrates the equilibrium, absent the presence of taxes. This equilibrium occurs at the intersection of the market supply and demand curves, denoted $S(p; W^0)$ and $D(p)$ respectively, where p is the output price, and W^0 a vector of input prices (user costs). The equilibrium price in this case is p^0 and the quantity is q^0. Ignore for the moment the rest of the diagram.[6]

Our approach exploits the vertical linkages between input and output markets. The output market is connected to the input markets by the fact that the aggregate supply curve is the (horizontal) sum of the marginal cost curves for the individual suppliers. The marginal cost of providing an additional unit of output reflects the user cost of the various inputs, which in turn reflects the supply and demand conditions in the input markets. This is emphasized by writing aggregate supply as a function of the vector of input prices W^0. This connection between the input and output markets provides the key to our simple measure of the marginal effective tax rate on production costs. Various taxes applied to firm inputs affect the marginal cost of providing the product by changing their user costs. For example, if the tax system causes the user cost of, say, labour to rise, the marginal cost of providing an additional unit of output will rise as well, and the industry supply curve will shift up.

Referring again to Figure 1, the after-tax aggregate supply curve is designated $S(p, W')$, where W' denotes the vector of gross-of-tax user costs. In the diagram it is presumed that the net impact of the imposition of the tax regime is to *increase* marginal costs, it is also possible that marginal costs may *decline* if the effective tax rate on some of the inputs is sufficiently negative. The after-tax equilibrium price and quantity are p' and q' respectively.

The gross-of-tax marginal cost of production at the after-tax equilibrium is $MC(q'; W')$, which is expressed as a function of the gross-of-tax user costs, W'.[7] Associated with this gross-of-tax marginal cost is a net-of-tax marginal cost, defined as $MC(q'; W^0)$, where recall that W^0 is the vector of user prices for the inputs that existed prior to the imposition of the taxes. We can then define the *effective tax rate on the marginal cost of production* as the tax rate T which, if (hypothetically) applied to production costs directly would yield the same gross-of-tax marginal cost that results under the existing tax regime. Thus, T solves the equation $(1+T)MC(q'; W^0) = MC(q'; W')$, which gives:

$$T = \frac{MC(q'; W')}{MC(q'; W^0)} - 1 \tag{1}$$

As defined in equation (1), the effective tax rate on the marginal cost of production tells us the rate of tax on marginal costs implied by the various taxes levied on business inputs. It can be viewed as aggregating these various taxes into a simple effective excise tax rate. In terms of Figure 1, the tax wedge, $MC(q'; W') - MC(q'; W^0)$, is expressed as a percentage of the net-of-tax marginal cost.

Most previous investigations of taxes levied on inputs have focused upon the resulting production inefficiencies caused by distortions to input ratios. While this is certainly a legitimate line of analysis, as shown above it is also the case that taxes on inputs can affect marginal costs in much the same way that an explicit excise tax on output can.

Indeed, so far the approach has focused on taxes which affect marginal costs through their impact on input prices. The approach can also incorporate output, or demand side, taxes. For example, referring to Figure 2, and ignoring taxes imposed at the input level, if the good is subject to an excise tax, the net-of-tax demand curve becomes $D^t(p)$. As is well-known, for any tax levied on the demand side of the market, there is an equivalent supply side tax levied on marginal costs. In the diagram, the equivalent tax on marginal costs would shift the supply curve to $S^t(p; W^0)$. In the presence of demand side taxes the effective tax rate on marginal costs becomes:

$$T = \frac{MC(q'; W^0)(1+t_d)}{MC(q'; W^0)} - 1 \tag{2}$$

where t_d is the effective demand side tax rate.

As will become evident below, the conceptual simplicity of the effective tax rate on marginal costs as described above belies several empirical complications which arise in actually measuring it. Nonetheless, the appeal of the approach lies in the fact that it is grounded firmly in (partial equilibrium) elementary price theory, and easily conveyed to policy-makers.

Tax Shifting

It is often said that "the devil is in the details," and no less is true in this case. Numerous issues which are important for the empirical implementation of the methodology were glossed over in the preceding discussion. This subsection deals with the issue of tax shifting (incidence). Subsequent subsections deal with the appropriate measurement of effective tax rates on inputs, and the choice of the functional form for the marginal cost function.

An important issue is the extent to which taxes levied on firm inputs are reflected in their user costs (denoted by the vector W' above), and therefore in marginal production costs. This is important because, under some conditions, taxes levied on inputs will not affect user costs at all, and will therefore not feed through to marginal costs.

In general, the extent to which taxes will be reflected in the user cost of the inputs depends upon the supply and demand conditions in the input markets. Consider the introduction of a tax t_i on input i where $w'_i = w_i(1 + t_i)$ is the user cost of input i (the ith element of the vector W'), and w_i is the equilibrium supply price. Assuming that the input market is competitive, equilibrium is determined by:

$$D_i(w_i(1 + t_i)) = S_i(w_i) \tag{3}$$

where $D_i(\bullet)$ is the demand function for input i and $S_i(\bullet)$ is the supply function.

Differentiating both sides of (3) with respect to the tax rate t_i, and evaluating the derivative at zero, gives, after some algebraic manipulation:

$$\frac{\partial w'_i}{\partial t_i} = w_i \left[\frac{\eta_i^S}{\eta_i^S + \eta_i^D} \right] \tag{4}$$

where η_i^D is the elasticity of demand for input i and η_i^S is the elasticity of supply. Equation (3) implicitly determines the equilibrium user cost of input i as a function of the tax rate t_i, $w'_i = w_i(t_i)$. A first-order Taylor series approximation of this implicit function yields:

$$w'_i = w_i(0) + t_i \frac{\partial w'_i}{\partial t_i} \tag{5}$$

Using equations (4) and (5) we have:

$$w'_i = w_i^0(1 + t_i\beta_i), \qquad \text{where } \beta_i = \left[\frac{\eta_i^S}{\eta_i^S + \eta_i^D} \right] \tag{6}$$

and w_i^0 is the ith element in the vector W^0.

The parameter $0 \leq \beta_i \leq 1$ is a tax-shifting factor. When $\beta_i = 1$ the tax is fully shifted forward to the demander of the input, and the user cost changes by the full amount of the tax/subsidy, as would be the case when the input supply function is perfectly elastic or demand perfectly inelastic. When $\beta_i = 0$, none of the tax is shifted forward to the user, and the user cost is unaffected by the tax or subsidy, as would be the case when supply is perfectly inelastic or demand perfectly elastic. In the intermediate case, the user cost increases by some fraction of the tax.

Determining Effective Tax Rates on Inputs

In order to calculate the effective tax rate on marginal costs, we must first determine the marginal effective tax rates on the various inputs. To make the measurement task manageable a certain amount of aggregation is required. In the empirical analysis which follows in section III, we include three types of physical capital (equipment, structures and land), as well as labour, and inventory capital.

To calculate the marginal effective tax rate on labour, one could incorporate personal income taxes, as well as various payroll taxes or other levies for social security, unemployment insurance, worker's compensation, etc., whether they are levied on employers or employees. Since taxes on labour are often applied at variable rates, depending upon income, and may also vary by individual characteristics (such as marital status), the difference between average and marginal rates can be quite important. A key consideration is the meaning of the marginal unit of labour. The approach we use here is to presume that the employment of a marginal unit of labour involves hiring an additional worker with "average" characteristics. We use employment data to construct a profile of an "average" worker in each sector and province being studied, most particularly their average salary, and then calculate the effective tax rate on labour for this "average" worker.[8] As discussed earlier, the extent to which the various taxes applied to labour are reflected in the user cost will be reflected in the tax-shifting parameter for labour, β_L.

Capital inputs offer their own special challenges. The difficulty here is that capital inputs give rise to a flow of outputs over time, which requires that we impute a per period cost of holding capital, and calculate the effective tax rate applied to this imputed cost. As is the case with the other inputs, some aggregation is required. For physical assets, the approach adopted here is similar to that taken in the user cost of capital literature, which examines the impact of corporate income taxes on investment.[9] That is, in the absence of taxes the imputed net-of-depreciation, real required rate of return to capital is:

$$r = bi + (1 - b)\rho - \pi \tag{7}$$

where $bi + (1 - b)\rho$ is the weighted average opportunity cost of finance (b is the debt/asset ratio, i the interest rate on debt, and ρ the opportunity cost of equity), and π is the inflation rate.

The impact of taxes on capital depends upon the particular characteristics of the tax system, which can vary across both sectors and jurisdictions. A generic tax system is examined here; complications specific to the jurisdictions being studied are incorporated in the empirical analysis of section III. The presence of corporate income taxes raises the cost of capital by taxing the marginal return to capital, and lowers the cost by allowing debt interest as a deduction and granting tax depreciation deductions and investment tax credits. Other taxes on capital, such as property and direct capital taxes, raise the user cost. Thus, the gross-of-tax, net-of-depreciation rate of return to capital required to yield the net rate of return given in (7) is:

$$r^g = (r^f + \delta - \pi)\left[\frac{1 - Z}{1 - u}\right] - \delta \tag{8}$$

where

$$r^f = bi(1 - u) + (1 - b)\rho \tag{9}$$

is the weighted average after-tax opportunity cost of finance, which reflects the tax deductibility of debt interest (b is the debt-asset ratio, or the proportion of the marginal unit of capital financed by debt),[10] u is the corporate tax rate, δ is the economic depreciation rate, and

$$Z = \frac{u\alpha - \phi(1 - u)}{r_f + \alpha} \tag{10}$$

is the reduction in the effective purchase price of $1 in capital due to the presence of a direct capital tax levied at rate ϕ, and the present value of the flow of corporate income tax depreciation deductions calculated using a declining balance tax depreciation rate of α.[11]

The marginal effective tax rate on capital, t_K, is the hypothetical rate that, if applied directly to the net rate of return on capital, would yield the gross rate of return suggested by the actual tax regime; t_K thus solves $r(1 + t_K) = r^g$, giving:[12]

$$t_K = \frac{r^g - r}{r} \tag{11}$$

The user cost of capital in the absence of taxes is $w_K^0 = p_K r$, where p_K is the relative price of a unit of capital. The gross-of-tax user cost of capital is then $w_K' = w_K^0(1 + t_K)$, where t_K is the effective tax rate defined in (11), with r given by (7) and r^g by (8)–(10).

The effective tax rate on land is determined in a similar way, simply setting $\delta = 0$. To calculate the effective tax rate on inventories, we follow the approach described in Boadway, Bruce and Mintz (1982). In this case, the gross-of-tax return required on a marginal investment in inventories is:

$$r^g = \frac{r^f + \delta - \pi + u\pi}{1 - u} \tag{12}$$

where it is presumed that the tax regime requires FIFO inventory accounting for tax purposes, which results in the taxation of inflationary increases in the value of inventories.

Other factors which could be important were ignored in the derivation of the effective tax rate on capital. For example, the presence of risk and the irreversibility of capital investments can both interact with the tax system to alter the user cost of capital and therefore the effective tax rate in important ways.[13] In general, both the user cost and the effective tax rate on capital will be higher in the presence of risk and irreversibility. See McKenzie (1994) for a discussion of the impact of irreversibility and different sources of risk on the effective tax rate.

Form of the Cost Function

To calculate the effective tax rate on marginal cost, as in equation (1) above, the marginal cost function must be parameterized. In general, marginal costs will depend upon the level of output, productivity parameters, input shares, factor prices, and the degree of substitutability between factors. In this section we illustrate the methodology by employing the commonly used linearly homogeneous Constant Elasticity of Substitution (CES) production function, which has the form:

$$q = H\left[\sum_i \frac{a_i}{f_i} x_i^\rho\right]^{\frac{1}{\rho}}, \qquad \sum_i a_i = 1 \tag{13}$$

where q is output, x_i is the quantity of input i employed, and H, the a_i's f_i's and ρ are production and technology parameters. The elasticity of substitution is determined by $\sigma = 1/(1 - \rho)$.

The gross-of-tax marginal cost function which arises from the CES production function is:

$$MC(q'; W') = H^{-1}\left[\sum_i a_i^{-\frac{b}{\rho}}(f_i w_i')^b\right]^{\frac{1}{b}}, \quad \text{where } b = \frac{\rho}{\rho - 1} \tag{14}$$

$MC(q', W^0)$ is determined by evaluating (14) at W^0 rather W'. Recalling from our earlier discussion that $w_i' = w_i^0(1 + t_i\beta_i)$, equations (14) and (1) given an effective tax rate on marginal cost for a CES production function of:

$$T = \left[\sum_i A_i(1 + t_i\beta_i)^b\right]^{\frac{1}{b}} - 1, \quad \text{where } A_i = \frac{a_i^{-\frac{b}{\rho}}(w_i^0 f_i)^b}{\sum_i a_i^{-\frac{b}{\rho}}(w_i^0 f_i)^b}, \sum_i A_i = 1 \tag{15}$$

and A_i is the factor share for input i.

It is possible to show from equation (15) that as the elasticity of substitution increases, the effective tax rate on marginal costs decreases. This is because as the degree of substitutability between inputs rises the firm is better able to respond to changes in relative factor prices by changing the input mix. As such, a tax induced increased in the relative price of an input has a lower impact on marginal costs the higher is the elasticity of substitution.

Two commonly used special cases of the CES production function which we will employ in the subsequent empirical analysis are the Cobb-Douglas (CD) and Leontief, or fixed proportions (FP), production functions. The elasticity of substitution for the CD case is unity, in which case equation (15) reduces (in the limit) to,

$$T = \prod_i (1 + t_i\beta_i)^{A_i} - 1 \tag{16}$$

For the FP case, the elasticity of substitution is zero, and the effective tax rate on marginal costs becomes,

$$T = \sum_{i=1}^{n} A_i(1 + t_i\beta_i) - 1 \tag{17}$$

It is interesting to note that the effective tax rate on marginal costs for the FP case reflects a simple arithmetic weighted average of the user costs of the inputs (with net of tax prices normalized to unity), while the rate for the CD case reflects the geometric weighted average. The arithmetic average for the FP production function reflects the fact that under this technology firms are not able to respond to tax induced changes in user costs by substituting away from (relatively) highly taxed factors. Factors are employed in fixed proportions and the effective excise tax rate on marginal costs is simply the arithmetic weighted average of the marginal effective tax rates on the inputs. In the case of a CD production function, with the elasticity of substitution equal to unity, there is some scope for substituting between factors, and the effective tax rate on marginal costs reflects the geometric weighted average of the tax rates on the inputs, which is lower than the arithmetic average.

III. An Empirical Illustration Using Canadian Provinces

In this section we illustrate how the approach may be applied empirically by calculating effective tax rates on marginal costs for various industrial sectors in Canada's ten provinces. Canadian provinces provide a particularly useful illustration of the methodology because although the basic fiscal structure across provinces is similar, there is substantial variation across provinces with respect to their reliance on sales, income, capital and payroll taxes. Also, we need not concern ourselves with monetary and exchange rate issues, although the methodology can be adapted to take them into account.

In order to calculate the effective tax rate on production costs it is necessary to first estimate the effective tax rates on the various inputs. As mentioned previously, the inputs included in our analysis are structures, equipment, land, inventories and labour. Many taxes potentially affect the user costs of these inputs, either directly or indirectly. Data limitations preclude the analysis of all of them, however, we do include most of the important taxes at both the federal and provincial level. Specifically, we include corporate income and capital taxes, as well as various payroll taxes levied on labour, including the federally run employment insurance program and Canada Pension Plan (CPP), provincially run Workers Compensation, and various provincial health and education taxes. We also include provincial sales taxes.

As discussed in the previous section, an important consideration concerns the extent to which firms bear the economic burden of the various taxes imposed on their inputs. Tax incidence is a notoriously controversial area in public finance, as there is little consensus regarding the incidence of many types of taxes. Nonetheless, we can draw on some of the existing literature to make some assumptions regarding the incidence of the various taxes analyzed.

We proceed as follows. In the case of capital inputs we invoke a small open economy assumption. As such, the required return to capital is treated as exogenous by domestic firms, and we may treat the required net-of-tax return to capital, r, as fixed and unaffected by taxes. The gross-of-tax rate of return to capital is then determined by equation (8) (or (12) in the case of inventories), and the effective tax rate on capital is given by equation (11). The open economy assumption also means that we may ignore domestic personal taxes on savings, as they determine only the proportion of investment financed by domestic vs. foreign saving and have no impact on the cost of capital. This is a common assumption in the standard effective tax rate literature, and seems appropriate here.[14]

In the case of labour, the incidence issue is somewhat more problematic. If the work force is perfectly mobile between provinces then we would expect firms to bear a large share of the burden of taxes on labour, but if workers are not perfectly mobile the burden on firms could be much lower. Compounding this is the fact that many payroll taxes, most particularly those related to employment insurance and CPP, involve joint payments by employers and employees. For our empirical analysis we invoke the following assumptions. Following Vermaeten, Gillespie, and Vermaeten (1993) we assume that employees bear the entire burden of personal income taxes; personal income taxes therefore do not to bear upon firm production costs. With regard to payroll taxes, while traditionally the position of the literature seems to be that in the long run employees also bear the bulk of the burden of payroll taxes, there is some recent evidence for Canada that employers in fact bear a substantial portion of these taxes. Wilton and Prescott (1995), for example, find no evidence that Canadian employers are able to shift their portion of payroll taxes back into employees. Di Matteo and Shannon (1995) also find that payroll taxes in Canada are borne to a significant extent by employers. In our numerical analysis we therefore assume that employers bear the entire burden of their share of payroll taxes, while employees bear the entire burden of their share. This too is one of the approaches taken by Vermaeten, Gillespie, and Vermaeten (1993).

Finally, there is a wide variation in provincial sales tax rates across the provinces. Wilton and Prescott (1995) provide evidence that roughly one-half of increases in sales tax rates are reflected in subsequent wage settlements, which increase the user cost of labour. In our numerical calculations we therefore include one-half of the relevant provincial sales tax rate in the effective tax rate on labour.

It is a straightforward matter to alter the shifting assumptions, and we have preformed numerous calculations under different sets of assumptions. Space considerations preclude reporting all of the results here.

As discussed in the previous section, given estimates of the effective tax rates on the inputs we estimate the effective tax rate on marginal production costs under two different assumptions regarding the production technology—CD and FP (Leontief). In both cases, the only technology parameters required are the factor shares for labour and the various types of capital. The factor share assumptions are shown in Table 1. The shares are based on input-output data obtained from Statistics Canada, as well as investment data obtained from the federal Department of Finance.

Our results are illustrated in Tables 2 through 10, which present effective tax rates for each of Canada's ten provinces. Effective tax rates for the five inputs for each of nine sectors are given, as well as the effective tax rate on marginal costs for each sector, calculated under the two assumptions regarding the production technology. While the results are largely self explanatory, some discussion will illustrate the strength of the methodology.

Looking first at the implications of the assumptions regarding the production technology, note that in all of the tables the results are very similar regardless of whether a CD or FP technology is presumed. In each case the relative magnitudes of the effective tax rates on marginal cost are very similar, with the FP figures slightly higher for each sector. As discussed above, the higher FP figures are due to the fact that there is no scope for factor substitution under a fixed-proportions technology, which intensifies the impact of a tax induced user price increase on marginal costs. It is perhaps somewhat surprising that the effective tax rates are so close under the two production technologies. We have undertaken other calculations (not reported) which suggest that the degree of factor substitutability does not have a substantial impact on the effective tax rate—the elasticity of substitution must get quite high before the effective tax rates are substantially different than the FP case.

Another point to note from the tables is that the effective tax rate on labour is substantially lower than the effective tax rates on the capital inputs, in all sectors and all provinces. This suggests that sectors which are relatively labour intensive, with a large portion of total costs going to payments to labour, are more likely to face low effective tax rates on marginal costs.

The low tax rate on labour thus favours wholesale and retail trade and services. Similarly, the effective tax rates on inventories tend to be very high, suggesting that sectors with a high inventory share, such as agriculture, forestry and fishing, and construction, will face higher effective tax rates on costs.

Comparing effective tax rates across sectors within provinces, we see that in every province the manufacturing sector faces a lower effective tax rate on costs than the other industries. The low effective tax rates on costs in manufacturing arise primarily because of the low effective tax rates on its capital inputs, particularly machinery, which constitute a relatively large share of its inputs. The effective tax rates on all of the capital inputs are quite low due to the lower statutory tax rate imposed on manufacturing by the federal government (21.84% vs. 29.12%) and most provinces (where the rate on manufacturing is typically about a percentage point lower than nonmanufacturing).

Other intersectoral comparisons reveal the strength of our methodology. Compare the service sector to agriculture, forestry and fishing. In every province the service sector faces a significantly lower effective tax rate on marginal production costs; typically about ten percentage points lower. This is despite the fact that the effective tax rates on *all* of the inputs are higher (sometimes substantially so) in services than in agriculture, forestry and fishing. The low effective tax rate on costs for the service sector reflects the fact that it is very labour intensive compared to agriculture, forestry and fishing (see Table 1). Thus, because it uses relatively more of the low taxed input, the effective tax rate on marginal costs for the service sector is lower than agriculture, forestry and fishing, despite the fact that it faces higher effective tax rates on all of its inputs.

Similarly, transportation faces higher effective tax rates than utilities on structures, land and inventories, and very similar effective tax rates on machinery and labour. Yet in every province the effective tax rate on marginal costs is higher in utilities, by about eight percentage points. This is because labour's share of costs is much higher in the transportation sector (see Table 1), as is the share of machinery and equipment. Moreover, although structures in transportation face an effective tax rate almost twenty percentage points higher than in utilities, structures share of costs in transportation is much lower, therefore the high effective tax rate does not have a significant impact on marginal cost.

Comparing now across the provinces, we see that the western provinces of British Columbia, Alberta and Saskatchewan tend to impose lower taxes on labour than the other provinces. This reflects three factors. First, unlike the other provinces, none of the western provinces levy payroll taxes to finance health and education.[15] Second, slightly higher average wages in these provinces (although not compared to Ontario) tend to lower the effective payroll tax rates associated with the federally financed employment insurance and CPP. Third, these provinces levy somewhat lower sales taxes, only half of which are assumed to feed through to wage increase. Indeed, Alberta imposes no sales tax at all.

Comparing effective tax rates on the capital inputs (structures, machinery, land, and inventories), we see that now the lower rates are in Quebec and the Atlantic provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland. In Quebec the low effective tax rates on capital inputs are due primarily to the relatively low provincial statutory corporate tax rate, the lowest in the country. This is countered to some extent, however, by a relatively high capital tax rate. In the Atlantic provinces, effective tax rates on capital are even lower, primarily due to the federal Atlantic Investment Tax Credit (AITC). The 10% AITC is available for most investment in machinery and equipment in the Atlantic provinces. The figures show that the AITC results in a substantial decline in the effective tax rate on machinery, which in fact is negative for many sectors, indicating the presence of a net subsidy to investment at the margin.

Comparing now the effective tax rates on marginal cost across provinces, we see that despite wide differences in effective tax rates on inputs across the provinces, to a large extent things tend to even out. That is, the lower effective tax rates on capital in Quebec and the Atlantic provinces are offset to a great degree by the higher effective tax rates on labour, and vice-versa in the western provinces. However, we see that some important differences remain. The lowest effective tax rates on costs are found in Alberta, New Brunswick, Nova Scotia and Prince Edward Island, particularly in the all important manufacturing sector. In manufacturing, effective tax rates on marginal costs range from a low of 8.88% in Prince Edward Island (for the CD), to a high of 28.9% in Manitoba; the manufacturing "heartland" of the country, Ontario, imposes an effective tax rate on manufacturing costs of 26.01%. This is to say, taxes on inputs increase the marginal cost of manufacturing output in Ontario by about 26%. Of the so-called "have" (wealthy) provinces of Alberta, British Columbia and Ontario, Alberta imposes the lowest effective tax rate on manufacturing costs, at 21.58%.

IV. Conclusions

In this paper we propose a new measure which aggregates effective tax rates in the presence of multiple inputs into a simple summary statistic in an economically meaningful way. Our approach is to measure the effective tax rate on marginal costs, which is the increase in the marginal cost of production due to the imposition of various taxes on firm inputs and outputs. We feel that this approach is superior to previous approaches of dealing with multiple inputs because it focuses on the production decision of firms in the presence of taxes rather than just the investment decision, properly takes account of firm technology and factor intensities, is consistent with elementary price theory, and can handle most aspects of most tax systems. Moreover, the concept is intuitive, and easily conveyed to policy makers. This may be one of the key advantages of our approach over more complicated computable general equilibrium approaches which take account of some of the same considerations.

As an application of the approach, we calculate and compare effective tax rates on production costs for nine sectors in Canada's ten provinces under two assumptions regarding the production technology. There is a wide variation in effective tax rates on individual inputs across sectors and provinces, which, absent our methodology, would make it difficult to determine the net impact of taxes on production and location decisions.

We believe the potential uses of our approach are quite rich. We have applied the approach to Canadian provinces; an obvious extension would be to consider other jurisdictions. We have focussed exclusively upon taxation; direct and indirect industrial subsidies could also be incorporated using a similar approach. Finally, a potential empirical application is to test econometrically whether or not our measure helps explain actual production and location decisions within and across jurisdictions.

Appendix: Formal Derivation

In this appendix, we formally derive our measure of the effective tax rate on marginal production costs using a dynamic model of firm value maximization. For simplicity, we assume that there are only two inputs in the production process—labour and one type of capital. Moreover, we also assume that the supply price of both inputs is fixed, so that taxes are borne fully by the firms employing them. Incidence issues are discussed in the text. Finally, for notational ease inflation is ignored.

The firm's value maximization problem may be expressed in the standard way as follows (suppressing time subscripts):

$$Max_{q,L,I} \int_0^\infty e^{-r^f t}[R(q) - wL - p_K I - T_L - T_K]dt \tag{A1}$$

subject to:

$$T_L = t_L wL \tag{A2}$$

$$T_K = u[R(q) - w(1 + t_L)L - \alpha B] \tag{A3}$$

$$q = F(L, K) \tag{A4}$$

$$r^f = bi(1 - u) + (1 - b)\rho \tag{A5}$$

$$\dot{K} = I - \delta K \tag{A6}$$

$$\dot{B} = p_K I - \alpha B \tag{A7}$$

$R(q)$ is the firm's revenue expressed as a function of its gross output q; $F(L, K)$ is the production function, with L the amount of labour employed and K the amount of capital. The supply price of labour (the wage rate, net of taxes) is w and the supply price of a unit of capital is p_K. Instantaneous gross investment is denoted by I with (A6) defining the equation of motion for the net capital stock over time. Total taxes on labour are T_L, where t_L is the effective tax rate on labour income. Corporate income taxes are T_K, where u is the statutory tax rate, α the declining balance tax depreciation rate, and B the amount of undepreciated capital for tax purposes; equation (A7) describes its motion over time. The discount rate, r^f, is the weighted average of the cost of debt, after deducting interest from corporate taxable income, $i(1 - u)$, and equity ρ, where b is the debt/asset ratio. For simplicity we assume that all taxes on labour are deducted from the corporate income tax.

Substituting the tax equations into (A1), the firm's value maximization becomes:

$$Max_{q,L,I} \int_0^{\infty} e^{-r^f t}[R(q)(1-u) - w(1+t_L)L - p_K I + u\alpha B]dt \tag{A8}$$

subject to (A4)–(A7).

To proceed, we first solve the firm's present value cost minimization problem, which gives conditional input demand functions and present a value cost function. These functions are evaluated in the steady state. Next, we substitute the cost function into the value function and determine the value maximizing level of output. The solution to this problem will give the firm's steady state output supply function in the presence of the taxes on labour and capital.

a) The Cost Minimization Problem

The present value cost function for a constant level of output net of depreciation is:

$$C(q^n; W') = Min_{L,I} \int_0^{\infty} e^{-r^r t}[w(1+t_L)(1-u)L + p_K I - p_K \delta K - u\alpha B]dt \tag{A9}$$

subject to (A6), (A7) and

$$q^n = F(L, K) - \delta p_K K \tag{A10}$$

where q^n is output net of depreciation and W' is a vector of gross-of-tax user costs (defined below). The cost function is defined for output net of depreciation so that the effective tax rate on marginal cost will be independent of the level of depreciation. This is analogous to the effective tax rate on capital being expressed as a percentage of the rate of return on capital, net of depreciation. The current value Hamiltonian is:

$$\begin{aligned} H \;=\; & w(1+t_L)(1-u)L + p_K I - p_K \delta K - u\alpha B - \lambda(I - \delta K) \\ & - \mu(p_K I - \alpha B) - \nu(F(L,K) - \delta p_K K - q^n) \end{aligned} \tag{A11}$$

The Lagrangean multipliers for the three constraints (A6, A7, A10) are ν, λ, and μ respectively.

The first-order conditions are (subscripts on F denote partial derivatives:

$$-\nu F_L + w(1+t_L)(1-u) = 0 \tag{A12}$$

$$-\lambda + p_K(1-\mu) = 0 \tag{A13}$$

$$-\nu(F_K - \delta p_K) + \lambda\delta - \delta p_K = -r^f \lambda + \dot{\lambda} \tag{A14}$$

$$-u\alpha + \alpha\nu = r^f \mu + \dot{\mu} \tag{A15}$$

In the steady state these reduce to:

$$\frac{F_K - \delta p_K}{F_L} = \frac{p_K(r^f - \delta)(1 - uZ) - \delta p_K}{w(1 + t_L)(1 - u)} \tag{A16}$$

where $Z = \alpha/(r^f + \alpha)$ is the present value of the flow of depreciation allowances on once dollar of capital.

Equation (A16) can be expressed in terms of the marginal effective tax rate on capital as follows. Let r^g denote the gross-of-corporate tax, net-of-depreciation, required rate of return on a marginal unit of capital. In equilibrium this is equal to the user cost of capital less the depreciation rate:

$$r^g \equiv \frac{F_K}{p_K} - \delta = \frac{(r^f + \delta)(1 - uZ)}{1 - u} - \delta \tag{A17}$$

This is the gross-of-corporate tax rate of return required to yield $r = bi + (1 - b)$ after corporate taxes and depreciation.

Let t_K denote the effective tax rate on the net-of-corporate-tax required rate of return which gives r^g gross of taxes. Following the effective tax rate literature, t_K solves $r(1+t_K) = r^g$. Using (A17) this gives:

$$\frac{(r^f + \delta)(1 - uZ)}{1 - u} = r(1 + t_K) + \delta \tag{A18}$$

Therefore (A16) may be written as:

$$\frac{F_K}{F_L} = \frac{p_{K^r}(1 + t_K)}{w(1 + t_L)} \tag{A19}$$

This is the familiar condition that the firm chooses its cost minimizing input vector so as to equate the marginal rate of technical substitution between factors to the ratio of the gross-of-tax user costs. This condition, along with the net production constraint (A10) gives the conditional input demand functions for L and K in the steady state, $L(q^n, W')$ and $K(q^n; W')$.

In the absence of non-linear adjustment costs of irreversibilities, the firm jumps immediately to the optimal steady state capital stock and stays there. Substituting the conditional input demand functions into (A9), carrying out the integration and rearranging gives the following present value cost function:

$$C(q^n; W') = \frac{\hat{C}(q^n; W')}{r^f} \tag{A20}$$

where,

$$\hat{C}(q^b; W') = w(1 + t_L)L(q^n; W') + p_{K^r}(1 + t_K)K(q^n; W') \tag{A21}$$

is the instantaneous cost function.

b) The Value Maximization Problem

Given the above present value cost function, the firm's present value maximization problem becomes:

$$Max_{q^n} \int_0^\infty e^{-r^f t} R(q^n) dt - C(q^n; W') \tag{A22}$$

Without loss of generality, we have expressed revenues as a function of the output net of depreciation (i.e. $R(q^n) = R(q) - \delta p_K K$). The first order condition for this problem is simply:

$$R_{q^n} = \hat{C}_{q^n}(q^n; W') \equiv MC(q^n; W') \tag{A23}$$

This gives the firm's steady state net output supply function, expressed as a function of the vector of input costs and the tax parameters.

c) The Effective Tax Rate on Marginal Cost

The effective tax rate on marginal production cost is the hypothetical rate of tax which if levied directly on the firm's net of depreciation production costs would yield the same marginal cost as the existing tax system. The use of output net of depreciation when determining marginal cost in (A23), means that the effective tax rate on production will be independent of the capital depreciation rate. As such, two firms facing the same effective tax rates on their inputs, and using the same technology, will have the same effective tax rate on production. The effective tax rate on production, denoted T, therefore solves $MC(q^n; W^0)(1+T) = MC(q^n; W')$, where W^0 is the vector of net-of-tax user costs (i.e., w and $p_K r$); thus $MC(q^n; W^0)$ is the net-of-tax instantaneous marginal cost of producing q^n. Solving this for T, gives an expression analogous to equation (1) in the text, the difference being that marginal costs are evaluated at output net of depreciation.

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Notes

1. KPMG (1994) assesses the "competitiveness" of New York state's business tax regime, by measuring the tax rate as the total present value of taxes divided by the present value of the return on capital, the latter measured as the difference between revenues and costs of production (excluding taxes).

2. We ignore incidence issues here, presuming that the entire payroll tax is borne by the firm. These issues are discussed in section II.
3. We presume no debt financing or depreciation in this example.
4. The project analysis and marginal effective tax rate approaches give the same answer in this example because the project is marginal, by assumption. Most "projects" evaluated using the project analysis approach are not designed to be marginal, and therefore the effective tax rates using the two approaches may differ.
5. This is an average tax rate on production costs; the methodology we derive below generates a marginal tax rate.
6. As discussed in Appendix A, the supply curve is defined over output net of depreciation. For expositional ease we ignore this "technical" issue in the discussion.
7. As discussed in the previous footnote, technically marginal costs are defined over output net of depreciation.
8. Technically we should use total compensation when calculating the effective tax rate on labour, not just the money salary. This is particularly important if these non-monetary benefits are not taxed. It turns out that this is not a major concern in Canada, as most non-pecuniary benefits are taxed, the only exceptions being health and dental plans. In any event, sectoral data on non-salary compensation are not available.
9. See King and Fullerton (1984), and Boadway, Bruce and Mintz (1984).
10. We assume that the marginal source of finance is a weighted average of debt and retained earnings. While there is some debate in the literature regarding this issue other studies, such as Auerbach (1979), Boadway (1987) and Boadway, Bruce and Mintz (1984) employ a similar assumption. Assuming that debt is the marginal source of finance would not materially affect the results, although it would lower the effective tax rates on the nonlabour inputs. It is also presumed here that i and ρ are not affected by the domestic tax regime. This would be the case for a small open economy, and is a reasonable approximation for a not-so-small open economy.
11. $\alpha/(r_f + \alpha)$ is the present value of the tax depreciation deductions on \$1 of capital; multiplying the corporate tax rate u gives the present value of the reduction in tax liabilities due to these deductions. It is presumed in equation (10) that capital taxes are deducted for income tax purposes, this may not be the case in some jurisdictions.
12. Here the marginal effective tax rate on capital is expressed relative to the required after-tax rate of return, r. In the effective tax rate literature it is common, though not universal, to express it relative to r^g. See Boadway (1987).
13. Capital is irreversible if some portion of its costs are "sunk." This may be the case for several reasons, including specificity in use (i.e., the capital is valuable only if used in a certain type of production), or the presence of a "lemons" problem in second-hand capital markets.
14. See Boadway, Bruce and Mintz (1984).
15. Alberta and B.C. impose health premiums on individuals rather than payroll taxes on employers. Kesselman (1994) reports that for about 60% of employees their premiums are paid by their employers; the calculations in the Tables reflect this for Alberta and B.C. Saskatchewan levies neither payroll taxes nor health premiums, choosing instead to impose a higher sales tax.

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Legend to tables.

AFF	Agriculture, Forestry and Fishing
MAN	Manufacturing
CON	Construction
TRN	Transportation
COM	Communications
PUB	Public Utilities
WST	Wholesale Trade
RTT	Retail Trade
SER	Services

Table 1. Input shares.

	Structures	Machinery	Land	Inventory	Labour
AFF	9.51%	12.21%	9.86%	36.11%	32.30%
MAN	13.52%	21.67%	1.19%	19.62%	44.00%
CON	13.13%	2.81%	2.56%	28.99%	52.50%
TRN	8.35%	35.26%	0.67%	6.33%	49.40%
COM	37.61%	11.70%	0.51%	0.28%	49.90%
PUB	41.39%	16.95%	1.49%	13.77%	26.40%
WST	3.59%	4.04%	0.92%	16.65%	74.80%
RTT	4.93%	7.21%	1.05%	12.01%	74.80%
SER	18.95%	5.41%	5.68%	3.16%	66.80%

Table 2. Effective tax rates on costs—British Columbia.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	40.69%	39.85%	35.84%	55.69%	13.11%	35.43%	36.62%
MAN	44.50%	16.11%	31.44%	60.11%	13.80%	26.44%	27.75%
CON	63.18%	54.26%	36.96%	71.90%	14.01%	36.40%	38.97%
TRN	68.95%	52.54%	40.98%	80.12%	13.64%	34.36%	36.36%
COM	40.46%	68.73%	36.91%	71.78%	12.50%	28.51%	29.88%
PUB	50.21%	53.95%	37.25%	72.49%	13.91%	42.72%	44.14%
WST	51.80%	56.02%	36.47%	70.90%	14.07%	25.05%	26.79%
RTT	27.44%	62.70%	36.97%	71.91%	14.87%	24.50%	26.02%
SER	48.22%	62.73%	36.11%	70.07%	14.43%	25.26%	26.44%

Table 3. Effective tax rates on costs—Alberta.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	35.30%	34.77%	31.31%	51.04%	10.06%	31.25%	32.37%
MAN	37.55%	12.49%	26.39%	51.79%	10.05%	21.58%	22.68%
CON	56.33%	49.14%	32.58%	64.86%	10.17%	31.38%	33.76%
TRN	61.93%	46.84%	36.45%	72.72%	10.04%	29.64%	31.49%
COM	35.40%	62.43%	32.52%	64.74%	9.14%	24.26%	25.52%
PUB	44.48%	48.40%	32.92%	65.54%	10.00%	37.44%	38.77%
WST	45.70%	50.44%	32.03%	63.75%	10.16%	20.57%	22.19%
RTT	23.40%	56.73%	32.59%	64.89%	11.22%	20.36%	21.77%
SER	42.32%	56.54%	31.63%	62.82%	10.61%	20.86%	21.95%

Table 4. Effective tax rates on costs—Saskatchewan.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	46.61%	45.44%	40.78%	61.25%	12.71%	38.69%	40.23%
MAN	51.18%	19.62%	36.27%	67.98%	12.76%	28.79%	30.56%
CON	71.13%	60.00%	41.94%	80.18%	12.74%	38.59%	42.03%
TRN	77.50%	59.25%	46.33%	89.24%	12.78%	36.92%	39.63%
COM	46.23%	75.86%	41.88%	80.05%	12.29%	31.03%	32.83%
PUB	56.90%	60.26%	42.24%	80.79%	12.78%	46.95%	48.89%
WST	58.72%	62.20%	41.43%	79.14%	12.73%	25.36%	27.70%
RTT	32.01%	69.45%	41.94%	80.19%	12.48%	23.88%	25.99%
SER	54.82%	69.46%	41.06%	78.28%	12.62%	25.68%	27.38%

Table 5. Effective tax rates on costs—Manitoba.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	45.15%	44.00%	39.55%	60.09%	14.47%	38.60%	39.94%
MAN	49.50%	18.61%	35.02%	66.09%	14.43%	28.89%	30.46%
CON	69.25%	58.53%	40.71%	78.28%	14.47%	39.01%	42.08%
TRN	75.66%	57.68%	45.11%	87.35%	14.50%	37.26%	39.64%
COM	44.81%	74.07%	40.65%	78.16%	13.83%	31.27%	32.84%
PUB	55.29%	58.66%	41.01%	78.90%	14.47%	46.42%	48.12%
WST	57.05%	60.61%	40.20%	77.25%	14.43%	26.44%	28.52%
RTT	30.86%	67.74%	40.71%	78.30%	14.20%	24.97%	26.86%
SER	53.22%	67.73%	39.83%	76.39%	14.35%	26.54%	28.01%

Table 6. Effective tax rates on costs—Ontario.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	39.46%	38.96%	34.85%	54.38%	15.28%	35.54%	36.52%
MAN	41.51%	15.18%	29.45%	55.95%	15.49%	26.01%	27.05%
CON	61.90%	53.53%	36.25%	70.45%	15.59%	36.88%	39.17%
TRN	67.46%	51.55%	40.09%	78.34%	15.64%	35.02%	36.76%
COM	39.61%	67.74%	36.19%	70.32%	14.11%	29.04%	30.25%
PUB	49.31%	53.22%	36.63%	71.21%	15.64%	42.67%	43.92%
WST	50.54%	55.09%	35.64%	69.21%	15.64%	26.05%	27.59%
RTT	26.83%	61.81%	36.27%	70.48%	15.38%	24.70%	36.13%
SER	46.91%	61.48%	35.19%	68.17%	15.56%	25.73%	26.76%

Table 7. Effective tax rates on costs—Quebec.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	35.17%	36.03%	31.45%	45.88%	16.35%	32.11%	32.70%
MAN	38.71%	15.97%	27.99%	51.37%	16.36%	25.52%	26.30%
CON	53.85%	50.14%	32.32%	60.72%	16.38%	33.96%	35.51%
TRN	55.82%	44.89%	34.07%	64.34%	16.37%	31.79%	32.87%
COM	34.96%	62.64%	32.29%	60.64%	14.99%	27.39%	28.29%
PUB	43.06%	49.08%	32.56%	61.20%	16.29%	38.50%	39.35%
WST	44.35%	51.55%	31.95%	59.95%	16.32%	25.08%	26.16%
RTT	23.76%	57.26%	32.34%	60.74%	16.11%	23.96%	24.98%
SER	41.39%	57.79%	31.67%	59.29%	16.27%	24.78%	25.51%

Table 8. Effective tax rates on costs—New Brunswick.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	37.05%	−12.46%	32.74%	53.22%	14.25%	26.97%	29.06%
MAN	40.28%	−27.27%	28.22%	55.51%	14.26%	13.32%	17.04%
CON	58.67%	2.89%	33.90%	67.51%	14.22%	33.41%	35.69%
TRN	64.90%	−2.44%	38.15%	76.15%	14.26%	14.67%	16.68%
COM	36.94%	6.97%	33.84%	67.39%	13.37%	21.12%	21.74%
PUB	46.30%	−7.47%	34.19%	68.11%	14.26%	29.10%	31.55%
WST	47.75%	−2.98%	33.39%	66.49%	14.19%	22.09%	23.59%
RTT	24.53%	1.14%	33.90%	67.52%	13.93%	19.04%	20.18%
SER	44.30%	−5.81%	33.02%	65.65%	14.14%	20.54%	21.48%

Table 9. Effective tax rates on costs—Nova Scotia.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	36.29%	−13.02%	32.12%	52.20%	14.52%	26.54%	28.57%
MAN	39.46%	−27.50%	27.67%	54.43%	14.59%	13.13%	16.80%
CON	57.53%	2.30%	33.26%	66.22%	14.57%	33.16%	35.32%
TRN	63.41%	−3.33%	37.31%	74.45%	14.59%	14.30%	16.28%
COM	36.19%	6.17%	33.20%	66.11%	14.45%	21.34%	21.90%
PUB	45.38%	−8.14%	33.55%	66.81%	14.63%	28.57%	30.97%
WST	46.80%	−3.62%	32.76%	65.22%	14.55%	22.15%	23.58%
RTT	23.98%	0.41%	33.26%	66.23%	14.29%	19.11%	20.20%
SER	43.41%	−6.51%	32.40%	64.39%	14.47%	20.52%	21.42%

Table 10. Effective tax rates on costs—Prince Edward Island.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	33.05%	−15.05%	29.50%	49.12%	N/A	N/A	N/A
MAN	30.27%	−29.98%	21.50%	41.61%	13.56%	8.88%	11.98%
CON	54.72%	0.85%	31.69%	63.06%	13.71%	31.49%	33.50%
TRN	60.37%	−5.14%	35.43%	70.74%	13.64%	12.73%	14.68%
COM	34.31%	4.19%	31.59%	62.87%	13.43%	19.89%	20.43%
PUB	43.59%	−9.45%	32.29%	64.28%	13.69%	27.04%	29.39%
WST	43.74%	−5.66%	30.73%	61.14%	13.57%	20.65%	21.95%
RTT	22.65%	−1.34%	31.72%	63.13%	13.34%	17.87%	18.91%
SER	40.07%	−9.47%	30.03%	50.53%	13.65%	18.96%	19.79%

Table 11. Effective tax rates on costs—Newfoundland.

	Structures	Machinery	Land	Inventories	Labour	Cobb-Douglas Marginal Cost	Leontief Marginal Cost
AFF	34.22%	−14.11%	30.46%	50.94%	17.76%	26.76%	28.67%
MAN	30.66%	−29.91%	21.76%	42.06%	17.78%	10.78%	14.00%
CON	56.85%	1.95%	32.88%	65.46%	17.04%	34.38%	36.28%
TRN	63.22%	−3.42%	37.03%	73.98%	17.75%	15.77%	17.77%
COM	35.70%	5.65%	32.78%	65.26%	17.65%	22.78%	23.24%
PUB	45.38%	−8.14%	33.55%	66.81%	17.78%	29.49%	31.80%
WST	45.39%	−4.56%	31.82%	63.34%	17.73%	24.34%	25.54%
RTT	23.68%	0.02%	32.92%	65.54%	17.44%	21.44%	22.43%
SER	41.53%	−8.40%	31.05%	61.57%	17.80%	22.27%	23.02%