The Economic Unit of Effective Tax Rates

by

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Abstract

This paper clarifies the appropriate economic unit of effective tax rates. Effective tax rates should give the percentage of the economic profit to be paid to the state as taxes. Only effective tax rates defined in this economic unit allow for an economically meaningful comparison with the statutory tax rate in order to reveal inter-industry distortions and inter-asset distortions caused by taxation. The widely used effective tax rates of King and Fullerton (1984) and Devereux and Griffith (2003) both follow this concept. This clarification of the appropriate economic unit of effective tax rates allows for a general definition of effective tax rates. Based on indifference considerations effective tax rates giving the percentage of the economic profit to be paid to the state as taxes can be calculated for arbitrary investments including complex simulations models as the European Tax Analyzer. Still such effective tax rates can be compared directly to statutory tax rates or to the effective tax rates of King and Fullerton (1984) and Devereux and Griffith (2003).

JEL-Classification

H25, H32, K34, M21

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1 Introduction

Statutory tax rates give the percentage of the periodically determined *tax accounting profit* to be paid to the state as taxes. Since the tax accounting profit typically is country and asset specific, a comparison of statutory tax rates is not sufficient for evaluating the tax load of firms. For this purpose we calculate effective tax rates based on a unique *reference tax base* to ensure comparability. The effective tax rate of an investment then is the tax rate yielding in combination with the reference tax base the same investment value as the statutory tax rate in combination with the actual tax accounting profit. Effective tax rates convert deviations of the actual tax accounting profit from a reference tax base into equivalent tax rate changes.

This has important consequences for the comparability of effective tax rates. Although effective tax rates typically are expressed in percentage figures, they must only be compared if the reference tax base underlying their computation and consequently their economic unit is identical.

Well defined effective tax rates not only inform on the tax load of investments combining information on the tax accounting profit and the statutory tax rate over the entire life of an investment into a single figure. They further allow to analyze inter-industry distortions and inter-asset distortions caused by taxation (See Burnham and Ozanne (2006) and Fullerton (1984)). However, only if economic profits are used as their reference tax base effective tax rates are able to reveal preferential or discriminatory taxation compared to statutory tax rates for arbitrary investments. Effective tax rates thus should give the percentage of the *economic profit* to be paid to the state as taxes. An effective tax rate below (above) the statutory tax rate on interest then supports the presumption that the level of investment is higher (lower) compared to a situation in which no taxes are considered.

What economic profits are has been determined in the seminal papers of Samuelson (1964) and Johannson (1969). The appropriate economic unit of effective tax rates is thus the percentage of the periodically determined economic profit of an investment to be paid to the state as taxes. As a result the effective tax rate is the tax rate applied to periodically determined economic profits and yielding the same shareholder value of the investment as when applying the statutory tax rate on periodically determined tax accounting profits.

I demonstrate, that the widely used effective tax rates of King and Fullerton (1984) and Devereux and Griffith (2003) both follow this concept and give the percentage of the economic profit to be paid to the state as taxes. Using this insight it is possible to generalize their concept of effective tax rates in order to calculate effective average tax rates for all types of investments including even complex simulation models as the European Tax Analyzer. Although such effective tax rates can be calculated for arbitrary investments, they still allow for an economically meaningful comparison with the statutory tax rate in order to reveal inter-industry or inter-asset distortions.

The article is organized as follows. In section 2 I present some definitions of forward-looking effective tax rates. In section 3 I generalize the concept of effective tax rates and show, that most other definitions of effective tax rates follow the here proposed concept. I show how to calculate effective tax rates for arbitrary investments including complex simulations models as the European Tax Analyzer. In section 4 I calculate some effective tax rates for Germany in order to demonstrate empirically the differences between the definitions due to different assumptions and measurement concepts.

2 Existing Definitions of Effective Tax Rates

I discuss forward-looking measures and not backward-looking measures calculated from aggregate data or accounting data as done by Mendoza, Razin and Tesar (1994). Recently Gordon, Kalambokidis and Slemrod (2004) as well as Becker and Fuest (2006) proposed measures for effective marginal tax rates in order to correct model based effective tax rates for the various complex provisions of tax codes using accounting data. Therefore, also their measures in the end rely on accounting data and share the same disadvantages as the measure by Mendoza, Razin and Tesar (1994).

Backward-looking measures calculated from aggregate data or accounting data are not connected to decision problems of firms (Fullerton (1984, 30)). Since investment decisions depend on current and expected future tax rules, a measure of the effective tax rate should in principle be forward-looking if it is meant to capture the effects of taxation on the incentive to invest. However, in practice, it is very difficult to incorporate the effects of all the complex details of the tax code in a forward-looking model of the effective tax rate. The main advantage of backward-looking measures is that the impact of all the special provisions in the tax law tend to be reflected in the revenue data used to construct these measures (Sørensen (2004)).

Therefore forward-looking measures capture the effects of taxation on the incentive to invest whereas backward-looking measures are important in order to control the results of forward-looking measures. If there are huge differences between average tax rates and model based effective tax rates, this gives hints for having chosen the wrong investment projects for the calculation of the effective tax rates.

2.1 The Definition of King and Fullerton

Well known is the *E*ffective *M*arginal *T*ax *R*ate ($EMTR^{KF}$) defined by King and Fullerton (1984). They calculate the pre tax real rate of return of all kind of investments. The wedge between the pre tax real rate of return and the after tax real rate return of investments (which always equals the after tax interest rate) is due to taxation. The resulting effective tax rate is defined as the percentage share of this wedge with respect to the pre tax real rate of return. This effective tax rate is equal to the statutory tax rate on interest for the capital market investment. It would be equal to the statutory tax rate for all other kinds of investments, if their tax accounting profits were determined equally. Since this is typically not the case, such effective tax rates inform on the effect of the tax base on the overall tax load. If the effective tax rate is below the statutory tax rate on interest, the tax accounting profit of the investment in question is determined too generous, if it is above the statutory tax rate on interest, it is determined too restrictive.

Formally they consider an investment (Jorgenson (1963) and Hall and Jorgenson (1967)) with capital value R^{KF} if the investment is financed by retained earnings. The firm invests in period $t = 0$ in the acquisition of a capital good of the value of 1. In the following periods $t > 0$ this investment brings in returns of $(p + \delta)(1 - \delta)^{t-1}$ before taxation determined by the statutory tax rate τ and depreciation allowances $\alpha(1-\alpha)^{t-1}$ in each period at the firm level and by the personal tax rate on dividend income m^d at the personal level.

$$\begin{aligned} R^{KF} &= (1-z)\gamma\Big\{-1+\sum_{t=1}^{\infty}\frac{(1-\tau)(p+\delta)(1-\delta)^{t-1}}{(1+\rho)^t}+ \\ &\quad +\sum_{t=1}^{\infty}\frac{\tau\alpha(1-\alpha)^{t-1}}{(1+\rho)^t}\Big\} = \\ &= (1-z)\gamma\Big\{-1+\frac{(1-\tau)(p+\delta)}{\delta+\rho}+\frac{\tau\alpha}{\alpha+\rho}\Big\} \end{aligned} \tag{1}$$

p is the real rate of return of the investment, δ economic depreciation, ρ the valuation factor of the shareholder ($\rho = \frac{(1-m^r)}{1-z}r$), $\gamma = \frac{1-m^d}{1-z}$ the tax factor due to personal taxation, m^r the personal tax rate on interest, z a modified tax rate on capital gains and r the real interest rate. Other than King and Fullerton (1984) I use discrete cash flows and a valuation factor ρ independent of the way of finance (Scott (1987)) since I calculate similar to the approach of Devereux and Griffith (2003) the shareholder value of a representative shareholder. Using the original specification of $EMTR^{KF}$ does not change any of the results in section 3.4.

The shareholder pays taxes on interest at rate m^r and taxes on capital gains at the modified tax rate z. The shareholder sells (See King (1974)) his shares each period (including period $t = 0$), respectively capital gains are taxed on an accrual basis. Due to this assumption $(1 - z)$ occurs in the denominator of the valuation factor $\rho = \frac{1-m^r}{1-z} r$, in the denominator of $\gamma = \frac{1-m^d}{1-z}$ and in front of equation (1). The discount rate of the shareholder is $s = (1 - m^r)r$. On the contrary ρ is a valuation factor under consideration of the effects of capital gains taxation on the shareholder value. Similar shareholder values can be computed if the investment is financed by new equity or debt.

Setting the shareholder value in equation (1) equal to zero and solving (Fixed-r-case, see King and Fullerton (1984, 12)) for p gives the real rate of return $\tilde{p}$ (cost of capital), which the investment must yield in order to be carried out in a world with taxation. The effective marginal tax rate $EMTR^{KF}$ is defined as

$$EMTR^{KF} = \frac{\tilde{p} - s}{\tilde{p}} \tag{2}$$

$EMTR^{KF}$ gives the part of the real rate of return $\tilde{p}$ the shareholder has to transfer to the state because of taxation.

2.2 The Definition of Devereux and Griffith

The effective marginal tax rate defined by King and Fullerton informs on the effect of taxation on the marginal investment decision: To what extent does taxation affect a firm's decision on the amount of investment chosen for different assets and countries? This is different from the effect of taxation on the location decision of multinationals. Multinationals are not mainly concerned with the effect of taxation on the marginal investment unit, their major concern is the tax load on the investment as a whole. Therefore Devereux and Griffith (2003) (See also Devereux and Griffith (1998b) and (2002)) define the effective average tax rate $EATR^{DG}$. This effective tax rate gives the reduction of an investment's value through taxation relative to its pre tax real rate of return. Their measure informs on the effects of taxation if firms choose between a number of mutually exclusive locations for their investment.

Formally the effective average tax rate $EATR^{DG}$ defined by Devereux and Griffith (2003) is based on an investment which increases the physical capital stock of the firm by one unit in period t only. The resulting pre-tax shareholder value $R^\star$ when the investment if financed by retained earnings and ignoring inflation ($\pi = 0$) is

$$R^\star = -1 + \frac{(p + \delta) + (1 - \delta)}{1 + r} \tag{3}$$

and the resulting post-tax shareholder value R^{DG} is

$$R^{DG} = \gamma\Big\{ -(1-A) + \frac{(1-\tau)(p+\delta)+(1-\delta)(1-A)}{1+\rho}\Big\} \tag{4}$$

with A being the net present value of depreciation allowances. Similar shareholder values can be computed if the investment is financed by new equity or debt. The resulting definition of the effective average tax rate is

$$EATR^{DG} = \frac{R^{\star} - R^{DG}}{p/(1+r)} \tag{5}$$

Setting equation (4) equal to zero and solving for p gives the cost of capital $\tilde{p}$. Using this $\tilde{p}$ it is possible to define the effective marginal tax rate $EMTR^{DG}$

$$EMTR^{DG} = \frac{\tilde{p} - r}{\tilde{p}} \tag{6}$$

Other than $EMTR^{KF}$, which is defined relatively to the post-tax rate of return s earned by the shareholder, $EMTR^{DG}$ is defined relatively to r. Therefore obviously $EMTR^{DG}$ and $EMTR^{KF}$ will differ when taking personal taxation into account.

2.3 The Definition of Schreiber et al.

Devereux and Griffith consider the reduction of an investment's value through taxation. However, the effect of taxation on an investment's value is twofold. Firstly, the taxation of the investment itself *decreases* its value. Secondly, the taxation of the alternative capital market *increases* its value (See Sinn (1987), p. 145–146, for a discussion of this effect) because of the resulting lower discount factor. Since only the first of the two effects is of interest for the location decision of firms, Schreiber, Spengel and Lammersen (2002) isolate the effect of the investment's taxation from the effect of the capital market taxation.

Formally they slightly change the defined capital value R^{DG} by the factor $(1-z)$ and assume, that the shares are sold also in period $t=0$. They define

$$R^{SSL} = (1-z)\Big[\gamma\Big\{ -(1-A) + \frac{(1-\tau)(p+\delta)+(1-\delta)(1-A)}{1+s}\Big\}\Big] \tag{7}$$

and the effective average tax rate

$$EATR^{SSL} = \frac{p - p_s}{p} \tag{8}$$

with $p = R^{\star}(1+r)+r$, $p_s = R^{SSL}(1+s)+s$ and $s=(1-m^r)r$. Similar shareholder values and corresponding average tax rates can be computed when the investment is financed by new equity or debt.

Considering the marginal investment project gives $EMTR^{SSL}$ ($R^{SSL} = 0$, hence $p_s = s$)

$$EMTR^{SSL} = \frac{p - s}{p} \tag{9}$$

and the definition of $EMTR^{SSL}$ is identical to the definition of $EMTR^{KF}$.

The main remaining shortcoming of $EATR^{SSL}$ as well as of $EATR^{DG}$ is, that both effective tax rates are derived from a one-period variation of the firm's capital stock. Therefore these models might not replace models that are based on the firm's financial and cash flow statements over a period of more than one year.

2.4 The European Tax Analyzer

The European Tax Analyzer (See Jacobs and Spengel (2000)) is a model firm computer program for calculating and comparing effective average tax burdens for companies located in different countries. The tax burden can be calculated for the level of the corporation as well as for the level of the shareholders. For the sake of comparability it is assumed that the model firm in each country shows identical data before any taxation. Due to this assumption any differences between pre- and post-tax data in the model can be solely attributed to taxation. The effective average tax burden is derived via simulating the development of a corporation over a T-year period considering detailed rules for tax profit computation as e.g. depreciation, inventory stock valuation, development costs, capital gains taxation, employee pensions schemes, provisions for bad debts and loss relief. The important advantage of the model firm approach compared to the above-presented definitions of effective tax rates is the possibility to include various complex provisions of tax codes.

Using the firm's cash-flow-statements the pre-tax value FV and the post-tax value FV^τ of the firm at the end of the T-year simulation period is derived. The pre-tax value FV and the post-tax value FV^τ can be transformed into an annualized pre-tax rate of return $\omega = \sqrt[T]{\frac{FV}{I_0}} - 1$ and into an annualized post-tax rate of return $\omega^\tau = \sqrt[T]{\frac{FV^\tau}{I_0}} - 1$ based on the initial equity of the firm I_0. Using these two annualized rates of returns the effective average tax rate $EATR^{ETA}$

$$EATR^{ETA} = \frac{\omega - \omega^\tau}{\omega} \tag{10}$$

is defined.

3 Generalizing the Concept of Effective Tax Rates

3.1 The Unique Reference Tax Base

Statutory tax rates give the percentage of the periodically determined *tax accounting profit* to be paid to the state as taxes. Since the tax accounting profit typically is country specific, a comparison of statutory tax rates is not sufficient for evaluating the tax load of firms. For this purpose we need a comparison of effective tax rates based on a *unique* reference tax accounting profit (reference tax base) to ensure comparability. The resulting effective tax rate will reveal that the considered investment's tax accounting profit is discriminatory/preferential compared to the reference tax base, if the resulting effective tax rate is higher/lower than the statutory tax rate. Comparing the effective tax rates to each other will reveal, which investment is taxed more/less favorable.

The importance of this point can not be underestimated. Although most effective tax rates are expressed in percentage figures, they are only comparable in a meaningful way if the reference tax base underlying the computation of the effective tax rates is identical.

3.2 An Economically Meaningful Reference Tax Base

Effective tax rates are expressed in the same economic unit and are thus comparable, as long as their reference tax base is identical. They then inform on the relative tax load of investments. However, only if this reference tax base fulfills certain economic criteria, effective tax rates are further useful for the analyses of inter-industry distortions and inter-asset distortions caused by taxation. In the following I discuss such economically meaningful reference tax bases.

3.2.1 Neutral Taxation - The Johansson/Samuelson Tax

If interest is subject to taxation[1] at the same rate as business profits and the true loss of economic value (economic depreciations) is permitted as a tax-deductible depreciation expense, then the capital value of an investment is independent of taxation (See Samuelson (1964) and Johansson (1969)). Such tax systems are neutral with respect to investment decisions, since the capital value in a world with taxation

[1] If interest payments are tax-exempt, neutrality can also be achieved using the cash-flow tax, see Brown (1948).

is identical to the capital value in a world without taxation. The periodically determined net cash receipts of an investment less economic depreciations is the reference tax base in this case.

3.2.2 The Modified Johansson/Samuelson Tax

Almost all tax systems are acquisition cost based tax systems (and hence allow only depreciations summing up to the acquisition costs of assets) and as a result a positive capital value because of economic rents is subject to tax (See Lammersen (2005), 138). Using the Johansson/Samuelson Tax as described above and taxing the capital value of investments, will still achieve neutrality but will result in effective tax rates not deviating from statutory tax rates because of the lacking taxation of economic rents. Therefore if choosing the Johansson/Samuelson as the reference tax system, the modified version should be used.

The resulting effective tax rate will reveal that the considered investment is taxed discriminatory/preferential, if the resulting effective tax rate is higher/lower than the statutory tax rate on interest. Comparing the effective tax rates to each other will reveal, which investment is taxed more/less favorable since such effective tax rates give the percentage of the economic profit defined using the modified Johansson/Samuelson tax an investor has to transfer to the state because of taxation.

However, the distortions calculated for investments generating economic rents will only matter if investors choose between mutually exclusive investments, since otherwise investors can get financial means from the (perfect) capital market in order to carry out their investments. The resulting effective tax rates will not allow to conclude whether there is under- or overinvestment in certain assets in general. For this purpose it is necessary to calculate the cost of capital or to report explicitly the effective tax rate calculated for the marginal investment ($p = r$).

3.2.3 Economic Depreciation of Marginal Investments as the Reference Tax Base

When using the Johansson/Samuelson tax as the reference tax system but keeping economic depreciations constant at the level of the marginal investment (including investments generating economic rents), all resulting effective tax rates will inform on whether taxes distort the level of investment chosen. An effective tax rate below (above) the statutory tax rate on interest supports the presumption that the level of investment is higher (lower) compared to a situation in which no taxes are considered or when taxes are neutral with respect to investment decisions

Such effective tax rates give the percentage of the real pre-tax rate of return an investor has to transfer to the state because of taxation and therefore allow to interpret the deviation of the effective tax rate from the statutory tax rate on interest in an economically meaningful way and to compare effective tax rates calculated for different pre-tax rates of return.

No information is available in this case, whether taxation distorts the choice of investors between a number of mutually exclusive investments generating economic rents. This reference tax system is used by King and Fullerton, Devereux and Griffith and Schreiber, Spengel and Lammersen.

3.2.4 Comparison of these Reference Tax Bases

Defining the reference tax base using the modified Johansson/Samuelson has the advantage to reveal distortions concerning mutually exclusive investments generating economic rents. However, the far most important situation where investors have to choose between a number of mutually exclusive investments generating economic rents is the international location decision and for such location decisions up to now no neutral tax systems exists (Auerbach, Devereux and Simpson (2007), 19). Hence defining the reference tax base using the modified Johansson/Samuelson tax has the advantage to reveal distortions concerning mutually exclusive *national* investments generating economic rents only. Whether such decision situations arise sufficiently frequent in order to justify the use of the modified Johansson/Samuelson tax is an empirical and so far unresolved issue. Furthermore in the (modified) Johansson/Samuelson tax system unless for $p = r$ depreciations do not sum up to the acquisition costs of assets. This deviation from the prevalent acquisition cost based tax systems has to be kept in mind when interpreting the effective tax rates and may be misleading for non-scientific users, e.g. when effective tax rates are used for policy consulting.

On the contrary using economic depreciations of marginal investments the resulting effective tax rates do not allow to reveal distortions concerning mutually exclusive investments generating economic rents, but instead inform on whether taxes distort the level of investment chosen. The influence of taxation on the investment level of firms has been proven to be empirically significant (See e.g. Chirinko (2002), Chirinko, Fazzari and Meyer (1999) and Cummins, Hassett and Hubbard (1996)). Furthermore using economic depreciations of marginal investments as the reference tax base is in line with acquisition-based tax systems, since such depreciations sum up to the acquisition cost of assets used for the investment.

Which reference tax base to choose therefore depends on the distortion to reveal. In section 4 effective tax rates are computed for both reference tax bases.

3.3 A General Definition of Effective Tax Rates

If the reference tax base is determined, the effective tax rate evaluates to which extent the actual tax accounting profit deviates from the reference tax base. The effective tax rate is the tax rate, which yields in combination with the reference tax base the same investment value as the statutory tax rate in combination with the actual tax accounting profit. In order to compute such effective tax rates formally as the first step I consider an arbitrary investment, e.g. the investment defined in equation (1) and calculate the resulting shareholder value R^{KF}

$$R^{KF} = (1-z)\gamma\Big\{-1+\frac{(1-\tau)(p+\delta)}{\delta+\rho}+\frac{\tau\alpha}{\alpha+\rho}\Big\} \tag{11}$$

As the second step I choose the reference tax base, which is the reference tax base described in section 3.2.3 here. The reference tax base thus is the periodically determined net cash receipts of the investment less economic depreciations, where economic depreciations are kept constant at the level of the marginal investment. I then reconsider the investment project assuming a tax system defined through the statutory tax rate κ and this reference tax base and calculate the resulting shareholder value R^{κ}, e.g. for the investment in equation (11)

$$R^{\kappa} = -1+\sum_{t=1}^{\infty}\frac{[(1-\kappa)p+\delta](1-\delta)^{t-1}}{(1+s)^{t}} = -1+\frac{(1-\kappa)p+\delta}{\delta+s} \tag{12}$$

Setting $R^{KF}=R^{\kappa}$

$$\begin{aligned} R^{KF} &= (1-z)\gamma\Big\{-1+\tfrac{(1-\tau)(p+\delta)}{\delta+\rho}+\tfrac{\tau\alpha}{\alpha+\rho}\Big\} = \\ &= R^{\kappa} = -1+\textstyle\sum_{t=1}^{\infty}\tfrac{[(1-\kappa)p+\delta](1-\delta)^{t-1}}{(1+s)^{t}} = -1+\tfrac{(1-\kappa)p+\delta}{\delta+s} \end{aligned} \tag{13}$$

and solving for κ gives the effective tax rate κ^{KF}. The investor is indifferent between the realization of the investment in the country, whose tax system is defined through the statutory tax rate κ^{KF} and a tax base, where investment allowances are equal to true economic depreciation, or in the country, whose tax system is defined through the statutory tax rate τ and depreciation allowances $\alpha(1-\alpha)^{t-1}$ in each period. I thus call such effective tax rates indifference based effective tax rates.

It is possible to use arbitrary investment projects instead of R^{KF}, including complex model firms as it does e.g. the European Tax Analyzer and including a multi-period framework, and to calculate the indifference tax rate. The concept of indifference based effective tax rates hence allows taking complex provisions of tax codes into account as e.g. provisions, loss carry forwards, accumulation strategies or imputation systems.

3.4 Comparing Indifference Based Effective Tax Rates to Existing Definitions of Effective Tax Rates

3.4.1 Indifference Based Effective Tax Rates and the Definition of King and Fullerton

Although the computation of the effective tax rate defined by King and Fullerton differs from the computation of indifference based effective tax rates, the resulting tax rates are identical. The only prerequisite is, that the reference tax base for calculating the indifference based effective tax rate is determined through economic depreciations of marginal investments as it is the case for the King and Fullerton effective tax rate. However, indifference tax based are the more general concept, since the King and Fullerton effective tax rate can be computed for marginal investments only.

Formally the definition of $EMTR^{KF}$ demands $R^{KF} = 0$. Setting R^{KF} equal to zero in (13) and solving for the indifference tax rate κ^{KF} gives

$$\begin{aligned} -1 + \frac{(1-\kappa^{KF})p + \delta}{\delta + s} &= 0 \qquad (14) \\ \kappa^{KF} &= \frac{p - s}{p} \end{aligned}$$

Hence the definitions of κ^{KF} and $EMTR^{KF}$ (see equation (2)) are identical. On the contrary[2] to $EMTR^{KF}$, κ^{KF} is defined for any value of p including investments generating economic rents ($p > \tilde{p}$).

3.4.2 Indifference Based Effective Tax Rates and the Definition of Schreiber et al.

Also the effective tax rate defined by Schreiber, Spengel and Lammersen is identical to indifference based effective tax rates, as long as the chosen reference tax base

[2]Using the fixed p-case proposed by King and Fullerton (1984) allows to calculate $EMTR^{KF}$ also in these cases. However, using the fixed p-case of King and Fullerton (1984) means relying on the internal rate of return as a measure of profitability, since the fixed p-case of King and Fullerton (1984) is defined through calculating s given p in order to set R^{KF} equal to zero. See Schreiber, Spengel and Lammersen (2002, 4) for the problems related to using internal rates of return as a measure of profitability.

is determined identically through economic depreciations of marginal investments. Formally if I calculate the indifference tax rate for the investment project considered by Schreiber, Spengel and Lammersen (2002) in equation (4), κ^{SSL} is defined by

$$R^{SSL} = (1-z)\gamma\Big\{-(1-A) + \tfrac{(1-\tau)(p+\delta)+(1-\delta)(1-A)}{1+s}\Big\} = \\ = -1 + \tfrac{(1-\kappa^{SSL})p+1}{1+s} \qquad (15)$$

Solving equation (15) for κ^{SSL} and using $p_s = R^{SSL}(1+s)+s$ gives

$$\kappa^{SSL} = \frac{p-p_s}{p} \qquad (16)$$

Hence the definition of κ^{SSL} and the effective average tax rate $EATR^{SSL}$ (see equation (8)) are identical. On the contrary to $EATR^{SSL}$, indifference based effective tax rates can be calculated for arbitrary investment projects, including complex simulation models like the European Tax Analyzer and including a multi-period framework.

3.4.3 Indifference Based Effective Tax Rates and the Definition of Devereux and Griffith

Following Schreiber, Spengel and Lammersen (2002, 15) $EATR^{SSL}$ and $EATR^{DG}$ are identical in the case of no personal taxation ($m^r = z = 0$). As a consequence also the effective tax rate proposed by Devereux and Griffith uses the here proposed economic unit for defining effective tax rates.

However, in the case of no personal taxation ($m^r = z = 0$) it is not possible to base $EATR^{DG}$ on indifference considerations. This is because $EMTR^{KF}$, $EATR^{SSL}$ and indifference based effective tax rates are measured in other economic units than $EATR^{DG}$: The former give the percentage of the real rate of return an investor has to transfer to the state because of taxation, whereas the latter gives the reduction in the capital value caused by the transition of a world without taxation to a world with taxation. Whether the capital value R^{DG} decreases or increases due to the introduction of taxation, depends on the comparison of the taxation of interest and the taxation of real investment.

E.g. if the joint taxation of returns through taxation at the firm level and dividend taxation is lower than the taxation of interest income, the capital value R^{DG} in a world with taxation is even larger (Sinn (1987, 145-146)) than in a world without taxation $R^{\star}$. In such situations $EATR^{DG}$ is negative giving the intuition that the investor receives subsidies, although there are positive tax payments at the firm and personal level. On the contrary $EMTR^{KF}$, $EATR^{SSL}$ or indifference based effective tax rates will never be zero or negative as long as there is a positive capital value of tax payments due to the considered investment.

This possible wrong intuition given by $EATR^{DG}$ when taking personal taxation into account is due to a change in the measurement concept of $EATR^{DG}$ when introducing personal taxation: Whereas $EATR^{DG}$ when ignoring personal taxation expresses the gap between the pre-tax real rate of return and the after-tax real rate of return as an effective tax rate as all other definitions of effective tax rates do, $EATR^{DG}$ when taking personal taxation into account gives the reduction in the capital value caused by the transition of a world without taxation to a world with taxation.

The modification of the concept of Devereux and Griffith proposed by Schreiber, Spengel and Lammersen (2002) or the here proposed indifference tax rates allow to calculate meaningful effective tax rates also with personal taxation. Furthermore the importance of personal taxation is crucial anyway, since it depends on whether personal taxation does or does not affect corporate investment decisions. There are good reasons for excluding personal taxation from such calculations (European Commission (2001, 77-78)).

3.4.4 Indifference Based Effective Tax Rates and the European Tax Analyzer

As pointed out by Spengel and Lammersen (2001) the effective average tax rate used by the European Tax Analyzer does not allow any comparison with statutory tax rates or with other effective tax rates. As a consequence $EATR^{ETA}$ can not be interpreted as an indifference tax rate.

However it is possible to calculate indifference based effective tax rates using the European Tax Analyzer. Therefore the shareholder value of the model firm has to be calculated twice: once based on the actual tax system and additionally based on the tax base defined by economic depreciation and tax rate κ. Equating these two shareholder values and solving for κ (e.g. by using iteration techniques) will give the indifference tax rate κ^{ETA}. This indifference tax rate is directly comparable to the statutory tax rate and to all effective tax rates that can be interpreted as indifference based effective tax rates such as $EATR^{SSL}$, $EMTR^{KF}$ and $EATR^{DG}$ (when ignoring personal taxation).

As a result, using indifference based effective tax rates and model firms like the European Tax Analyzer, it is possible to calculate effective tax rates taking complex provisions of tax codes into account and to compare them directly to the effective tax rates calculated e.g. by the European Commission (2001). This may be a very helpful sensitivity analysis. Such indifference based effective tax rates reveal inter-asset and inter-industry distortions. They can be compared to statutory tax rates in order to indicate, whether an investment is advantaged or disadvantaged.

3.5 Benefits from Using Indifference Based Effective Tax Rates

Indifference based effective tax rates higher/lower than the statutory tax rate on interest reveal, whether an investment is taxed discriminatory/preferential. Indifference based effective tax rates can be calculated for arbitrary investment projects, including complex simulation models like the European Tax Analyzer and including a multi-period framework. They allow taking complex provisions of tax codes into account as e.g. provisions, loss carry forwards, accumulation strategies or imputation systems. On the contrary the definition of King and Fullerton (1984) is tied to marginal investment projects and the definition of Devereux and Griffith (2003) as well as the definition of Schreiber, Spengel and Lammersen (2002) is tied to a very special investment project, which increases the physical capital stock of the firm by one unit in period t only (one-period framework). Indifference based effective tax rates calculated for complex simulation models like the European Tax Analyzer can be compared to statutory tax rates in order to indicate, whether an investment is advantaged or disadvantaged compared to (neutrally taxed) financial assets.

Using complex simulation models and considering specific issues of tax codes like e.g. the treatment of loss carry forwards, provisions or the attractiveness to accumulate profits due to lower tax rates for corporations may result in large deviations from the effective tax rates calculated using the definition of Devereux and Griffith (2003) or Schreiber, Spengel and Lammersen (2002) as demonstrated in section 4.

Since it is technically not possible to extend the one-period framework used for the calculation of the effective average tax rate defined by Schreiber, Spengel and Lammersen (2002) to a multi-period framework (Schreiber, Spengel and Lammersen (2002, 16)), the use of this effective tax rate results in a systematic underestimation of the effect of capital gains taxation and inflation on the effective tax rate. With regard to capital gains taxation ($z > 0$) the multi-period framework will result in a higher shareholder value due to the longer duration of the investment and hence higher capital gains tax payments. With regard to inflation tax codes normally allow no correction of capital decreases for inflation. But the later capital decreases occur, the higher the effect of inflation in combination with personal taxation and finance by new share issues on the effective tax rate is.

Other than the effective tax rate defined by Devereux and Griffith (2003) indifference based effective tax rates with and without personal taxation can be compared in order to show the effect of personal taxation. On the contrary comparing $EATR^{DG}$ with and without personal taxation will lead to a systematic underestimation of the effect of personal taxation.

Indifference based effective tax rates give the percentage of the real pre-tax rate of return an investor has to transfer to the state because of taxation and therefore allow to interpret the deviation of the indifference tax rate from the statutory tax rate on interest in an economically meaningful way. This interpretation of the deviations from the statutory tax rate also allows comparing indifference based effective tax rates calculated for different pre-tax rates of return. The higher the resulting indifference tax rate is, the higher is the percentage of the real pre-tax rate of return an investor has to transfer to the state because of taxation and the less favorable the tax treatment is. Therefore indifference based effective tax rates are suitable for international comparisons of the effective tax burden.

Indifference based effective tax rates offer a simple economic intuition for the interpretation of effective tax rates. Indifference based effective tax rates as well as all other definition of effective tax rates, which have been shown to be identical to indifference based effective tax rates in section 3.4, translate deviations from a given tax base into equivalent changes in tax rates. Is the actual tax base more favorable than a tax base, where investment allowances are equal to true economic depreciation, the effective tax rate is lower than the statutory tax rate and vice versa. This simple economic intuition for the interpretation of effective tax rates offered by the concept of indifference based effective tax rates allows understanding the economic reasoning behind the concepts of effective tax rates without any need to get involved into the sometimes technically complicated calculation of effective tax rates.

4 An Example

4.1 Assumptions

In order to demonstrate the differences in the effective tax rates, I calculate effective tax rates for Germany as proposed by the Tax Reform Act 2008 for fiscal year 2008. I consider the investment in machines of an individual in a German corporation.

Table 1: Effective marginal tax rates - Scenario 1

in %	NE	RE	D
cost of capital KF	4.70	4.40	5.04
cost of capital DG	4.70	4.40	5.04
cost of capital SSL	4.70	4.40	5.04
$EMTR^{KF}$	44.12	40.31	47.89
$EMTR^{DG}$	-6.38	-13.64	0.79
$EMTR^{SSL}$	44.12	40.31	47.89
κ^{KF}	44.12	40.31	47.89
κ^{JS}	41.94	36.32	48.18
κ^{JSm}	41.88	36.21	47.87

$r = 0.05$, $\pi = 0.00$, $\delta = 0.2$, $m^d = 0.2374$, $m^r = 0.4748$, $z = 0.1880$, $\tau = 0.2983$, $\alpha = \frac{1}{7}$ for $t = 1 - 7$; cost of capital KF: real rate of return $p = \tilde{p}$ resulting from setting equation (1) to zero and solving for p; cost of capital DG: real rate of return resulting from setting equation (4) to zero and solving for p; cost of capital SSL: real rate of return resulting from setting equation (7) to zero and solving for p; κ^{KF} uses economic depreciations of marginal investments as the reference tax base as described in section 3.2.3, κ^{JS} uses the Johansson/Samuelson tax as the reference tax base as described in section 3.2.1 and κ^{JSm} uses the modified Johansson/Samuelson tax as the reference tax base as described in section 3.2.2; NE: new equity financing; RE: retained earnings financing; D: debt financing.

Corporations are taxed at a joint rate including corporate and trade[3] taxation of $\tau = 29.83\%$. Machines can be depreciated linearly over 7 years. At the personal level dividends are taxed at a rate of $m^d = 23.74\%$ and interest at a rate of $m^r = 47.48\%$ including the solidarity surcharge. The statutory capital gains tax is $z_s = 23.74\%$ for qualified participations and the modified[4] capital gains tax is $z = 18.80\%$. I assume further a real interest rate $r = 0.05$, no inflation $\pi = 0.00$ and economic depreciation $\delta = 0.20$ (scenario 1). I calculate the effective marginal tax rates in table 1 and the effective average tax rates in table 2. For the calculation of the effective average tax rates I assume a real pre-tax rate of return $p = 0.20$ and for the calculation of the effective marginal tax rates a real pre-tax rate of return equal to the cost of capital. The effective tax rates are calculated using the above made assumptions and the definitions made in section 2 respectively 3.3 in the case of κ^{KF}.

4.2 Effective Marginal Tax Rates

Comparing the effective marginal tax rates in table 1 I find a large difference (around 50 percentage points in all cases) between $EMTR^{DG}$ and the other effective marginal tax rates. This difference is due to the fact, that $EMTR^{DG}$ is defined relative to r rather than relative to the post-tax rate of return s earned by the shareholder as the other definitions. The reference tax base for calculating the indifference based effective tax rate κ^{KF} is determined through economic depreciations of marginal investments as described in section 3.2.3. There is no difference between κ^{KF} and $EMTR^{SSL}$, since I assume no inflation and capital gains taxation does not matter for marginal investments. The indifference tax rate κ^{KF} is based on the investment project considered by King and Fullerton (1984) and therefore the resulting capital costs as well as the resulting marginal effective tax rate is identical to $EMTR^{KF}$ as shown in section 3.4.1.

The indifference based effective tax rate κ^{JS} uses the Johansson/Samuelson tax as the reference tax base as described in section 3.2.1 and the indifference based effective tax rate κ^{JSm} uses the modified Johansson/Samuelson tax as the reference tax base as described in section 3.2.2. They are both lower than κ^{KF} in the case of new equity (NE) and retained earnings (RE), because economic depreciations calculated for the cost of capital below the real interest rate $r = 0.05$ are smaller than the economic depreciations calculated for $p = r = 0.05$. κ^{JS} and κ^{JSm} only differ slightly, since the taxation of the capital value does not matter too much for real pre-tax rate of returns p near the real interest rate $r = 0.05$.

4.3 Effective Average Tax Rates

4.3.1 Comparing κ^{KF} and $EATR^{SSL}$

Comparing the effective average tax rates (calculated at a real pre-tax rate of return of $p = 20\%$) in table 2 I find a rather small difference (around one percentage point in all cases) between the indifference tax rate κ^{KF} and $EATR^{SSL}$. This difference is due to a systematic underestimation of capital gains taxation when using the definition of Schreiber, Spengel and Lammersen (2002) as argued above in section 3.5. The systematic underestimation arises, since $EATR^{SSL}$ is based on considering an increase in the physical capital stock of a firm by one unit in period t only.

[3] For the purpose of trade taxation only 75 % of the interest payments can be deducted in the case of debt finance.

[4] I assume $\lambda = 0.1$, for the calculations see Schreiber, Spengel and Lammersen (2002), 13.

Table 2: Effective average tax rates - Scenario 1

in %	NE	RE	D
κ^{KF}	46.99	46.21	47.88
κ^{JS}	117.48	115.54	119.71
κ^{JSm}	42.81	41.97	43.78
$EATR^{DG}$	23.71	22.71	24.85
$EATR^{SSL}$	46.16	45.34	47.07
$EATR^{DGz}$	33.35	32.54	34.28

$r = 0.05$, $\pi = 0.00$, $\delta = 0.2$, $m^d = 0.2374$, $m^r = 0.4748$, $z = 0.1880$, $\tau = 0.2983$, $\alpha = \frac{1}{7}$ for $t = 1 - 7$, $p = 0.2$; κ^{KF} uses economic depreciations of marginal investments as the reference tax base as described in section 3.2.3, κ^{JS} uses the Johansson/Samuelson tax as the reference tax base as described in section 3.2.1 and κ^{JSm} uses the modified Johansson/Samuelson tax as the reference tax base as described in section 3.2.2; NE: new equity financing; RE: retained earnings financing; D: debt financing.

Table 3: Effective average tax rates - Scenario 2 A

in %	NE	RE	D
κ^{KF}	49.99	56.17	50.81
$EATR^{SSL}$	46.73	53.46	47.63

$r = 0.05$, $\pi = 0.02$, $\delta = 0.2$, $m^d = 0.2374$, $m^r = 0.4748$, $z = 0.5000$, $\tau = 0.2983$, $\alpha = \frac{1}{7}$ for $t = 1 - 7$, $p = 0.2$; NE: new equity financing; RE: retained earnings financing; D: debt financing.

However the difference between the indifference tax rate κ^{KF} and $EATR^{SSL}$ may be much higher when assuming higher inflation or a higher capital gains tax rate. If I assume e.g. an effective capital gains tax rate of $z = 50\%$ (scenario 2 A) instead of $z = 18.80\%$ as before, I calculate the average tax rates presented in table 4. Now I find a difference of around three percentage points in all cases.

The difference between the indifference tax rate κ^{KF} and $EATR^{SSL}$ may increase even more in case of inflation. If I assume e.g. an effective capital gains tax rate of $z = 50\%$ and an inflation rate $\pi = 0.02$, I calculate the average tax rates presented in table 3. Now I find a difference of around five percentage points in all cases.

As to be expected the indifference based effective tax rates κ^{JS} using the Johansson/Samuelson tax as the reference tax base are much higher than the other effective tax rates reflecting the fact, that under the current German tax system economic rents are subject to tax. On the contrary the indifference based effective tax rates

Table 4: Effective average tax rates - Scenario 2 B

in %	NE	RE	D
κ^{KF}	56.22	63.96	57.25
$EATR^{SSL}$	51.16	60.43	52.39

$r = 0.05$, $\pi = 0.02$, $\delta = 0.2$, $m^d = 0.2374$, $m^r = 0.4748$, $z = 0$, $\tau = 0.3500$, $\alpha = \frac{1}{7}$ for $t = 1 - 7$, $p = 0.2$; NE: new equity financing; RE: retained earnings financing; D: debt financing.

κ^{JSm} using the modified Johansson/Samuelson tax as the reference tax base are even lower than the indifference based effective tax rate κ^{KF}. The current acquisition based German tax base is in favor of real investments (See Homburg (2005), 343) and much closer to neutrality as one may think using the Johansson/Samuelson tax as the benchmark.

4.3.2 Comparing $EATR^{DG}$, $EATR^{SSL}$ and κ^{SSL}

Comparing the effective average tax rates (calculated at a real pre-tax rate of return of $p = 20\%$) in table 2 I find a huge difference between $EATR^{DG}$ and $EATR^{SSL}$ (and hence also a huge difference between $EATR^{DG}$ and κ^{SSL}, since $\kappa^{SSL} = EATR^{SSL}$ when the definition of the indifference tax rate is based on R^{SSL} in equation (7)). Firstly this is because Schreiber, Spengel and Lammersen (2002) slightly change the defined capital value R^{DG} by the factor $(1 - z)$ and assume, that the shares are sold also in period $t = 0$, whereas Devereux and Griffith (2003) do not assume, that the shares are sold in period $t = 0$.

Secondly this is due to different measurement concepts as discussed above in section 3.4.3. I calculated $EATR^{DGz}$ (see table 2) using the definition of R^{SSL} in equation (7) instead of R^{DG} in equation (4). The huge difference remaining between $EATR^{DGz}$ (= 32.54%, retained earnings) and $EATR^{SSL}$ (= 45.34%) thus is only due to measuring in different economic units and not any more to differences in the considered investments.

The overall decrease of the capital value in a world with taxation compared to the capital value in a world without taxation (relevant for the definition of $EATR^{DG}$ and $EATR^{DGz}$) is smaller than the decrease in the real rate of return (relevant for the definition of $EATR^{SSL}$ and κ^{SSL}) caused by the taxation of the investment. The capital value and the real rate of return decrease because of the taxation of the real investment. But because of the taxation of interest reflected in the denominator of the after-tax capital value, taxation also leads to a higher after-tax capital value. There is no comparable effect on the after-tax real rate of return and hence on $EATR^{SSL}$ or κ^{KF}.

4.3.3 The Effect of Personal Taxation

The positive effect of personal taxation on the after-tax capital value R^{DG} may even outweigh the negative effect and as a result $EATR^{DG}$ becomes negative. Assume interest is taxed more heavily at a tax rate of $m^r = 60.00\%$ and the corporate tax rate is only $\tau = 10\%$. Then $EATR^{DG}$ in the case of retained earnings is -0.71%. The transition from a world without taxation to a world with taxation increases the capital value, since interest income is taxed more heavily than income from real investment. Still there are positive tax payments at the firm and personal level because of the investment undertaken, which is not reflected in the definition of $EATR^{DG}$. $EATR^{DG}$ gives the misleading impression that personal taxation is in favor of the investor.

Calculating $EATR^{DG}$ for the case of retained earnings and assuming no personal taxation ($m^d = m^r = z = 0$) gives $EATR^{DG} = 28.84\%$ (whereas $EATR^{DG}$ is 22.71% when taking personal taxation into account, see table 2). Therefore $EATR^{DG}$ seems to show, that the tax load is lower when taking personal taxation into account. This is not true, since the taxation of dividends and capital gains taxation leads to additional tax payments. Therefore $EATR^{DG}$ when taking personal taxation into account is far too low and the impact of personal taxation is systematically underestimated.

This is because $EATR^{DG}$ without personal taxation is measured in other economic units than $EATR^{DG}$ with personal taxation: The former gives the percentage of the real rate of return an investor has to transfer to the state because of taxation, whereas the latter gives the reduction in the capital value caused by the transition of a world without taxation to a world with taxation. Therefore the results differ systematically and the impact of personal taxation is underestimated. The two measures must not be compared.

4.4 Implementing Complex Provisions of Tax Codes

Existing tax systems are much more complicated than the part of the tax system considered for calculating the effective tax rates defined either by King and Fullerton or Devereux and Griffith. Whereas the latter can be summarized using a few mathematical variables, already the tax codes of existing tax systems cover several books. Therefore calculating effective tax rates taking the real world complexities of tax codes into account is a necessary sensitivity analysis. Calculating indifference based effective tax rates for complex simulation models as e.g. the European Tax Analyzer will allow to compare the resulting effective tax rates to effective tax rates calculated using the prevalent definitions of King and Fullerton or Devereux and Griffith for the first time. This will be a very helpful sensitivity analysis in order see, to what extent the tax load of real world investments may differ from the suggested tax load based on existing concepts of effective tax rates.

One example for the various complex provisions of tax codes affecting the effective tax rate is the possibility to accumulate profits in corporations. Since the corporate tax rate is $\tau = 29.83\%$, whereas the tax rate on interest is $m^r = 47.48\%$, it is advantageous for corporations to accumulate profits instead of distributing them. If I assume (scenario 3) e.g., that the corporation accumulates all profits for period $t = 1 - 10$ at the after-tax market interest rate $(1 - \tau)i = (1 - \tau)(r + \pi + r\pi)$ and then distributes all accumulated profits in period $t = 10$, I calculate the effective tax rates presented in table 5. I assume furthermore, that the shares are not sold (hence $z = 0$), since in case of capital gains taxation the accumulation strategy is not advantageous. All other assumptions remain unchanged compared to scenario 1 (see section 4.1; the real pre-tax rate of return is $p = 0.2$).

Due to the technical restrictions of the model of Devereux and Griffith (2003) or the similar model of Schreiber, Spengel and Lammersen (2002), which are based on a one-period framework, it is not possible to calculate $EATR^{DG}$ or $EATR^{SSL}$ for the above described scenario 3 (See Schreiber, Spengel and Lammersen (2002), 22). The European Tax Analyzer allows taking accumulation strategies into account. However, as argued in section 3.4.4, the effective tax rates $EATR^{ETA}$ calculated using the European Tax Analyzer can not be compared to other effective tax rates or statutory tax rates in order to indicate, whether an investment is advantaged or disadvantaged compared to (neutrally taxed) financial assets. Therefore no[5] sensitivity analysis with respect to $EATR^{DG}$, $EATR^{SSL}$ or statutory tax rates is possible. The only effective tax rates, which can be calculated for scenario 3, are the indifference based effective tax rates κ^p presented in table 5.

When using the accumulation strategy κ^p is around 7 percentage points lower than when not using the accumulation strategy. Considering various complex provisions of tax codes may hence lead to serious deviations from effective average tax rates cal-

[5] $EATR^{ETA}$ only allows to check whether the ranking of investment alternatives is preserved, see Spengel and Lammersen (2001).

Table 5: Effective average tax rates - scenario 3

in %	no acc.	acc.
κ^{KF}	42.89	36.11
$EATR^{SSL}$	42.89	n.a.

$r = 0.05$, $\pi = 0.00$, $\delta = 0.2$, $m^d = 0.2374$, $m^r = 0.4748$, $z = 0$, $\tau = 0.2983$, $\alpha = \frac{1}{7}$ for $t = 1 - 7$, $p = 0.2$; acc.: I assume that the corporation accumulates all profits in period $t = 1 - 10$ at the after-tax market interest rate $(1 - \tau)i = (1 - \tau)(r + \pi + r\pi)$ and then distributes all accumulated profits in period $t = 10$; no acc.: Profits are distributed immediately to the shareholders; I assume retained earnings financing.

culated using the definition of Devereux and Griffith (2003) or the similar definition of Schreiber, Spengel and Lammersen (2002). Besides for accumulation strategies there are much more complex provisions of tax codes to be considered as demonstrated in the European Tax Analyzer.

It is technically not possible to calculate $EATR^{SSL}$ for the accumulation strategy. When not using the accumulation strategy $EATR^{SSL}$ is identical to κ^p, since there is no capital gains taxation.

5 Conclusion

I clarify the appropriate economic unit of effective tax rates. Effective tax rates give the percentage of the economic profit to be paid to the state as taxes. Only effective tax rates such as the effective tax rates proposed by King and Fullerton (1984) and Devereux and Griffith (2003) using this economic unit allow for a meaningful comparison with the statutory tax rate. Effective tax rates above the statutory tax rate indicate inter-industry distortions and inter-asset distortions caused through taxation.

This insight allows for a generalization of the concept of effective tax rates. Based on indifference considerations and using economic profits as the reference tax base it is possible to calculate effective tax rates for arbitrary investments including complex simulation models such as the European Tax Analyzer. On the contrary the definition of Devereux and Griffith (2003) as well as the definition of Schreiber, Spengel and Lammersen (2002) is tied to a one-period framework. Although such indifference based effective tax rates can also be calculated for models considering a firm's financial and cash flow statements over a period of more than one year, they are directly comparable to the effective tax rates defined by King and Fullerton (1984) and by Devereux and Griffith (2003). The economic intuition behind such indifference based effective tax rates is simple: They convert deviations from a reference tax base defined by economic depreciation into equivalent changes in statutory tax rates. As a consequence deviations of indifference based effective tax rates from the statutory tax rate on interest indicate, whether an investment is advantaged or disadvantaged compared to (neutrally taxed) financial assets. Using such indifference based effective tax rates I show, that considering various complex provisions of tax codes may lead to significant deviations from the effective average tax rate calculated using the definition of Devereux and Griffith (2003)).

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