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Measuring the Impact of Taxation on Investment and Financing Decisions

Abstract

Effective tax rates are a useful tool for policy makers as well as for business managers who might demand condensed but sophisticated information on investment tax burdens. Our paper discusses the measurement of the effective tax rate on profitable investment, i.e., investment that generates an economic rent. Based on an approach presented by *Devereux* and *Griffith*, we develop a standard measure of the effective average tax rate. This measure is directly connected with the widely used effective marginal tax rate. The measure uses a comparison with the statutory tax rate to indicate whether or not an investment is tax advantaged.

JEL-Classification: H24, H25, K34, M21.

1 Introduction

To a great extent, taxes influence investment and financing decisions. Decision makers must cope with the complexity of existing tax systems. They might be inclined to ignore complicated tax features and rely on statutory tax rates. Hence, they may make the wrong decisions with respect to taxes.

A promising way to deal with the complexity of taxes that does not ignore the most important features of tax systems beyond statutory tax rates is to use effective tax rates. Effective tax rates comprise the most important elements of a tax system. Such rates are useful for policy makers as well as for business managers, who demand condensed but sophisticated information on investment tax burdens.

In October 2001, the European Commission has presented an analytical study of company taxation in the European Community[1]. The report has been labelled the “Ruding II” report[2], in succession to the earlier original “Ruding” report[3], which was based on effective marginal tax burdens. These measures are appropriate for

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1 See *European Commission* (2001).

2 See *Kippenberg* (2001), p. 1.

3 See *European Commission* (1992).

assessing the impact of taxation on investments that do not earn more than their cost of capital.

However, investment decisions often concern inframarginal, profitable investments. For example, a multinational corporation would expect to earn an economic rent when deciding the location of a new plant. The measures presented by the "Ruding II" report, which are based on a new approach developed by *Devereux* and *Griffith*, take profitable investments into account.

Our paper focuses on technical and practical issues inherent in the measurement of effective tax burdens. In Section 2 we highlight the problems in the measurement of the effective tax burden on profitable investment. In Section 3 we discuss the approach developed by *Devereux* and *Griffith* (Section 3.1). Based on this approach, we develop an alternative measure of effective tax burdens on inframarginal investment projects (Section 3.2). We highlight the useful properties of this alternative measure in Section 3.3. In Section 4 we present an example based on the German 2000 corporate tax reform to illustrate the calculation and the interpretation of effective tax rates. Section 5 summarizes and concludes.

2 Approaches to Measuring the Effective Tax Burden

Measuring the effective tax burden for the effects of taxation on investment decisions requires a standard measure in order to separate the effects that stem from the statutory tax rates (and the interplay of personal and corporate taxes) and the effects that are attributable to the legal definition of the tax base. In the case of a uniform proportional income tax, this standard measure is well known. The effective tax burden on a marginal investment is equal to the statutory tax rate on interest payments once the allowances for each period follow the change in the earnings capacity value[4]. This result is valid only under several restrictive assumptions, the most important of which is the existence of a perfect capital market under certainty[5].

The effective marginal tax rate may differ from the statutory tax rate on interest payments, indicating that investment is advantaged or disadvantaged. An effective tax burden lower than the statutory tax rate shows that the determination of the tax base favors real investments over (neutrally taxed) financial assets. Otherwise it puts real investment at a disadvantage. This property of the measure makes it possible to draw a conclusion about the effects of taxation on allocative efficiency. An effective tax rate below (above) the statutory rate 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.

4 See *Samuelson* (1964); *Schneider* (1992), p. 243. An *EMTR* at the statutory tax rate only indicates neutrality for the investment decision in a system that taxes income comprehensively, i.e., which taxes interest. For a neutral consumption-based tax system, which we do not examine here, the effective marginal tax rate would be zero. See *King/Fullerton* (1984), p. 26.

5 For a survey of the premises of an investment neutral tax system see *Schneider* (1992), pp. 230–231.

A number of international studies[6] use the effective tax burden on marginal investment, calculated after the well-known approach developed by *King* and *Fullerton*[7], to explain the impact of taxation on cross-border investment activity. However, these studies only permit an analysis of whether the limit of profitability has been shifted by the tax system. Therefore, marginal effective tax rates are not relevant when the decision is between mutually exclusive investment opportunities. Companies that must decide between mutually exclusive investments calculate post-tax net present values to rank their investment opportunities.

Choosing between different countries in which to locate is a particularly good example of a decision of this type[8]. One of the advantages of a specific location may be a low effective level of taxation, as far as this cannot be achieved in another way. For example, a company might exploit margins for setting transfer prices inside an international group of companies. Another example of managerial decisions of this type is the choice of one of several mutually exclusive technologies for the production of a good that generates an economic rent. Or managers might have to choose an investment in a certain product type, e.g., the decision of a property developer on whether to build a business or an apartment structure on a given building site[9].

Therefore, the measurement of the effective tax burden on profitable investment, denoted as the effective *average* tax burden[10] (as opposed to the effective *marginal* tax burden), provides information on the impact of taxation on investment decisions of this type. This measure may be useful for business managers who rank investment projects, e.g., investments in different locations. Effective average tax rates give a first impression about the impact of tax rules on the post-tax economic rent associated with a project. Also, policy makers might be interested in this information, which they can use to improve national welfare, e.g., by attracting foreign direct investment, or to secure an efficient allocation of resources. Allocative effects can be expected if taxation changes the ranking of investment opportunities. This change is clearly illustrated when the investor is indifferent between two alternatives before taking taxes into account, but loses this indifference when he considers taxes[11].

Whereas the comparison of net present values shows the impact of taxation on the level and ranking of the present values, it is unsettled how an appropriate measure for the effective tax burden can be constructed. The measurement of the

6 See, e.g., *OECD* (1991); *European Commission* (1992).

7 See *King/Fullerton* (1984), pp. 7–30.

8 See *Bond* (2000), p. 171; *Devereux* (2000), p. 113; *Richter/Seitz/Wiegard* (1996), p. 19.

9 For this and other examples on decisions of this type see *Devereux/Griffith* (1999), pp. 10–13.

10 The concept of the effective average tax rate as the tax burden on profitable investment should not be confused with the concept of the average statutory tax rate or a concept of an effective average tax burden that measures distributional aspects of taxation by taking into account the overall tax burden on the income of an individual. Regarding the latter, see *Schneider* (1992), pp. 191–192; *Fullerton* (1984), p. 25.

11 However, this loss of indifference does not mean that there must be losses in allocative efficiency, since it cannot be established whether an investment with greater pre-tax profitability is displaced by one that is less profitable, but favored when taxes are taken into account.

effective tax burden on profitable investment presents a dilemma, since the statutory tax rate can no longer serve as a standard measure[12]. Without such a measure, it is impossible to determine the degree to which a tax system, especially with regards to the definition of the tax base and the system of dividend taxation, advantages or disadvantages real investment in comparison to financial assets. Hence, decision makers might not be able to understand the impact of the different tax features on the effective tax burden. However, it is important for both business managers and policy makers to know how sensitive investment decisions are to changes in the tax base, the tax system, and the statutory tax rates.

It is possible to construct a measure of the effective tax burden on profitable investment that will indicate whether the current tax system is advantageous compared with a neutral tax system (where, beyond the initial cost, the whole net present value is allowable) by using a comparison with the statutory tax rate[13]. However, there is no such measure for cases in which the sum of depreciation allowances is restricted to the initial cost of the asset. Thus, it is not possible to conclude whether such an investment effectively bears a higher or lower tax burden than indicated by the statutory tax rate.

This dilemma can be overcome by relying on the internal rate of return as a measure of profitability. When there are no changes in the algebraic sign of the cash flows after the period of investment, the internal rate of return can be determined unambiguously. The present value of the cash flow, discounted at the internal rate of return, equals the initial cost of the investment. The income earned in each period is calculated as the difference between the surplus of payments and the difference in the present value of expected future payments (economic depreciation). This income is equal to the return on the capital used. If a uniform statutory tax rate applies and the definition of depreciation allowances for tax purposes follows this concept of depreciation, the effective tax rate, measured as the proportionate difference between the pre- and post-tax rates of return, equals the statutory tax rate. Thus, a standard measure is achieved, which indicates, when the nominal capital is maintained, an advantage or disadvantage that is due to the definition of the tax base.

This result could be a starting point for applying the approach developed by *King* and *Fullerton*[14]. However, such a measure is based on the critical assumption that the return on the investment can be reinvested at the internal rate of return. If the return is reinvested at an exogenous rate (e.g., the market interest rate) and the average rate of return is calculated based on the terminal value of the investment, the standard measure is again lost.

However, the rate of return is a reliable measure of profitability when only a single period is regarded. Then, the comparison between the investment's rate of return and the market interest rate shows whether the real investment is favored over the financial investment. Furthermore, the comparison between the rates of

12 See *Schneider* (1992), pp. 243–244.

13 See *König* (1997), pp. 44–58; *Oldenburg* (1998), p. 43.

14 See *King/Fullerton* (1984), p. 18.

return of different real investments establishes their ranking. *Devereux* and *Griffith*[15] base their model on the present value of investment, but focus on a single-period investment. Thus, their model provides a framework for the construction of a standard measure of the effective tax burden on profitable investment, one which is based on a reliable, one-period measure of profitability.

3 A Model for Calculating Effective Tax Rates

3.1 Framework of the Model

As with the approach by *King* and *Fullerton*, *Devereux* and *Griffith* base their model on the assumption of a perfect capital market under certainty. Since they consider a firm with an exogenous investment and financing programme, dividend payments also are exogenous. The model, which is presented here in a slightly modified form and under the assumption of price stability, starts off from the capital market equilibrium condition[16]:

$$(1-m^r)\cdot r\cdot V_t = \frac{1-m^d}{1-c}\cdot D_{t+1} + (1-z)\cdot(V_{t+1} - V_t - N_{t+1}). \tag{1}$$

The term r denotes the market interest rate, D_t and N_t denote dividend payments and new equity issued in period t, respectively. The terms m^r, m^d and z, respectively, denote the personal income tax rates on interest, dividend payments, and capital gains on the value of the shares. The term c denotes the rate of imputation tied to a dividend, expressed as the ratio of the tax credit to the gross dividend. In equilibrium, the post-tax rate of interest on the value of the firm equals the amount of dividends and capital gains earned in $t+1$, adjusted for changes in equity capital due to new share issues and repayments of equity capital.

Since the value of the firm depends on future cash flows, V_t is calculated as the present value of all future dividends and capital repayments. Therefore, from (1) it follows that:

$$V_t = \sum_{s=t}^{\infty}\frac{\gamma\cdot D_{s+1} - N_{s+1}}{(1+\rho)^{s-t+1}} \text{ with} \tag{2}$$

$$\gamma = \frac{(1-m^d)}{(1-c)\cdot(1-z)} \text{ and} \tag{3}$$

$$\rho = \frac{(1-m^r)\cdot r}{(1-z)}; \tag{4}$$

15 See *Devereux/Griffith* (1999), pp. 14–28.

16 For the following, see *Devereux/Griffith* (1999), pp. 14–28.

γ denotes the discrimination factor between distributed and retained earnings, ρ the shareholder's discount rate. In contrast to the approach used by *King* and *Fullerton*, the discount rate here does not depend on the source of finance of the corporation[17].

Now an investment is considered that raises the capital stock in period $t = 0$ by one unit. In $t = 1$, the net investment is reduced by an amount sufficient to return to the exogenous level of the capital stock. The effect of the additional investment on the value of the flow of dividends in $t = 0$ is measured. Without considering taxation, the difference in the net present values of the distributions due to the additional investment is

$$R^* = -1 + \frac{1}{1+r} \cdot [(p+\delta) + (1-\delta)] = \frac{p-r}{1+r}. \tag{5}$$

The first summand describes the initial cost in $t = 0$ and the second one describes the present value in $t = 0$ of the cash flow in $t = 1$. The investment yields the financial return p and the economic depreciation at a rate δ of the initial cost, which is not derived from the cash flow generated by the investment, but from the replacement cost of the asset[18]. The net investment is reduced by the amount of $(1 - \delta)$ when the firm returns to the exogenous capital stock in $t = 1$.

When taxation is taken into account, the net present value of the investment is determined by the change in net dividends due to the additional investment. If the project is financed by retained earnings, the net present value is calculated as

$$R = \left\{ -\gamma \cdot (1-A) + \frac{\gamma}{1+\rho} \cdot [(p+\delta) \cdot (1-\tau) + (1-\delta) \cdot (1-A)] \right\} \cdot (1-z), \tag{6}$$

where τ denotes the uniform corporate profit tax rate. The term in braces represents the post-tax present value of the additional distributions, and the factor $(1 - z)$ is the cut in the net present value due to capital gains tax in period $t = 0$. A denotes the present value of the reduction of the tax payments that is due to depreciation allowances for tax purposes[19]:

$$A = \tau \cdot \phi \cdot \sum_{s=0}^{\infty} \frac{(1-\phi)^s}{(1+\rho)^{s+1}} = \frac{\tau \cdot \phi}{\phi + \rho}, \tag{7}$$

with ϕ denoting the declining balance depreciation rate for tax purposes. We assume that the first allowance is deductible one period after the purchase of the asset.

The investment reduces dividend payments at a value of γ. Furthermore, the present value of distributions rises due to the depreciation allowances by $\gamma \cdot A$. In

17 See *King/Fullerton* (1984), pp. 21–23; *Scott* (1987), pp. 258–259.
18 For a discussion see *Bond/Devereux* (1995).
19 See *King/Fullerton* (1984), pp. 19–20; *Devereux/Griffith* (1999), p. 15.

$t = 1$, the surplus $p + \delta$ is taxed. From the expenses $(1 - \delta)$ that have been saved, the value of tax reductions $(1 - \delta) \cdot A$ lost due to the foregone depreciation allowance has to be deducted.

If the investment is financed with new equity or with debt, (6) is modified to take into account the value of external financing F. For new equity financing, the owner is assumed to provide the funds. To transform the dividend flow valid for financing with retained earnings into one that is valid for financing with new equity, the following term F^{NE} has to be added to the term in braces in (6):

$$F^{NE} = -1 + \gamma + \frac{1-\gamma}{1+\rho} = \frac{-\rho \cdot (1-\gamma)}{(1+\rho)}. \tag{8}$$

The firm covers the initial cost of one by issuing new shares to the owners, who expend the amount of one. In turn, compared with the situation when the investment is financed by retaining earnings, the owners obtain a distribution of γ. In $t = 1$ the corporation repurchases the shares. The funds needed for the repurchase reduce the amount of the distribution.

The same principles apply when modelling debt financing. However, here it is assumed that external lenders supply the funds. Therefore:

$$F^{D} = \gamma - \frac{\gamma \cdot [1 + r \cdot (1 - \tau^{r})]}{1+\rho}. \tag{9}$$

The corporation is able to pay an additional dividend in $t = 0$, which is not mirrored by an expense on the part of the shareholders. In turn, the distribution in $t = 1$ is reduced not only by the redemption of the funds, but also by the interest payment, which is deductible from the corporation's tax base and thus is only worth $r \cdot (1 - \tau^r)$; τ^r denotes the corporate tax rate for deducting interest payments.

To better understand the basic principles of the model, we present a cash-flow-based example of an equity financed company. The nominal capital K of the corporation is ten, with an economic depreciation rate of $\delta = 25\%$ and a real rate of return of $p = 20\%$. Thus, the corporation generates in each period proceeds E (after the deduction of variable costs) amounting to $(p + \delta) \cdot K = 4.50$. The corporation reinvests the amount $\delta \cdot K = 2.50$ each period, thus keeping the capital stock constant over time. The corporation distributes a uniform and infinite amount of $D = p \cdot K = 2$, which the owners discount at the pre-tax interest rate $r = 10\%$. Hence, the value of the firm at each moment is $V = D/r = 20$.

Now we assume that the company decreases its distributions in $t = 0$ by the amount of one. It does so to carry out an additional investment financed by retained earnings, which earns a rate of return of p. In $t = 1$, the corporation generates additional proceeds $(p + \delta) = 0.45$ from the invested capital. The corporation decreases reinvestment by $(1 - \delta) = 0.75$ from 2.50 to 1.75, to reduce the capital stock K to the former level of ten, and increases its distribution by

$(p + \delta) + (1 - \delta) = (1 + p) = 1.20$. According to (5) the net present value of the additional investment is $R^* = 0.09 = -1 + 1.20/(1 + 0.10)$. This investment of one decreases the distribution in $t = 0$ to one and increases it to 3.20 in $t = 1$. In $t = 0$, the value of the shares increases by the earnings capacity value of the investment of $1 + R^* = 1.09$ (see *Table 1*).

Table 1: Pre-tax Cash Flows

Period (t)	–1	0	1	2	3	4 - ∞
Proceeds (E)		4.50	4.95	4.50	4.50	
Capital stock (K)	10.00	11.00	10.00	10.00	10.00	
Investment		3.50	1.75	2.50	2.50	
Depreciation ($\delta \cdot K_{t-1}$)		2.50	2.75	2.50	2.50	
Profit ($E - \delta K_{t-1}$)		2.00	2.20	2.00	2.00	
Distribution (D)		1.00	3.20	2.00	2.00	2.00
NPV of additional investment (R^*)		0.09				
Value of the shares (V)		21.09	20.00	20.00	20.00	20.00

We introduce a tax system that is neutral in its tax rates and system of dividend taxation ($m^r = m^d = c = \tau = 40\%$; $z = 0\%$), which implies that $\gamma = 1$. Declining balance depreciation for tax purposes is allowed at $\phi \cdot K = \delta \cdot K$. Without the additional investment, a corporate tax payment of $\tau \cdot (p + \delta - \phi) \cdot K = \tau \cdot p \cdot K = 0.80$ results. The post-tax level of the distribution is $D = p \cdot (1 - \tau) \cdot K = 1.20$. The discount rate decreases to $\rho = r \cdot (1 - m^r) = 6\%$, and the value of the shares is not affected ($V = \gamma \cdot D/\rho = 20$).

The additional investment in $t = 0$ again reduces the distribution by one. Since the investment is depreciated for tax purposes at the rate ϕ, the depreciation allowances affect the tax payments in later periods. Therefore, the advantage of calculating the net present value from the cash flows of a single period seems to be lost.

However, we can attribute the present value of the changes in the depreciation allowances to the additional one-period investment. In $t = 0$, according to (7) the additional investment increases the present value of depreciation allowances by A/τ. In $t = 1$, investment is reduced, and the value of depreciation allowances decreases by the amount of $(1 - \delta) \cdot A/\tau$. Overall, the value of additional depreciation allowances in $t = 0$ is $(A/\tau) \cdot [1 - (1 - \delta)/(1 + \rho)]$. The accumulation of this difference at the accumulation factor $(1 + \rho)$ results in a value of depreciation allowances in $t = 1$, the first point of time at which an additional allowance reduces the tax bill, of $A/\tau \cdot (\rho + \delta)$.

Since $\phi = \delta$, the additional value of allowances in $t = 1$ is δ. In this period, the distributions increase by $(p + \delta) + (1 - \delta) - \tau \cdot (p + \delta - \delta) = 1 + p \cdot (1 - \tau) = 1.12$. The post-tax net present value of the investment is again determined by the changes in the distributions. It amounts to $R = -1 + (1 + p - p \cdot \tau)/(1 + \rho) = -1 + 1.12/(1 + 0.06) = 0.06$, which is equivalent to (6). The definition of the taxable base has no impact on the net present value of the investment. The investment of one decreases the distribution in $t = 0$ to 0.20 and increases it in $t = 1$ to 2.32. The value of the shares increases in $t = 0$ by the earnings capacity value of the investment of $1 + R = 1.06$ (see *Table 2*).

Table 2: Post-tax Cash Flows; Neutral Depreciation for Tax Purposes

Period (t)	–1	0	1	2	3	4 - ∞
Proceeds (E)		4.50	4.95	4.50	4.50	
Capital stock (K)	10.00	11.00	10.00	10.00	10.00	
Investment		3.50	1.75	2.50	2.50	
Depreciation for tax purposes		2.50	2.75	2.50	2.50	
Taxable profit		2.00	2.20	2.00	2.00	
Corporation tax		0.80	0.88	0.80	0.80	
Distribution (D)		0.20	2.32	1.20	1.20	1.20
NPV of additional investment (R)		0.06				
Value of the shares (V)		21.06	20.00	20.00	20.00	20.00

By setting $\phi = 50\% > \delta = 25\%$, we find that in $t = 1$, the value of additional allowances is $A/\tau \cdot (\rho + \delta) = 0.28$. The net present value of the additional investment in $t = 0$ now is $R = -1 + [(0.20 + 0.25) + (1 - 0.25) - 0.40 \cdot (0.20 + 0.25 - 0.28)]/1.06 = 0.07$, which again is equivalent to (6). The accelerated depreciation schedule thus increases the value of the investment from $R = 0.06$ to $R = 0.07$. The value of the shares in $t = 0$ increases to 21.07, again mirroring the earnings capacity value of the investment. When $\phi = 12.5\% < \delta = 25\%$, we obtain $A/\tau \cdot (\rho + \delta) = 0.21$ and $R = 0.04$. The value of the shares in $t = 0$ increases by 1.04 to the amount of 21.04.

3.2 Measures of the Effective Tax Rate

3.2.1 Effective Average Tax Rate

Once we know the pre-tax and post-tax net present values of an investment, we can construct a measure of the effective tax burden on the investment. At first sight, the following definition of the effective average tax rate (*EATR*) seems to be appropriate:

$$EATR = (R^* - R)/R^*. \tag{10}$$

However, this measure is ruled out since it is not defined for an investment that is marginal before taxes are taken into account, where $R^* = 0$. Therefore, *Devereux* and *Griffith* use the difference of the pre- and post-tax net present values of an incremental investment of one and the pre-tax income stream[20]:

$$EATR^{DG} = (R^* - R)/[p/(1+r)]. \tag{11}$$

20 See *Devereux/Griffith* (1999), p. 20.

Alternatively, we can construct a measure based on rates of return:

$$EATR^p = (p - p_s)/p. \tag{12}$$

This familiar measure is reliable because a single-period change in the value of the firm is considered. We can obtain the rates of return from a transformation of the net present values. For an investment of one and considering $R^* = (p - r)/(1 + r)$, it follows for the pre-tax rate of return that $p = R^* \cdot (1 + r) + r$. From $R = (p_s - s)/(1 + s)$ it follows that we can calculate the post-tax rate of return as $p_s = R \cdot (1 + s) + s$, with

$$s = (1 - m^r) \cdot r \tag{13}$$

denoting the post-income-tax interest rate. Thus, we can interpret the term p_s as the post-tax income stream that a financial asset must yield if it is to achieve the same net present value as the corporate investment. The tax wedge $p - p_s$ expresses the tax induced reduction of the investment's rate of return.

3.2.2 Effective Marginal Tax Rate

The effective marginal tax rate can be calculated in a similar way to that presented by *King* and *Fullerton*[21]. First, the cost of capital $\tilde{p}$ has to be determined, i.e., the pre-tax rate of return necessary for the investment to yield the minimum expected return. Therefore, the post-tax net present value is set equal to zero, and the equations are solved for the pre-tax rate of return p:

$$\tilde{p} = \frac{(1 - A) \cdot (\rho + \delta)}{1 - \tau} - \frac{F \cdot (1 + \rho)}{\gamma \cdot (1 - \tau)} - \delta. \tag{14}$$

The effective marginal tax rate (*EMTR*) is calculated as:

$$EMTR = (\tilde{p} - s)/\tilde{p}. \tag{15}$$

This definition of the *EMTR* follows the so-called fixed-*r*-case.

3.3 Discussion of the Measures

3.3.1 Impact of Specific Taxes

The combined statutory tax rate of the corporate income tax, its surcharges, and other corporate profit taxes enter the model as the parameter τ. The approach can be extended to take into account many of the features of these taxes. As in the model presented by *King* and *Fullerton*, practically all relevant tax depreciation schemes can be included. The most essential features of inventory valuation, of restrictions regarding the deductibility of interest payments, and of rules regard-

21 See *King/Fullerton* (1984), p. 9.

ing an allowance for corporate equity or a dual income tax can be introduced. Special rules concerning the definition of the taxable base can be modelled especially for those cases in which the special rules refer to an event that can be isolated in the algebra (such as the deduction of interest payments). Also, property taxes can be included.

For the personal income tax, dividends must be distinguished from interest payments and capital gains when the owners sell shares. The taxes on these components of capital income enter the model in a quite different way. It is common to them that only a single uniform (effective) tax rate is assumed.

The system of dividend taxation is modelled by adjusting the dividend integration factor $(1 - m^d)/(1 - c)$ in the parameter γ, which describes the way a cash flow is transformed from the corporate level to the level of the (individual) shareholder. The most relevant systems of dividend taxation (full and partial imputation, shareholder relief, split rate, classical system) can be covered by varying m^d and c.

For a marginal investment financed by retained earnings, the taxation of dividends has no impact on the effective tax burden: Under a uniform tax rate m^d, dividend taxes are saved the moment funds are retained, but become due upon the distribution of dividends. This result is in line with the so-called "new view" of dividend taxation[22]. For projects that earn an economic rent, dividend taxes are relevant. This result is also in line with the "new view".

The taxation of dividends is also not relevant in the case of a debt-financed marginal investment. In this instance, the investment earns just enough to service the debt, and the present value of dividends is zero. In contrast, the taxation of dividends always has an impact on present values when the firm finances the investment with new equity. The same is true for profitable, debt-financed investment, since the debt is always served at the market interest rate r. Any further surplus is assumed to be distributed to the shareholders.

The taxation of interest payments affects the discount rate of the shareholder ρ and the marginal post-tax rate of return to the shareholder s. For all assets, the investor demands a rate of return that at least equals the post-tax rate of return on financial assets that yield the single market interest rate r before taxes. Raising personal taxes on interest income favors real investment: Once the alternative use of funds is taxed more heavily, to compete, real investment may yield a lower rate of return.

It is more difficult to capture the personal income tax on capital gains when investors sell shares. This tax has an impact on share values and thus its own tax base. Moreover, although such taxes are commonly realization-based, it is modelled as a tax on accrual.

The capital gains tax enters the model at three points: First, for profitable investment, the net present value of the investment is cut in $t = 0$. Second, the tax raises the discount rate of the shareholder. Each additional cash flow earned by the cor-

22 See *Sinn* (1991), p. 34; *Zodrow* (1991), pp. 498–501; *Sørensen* (1995), pp. 282–283.

poration adds to the reserves as long as it is not distributed, and thus leads to a (potential) capital gain at the shareholder level. Third, the effective capital gains tax rate enters into the definition of the discrimination factor γ, and thus increases the value of distributions. Hence, when the reserves are distributed, a corresponding refund occurs. According to the basic principle of a capital gains tax that treats equally capital gains and capital losses that are attributable to a temporary additional investment, only a timing effect remains.

As it is modelled, the capital gains tax would only be equivalent to a realization-based tax if all shares were turned over once each period. In cases in which only a fraction of all shares is turned over, the importance of this tax decreases. *King*[23] developed the standard formula of the effective capital gains tax rate. When the fraction λ of the shares is turned over in each period, the relation between the effective capital gains tax rate z, which sums up the discounted tax payments on all transactions between the actual period and the infinite time horizon, and the statutory tax rate on these capital gains z_s is

$$z = \frac{[1 + r \cdot (1 - m^r)] \cdot z_s \cdot \lambda}{\lambda + r \cdot (1 - m^r)}. \qquad (16)$$

Since this rate separately is applied to each change in the share value, the course of the share value itself does not affect the level of the effective capital gains tax rate.

The capital gains tax rate generally raises the effective tax burden on investment for two reasons. First, when earnings are retained, the tax on the increased value of the shares must be financed for one period. Second, there is a tax burden in the time between the discovery and the distribution of an economic rent.

3.3.2 Properties of the Measures

Devereux and *Griffith* point out that the $EATR^{DG}$ shows some useful properties in all cases where personal taxes on interest and capital gains are omitted and the sum of depreciation allowances is based on the initial cost of the investment[24]. In these cases, the $EATR^{DG}$ for a marginal investment equals the *EMTR* as derived above. For highly profitable investments, the $EATR^{DG}$ tends towards the combined statutory tax rate on distributions $1 - \gamma \cdot (1 - \tau)$[25].

In addition to the propositions presented by *Devereux* and *Griffith*[26], we can show this property in a single algebraic expression:

23 See *King* (1977), p. 74.
24 See *Devereux/Griffith* (1999), pp. 21–24.
25 For a classical system of corporate taxation with $\gamma = (1 - m^d)$ the combined statutory tax rate equals $\tau + m^d - \tau \cdot m^d$.
26 See *Devereux/Griffith* (1999), pp. 21–22.

$$EATR^{DG} = \frac{R^* - R}{p/(1+r)} = \frac{\tilde{p}}{p} \cdot \frac{\tilde{p} - r}{\tilde{p}} + \frac{p - \tilde{p}}{p} \cdot [1 - \gamma \cdot (1 - \tau)]. \qquad (17)$$

When $m^r = 0$, $z = 0$, the $EATR^{DG}$ is equal to the weighted average of the effective marginal tax rate *EMTR*, which is represented by the term $(\tilde{p} - r)/\tilde{p}$, and the combined statutory tax rate on distributions, which is represented by $1 - \gamma \cdot (1 - \tau)$. The weights are determined by the fraction of the financial return p that is covered by the cost of capital (for the *EMTR*) and the fraction which is not (for the combined tax rate).

With an increasing rate of return, the measure approaches the combined statutory tax rate[27]. This is because the economic rent is always taxed at this rate. The effective tax burden on a profitable investment tends to increase when the statutory tax rate exceeds the effective marginal tax rate[28]. Any additional revenue will not be mirrored by an additional expense, so the statutory tax rate becomes fully relevant.

Therefore, for a marginal investment, the rules for the depreciation allowances, property taxes, net wealth taxes, and the treatment of the different sources of finance play an important role in addition to the statutory tax rate. Whereas, for a more profitable investment, the features of the tax system mentioned initially decrease in importance, and the (combined) statutory tax rate becomes the dominant factor in determining the effective tax burden.

Once we consider personal taxes on interest or capital gains, the relation shown in (17) is no longer valid. For a neutrally taxed marginal investment ($R^* = R = 0$), the $EATR^{DG}$ shows an effective tax burden of zero. Since that investment in fact bears a tax burden at the statutory tax rate, this result might lead to a misinterpretation. For the $EATR^p$, which is based on rates of return instead of net present values, the following relation exists:

$$EATR^p = \frac{p - p_s}{p} = \frac{\tilde{p}}{p} \cdot \frac{\tilde{p} - s}{\tilde{p}} + \frac{p - \tilde{p}}{p} \cdot \left[1 - \gamma \cdot (1 - z) \cdot \left(1 - \frac{\rho \cdot z}{1 + \rho}\right) \cdot (1 - \tau)\right]. \qquad (18)$$

The $EATR^p$ is equal to the weighted average of the *EMTR* and a combined tax rate on distributions. This combined tax rate takes into account the capital gains tax that burdens on the economic rent for one period[29]. For $m^r = z = 0$ with $s = \rho = r$, it follows that:

27 See *Devereux/Griffith* (1999), p. 22.

28 See *Fullerton* (1984), p. 28.

29 When $z > 0$, two modifications occur: First, the combined statutory rate on distributions does not depend on the capital gains tax. The factor γ therefore is multiplied by $(1 - z)$ to obtain the integration factor. Second, capital gains due to economic rents are taxed in $t = 0$; this capital gains tax payment is reversed in $t = 1$. Thus, the investor must finance the capital gains tax on the increase of the value of the shares for one period. These effects result in an effective tax burden of $z - z/(1 + \rho) = \rho \cdot z/(1 + \rho)$.

$$EATR^p = \frac{p-[R\cdot(1+r)+r]}{p} = \frac{\frac{p-r}{1+r}-R}{p/(1+r)} = \frac{R^*-R}{p/(1+r)} = EATR^{DG}; \qquad (19)$$

both measures are identical, thus (17) also holds for the $EATR^p$.

Under an income tax that limits depreciation allowances to the initial cost of the investment, allows for a depreciation rate of $\phi = \delta$ in each period, and stipulates – in the absence of personal taxes on capital gains ($z = 0$) – uniform statutory tax rates on interest, retained profits, and distributed profits ($m^r = m^d = c = \tau$), the *EMTR* equals the (single) statutory tax rate. The $EATR^{DG}$ for such an investment is zero. With an increasing rate of return, the $EATR^{DG}$ approaches the statutory rate. Under these assumptions, the $EATR^p$ is equal to the statutory tax rate for both a marginal and a profitable investment. From the $EATR^{DG}$, only for marginal investments a standard measure can be derived ($EATR^{DG} = 0$). For the $EATR^p$, the standard measure, irrespective of the assumed level of profitability, equals the statutory tax rate.

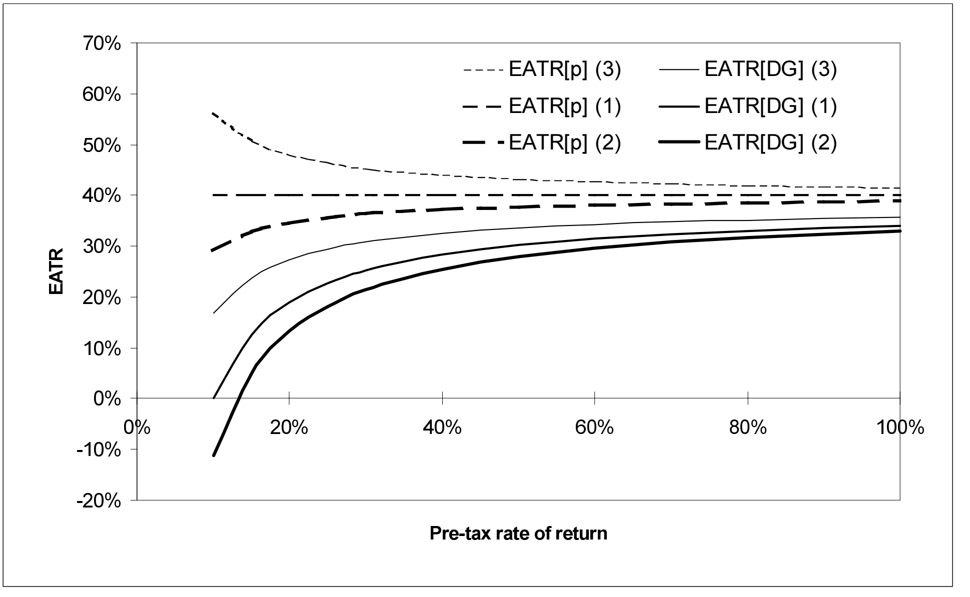
As investment projects might show different pre-tax net present values but equal post-tax $EATR^p$, only the post-tax rate of return, not the $EATR^p$ itself, permits a conclusion about the ranking of investment projects. The intuition behind this measure is that under a proportional tax schedule, the fraction of the profits that must be paid to the fiscal authorities does not depend on the level of profitability. An effective tax rate that deviates from the statutory rate suggests preferential treatment of, or discrimination against, the investment compared with an equally profitable financial asset in the hands of the investor.

The properties of the measures are demonstrated by the results from the example above: We compare (1) the tax depreciation schedule which follows economic depreciation ($\phi = \delta = 25\%$), (2) the accelerated tax depreciation schedule ($\phi = 50\% > \delta = 25\%$) and (3) the decelerated tax depreciation schedule ($\phi = 12.5\% < \delta = 25\%$). *Figure 1* shows the effective tax rates, depending on the investment's pre-tax level of profitability.

In all cases, the $EATR^{DG}$ grows with an increasing level of profitability and tends towards a value that is, because of personal taxes on interest, a little below the statutory tax rate. However, the $EATR^p$ in case (1) indicates the statutory tax rate, regardless of the level of profitability. In case (2), it increases with a growing level of profitability, whereas in case (3) it decreases.

For an increasing rate of profitability, both measures indicate the diminishing importance of the definition of the tax base. Nevertheless, only the $EATR^p$ allows us to compare the statutory tax rate to identify an advantage or disadvantage caused by the tax base. The investor would compute the same net present value for an equity-financed investment under neutral depreciation and a statutory tax rate on profits and distributions (τ, m^d, c) equal to the $EATR^p$. In case (2), at a pre-tax rate of return of $p = 10\%$ (20%) the $EATR^p$ is 29.3% (34.6%). Hence, the accelerated depreciation is equivalent to a reduction in the statutory tax rate of 10.7 (5.4) percentage points. In case (3), the $EATR^p$ for these rates of return is

Figure 1: Effective Average Tax Rates under a (1) Neutral, (2) Accelerated and (3) Decelerated Depreciation Schedule for Tax Purposes



56.2% (48.1%), indicating that decelerated depreciation is equivalent to an increase in the statutory tax rate of 16.2 (8.1) percentage points.

However, the comparability with the statutory tax rate leads to a restriction in the interpretation of the *EATR*^{p}. When comparing mutually exclusive investments, their ranking should be mirrored by the levels of the effective tax rates. This is the case for both measures, as long as we assume a single post-tax market rate of return. In cases where alternative projects are compared and the post-tax market rates of return differ (because the investors face different personal income tax rates on interest payments), only the measure developed by *Devereux* and *Griffith* preserves the ranking of net present values. Therefore, both measures are suitable for international tax burden comparisons if an investor whose interest receipts are taxed in the country of his residence compares locations that offer identical pre-tax rates of return. However, if the investors are assumed to reside in different countries, for a comparison of locations with respect to which one of the investors computes the greatest net present value, e.g. to show clientele effects of taxation[30], the measure developed by *Devereux* and *Griffith* has to be applied.

3.4 A Brief Evaluation of the Model

The *EATR*^{p} is closely related to the concept of the *EMTR* and thus the standard measure of the statutory tax rate. Due to the low complexity of the model, the

30 See *Scholes/Wolfson* (1992), pp. 116–121.

effects of taxation on corporate investment can be explored easily. Thus, the model is useful especially for large-scale tax burden comparisons. However, low complexity comes at the price of restrictive assumptions. By relaxing these assumptions for the sake of improved modelling of both the investment decisions of the firm and institutional issues, one has to sacrifice an easily comprehensible standard measure of the effective tax burden. This is especially the case when we give up the one-period view in favor of a multi-period approach based on financial statements and cash-flows of each period. That said, we note that even complex models might not fully explain the impact of taxation on investment behavior.

4 An Example on Effective Tax Rates

The model permits the calculation of effective tax burdens for investment projects that consist of a bundle of different assets. These assets can be financed by a mix of equity and debt; the shares can then be held by a number of shareholders each in a different tax position. In this instance, the effective tax burden is calculated as a weighted average of the single tax burdens[31]. The calculations can be undertaken just as well for the corporate level only, i.e., disregarding shareholder taxation completely. For example, this is the relevant scenario when management takes investment decisions that do not take into account shareholder taxation, perhaps because management does not know the tax position of the corporation's relevant owners.

However, the following example only considers a single combination of one asset, one type of shareholder, and one source of finance at a time. The point of the example is not to make a detailed comparison of tax burdens, but to demonstrate the model in a way that the calculations can be reconstructed. Therefore, we base the calculations on the model above, which implies that we have not taken into account a number of details.

We base our example on the German corporate tax reform in 2000[32]. A corporation in the hands of a U.S. investor[33] in the top income tax bracket invests in a new machine that is financed by retained earnings (RE), new equity (NE) or debt (DE). We assume that the corporation is located either in the U.S., in Germany under the former (2000) corporate tax law, or in Germany under the new (2002) corporate tax law. This case of an international choice of location may be less relevant than the one of a direct investment by a multinational parent company. However, since we do not deliver an empirical analysis of the German tax reform, but instead focus on the interaction of tax drivers that mirror in the effective tax rates, this case makes it possible to show the principles of the model without adding more algebra. In general, the approach presented by *Devereux* and *Griffith* can be extended to direct investment by a multinational, multilevel group of companies without creating any problems[34].

31 This corresponds to the approach used by *King* and *Fullerton*, see *King/Fullerton* (1984), pp. 14 –16.

32 See Tax Reduction Act (2000).

33 The U.S. tax data assumed for the example corresponds to the situation in the state of California.

34 See e.g. *Devereux/Griffith* (1999), pp. 24–30.

We consider the following measures of the German tax reform in the calculations (see *Table 3*): The reform reduces the corporate income tax rate from 40% (51.8% including trade tax at an assumed municipal levy of 400% and solidarity surcharge at 5.5%) to 25% (38.6%)[35]. It broadens the tax base by restricting the maximum rate for declining balance depreciation from 30% to 20%. Furthermore, the reform replaces the former split rate (40% corporate tax rate on retained and 30% on distributed profits) imputation system with a shareholder relief system of dividend taxation. Before the reform, even some U.S. shareholders could take advantage of this imputation system, since a further reduction of taxes at 5% of the dividend was granted by section 10 (3) of the U.S.-German tax treaty. This reduction and the split rate system are mirrored in the definition of m^d for the German pre-reform case (D 2000)[36].

We assume $\delta = 20\%$[37], $r = 5\%$, $\lambda = 10\%$, and calculate effective tax rates at the marginal level ($p = \tilde{p}$) and at a pre-tax real rate of return of $p = 20\%$.

Table 3: Tax Parameters used for the Examples

Corporation (US/D)				US Shareholder			
	US	D '00	D '02		US	D '00	D '02
τ	40.75	51.83	38.65	z_s	25.63	25.63	25.63
τ^r	40.75	47.02	32.51	m^d	45.22	31.41	45.22
ϕ	40.00	30.00	20.00	c	0.00	0.00	0.00
				m^r	45.22	45.22	45.22

The effective marginal tax rates differ substantially between the different sources of finance (*Figure 2*). Under the assumptions used here, the benchmark that indicates neutrality is the statutory personal income tax rate on interest payments ($m^r = 45.2\%$). This effective tax rate indicates that the cost of capital is equal to the real interest rate.

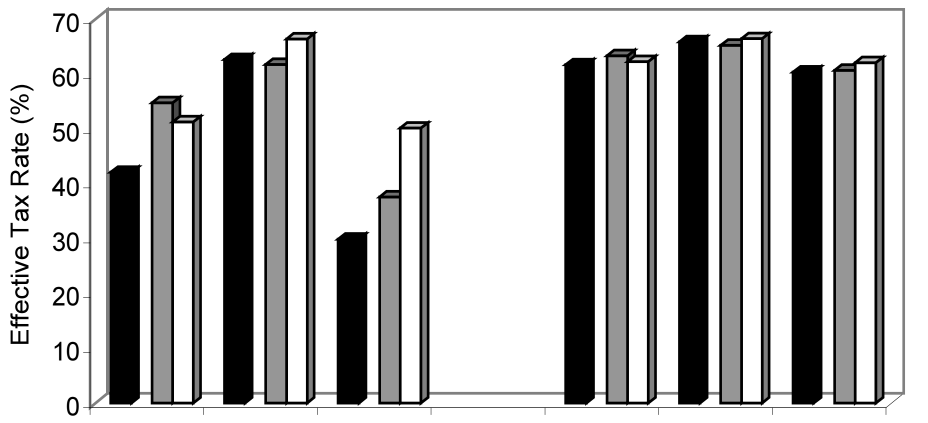
In the marginal case, it is tax efficient to finance U.S. investment with debt. The U.S. shareholder can completely avoid corporation tax on the return because interest payments are fully tax deductible. Since the investor can take advantage of the 40% depreciation rate, which is double the rate of economic depreciation, the *EMTR* for debt-financed U.S. investment is well below the statutory tax rate on interest payments ($EMTR < m^r$). Because dividends are taxed twice under the classical system of dividend taxation, U.S. new equity financed investment must earn a relatively high cost of capital ($EMTR > m^r$). There is also double taxation of

35 $0.518 = 0.4 \cdot 1.055 + 0.167 - 0.4 \cdot 1.055 \cdot 0.167$; $0.167 = 0.05 \cdot 4/(1 + 0.05 \cdot 4)$; $0.386 = 0.25 \cdot 1.055 + 0.167 - 0.25 \cdot 1.055 \cdot 0.167$.

36 When profits are distributed, the corporate tax rate is reduced from 51.8% to 43% and a 10% withholding tax is levied. For details on the tax reduction granted by section 10 (3) of the U.S.-German tax treaty see *Wolff* (1997), pp. 28–29. The net income from distributing one unit of reserves at the level of the corporation is $(1 - 0.4304)/(1 - 0.5183) \cdot \{1 - [(1 - 0.1)/(1 - 0.15) \cdot (0.4522 - 0.15) + 0.1]\} = 0.6859$, which implies that $m^d = 1 - 0.6859 = 31.41\%$.

37 This assumption allows the isolation of the tax rate's effects. However, it does not mean that the post-reform depreciation allowances are in fact neutral, i.e., equal to true economic depreciation.

Figure 2: Effective Tax Burdens on U.S. and German Investment for a U.S. Shareholder



	RE		NE		DE		RE	NE	DE
	EMTR (%) (cost of capital in italics)						$EATR^p$ (%)		
US	42.1	*4.7*	62.7	*7.3*	29.9	*3.9*	61.7	65.9	60.4
D '00	54.8	*6.1*	61.8	*7.2*	37.6	*4.4*	63.4	65.3	60.7
D '02	51.3	*5.6*	66.4	*8.1*	50.2	*5.5*	62.3	66.5	62.1

retained profits. However, when the investor sells shares, the capital gains are not taxed at the full income tax rate. The cost of capital is below the real interest rate ($EMTR < m^r$).

Prior to the German tax reform, the marginal tax burden on an investment by a German corporation was close to (NE) or above (RE, DE) the one on U.S. investment. A reason for the small advantage of new equity financed German investment over new equity financed U.S. investment is the split-rate system combined with the additional tax reduction established by the tax treaty. Debt-financed German investment is burdened with German trade tax, since, for purposes of calculating the base of the trade tax, in Germany only half of the interest payments were, and continue to be, deductible.

The German tax reform reduces the tax burden on investment financed by retained earnings. The effect of reducing the corporate tax rate on retained profits from 40% to 25% exceeds the effect of reducing depreciation allowances. However, the tax burden on investments financed by new equity or debt increases for a U.S. shareholder. In both cases, the reduction of the statutory tax rate has almost no impact: The corporate income tax on profit distributions to U.S. shareholders had already been reduced to about 25% by the split rate and the tax treaty before the reform. For debt-financed investment, interest payments can be set against taxable earnings. Thus, the corporate income tax has little relevance. Under our assumptions, for all sources of finance the marginal tax burden is higher in post-reform Germany than in the U.S. As it was before the reform, German investment is best financed by debt, but the cost of capital thereon now is

1.6, the *EMTR* 20.3 percentage points higher than for a debt financed U.S. investment.

For a profitable investment, effective tax burdens – which we express in terms of the $EATR^p$, since only the $EATR^p$ can be compared to the *EMTR* when personal taxes are included – on the different sources of finance and on investment in the two locations converge. In contrast to marginal tax burdens, which are driven to a great extent by the definition of the tax base, tax burdens on profitable investment are driven more by statutory tax rates and the combined corporate and personal tax rate on distributions. Further, the combined tax rate is largely determined by the system of dividend taxation. Additional returns are assumed to be distributed to the shareholders. Thus, this combined tax rate on dividends is not only important for investment financed by new equity, as in the marginal case, but also for investment financed by retained earnings or debt. For very high levels of profitability, effective tax rates approximate the combined statutory tax rate on distributions, which is 67.8% for the U.S. case.

The situation is similar under the previous German tax system: On one hand, there was some tax relief for U.S. shareholders. On the other hand, German profits were taxed more heavily than U.S. profits at the corporate level. Both effects almost completely cancel each other out. The combined statutory tax rate on distributions from Germany was 67.2% and thus only 0.6 percentage points lower than the one on distributions from U.S. corporations.

The reform reduced the combined statutory tax rate by only 0.6 percentage points, to 66.6%. Therefore, the broadening of the tax base outweighs the reduction in tax rates for new equity and debt-financed investment. Only investment financed by retained earnings experiences some relief. The results suggest that a U.S. investor prefers the U.S. investment regardless of the source of finance chosen.

However, compared with the marginal case, the gap between the effective average tax rates under the tax efficient source of finance decreases to 1.7 percentage points, indicating that the advantage of the comparatively generous definition of the U.S. tax base almost vanishes.

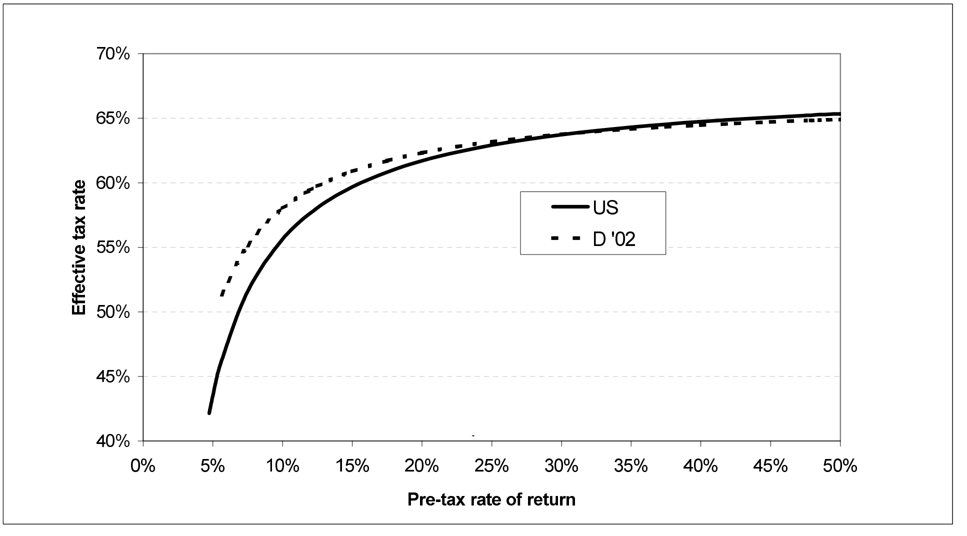
To sum up, from the point of view of a U.S. investor, the most important effects of the German tax reform are the increase of the marginal tax burden on investment financed by new equity and by debt, and the decrease of the effective marginal tax burden on investment financed by retained earnings. The latter appears to be an empirically important source of finance[38]. However, for the $EATR^p$ there is almost no change in effective tax burdens. This result indicates that Germany has not become a much more attractive investment location from the perspective of a U.S. investor.

It should be noted that we derive these conclusions for a given rate of profitability of the investment. To show the impact of different levels of profitability on effective tax rates, *Figure 3* plots the $EATR^p$ depending on the pre-tax rate of return for

38 See e.g. the results of *Corbett/Jenkinson* (1997), pp. 77–85.

an investment that is financed with retained earnings in the U.S. and in post-reform Germany. Both lines start off from the tax burden on the marginal investment, i.e., the starting points indicate the combination of the cost of capital on the abscissa and the *EMTR* on the ordinate. The further to the left (to the bottom) a line starts off, the lower is the cost of capital (the effective marginal tax rate) of the investment.

Figure 3: Effective Tax Rates of an Investment in the U.S. and in Germany



The cost of capital, and consequently the *EMTR*, is lower for the U.S. investment. This situation can be attributed mainly to more generous depreciation allowances. The relevance of these allowances diminishes with an increasing rate of return of the investment. The small differential in corporate tax rates in favour of the German investment gains in importance. Under the assumptions of the model, the lower corporate tax rate in Germany outweighs the more generous depreciation allowance in the U.S. at a pre-tax rate of return of about 31%. For an investment that yields a pre-tax rate of return of more than 31%, the investor calculates the greater net present value for the German investment.

As the example demonstrates, effective marginal and effective average tax rates can lead to different conclusions on the favorability of investment locations. Therefore, the different areas in which the two measures might be applied have to be considered: The effective marginal tax burden is based on the assumption that the last unit invested yields the post-tax rate of return demanded by the investor. Therefore, a multinational company would invest just enough in each of the different locations so that the pre-tax rate of return equals the cost of capital. The conclusion might be that the level of investment is highest in the location that offers the lowest cost of capital. However, if we assume that the choice of location is shaped by the existence of profitable, mutually exclusive investment projects and economic rents that are independent of a specific location, only the concept of effective average tax rates will lead to the right conclusions about investment behavior[39]. Given identical pre-tax net present values, the investment will be made where the investor can expect the lowest effective average tax burden.

5 Summary

(1) Effective tax rates are a useful tool for both policy makers and for business managers, who demand condensed but sophisticated information on the investment tax burden.

(2) The effective marginal tax rate is a useful measure for analyzing the incentive effects of taxation on the level of investment. The tax base and property or net wealth taxes have an important impact on the effective tax burden.

(3) However, the effective average tax rate considers profitable investments and serves to assess the impact of taxation on mutually exclusive investment projects. It is particularly affected by the level of statutory tax rates.

(4) Building on the well-known approach by *King/Fullerton*, *Devereux* and *Griffith* present a measure of the effective average tax rate. This measure relies on net present values and has the advantage of indicating the ranking of post-tax net present values in all cases.

(5) A measure of the effective average tax rate that is based on post-tax rates of return is directly connected with the measure of the effective marginal tax rate. A comparison with statutory tax rates indicates whether corporate investment is tax advantaged or tax disadvantaged. The measure preserves the ranking of net present values in those cases where the investors' discount rates are equal.

(6) Both measures of the effective average tax rate are derived from a one-period variation of the firm's capital stock. Thus, the model presented by *Devereux* and *Griffith* might not replace models that are based on the firm's financial and cash flow statements over a period of more than one year.

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39 This is also supported by empirical findings, see *Devereux/Griffith* (1998), pp. 353, 362.

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