Firm-specific Forward-looking Effective Tax Rates

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Abstract

This paper computes (marginal and average) forward-looking effective tax rates for a sample of more than 650,000 firms in and outside of Europe using Bureau van Dijk's ORBIS data-base. Comparing the firm-level effective tax rates with their country-level counterparts we arrive at two important findings for empirical research on the behavioral response to taxation. First, the firm-level component of the effective tax burden is generally much more important than the one at the country level. Second, tentative empirical results on the nexus between firm level investment and corporate taxation illustrate that the conclusions obtained with forward looking firm-level effective tax rates differ starkly from those based on country-level forward-looking rates.

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1 Introduction

The availability of large firm-level data-bases enables tax researchers to study firms' behavioral response to effective profit tax rates (e.g., in terms of investment, sales and employment). A fairly recent strand of literature exploits micro-level information on profit taxes – so-called *backward-looking effective* profit tax rates,[1] which are defined as the ratio between a firm's profit tax payments and its operating profits (see, e.g., Kemsley, 1998; Desai, Foley, and Hines, 2004; Mutti and Grubert, 2004). One notable advantage of such data is the variation in tax rates even within countries, which facilitates identification of firms' response to taxation. However, a major drawback of backward-looking rates is that tax liabilities may be affected by firms' tax planning activities (for instance, higher investments in the past are associated with an increased amount of current depreciation allowances and, hence, with lower tax payments). Thus, backward-looking effective tax rates are inherently prone to endogeneity inducing possibly biased estimation results (see Devereux and Griffith, 2002, for a discussion).

At the aggregate country level, the dominant paradigm is that one should use *forward-looking* effective tax rates for inference about the response of economic activity to profit taxation (see, e.g., Devereux and Freeman, 1995; Devereux and Griffith, 1998; Devereux, 2007, provides an excellent overview). Forward-looking effective tax rates inform about the effective tax burden of a hypothetical investment project. The general idea behind these rates is to incorporate relevant determinants of the tax code (i.e., statutory tax rates and tax base allowances) into a neoclassical investment model (see Jorgensen, 1963; Hall and Jorgensen, 1967). Taking standard assumptions about a firm's investment, financing, and repatriation decisions and assuming that a firm seeks the most favorable tax base allowances, forward-looking effective tax rates are independent of tax planning activities and are, therefore, exogenous from an empirical perspective. Such forward-looking effective tax rates are typically calculated at the country level for a given set of investment and financing opportunities (e.g., buildings, machinery, and inventory; debt, new equity and retained earnings). The country-specific effective tax rate is a weighted average over these opportunities, where the weights are pre-defined and typically identical for all countries under consideration.[2]

[1] Tax burden measures derived from balance sheets are usually known as *backward-looking*, since they are calculated ex-post from the viewpoint of a firm's business strategies and tax planning activities. They are referred to as *effective* tax rates, since they encompass statutory tax rates but also tax base allowances (such as depreciation and extra investment allowances, valuation of inventories, deductions of financing costs, loss-carry-forwards and -backwards, etc.).

[2] Most of the existing studies refer to the OECD (1991) when using pre-defined weights

To summarize, in contrast to profit tax rates from balance sheets, forward-looking effective tax rates avoid problems of endogeneity through a firm's tax planning activities. Similar to balance sheet tax rates they are effective by representing a non-linear combination of a number of elements of profit taxation affecting a firm's tax payments (tax rates, depreciation allowances, etc.). However, the obvious disadvantage of previously used forward-looking effective tax rates is that what is a *model company* with regard to investment and financing opportunities starkly differs across industries. Accordingly, available effective tax rates at the country level may be inappropriate when estimating response parameters at a more disaggregated (industry or firm) level. Since investment structure and financing opportunities differ across industries and even firms, an identical change in, say, the statutory corporate tax rates or the depreciation allowance parameters will translate into different changes of effective tax rates at the firm level. With micro-level data, one would wish to exploit the much larger variation in data about economic outcome and tax rates as compared to country-level studies but still entertain the advantage of forward-looking tax rates to avoid endogeneity problems associated with tax planning activities of firms. It is this paper's goal to compute firm-specific *forward-looking* effective (marginal and average) tax rates.

We exploit firm-level information for the computation of forward-looking effective tax rates by assuming that the hypothetical investment is identical to the existing investment and financing structure of a firm. Applying this framework, we compute forward-looking effective (marginal and average) tax rates for a sample of 652,337 firms as compiled in Bureau van Dijk's ORBIS data-base. The analysis turns out very insightful. For instance, we find that the country-specific element in these rates is relatively large for effective *average* tax rates (which are relevant for discrete/lumpy investment decisions) but relatively small for effective *marginal* tax rates (i.e., for investment decisions at the intensive margin). For the latter, firm-specific effects and, to a lesser extent, industry-specific effects are relatively important.

To illustrate the relevance of exploiting firm-level variation in effective tax rates, we refer to an example where we study the role of corporate taxation on net investment as measured by the log difference in (total or fixed) assets contained in ORBIS. We identify a significantly negative impact of cost of capital – which is algebraically related to the effective *marginal* tax rate – on net investments when using firm-level cost of capital. Alternatively, basing cost of capital on the country-level effective *marginal* tax rate, we obtain the counter-intuitive result that net investments are positively affected by an increase in

to compute an average of effective tax rates over all possible combinations of investment and financing opportunities.

cost of capital. The latter indicates that inference on the impact of effective taxes on firm outcome should be based on firm-level rather than country-level effective tax rates to avoid erroneous conclusions.

The remainder of the paper is organized as follows. The next section outlines the methodological approach to computing firm-level effective tax rates. Section 3 describes the data at hand and delivers descriptive statistics about firm-level and country-level effective tax rates. Section 4 illustrates the importance of using firm-level effective tax rates in firm-level studies by delivering an example about the impact of cost of capital on firms' net investments. The last section concludes with a summary of our key insights.

2 Conceptual framework to calculate firm-specific forward-looking effective tax rates

In a first step, we briefly describe the assumptions and procedures underlying the computation of country-specific forward-looking effective marginal and average tax rates (EMTR and EATR). There, we closely follow Devereux and Griffith (1999, 2003; see also King and Fullerton, 1984; OECD, 1991; Commission of the European Community, 1992, 2001; and Yoo, 2003). In a second step, we explore the role of firm-specific information about investment and financing opportunities for the computation of EMTR and EATR.

2.1 Country-specific effective tax rates

Consider a hypothetical investment which raises a firm's capital stock at time t by one unit. Assume that the investment changes the capital stock only for one time period. This requires an investment of $dI_t = 1$ in period t, and a disinvestment of $dI_{t+1} = -(1-\delta)(1+\pi)$ in $t+1$, where δ is the economic rate of depreciation and π is the inflation rate. The perturbation of the capital stock increases output in period $t+1$, Q_{t+1}, by $dQ_{t+1} = (p+\delta)(1+\pi)$, with p representing the (pre-tax) real rate of return on capital. In the absence of taxation, the net present value (NPV) of investment, R^*, is given by

$$R^* = -1 + \frac{1}{1+i}\left\{(p+\delta)(1+\pi) + (1-\delta)(1+\pi)\right\} = \frac{p-r}{1+r}, \qquad (1)$$

where $i = (1+r)(1+\pi) - 1$ is the nominal interest rate.

The investment can be financed through retained earnings, new equity, and external debt. In case of new equity financing, it is assumed that the initially distributed shares are repurchased in $t+1$, so that the total number of outstanding shares remains constant. For both forms of equity, the investment costs in t

are equal to 1 (as indicated by entry -1 in the first expression of (1)).[3] For debt financing, we have zero investment cost at t, but the dividend is reduced by $(1+i)$ units in period $t+1$. Changing entry -1 to 0 in the first expression of (1) and subtracting $(1+i)$ in the parentheses, we are left with $R^* = (p-r)/(1+r)$. Therefore, in the absence of taxation the NPV of investment is independent of the source of finance.

Now, let us introduce a corporate tax. Under the assumption that investment costs are fully deductible over the lifetime of the investment good, net investment costs at t are equal to $dI_t = (1 - A)$, where A is the NPV of tax depreciation allowances per unit of investment, discounted by ρ.[4] Further, the increase in output at time $t + 1$ is reduced to $Q_{t+1} = (p + \delta)(1 + \pi)(1 - \tau)$, where τ is the statutory corporate tax rate.

It useful to define the after-tax rate of return on investment relative to the case where it is financed through retained earnings. Under this source of finance, the shareholder has to give up $(1 - A)$ units of dividends in period t. The retained funds are fully distributed as dividends in $t+1$. Net income (i.e., repatriated profits minus net investment costs) is subject to personal income taxation. The overall tax liability of the shareholder is determined by the integration between corporate and personal income taxation, captured by $\gamma = (1 - m^d)/(1 - c)(1 - m^g)$, where m^d and m^g are the personal income tax rates on dividends and capital gains and c is the rate of tax credit.[5] Then, the net dividend amounts to $\gamma(p+\delta)(1+\pi)(1-\tau)$ and the after-tax NPV of investment to the shareholder is

$$\begin{aligned} R^{RE} &= -\gamma(1 - A) + \frac{\gamma}{1 + \rho}\left[(1 + \pi)(p + \delta)(1 - \tau) + (1 + \pi)(1 - \delta)(1 - A)\right] \\ &= \frac{\gamma}{1 + \rho}\left\{(1 + \pi)(p + \delta)(1 - \tau) - (1 - A)\left[(1 + \rho) - (1 + \pi)(1 - \delta)\right]\right\} \quad (2) \end{aligned}$$

If investment is financed by issuing new shares, the cost of raising one unit of new equity is $(1 - \tau\hat{\delta})$, where $\hat{\delta}$ denotes the tax depreciation in the initial period t. Compared to retained earnings, the dividend paid to the shareholder in t is $\gamma(1 - \tau\hat{\delta})$. In $t + 1$, the shareholder receives $(1 - \tau\hat{\delta})$ as a repurchase of

[3] The underlying assumption is that the firm owner (shareholder) pays one unit of capital to obtain $(p+\delta)(1+\pi)$ units as dividends in period $t+1$. In case of financing through retained earnings, the shareholder has to give up one unit of dividends in t.

[4] $\rho = (1-m^i)i/(1-m^g)$ is the shareholder's nominal discount rate, which is exposed to the personal income tax rate on interest, m^i, and on capital gains, m^g (see King and Fullerton, 1984, p. 23). A depends on the allowance scheme (straight line and declining balance as well as combinations thereof) and on the rate of tax depreciation (the number of years for which depreciation allowances can be claimed) as laid out in the tax codes. It is calculated according to the formulas given in Devereux and Griffith (1999) and Yoo (2003).

[5] For instance, under a (pure) classical corporate tax system company profits are taxed twice – once at the level of the firm and once when distributed as dividends, i.e., $c = 0$ (see King, 1974). Assuming a comprehensive income tax ($m^d = m^g$), we obtain $\gamma = 1$.

equity. In comparison to retained earnings, this reduces dividend payments by the same amount so that the shareholder's net income is reduced by $\gamma(1-\tau\hat{\delta})$. Hence, the after-tax NPV of investment to the shareholder under new equity financing is $R^{NE} = R^{RE} + F^{NE}$, where

$$F^{NE} = -(1-\gamma)(1-\tau\hat{\delta}) + \frac{(1-\gamma)(1-\tau\hat{\delta})}{1+\rho} = -\frac{\rho(1-\gamma)(1-\tau\hat{\delta})}{1+\rho}. \quad (3)$$

In case of debt financing, the firm borrows $(1-\tau\hat{\delta})$ in t, the shareholder earns a gross dividend of exactly this amount (which does not have to be given up, as in the case of retained earnings). In period $t+1$, debt plus interest has to be repaid, $(1-\tau\hat{\delta})(1+i)$. If interest payments are fully deductible (as in most tax systems), investment costs are reduced by $(1-\tau\hat{\delta})i\tau$. Hence, compared to the case of retained earnings, the shareholder's net income is reduced by $\gamma(1-\tau\hat{\delta})[1+i(1-\tau)]$. Then, the shareholder's after-tax NPV of investment under debt financing is $R^D = R^{RE} + F^D$, where

$$F^D = \gamma(1-\tau\hat{\delta}) - \frac{\gamma(1-\tau\hat{\delta})[1+i(1-\tau)]}{1+\rho} = \frac{\gamma(1-\tau\hat{\delta})[\rho - i(1-\tau)]}{1+\rho}. \quad (4)$$

To summarize, the after-tax NPV of investment, R, is given by

$$R = R^{RE} + F, \quad (5)$$

where

$$F = \begin{cases} 0 & : \text{ Retained earnings} \\ F^{NE} & : \text{ New equity} \\ F^D & : \text{ Debt} \end{cases}$$

denotes the additional costs of finance.

Different types of assets are treated differently by tax law. For instance, depreciation rates for machinery are usually higher than for buildings. Some countries also apply different depreciation schemes for different investment goods. Therefore, A depends on the type of assets. For purposes of inventory valuation, there are generally three methods applicable: the LIFO (last-in, first-out), the FIFO (first-in, first out) and the average cost method.[6]

[6]Under the LIFO, assets purchased most recently at the higher prices are matched against taxable revenues. Hence, only the LIFO avoids taxation of variations in stock values due to inflation, and R^{RE} is equal to (2). In case of the FIFO, any increase in value due to inflation is subject to taxation. Therefore, R^{RE} is adjusted to

$$R^{RE}_{inv} = R^{RE} - \frac{\gamma}{(1+\rho)}\frac{\tau\pi}{(1-\tau)(1+\pi)}.$$

If the tax code only allows the average cost method, we multiply the second term of R^{RE}_{inv} by

The framework described above can be used to compute the tax burden on a *marginal* investment, whose after-tax rate of return is just equal to the after-tax rate of return on an alternative asset (i.e., a project with a zero after-tax rate of return). The corresponding before-tax rate of return is known as the *cost of capital* (see Auerbach, 1979). Using (2) and (5), and setting $R = 0$, the cost of capital, $\widetilde{p}$, is

$$\widetilde{p} = \frac{1 - A}{(1 - \tau)(1 + \pi)} \left[\rho + \delta(1 + \pi) - \pi\right] - \frac{F(1 + \rho)}{\gamma(1 - \tau)(1 + \pi) - \delta}. \tag{6}$$

The effective marginal tax rate (EMTR) is defined as the difference between the cost of capital and the after-tax rate of return of an alternative asset over the cost of capital

$$EMTR = \frac{(\widetilde{p} - \bar{r})}{\widetilde{p}}, \tag{7}$$

where $\bar{r}$ is the after-tax rate of return of an alternative asset, defined as $\bar{r} = [(1 - m^i)i - \pi]/(1 + \pi)$. Note that $\bar{r} = r$ in the absence of shareholder taxation.

In contrast to the EMTR, the effective average tax rate (EATR) informs about the tax burden on an *average* (infra-marginal) investment, which yields a higher rate of return than the marginal investment (see Devereux and Griffith, 1999). The EATR is defined as the difference between the pre-tax NPV of investment and the after-tax NPV of investment over the NPV of the pre-tax rate of return on capital, $p/(1 + r)$

$$EATR = \frac{R^* - R}{p/(1 + r)}, \tag{8}$$

where R^* is defined in (1) and R is given in (5).

2.2 Parametrization

Following the OECD (1991), Devereux and Griffith (1999, 2003), and Yoo (2003), we parameterize the above described equations in the following way: $p = 0.2$, $r = 0.05$, $\pi = 0.025$; The rate of economic depreciation is set at $\delta^m = 0.1225$ for machinery, $\delta^b = 0.0361$ for buildings, $\delta^{inv} = 0$ for inventories, and $\delta^I = 0.15$ for intangible assets. δ, p, r and π are identical for all countries. Information about statutory corporate tax rates and tax base deductions (depreciation schemes and the corresponding rates for machinery, buildings and intangibles, $\hat{\delta}^m$, $\hat{\delta}^b$, and $\hat{\delta}^I$; extra-investment allowances; valuation of inventory) are taken from various sources which are described in more detail in the appendix. For federal countries we also take into account local profit taxes and,

0.5.

if applicable, their deduction from the tax base for federal profit taxes. As a rule of thumb we use the unweighted average of local taxes for large countries (e.g. United States or Germany) and a typical rate for the economic center for small countries (e.g. Luxembourg).

If alternative depreciation schemes are allowed, we apply the most generous one to calculate the NPV of depreciation allowances.[7] Similarly, if tax law allows for an optional choice over the inventory valuation methods, we apply the most favorable one (i.e., LIFO is chosen against the average cost method, which, in turn, is preferred over FIFO). Finally, we abstract from shareholder taxation, implying $m^i = m^d = m^g = 0$ and $\gamma = 1$.[8] Under $\gamma = 1$, the last expression in (3) becomes zero, indicating that the after-tax NPV of investment to the shareholder between retained earnings and new equity financing is identical.

Applying this parametrization and the above described equations, we are able to compute country-specific effective tax rates for a set of four investment goods (buildings, machinery, inventory and intangible assets) and three financing opportunities (retained earnings, new equity and debt). Instead of calculating effective tax rates for each of these twelve combinations and weighting them to a country-specific average effective tax rate afterwards, we compute financed-weighted effective tax rates for each asset using the following weights: 55% retained earnings, 10% new equity and 35% debt (see OECD, 1991). Next, we follow the Commission of the European Communities (2001) and use equal weights for each asset to calculate country-specific averages of EMTR and EATR.

2.3 Firm-specific effective tax rates

In the following, we describe how the framework to calculate country-specific EMTR and EATR can be adopted to compute firm-specific effective tax rates. For this purpose, we employ firm-level information from the Bureau van Dijk's ORBIS data-base, covering the necessary balance sheet information for more than 650,000 firms.[9]

[7] In some cases, it is possible to change from the declining balance to the straight line, where the point in time for this switch is typically defined in tax law. Otherwise, we assume that the switch is chosen as soon as the value of the straight line depreciation exceeds the one of the declining balance (see also Devereux and Griffith, 1999).

[8] Our firm-level data-set used below also includes large publicly owned companies, where the identity of the shareholders, and, therefore, the applicable tax regime (e.g., personal income tax rate on capital income, residence country, etc.) is unknown. Further, a substantial part of firms is owned by other firms, so that shareholder taxation is probably not too relevant here. To avoid possibly biased estimation results coming from these sources, we decided to exclude shareholder taxation. This also in line with previous literature (see Devereux and Griffith, 1998, 1999, 2003; Devereux, Griffith, and Klemm, 2002)

[9] See Table A.1 and Table A.2 in the Appendix for a list of variables and the according definition in ORBIS (balance sheets as well as profits and loss accounts).

To calculate country-specific effective tax rates we use pre-defined weights over financing opportunities and assets. For the computation of firm-specific effective tax rates, we first decompose a firm's total assets into tangible and intangible ones. We define Θ_f^T, Θ_f^I, and Θ_f^S as the firm specific share of tangible fixed assets, TFA_f, intangible fixed assets, IFA_f, and stocks of current assets (i.e., inventories), STO_f, in total assets

$$\begin{aligned}
\Theta_f^T &= \frac{TFA_f}{IFA_f + TFA_f + STO_f} \\
\Theta_f^I &= \frac{IFA_f}{IFA_f + TFA_f + STO_f} \\
\Theta_f^S &= \frac{STO_f}{IFA_f + TFA_f + STO_f},
\end{aligned} \tag{9}$$

where f indicates the fth firm. Note that the sum of all fixed asset shares is equal to one: $\Theta_f^T + \Theta_f^I + \Theta_f^S = 1$. ORBIS does not report separate balance-sheet figures for buildings and machinery. While this lack of information does not allow splitting Θ_f^T into further components, we can use industry-specific weights, as reported in McKenzie, Mansour, and Brule (1998), to account for the heterogeneous composition of capital stocks across sectors.[10] Denoting the kth industry weight by θ_k^b for buildings, by θ_k^m for machinery, and by θ_k^l for land, we can decompose the firm-specific share of tangible fixed assets Θ_f^T into

$$\begin{aligned}
\Theta_f^b &= \Theta_f^T \theta_k^b \\
\Theta_f^m &= \Theta_f^T \theta_k^m \\
\Theta_f^l &= \Theta_f^T \theta_k^l.
\end{aligned} \tag{10}$$

Since $\theta_k^b + \theta_k^m + \theta_k^l = 1$ it follows that $\Theta_f^b + \Theta_f^m + \Theta_f^l = \Theta_f^T$ (see Table A.5 in the Appendix). According to Table A.5, the industry weights for θ are not identical for large and small companies. Therefore, we use firm type-specific values of θ_k^b, θ_k^m and θ_k^l in (10), defining a company as large if it has more than 100 mn. U.S. dollars of total assets.

The weights in (10) are used to calculate the firm-specific economic depreciation rates, δ_f, tax depreciation allowances that can be claimed on the first year of the investment at the firm level, $\hat{\delta}_f$, and the firm-specific NPV of depreciation

[10] Tables A.3 and A.4 provide information on how the industry codes from McKenzie, Mansour, and Brule (1998) are matched with the ones in the ORBIS data-base. Table A.5 reports the industry-specific weights that are used in (9).

allowances, A_f

$$\begin{aligned}
\delta_f &= \delta^b\Theta_f^b + \delta^m\Theta_f^m + \delta^l\Theta_f^l + \delta^I\Theta_f^I + \delta^{inv}\Theta_f^S \\
\hat{\delta}_f &= \hat{\delta}^b\Theta_f^b + \hat{\delta}^m\Theta_f^m + \hat{\delta}^l\Theta_f^l + \hat{\delta}^I\Theta_f^I + \hat{\delta}^{inv}\Theta_f^S \\
A_f &= A^b\Theta_f^b + A^m\Theta_f^m + A^l\Theta_f^l + A^I\Theta_f^I + A^{inv}\Theta_f^S. \qquad (11)
\end{aligned}$$

δ indicates the rate of economic depreciation as defined above (i.e., $\delta^m = 0.1225$, $\delta^b = 0.0361$, and $\delta^I = 0.15$), and A is the NPV of depreciation allowances, depending on tax depreciation rates and the allowance scheme. $\hat{\delta}$ is the depreciation rate for tax purposes, taken from national tax codes. Note that land and inventories are not tax depreciable, i.e., $\hat{\delta}^l = 0$, $\hat{\delta}^{inv} = 0$. Similarly, $\delta^{inv} = 0$, $\delta^l = 0$, and, hence, $A^{inv} = 0$, $A^l = 0$. As for country-specific effective tax rates, we account for the valuation of inventories for tax purposes.

The second point where firm-level variation comes in is the financing structure of firms. As discussed above, we do not account for shareholder taxation, i.e., $\gamma = 1$ and $F^{NE} = 0$ in (4), implying that the NPV of new equity financing is equal to the one of retained earnings. Therefore, we only distinguish between equity (the sum of retained earnings and new equity) and debt financing when weighting all combinations between financing opportunities and assets to a single (overall) EMTR or EATR for each firm.[11] Specifically, the weighting parameter for debt is equal to the debt ratio, b_f, as defined by the sum of current liabilities, CL_f, and non-current liabilities, NL_f, to total assets, TA_f

$$b_f = \frac{CL_f + NL_i}{TA_f}. \qquad (12)$$

Accordingly, the weighting parameter for both sources of equity is $1 - b_f$. To exclude outliers, we drop all observations with $0 > b_f > 1$.[12]

[11] By considering the observed financing structure at the firm level, we assume that the forward looking effective tax rates are not subject to additional planning going forward and that we may hold the firm to the effects of its past planning. Based on this assumption, we may treat the firm-specific forward-looking effective tax rates as exogenous in the subsequent empirical analysis.

[12] While it is possible that $b_f > 1$ in the short-run (e.g., under current losses and/or negative loss carry-forwards), this assumption is less reasonable for the purpose of financing an investment project. In addition, we drop all observations with missing values or entries less than zero for total assets, fixed assets, stocks of current assets, tangibles and intangibles, turnover, current and non-current liabilities.

3 Firm-level versus country-level effective tax rates

3.1 Data

We use a panel data-set of all firms with total assets larger than 2 mn. U.S. dollars contained in Bureau van Dijk's ORBIS data-base within the period 2000-2005. After eliminating all observations for which the necessary data on assets and finance are not available (see the previous section), we are left with an unbalanced data-set of 652,337 firms in 38 countries and 6 years which contains 2,522,668 observations.

Table 1 provides insights in the allocation of data-points across the 38 countries in the sample. Obviously, the firm coverage is quite high for Belgium, Denmark, France, Italy, Norway, Spain, and United Kingdom. Of all observations in the sample, 2,399,703 are based upon unconsolidated balance sheets and 122,965 refer to consolidated ones. Since the data-set is unbalanced, it may be useful to provide some information about the spacing of the data points in time. Table 2 summarizes the latter and suggests that for only about one-fifth of the firms the necessary information to compute forward-looking effective tax rates at the firm-level is available in each of the six years. However, for more than one-half of the firms we are able to compute such tax rates in at least four of the six years covered.

> Tables 1 and 2 <

In principle, forward-looking effective tax rates are a function of intangible assets but data on the latter are not available for all firms in the sample. Therefore, we also compute effective tax rates on the basis of tangible assets only. It turns out that the results are very similar for the two concepts (including versus excluding intangibles) so that we use effective tax rates which ignore intangibles in part of the empirical exercise for the sake of maximum sample coverage.

3.2 Descriptive statistics

In a first step, let us provide moments of the distributions of firm-level and country-level effective tax rates. Table 3 summarizes firm-level backward-looking effective tax rates (AETR)[13] and firm- as well as country-level EMTR

[13] In line with previous research (see Mutti and Grubert, 2004, and Desai, Foley and Hines 2004), we refer to balance sheet information defining backward looking effective tax rates. More precisely, they reflect profit tax payments as a fraction of pre-tax profits.

and EATR for various percentiles of the respective distributions along with the means, standard deviations, minimum and maximum values.

> Table 3 <

The variation of firm-level EATR comes mainly from the tails of the distribution but it is small between the 20th and the 80th percentile. AETR varies less in the tails but comparatively more in the inter-quartile range than its forward-looking counterpart. The variance in forward-looking EMTR is comparatively higher both in the tails and the center of the distribution. Note that the EMTR might be negative if the investment is financed to large degree with tax- deductible debt or when a country offers favorable depreciation allowances and extra investment credits. In our sample, the forward-looking EMTR is negative for 880,211 observations.

One key insight from Table 3 is that firm-level effective tax rates vary a lot more than country-level effective tax rates. Two major sources of this variance in the data are industry-specific differences in the composition of assets (for instance, buildings versus machinery) and differences in financing at the firm level.

How much of this variance is actually due to the country versus the firm level? This question can be answered by means of an analysis of variance (ANOVA). There, we use a design matrix of indicator variables (country and other dummy variables) to exactly decompose the total variance in AETR, EMTR, and EATR into its components. We suggest a model which reads

$$y_{ckstf} = \alpha + \mu_c + \lambda_k + \zeta_s + \xi_t + \eta_{ckstf}, \tag{13}$$

where y_{ckstf} is the corresponding effective tax rate in country $c = 1, ..., 38$, NACE 4-digit industry $k = 1, ..., 717$, size class[14] $s = 1, ..., 10$, and year $t = 2000, ..., 2005$. The index $f = 1, ..., 652, 337$ in y and η refers to firms. α is the constant of the model; μ_c is the parameter for the effect specific to country c (e.g., capturing the importance of country-specific effective tax rates); λ_k is the parameter for the value of y_{ckstf} specific to industry k; ζ_s is the parameter for the value of y_{ckstf} specific to size class s; ξ_t is the parameter for the value of y_{ckstf} specific to year t; and η_{ckstf} is a remainder component which is not attributable to either countries, industries or size classes. Anything that is not contributed by countries (and the constant) should be captured by $\lambda_k + \zeta_s + \xi_t + \eta_{ckstf}$. We may refer to the total variance in y_{ckstf} as SS_y and to the partial sums

[14] Measured by ten indicator variables for deciles of the distribution of total assets.

of squares of the country, industry, size-class, and time effects as SS_c, SS_k, SS_s, and SS_t, respectively. The residual sum of squares of that model is SS_η. In an ANOVA as in equation (13), $SS_y = SS_c + SS_k + SS_s + SS_t + SS_\eta$, and $SS_c+SS_k+SS_s+SS_t$ is referred to as the 'model' sum of squares. Consequently, SS_η is the 'residual' sum of squares.

If country-level effective tax rates were the major drivers of firm-level effective tax rates, we should observe SS_c to contribute in a major way to SS_y. If idiosyncratic effects at the firm level dominate, SS_c or even $SS_c+SS_k+SS_s+SS_t$ would contribute to a minor extent to SS_y. Note that $(SS_c+SS_k+SS_s)/SS_y = 1 - SS_\eta/SS_y$ is nothing else than the model R^2. Table 4 sheds light on the empirical estimates of the ANOVA as outlined in equation (13) for the AETR and Table 5 summarizes comparable findings for the EMTR and EATR.

> Tables 4 and 5 <

The findings in the tables support two conclusions. First, the firm-level component in effective tax rates is quite sizable, according to the R^2: country-specific, industry-specific, size-class-specific, and time-specific effects together explain only about 18 percent of the variation in AETR, about 57 percent of the variation in EATR and about 24 percent of the variation in EMTR. The remaining part of the variation is firm specific. Moreover, it is interesting to see that country-level variation in effective tax rates is fairly small. Of the model sum of squares, the country-specific component explains about 68 percent of AETR (Table 4), about 83 percent of EATR (Table 5), and about 56-60 percent of EMTR (in Table 5). But recall that the model R^2 as such was fairly small, especially, for EMTR.

While the ANOVA models in Tables 4 and 5 indicate that the nexus between country-specific effects and firm-level effective tax rates is small in general, it is not informative about the correlation between country-level and firm-level effective tax rates as such. Table 6 sheds light on the latter and reports pairwise correlation coefficients for EATR and EMTR at the country and the firm level along with the corresponding p-values.

> Table 6 <

The results in the table suggest that the country-specific effective tax rates are significantly and positively correlated with firm-specific ones: the correlation coefficients between country-level EATR and firm-level EATR as well as AETR are significant, and also the one between EMTR at the country versus

firm level is significant, irrespective of whether we include intangibles in the computation of forward-looking tax rates or not (see the light-gray-shaded cells in Table 6). Yet, the correlation coefficient for forward-looking country-specific and firm-specific EMTRs is fairly small (notice also that the correlation coefficient between AETR and firm-level EATR is small). The correlation coefficients between country- and firm-specific EATR are higher than that of country- and firm-specific EMTR (compare the coefficient in row [3] and column [2] with the one in row [5] and column [4] of Table 6).

4 Tentative empirical analysis: net investments and cost of capital

The main goal of this paper is to deliver an approach for computing effective tax rates at the firm level and to calculate such rates in a large cross-sectional dataset along with providing a comparison with their country-level counterparts. In this section, we indicate their potential role in firm-level studies on the consequences of corporate taxation for economic activity.

Let us consider the effect of *cost of capital* ($\widetilde{p}$ in Section 2) on net investment, which represents a classical question in econometrics (for instance, see the early contributions by Hall and Jorgenson, 1967; Eisner and Nadiri, 1968; Jorgenson and Siebert, 1968) as well as public finance (see, e.g., Cummins, Hassett, and Hubbard, 1994; Hassett and Hubbard, 2002, provide an overview). $\widetilde{p}$ is defined in equation (6) and its relationship to EMTR is given by equation (7).

Our short and highly unbalanced panel data hardly allows to estimate dynamic investment models (see, e.g., Blundell, Bond, and Meghir, 1996). However, it is possible to infer the impact of $\widetilde{p}$ on net investment based on the within variation of our data set. More specifically, we estimate the following econometric model relying on the early investment literature

$$\ln \widetilde{I}_{tf} = \beta_0 + \beta_1 \Delta \widetilde{S}_{tf} + \beta_2 \Delta \widetilde{p}_t + \xi_t + \nu_{tf}, \tag{14}$$

where $\ln \widetilde{I}_{tf}$ denotes the annual difference in log (total or fixed) assets of firm f in year t, $\Delta \ln \widetilde{S}_{tf}$ annual difference in log sales of firm f in year t, $\Delta \ln \widetilde{p}_t$ is the annual difference in log $\widetilde{p}_t$ (cost of capital) of either firm f in country c and year t or the average firm in country c in year t,[15] ξ_t is a fixed time effect, and ν_{tf} is the disturbance term of firm f in year t. The unknown regression coefficients are denoted by β_0, β_1, and β_2. In general, we report standard errors of these parameters which are robust to heteroskedasticity and up to fifth-order

[15] The former is based upon the firm-specific EMTR in equation (6) while the latter is based upon the country-specific EMTR in equation (6).

autocorrelation in ν_{tf}. Clearly, we expect $\beta_1 > 0$ and $\beta_2 < 0$. Let us summarize our findings for the data at hand in Table 7.

> Table 7 <

A key insight from Table 7 is that consideration of firm-specific variation in forward-looking effective tax rates may be crucial. In our application, the use of country-specific cost of capital instead of firm-specific cost of capital is very misleading: while country-specific cost of capital display a positive impact on net investments – which seems counterintuitive – firm-specific ones reduce net investments significantly as expected. This result is independent of whether we use total or fixed assets to determine net investments.

The reason for this finding lies in the relatively strong difference in the moments of the distribution of firm-specific versus country-specific effective tax rates (see Table 3): average firm-specific EATR is somewhat smaller than average country-specific EATR in our data, and average firm-specific EMTR is much smaller than average country-specific EMTR; moreover, the firm-specific EATR and EMTR have a larger variance than their country-specific counterparts. We have seen that firm-specific effective tax rates are correlated with country-specific ones (see Table 6). Accounting for country-specific cost of capital or effective tax rates in a firm-level study induces measurement error and likely leads to an endogeneity bias. The reason is that the disturbance term picks up firm-level variation in true firm-level cost of capital which is correlated with the average country-level cost of capital.

We have addressed the robustness of the results in Table 7 in two regards: the chosen parameterization to compute forward-looking effective tax rates and the possible influence of loss carry forwards.[16]

First, forward looking effective tax rates are known to be sensitive to the choice of expected rates of inflation and return. The benchmark results reported in the tables are based on a rate of inflation of 2.5 percent and a rate of return of 5 percent. In the sensitivity analysis we chose alternative parameter values of 5 percent for the rate of inflation and 3 percent for the the rate of return, respectively. However, while this affects the matrix of correlation coefficients as reported in Table 6 quite significantly, our conclusions from Table 7 do not change in qualitative terms: the impact of the country-level cost of capital on investment is positive (which is at odds with our expectations) and the one of firm-level cost of capital is negative as expected. The estimated parameters of sales and cost of capital are in a similar range as the ones in Table 7.

[16] We will be happy to make tables available upon request but suppress them here and only briefly summarize our findings below.

Second, loss carry forward would eliminate a possible impact of profit taxation due to the deductibility of losses in the past. To avoid this problem to the largest possible extent, we ran the models as in Table 7 on a sub-sample of firms which did not report negative profits in any single year between 2000 and 2005. While this reduces the number of observations from 1,283,906 in Table 7 to 788,029, the originally drawn conclusions remain valid in qualitative terms. Again, the results suggest that relying on firm-level rather than country-level effective tax rates leads to the negative relationship between cost of capital and net investment while this is not the case for cost of capital based on the country level.

Taking stock, we may draw the following conclusions. Recent empirical work in public finance increasingly relies on firm-level data. With such data one may entertain the advantage of controlling for unobservable effects so that, e.g., unbiased profit tax elasticities may be inferred which is much harder at the aggregate (country) level. However, related empirical work increasingly employs country-level effective tax rates to infer the tax elasticities of firm-level outcome (see Buettner and Ruf, 2007, or Moore and Ruane, 2005, for recent examples). Our study illustrates that this may be harmful, and there are two reasons for that. First, firms are heterogeneous with regard to the structure of their capital stocks and the associated depreciation rates, and they differ with regard to debt and other financial variables influencing firm-level effective tax rates. Ignoring this heterogeneity may be harmful when drawing inference of the importance of tax policy at the micro level. Second, ignoring firm heterogeneity may be even harmful for aggregate (country-level) inference. Since effective tax rates are nonlinear functions of tax and non-tax parameters, (weighted or un-weighted) country-level effective tax rates - and, hence, the responsiveness of aggregate outcome to country-level effective tax rates - which are computed from firm-level effective tax rates may differ starkly from ones that are computed from averages of characteristics of all firms in a country. The latter may lead to both a misrepresentation of the country-specific effective tax rates as such as well as biased inference about the responsiveness of economic outcome to taxation.

5 Conclusions

Studies on the behavioral response to taxation at the firm level typically use backward-looking tax burden measures or country-specific forward-looking effective tax rates as developed by King and Fullerton (1984) and Devereux and Griffith (1999, 2003), among others. The former are based on a firm's tax payments relative to profits according to balance sheet information. Tax payments, however, may be influenced by tax planning activities. Therefore, profit

tax rates from balance sheets are not exogenous from an empirical perspective. This is not the case for forward-looking effective tax rates, which inform about the tax burden on a hypothetical investment project with a pre-defined mix of investment and financing opportunities. However, the nature of a hypothetical investment is typically assumed symmetric across industries and firms and dismisses any industry- and firm-specific component in the underlying assumptions about investment and financing opportunities. From this perspective, there is obvious demand in empirical research for a tax burden measure that maintains the advantage of forward-looking effective tax rates (i.e., the exogeneity vis-à-vis tax planning activities) while entertaining variation across firms and industries.

This paper applies and extends the Devereux and Griffith (1999, 2003) approach to calculate forward-looking effective marginal and average tax rates (EMTR and EATR) at the firm- rather than the country-level. We compute these rates using a sample of more than 650,000 firms within and outside Europe as compiled in Bureau van Dijk's ORBIS database. Comparing the variation of firm-specific EMTR and EATR with their country-specific counterparts we find that the country-level component in a firm's effective tax burden is generally much less important than the firm-specific one. However, country-level effective tax rates are significantly related to those at the firm level, especially for the EATR.

We demonstrate the potential importance of these findings in an empirical example about the influence of cost of capital (which is algebraically related to EMTR) on firm-level changes in net investments. In particular, we use firm-specific cost of capital in our regressions and contrast the results to the ones that are obtained when using country-specific cost of capital. We identify a clear negative impact of firm-specific cost of capital but a positive one of country-specific cost of capital on net investments. Clearly, the latter is counterintuitive and has to do with the mis-measurement of effective tax rates for individual firms when using country-specific EMTR to compute cost of capital. This evidence suggests that it seems problematic to employ country-level effective tax rates in firm-level studies, because this could lead to potentially misleading conclusions.

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Table 1: Composition of the firm-level data by country

Country	Number of observations	Country	Number of observations
Austria	6,767	Latvia	4,237
Belgium	120,527	Lithuania	3,587
Bulgaria	7,070	Luxembourg	1,635
Canada	6,428	Malta	177
Croatia	18,101	Netherlands	56,368
Cyprus	8	Norway	92,683
Czech Republic	31,541	Poland	36,051
Denmark	92,246	Portugal	26,362
Estonia	7,961	Russia	66,183
Finland	41,156	Slovak Republic	6,743
France	420,381	Slovenia	7,808
Germany	57,779	Spain	360,342
Greece	55,501	Sweden	76,567
Hungary	17,796	Switzerland	3,579
Iceland	749	Turkey	216
Ireland	14,854	Ukraine	32,165
Italy	504,145	United Kingdom	235,410
Japan	43,623	United States	29,547
Korea	25,044	Yugoslavia	11,241

Notes: The total number of firms is 652,337. The total number of observations is 2,522,668. There are 38 countries and 6 years (2000-2005).

Table 2: Allocation of the firms across time

No. of firms	Percent	Years covered 2000	2001	2002	2003	2004	2005
137,472	21.07	●	●	●	●	●	●
113,927	17.46	●	●	●	●	●	
48,152	7.38						●
40,998	6.28					●	●
28,961	4.44		●	●	●	●	●
28,294	4.34				●	●	●
25,716	3.94	●	●	●	●		
23,164	3.55		●	●	●	●	
21,096	3.23				●	●	
184,557	28.29	other patterns					

Notes: The total number of firms is 652,337 (100 percent).
● indicates an entry in this year.

Table 3: Moments of the distributions of firm-level and country-level effective tax rates

Statistic	**Firm-level backward-looking effective tax rate**[a]	**Firm-level forward-looking effective tax rates**				**Country-level effective tax rates**	
		EATR	EMTR	EATR	EMTR	EATR	EMTR
		Including Intangibles		**Excluding Intangibles**		**Including Intangibles**	
Minimum	0.000	0.055	-4.357	0.049	-2.408	0.095	-0.017
10^{th} percentile	0.000	0.211	-0.196	0.211	-0.206	0.264	0.220
20^{th} percentile	0.027	0.234	-0.095	0.233	-0.108	0.281	0.248
30^{th} percentile	0.113	0.248	-0.028	0.247	-0.042	0.290	0.253
40^{th} percentile	0.188	0.260	0.027	0.258	0.014	0.317	0.257
50^{th} percentile	0.247	0.272	0.077	0.269	0.064	0.321	0.259
60^{th} percentile	0.296	0.283	0.125	0.280	0.114	0.332	0.266
70^{th} percentile	0.340	0.295	0.175	0.292	0.165	0.339	0.273
80^{th} percentile	0.393	0.311	0.231	0.308	0.223	0.344	0.293
90^{th} percentile	0.500	0.334	0.296	0.331	0.289	0.358	0.333
Maximum	1.000	0.534	0.584	0.523	0.542	0.457	0.415
Average	0.250	0.271	0.056	0.268	0.048	0.312	0.263
Standard deviation	0.202	0.051	0.203	0.050	0.191	0.047	0.048

Notes: Moments of firm-level effective tax rates are based on the 652,337 firms in Table 1 and those of the country-level effective tax rates are based on 38 countries. All moments are calculated by using data for 6 years (2000-2005) as in Tables 1 and 2.

[a] Firm-level backward looking effective tax rates are profit tax payments as a fraction of earnings before interest and taxation.

Table 4: Analysis of variance of firm-level backward-looking effective tax rates

Component		**Backward-looking effective tax rates at the firm level (AETR)**			
		Partial sum of squares	**Degrees of freedom**	**F-statistic**	**p-value**
Industry effects (Nace 4-digit)	[1]	2,749.25	769	107.14	0.000
Country effects	[2]	10,534.08	37	8,532.17	0.000
Firm size class effects (deciles)	[3]	20.20	9	67.25	0.000
Year effects	[4]	55.52	5	332.76	0.000
Model	[5]	15,479.00	820	565.71	0.000
Residual	[6]	69,394.88	2,079,658		
Total	[7]	84,873.88	2,080,478		
R^2	[8]	0.182			

Table 5: Analysis of variance of firm-level forward-looking effective tax rates

Component		Effective average tax rate (EATR) at the firm-level including intangibles				Effective average tax rate (EATR) at the firm-level excluding intangibles			
		Partial sum of squares	**Degrees of freedom**	**F-statistic**	**p-value**	**Partial sum of squares**	**Degrees of freedom**	**F-statistic**	**p-value**
Industry effects (Nace 4-digit)	[1]	289.83	716	364.44	0.000	280.98	716	370.12	0.000
Country effects	[2]	3,060.85	37	74,480.07	0.000	2,910.44	37	74,187.60	0.000
Firm size class effects (deciles)	[3]	0.56	9	55.87	0.000	0.41	9	42.78	0.000
Year effects	[4]	96.11	5	17,306.63	0.000	102.54	5	19,340.97	0.000
Model	[5]	3,677.75	767	4,317.05	0.000	3,506.96	767	4,312.30	0.000
Residual	[6]	2,801.10	2,521,900			2,673.95	2,521,900		
Total	[7]	6,478.85	2,522,667			6,180.91	2,522,667		
R^2	[8]	0.568				0.567			

Component		Effective marginal tax rate (EMTR) at the firm-level including intangibles				Effective marginal tax rate (EMTR) at the firm-level excluding intangibles			
		Partial sum of squares	**Degrees of freedom**	**F-statistic**	**p-value**	**Partial sum of squares**	**Degrees of freedom**	**F-statistic**	**p-value**
Industry effects (Nace 4-digit)	[1]	8,676.38	716	391.16	0.000	8,196.04	716	414.55	0.000
Country effects	[2]	15,194.04	37	13,255.73	0.000	12,652.61	37	12,384.19	0.000
Firm size class effects (deciles)	[3]	21.14	9	75.83	0.000	15.66	9	63.03	0.000
Year effects	[4]	73.48	5	474.38	0.000	64.59	5	467.83	0.000
Model	[5]	25,461.03	767	1,071.55	0.000	22,654.79	767	1,069.68	0.000
Residual	[6]	78,126.08	2,521,900			69,636.81	2,521,900		
Total	[7]	103,587.11	2,522,667			92,291.60	2,522,667		
R^2	[8]	0.246				0.245			

Table 6: Correlation matrix for country-level and firm-level effective tax rates

		Including intangibles				
Tax rate		[1]	[2]	[3]	[4]	[5]
		.				
Backward-looking rate (firm)	[1]	1.000				
p-value		-				
Forward-looking EATR (country)	[2]	0.226	1.000			
p-value		0.000	-			
Forward-looking EATR (firm)	[3]	0.215	0.733	1.000		
p-value		0.000	0.000	-		
Forward-looking EMTR (country)	[4]	0.076	0.843	0.642	1.000	
p-value		0.000	0.000	0.000	-	
Forward-looking EMTR (firm)	[5]	0.001	-0.071	0.564	0.125	1.000
p-value		0.400	0.000	0.000	0.000	-
		Excluding intangibles				
Tax rate		[1]	[2]	[3]	[4]	[5]
Backward-looking rate (firm)	[1]	1.000				
p-value		-				
Forward-looking EATR (country)	[2]	0.226	1.000			
p-value		0.000	-			
Forward-looking EATR (firm)	[3]	0.223	0.733	1.000		
p-value		0.000	0.000	-		
Forward-looking EMTR (country)	[4]	0.076	0.843	0.622	1.000	
p-value		0.000	0.000	0.000	-	
Forward-looking EMTR (firm)	[5]	0.003	-0.094	0.556	0.092	1.000
p-value		0.000	0.000	0.000	0.000	-

Table 7: Effects of country-level and firm-level user-cost of capital on net investments per firm (2000-2005)

	Dependent variable is net investments: log assets$_t$ - log assets$_{t-1}$ based on			
Explanatory variables	Total Assets	Fixed Assets	Total Assets	Fixed Assets
Firm-level log sales$_t$ - log sales$_{t-1}$	0.188***	0.160***	0.189***	0.160***
	0.003	0.003	0.003	0.003
Country-level log u.c.c$_t$ - log u.c.c$_{t-1}$	0.272***	0.310***	-	-
	0.016	0.024	-	-
Firm-level log u.c.c$_t$ - log u.c.c$_{t-1}$	-	-	-0.859***	-0.136***
	-	-	0.010	0.015
R^2	0.119	0.033	0.154	0.033
Firms	394,557	390,598	394,557	390,598
Observations	1,283,906	1,268,403	1,283,906	1,268,403
Fixed year effects	YES	YES	YES	YES

Notes: u.c.c. denotes user cost of capital. For each variable, the second line displays the estimated standard errors of the estimated coefficient. They are robust to heteroskedasticity and up to fifth-order autocorrelation (see Newey and West, 1987). Since the data appear in first differences, the regressions are based on annual differences for 2001, 2002, 2003, 2004, and 2005.

Table A.1: Data available from Orbis: Balance sheet

Item	Description	Definition	Variable
1	**Fixed Assets**	1a + 1b + 1c	FA_i
1a	Intangible Fixed Assets		IFA_i
1b	Tangible Fixed Assets		TFA_i
1c	Other Fixed Assets		OFA_i
2	**Current Assets**	2a + 2b + 2c + 2d	CA_i
2a	Stocks		STO_i
2b	Debtors		DBT_i
2c	Other Current Assets		OCA_i
2d	Cash and Cash Equivalent		CSH_i
3	**Total Assets**	**1 + 2**	TA_i
4	**Shareholders Funds**	4a + 4b	SF_i
4a	Capital		CAP_i
4b	Other Shareholders Funds		OSF_i
5	**Non Current Liabilities**	5a + 5b	NL_i
5a	Long Term Debt		LTD_i
5b	Other Non Current Liabilities		ONL_i
6	**Current Liabilities**	6a + 6b + 6c	CL_i
6a	Loans		LNS_i
6b	Creditors		CRD_i
6c	Other Current Liabilities		OCL_i
7	**Total Shareholders Funds and Liabilities**	**1 + 2**	TL_i
8	**Memo Lines**		
8a	Working Capital	2a + 2b - 6b	WKC_i
8b	Net Current Assets	**2 - 6**	NCA_i
8c	Enterprise Value		EVA_i
8d	Employees		EMP_i

Table A.2: Data available from Orbis: Profit and loss account

Item	Description	Definition	Variable
1	**Operating revenue**		$OREV_i$
1a	Sales		$SALE_i$
2	**Cost of Goods Sold**		$CGDS_i$
3	**Gross Profit**	**1 - 2**	$GRPR_i$
4	**Other Operating Expenses**		$OOPE_i$
5	**Operating Profit/Loss[=EBIT]**	**3 - 4**	$EBIT_i$
5a	Financial Revenues		$FREV_i$
5b	Financial Expenses		$FEXP_i$
6	**Financial Profit/Loss**	5a - 5b	FPL_i
7	**Profit/Loss before Tax and Extraordinary Items**	**5 - 6**	$PLBT_i$
7a	Taxation		TAX_i
8	**Profit/Loss after Tax**	**7** - 7a	$PLAT_i$
8a	Extraordinary Revenues		$EREV_i$
8b	Extraordinary Expenses	$EEXP_i$	
9	**Extraordinary Profit/Loss**	8a - 8b	$EXPL_i$
10	**Profit/Loss for Period [=Net Income]**	**8 - 9**	$PRLO_i$
11	**Memo Lines**		
11a	Export Turnover		EXP_i
11b	Material costs		$MATC_i$
11c	Cost of employees		$CEMP_i$
11d	Depreciation		$DEPR_i$
11e	Interest paid		INT_i
11f	Cash flow	**10** + 11d	CF_i
11g	Added value	7a + **10** + 11c + 11d + 11e	$ADDV_i$
11h	EBITDA	**5** + 11d	$EBITDA_i$

Table A.3: Industry classifications: McKenzie et. al.

Industry Name	**SIC Code (1980)**	**Division Name**
Agriculture	0100-0299	Agriculture, Forestry and Fishing
Fishing and Trapping	0300-0399	Agriculture, Forestry and Fishing
Subtotal	*0100-0399*	*Average Agriculture, Forestry and Fishing*
Forestry	0400-0599	Agriculture, Forestry and Fishing
Mining	0600-0629	Mining
Oil and Gas	0630-0799	Oil and Gas
Mining	0800-0899	Mining
Oil and Gas	0910-0919	Oil and Gas
Mining	0920-0999	Mining
Food	1000-1099	Manufacturing
Beverages	1100-1199	Manufacturing
Tobacco	1200-1299	Manufacturing
Rubber	1500-1599	Manufacturing
Plastic	1600-1699	Manufacturing
Leather	1700-1799	Manufacturing
Textile	1800-1999	Manufacturing
Clothing	2400-2499	Manufacturing
Wood	2500-2599	Manufacturing
Furniture	2600-2699	Manufacturing
Paper	2700-2799	Manufacturing
Print and Publishing	2800-2899	Manufacturing
Primary Metal	2900-2999	Manufacturing
Metal Fabrication	3000-3099	Manufacturing
Machinery	3100-3199	Manufacturing
Transportation Equipment	3200-3299	Manufacturing
Electrical	3300-3399	Manufacturing
Mineral	3500-3599	Manufacturing
Petroleum	3600-3699	Manufacturing
Chemical	3700-3799	Manufacturing
Miscellaneous Manufacturing	3900-3999	Manufacturing
Subtotal	*1000-3999*	*Average Manufacturing*
Construction	4000-4499	Construction
Transportation	4500-4699	Transportation and Storage
Storage	4700-4799	Transportation and Storage
Subtotal	*4500-4799*	*Average Transportation and Storage*
Communications	4800-4899	Communication
Electrical Power, Gas and Water	4900-4999	Public Utilities
Wholesale Trade	5000-5999	Wholesale Trade
Retail Trade	6000-6999	Retail Trade
Services to Business Management	7700-7799	Other Services
Government, Personal and Misc. Services	9100-9999	Other Services
Subtotal	*7700-7799*	*Average Other Services*
Total	**0100-9999**	

Table A.4. Correspondence between Industry classifications: McKenzie et. al. and NACE 2 digit

NACE 2 code	**Description NACE2**	**Industry Name (McKenzie et. al)**	**SIC Code (1980)**
1	Agriculture, hunting and related service activities	Agriculture	0100-0299
2	Forestry, logging and related service activities	Forestry	0400-0599
5	Fishing, fish farming and related service activities	Fishing and Trapping	0300-0399
10	Mining of coal and lignite: extraction of peat	Mining	0600-0629, 0800-0899, 0920-0999
11	Extraction of crude petroleum and natural gas: service activities incidental to oil and gas extraction, excluding surveying	Oil and Gas	0630-0799, 0910-0919
12	Mining of uranium and thorium ores	Mining	0600-0629, 0800-0899, 0920-0999
13	Mining of metal ores	Mining	0600-0629, 0800-0899, 0920-0999
14	Other Mining and quarrying	Mining	0600-0629, 0800-0899, 0920-0999
15	Manufacture of food products and beverages	Food	1000-1099
15.9	Manufacture of beverages	Beverages	1100-1199
16	Manufacture of tobacco products	Tobacco	1200-1299
17	Manufacture of textile products	Textile	1800-1999
18	Manufacture of wearing apparel; dressing and dyeing of fur	Clothing	2400-2499
19	Tanning and dressing of leather; manufacture of luggage, handbags,		

Table A.4. Correspondence between Industry classifications: McKenzie et. al. and NACE 2 digit (continued)

NACE 2 code	**Description NACE2**	**Industry Name (McKenzie et. al)**	**SIC Code (1980)**
	saddlery, harness and footwear	Leather	1700-1799
20	Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials	Wood	2500-2599
21	Manufacture of pulp, paper and paper products	Paper	2700-2799
22	Publishing, printing and reproduction of recorded media	Print and Publishing	2800-2899
23	Manufacture of coke refined petroleum products and nuclear fuel	Petroleum	3600-3699
24	Manufacture of chemicals, chemical products	Chemical	3700-3799
25	Manufacture of rubber products	Rubber	1500-1599
25.2	Manufacture of plastic products	Plastic	1600-1699
26	Manufacture of other non-metallic mineral product	Mineral	3500-3599
27	Manufacture of basic metals	Primary Metal	2900-2999
28	Manufacture of fabricated metal products, except machinery and equipment	Metal Fabrication	3000-3099
29	Manufacture of machinery and equipment n.e.c.	Machinery	3100-3199
30	Manufacture of office		

Table A.4. Correspondence between Industry classifications: McKenzie et. al. and NACE 2 digit (continued)

NACE 2 code	**Description NACE2**	**Industry Name (McKenzie et. al)**	**SIC Code (1980)**
	machinery and computers	Machinery	3100-3199
31	Manufacture of electrical		
	machinery and apparatus n.e.c.	Electrical	3300-3399
32	Manufacture of radio, television		
	and communication equipment and apparatus	Electrical	3300-3399
33	Manufacture of medical,		
	precision and optical instruments,		
	watches and clocks	*Average Manufacturing*	*1000-3999*
34	Manufacture of motor vehicles	Transportation Equipment	3200-3299
35	Manufacture of other transport equipment	Transportation Equipment	3200-3299
36	Manufacture of furniture:	Furniture	2600-2699
36.6	Manufacturing n.e.c.	Miscellaneous Manufacturing	3900-3999
37	Recycling	*Average Manufacturing*	*1000-3999*
40	Electricity, gas, steam	Electrical Power,	
	and hot water supply	Gas and Water	4900-4999
41	Collection, purification	Electrical Power,	
	and distribution of water	Gas and Water	4900-4999
45	Construction	Construction	4000-4499
50	Sale, maintenance and repair		
	of motor vehicles and motorcycles;		
	retail sale of automotive fuel	Retail Trade	6000-6999
51	Wholesale trade and commission trade,		

Table A.4. Correspondence between Industry classifications: McKenzie et. al. and NACE 2 digit (continued)

NACE 2 code	**Description NACE2**	**Industry Name (McKenzie et. al)**	**SIC Code (1980)**
	except of motor vehicles and motorcycles	Wholesale Trade	5000-5999
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	Retail Trade	6000-6999
55	Hotels and restaurants	*Average Services*	*7700-9999*
60	Land transport; transport via pipelines	Transportation	4500-4699
61	Water transport	Transportation	4500-4699
62	Air transport	Transportation	4500-4699
63	Supporting and auxiliary transport activities; activities of travel agencies	*Average Services*	*7700-9999*
64	Post and telecommunications	Communications	4800-4899
65	Financial intermediation, except insurance and pension funding	*Average Services*	*7700-9999*
67	Activities auxiliary to financial intermediation	*Average Services*	*7700-9999*
70	Real estate activities	*Average Services*	*7700-9999*
71	Renting of machinery and equipment without operator and of personal and household goods	*Average Services*	*7700-9999*
72	Computer and related activities	*Average Services*	*7700-9999*
73	Research and development	*Average Services*	*7700-9999*
74	Other business activities	Services to Business Management	7700-7799

Table A.4. Correspondence between Industry classifications: McKenzie et. al. and NACE 2 digit (continued)

NACE 2 code	**Description NACE2**	**Industry Name (McKenzie et. al)**	**SIC Code (1980)**
75	Public administration and defence, compulsory social security	Government, Personal and Misc. Services	9100-9999
80	Education	*Average Services*	*7700-9999*
85	Health and social work	*Average Services*	*7700-9999*
90	Sewage and refuse disposal, sanitation and similar activities	*Average Services*	*7700-9999*
91	Activities of membership organisations	*Average Services*	*7700-9999*
92	Recreational, cultural and sporting activities	*Average Services*	*7700-9999*
93	Other services activities	*Average Services*	*7700-9999*
95	Activities of households as employers of domestic staff	*Average Services*	*7700-9999*
99	Extra-territorial organisations and bodies	*Average Services*	*7700-9999*
XX	non-specified	**Total**	**0100-9999**

Table A.5. Industry-specific weights for the tangible fixed assets: McKenzie et. al.

	Large companies			Small companies		
Industry Name	**Structures**	**Machinery**	**Land**	**Structures**	**Machinery**	**Land**
Agriculture	n.a.	n.a.	n.a.	0.1544	0.3241	0.5215
Fishing and Trapping	n.a.	n.a.	n.a.	0.2440	0.6480	0.1080
Subtotal	n.a.	n.a.	n.a.	0.1575	0.3333	0.5092
Forestry	0.6479	0.3099	0.0423	0.0726	0.8710	0.0565
Mining	0.6549	0.2832	0.0619	n.a.	n.a.	n.a.
Oil and Gas	0.3827	0.5926	0.0247	n.a.	n.a.	n.a.
Food	0.3349	0.6179	0.0472	0.3906	0.5322	0.0773
Beverages	0.3079	0.6372	0.0549	0.4000	0.5054	0.0946
Tobacco	0.1818	0.8095	0.0087	0.0000	1.0000	0.0000
Rubber	0.2444	0.6667	0.0889	0.0000	0.9524	0.0476
Plastic	0.2079	0.7416	0.0506	0.0947	0.8580	0.0473
Leather	0.3478	0.6087	0.0435	0.0667	0.9333	0.0000
Textile	0.2479	0.7265	0.0256	0.1150	0.8850	0.0000
Clothing	0.3333	0.6000	0.0667	0.2712	0.7288	0.0000
Wood	0.3247	0.6494	0.0260	0.3913	0.5362	0.0725
Furniture	0.4198	0.5185	0.0617	0.2763	0.6447	0.0789
Paper	0.5808	0.4072	0.0120	0.1855	0.7903	0.0242
Print and Publishing	0.2193	0.6845	0.0963	0.1650	0.8250	0.0100
Primary Metal	0.6988	0.2771	0.0241	0.0924	0.8824	0.0252
Metal Fabrication	0.2418	0.7033	0.0549	0.2984	0.6290	0.0726
Machinery	0.3095	0.5833	0.1071	0.2500	0.6848	0.0652

Table A.5. Industry-specific weights for the tangible fixed assets: McKenzie et. al. (continued)

	Large companies			Small companies		
Industry Name	**Structures**	**Machinery**	**Land**	**Structures**	**Machinery**	**Land**
Transportation Equipment	0.1702	0.8156	0.0142	0.2810	0.5620	0.1570
Electrical	0.2810	0.6777	0.0413	0.4369	0.5437	0.0194
Mineral	0.2961	0.6908	0.0132	0.2397	0.6575	0.1027
Petroleum	0.5424	0.3559	0.1017	0.0903	0.8428	0.0669
Chemical	0.4437	0.5166	0.0397	0.2483	0.6623	0.0894
Miscellaneous Manufacturing	0.3457	0.6049	0.0494	0.5652	0.4058	0.0290
Subtotal	0.3711	0.5912	0.0377	0.2876	0.6471	0.0654
Construction	0.7541	0.0984	0.1475	0.3390	0.5085	0.1525
Transportation	0.1837	0.8027	0.0136	0.1026	0.8654	0.0321
Storage	0.5109	0.3478	0.1413	0.6438	0.1625	0.1938
Subtotal	0.1944	0.7917	0.0139	0.1603	0.7885	0.0513
Communications	0.7500	0.2392	0.0108	0.1531	0.8176	0.0293
Electrical Power, Gas and Water	0.7385	0.2395	0.0220	0.0466	0.9172	0.0362
Wholesale Trade	0.4151	0.4717	0.1132	0.3043	0.5870	0.1087
Retail Trade	0.3273	0.6000	0.0727	0.3750	0.5000	0.1250
Services to Business Management	0.6923	0.0846	0.2231	0.6138	0.0828	0.3034
Government, Personal and Misc. Services	0.4803	0.3886	0.1310	0.5153	0.3493	0.1354
Subtotal	0.6632	0.1295	0.2073	0.5879	0.1508	0.2613
Total	0.5280	0.3851	0.0870	0.4430	0.3291	0.2278

Notes: Large (small) companies are defined as ones with more (less) than 100 mn US Dollar total assets.

A Data Sources

The data-set of tax parameters used in this paper is an extension of the tax data used by Loretz (2008).

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