A Backward Looking Measure of the Effective Marginal Tax Burden on Investment

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Abstract

Forward looking measures like the well-known effective marginal tax rate developed by King and Fullerton (1984) are often criticized for not taking into account the complexity of the tax law. This paper derives a method of evaluating this kind of measure and of quantifying the bias resulting from simplifying assumptions, especially on the pattern of depreciation deductions. We apply our method to German data and find that even small estimation biases in determining the tax deductions have a large impact on the effective tax rates for marginal and inframarginal investment projects. We conclude that our method may be used to quantify exactly the difference between the actual use of depreciation deductions and the King-Fullerton assumptions and therefore to correct the conventional forward looking measures.

JEL Code: H21, H25.

Keywords: effective tax rates, corporate taxation.

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1 Introduction

In recent years, many countries have implemented tax reforms designed to stimulate investment and growth. Given this objective, it is important to assess the impact of these reforms on the effective tax burden on investment. Measuring the tax burden on investment, however, is a difficult task. In the literature, the dominating concept is the effective marginal tax rate measure introduced by King & Fullerton (1984). The KF effective marginal tax rate is a forward looking concept. On the basis of statutory tax rates and tax bases, KF (1984) consider a permanent increase in the capital stock of a representative firm and calculate the tax burden on the basis of the difference between the rate of return of the marginal investment and the return required by the investor. The KF approach allows to calculate the marginal tax burden on investment in different types of assets and under different assumptions on the source of financing. As every forward looking concept, the KF approach has the disadvantage that it does not use the actual behaviour of economic agents in order to assess the tax burden on investment.[1]

Recently, Gordon, Kalambokidis & Slemrod (2003) have suggested a new measure of the marginal tax burden on investment. The difference to KF (1984) is that this new measure is a backward looking concept. Under certain assumptions it can be shown that the depreciation deductions in one period can be used to approximate the future deductions of the investment project under consideration. However, due to its strict assumptions this new measure has several shortcomings when applied to real world data.

The purpose of the analysis in this paper is twofold. Firstly, we reconsider and refine the main idea of the GKS approach and we explore the consequences of relaxing some of the assumptions made in GKS (2003). On the basis of this idea, we develop a method of evaluating the KF-style measures and correcting them for errors due to tax law complexities. The second purpose of this paper is to apply our method to German balance sheet data. The results of our empirical analysis suggest that forward looking measures slightly overestimate the average effective marginal tax burden on investment. The reason is that the assumed tax depreciation rules are more restrictive than the tax depreciation actually observed in the data. Moreover, the accuracy of forward looking indicators varies considerably across firms. We investigate the factors explaining the differences across firms and find that tax depreciation is unexpectedly high in firms with a low share of fixed assets and low levels of debt financing.

Apart from serving as an empirical check on the accuracy of forward looking indicators of the effective tax burden, our methodology and our empirical results may also be seen as a first step towards reconciling the results of studies based on forward looking measures of the effective tax burden with those based on backward looking measures, who usually find lower

[1] Devereux & Griffith (1998) develop a variant of the KF approach that allows to compute effective marginal and average tax rates in a common theoretical framework. Another well known forward looking concept is the European Tax Analyzer developed by Jacobs & Spengel (1996). Their approach is based on a model firm and allows to derive effective average tax rates.

effective tax rates.

The setup of the paper is as follows. In the next section, we consider a standard model of investment and describe the theoretical basis of the empirical approach we use. In section 3, we apply our method to German data and compute the adjusted effective tax rates. Section 4 concludes.

2 The model

2.1 The capital cost approach

We consider a standard model of an infinitely lived firm. At the beginning of period t, the firm invests I_t in non-financial assets. The firm's capital stock in period t is K_t, where

$$K_t = (1-\delta)K_{t-1} + I_t \tag{1}$$

is the capital stock resulting from investment in the current and earlier periods. I_t is the amount of gross investment in period t and δ is the rate of economic depreciation. Investment is either financed by debt or retained earnings. The share of debt financing is denoted by b. Following King & Fullerton (1984), we assume that the firm considers a permanent increase in the capital stock. This implies that an investment I_t in period t triggers an additional replacement investment of δI_t in each subsequent period. Given this, the firm's market value V_t of the project under consideration can be written as

$$V_t^* = -I_t(1-b) - \sum_{s=1}^{\infty} \frac{ibI_t}{(1+i)^s} + \sum_{s=1}^{\infty} \frac{(1+\pi)^s[F_{t+s}(K_t) - F_{t+s}(K_t - I_t) - \delta I_t]}{(1+i)^s} \tag{2}$$

where i is the nominal interest rate and π is the rate of inflation. Henceforth, the "*" stands for the absence of taxes. We assume that inflation in output prices equals inflation in prices for investment goods. With $f_t = \frac{F_t(K_t)-F_t(K_t-I_t)}{I_t}$ the output surplus per unit of investment and $v_t = \frac{V_t}{I_t}$, it follows:

$$v_t^* = -1 + \sum_{s=1}^{\infty} \left(\frac{1+\pi}{1+i}\right)^s (f_{t+s} - \delta) \tag{3}$$

With $f_{t+s} = f$, for every s, the project value becomes:

$$v_t^* = -1 + (f-\delta)\,\frac{1+\pi}{i-\pi} \tag{4}$$

What is the impact of introducing taxes? We focus on taxes at the firm level and abstract from personal taxes. In the presence of taxes, the present value of the firm's cash flow related to the project becomes

$$v_t = -(1-b) + u\sum_{s=1}^{\infty}\frac{d_s}{(1+i)^s} - \delta\sum_{s=1}^{\infty}\frac{(1+\pi)^s\left(1-u\sum_{\tau=1}^{\infty}\frac{d_s}{(1+i)^\tau}\right)}{(1+i)^s}$$
$$-(1-u)\sum_{s=1}^{\infty}\frac{ib}{(1+i)^s} + (1-u)\sum_{s=1}^{\infty}\left(\frac{1+\pi}{1+i}\right)^s f_{t+s} \quad (5)$$

where u is the corporate tax rate and d_s is the rate of depreciation for s year old investment goods. Note that future replacement investment is assumed to be fully financed through equity and depreciated as any other kind of non-financial investment.

For the marginal investment, the project value (denoted as v_t^m) equals zero.

$$v_t^m = -(1-b) + u\sum_{s=1}^{\infty}\frac{d_s}{(1+i)^s} - \delta\sum_{s=1}^{\infty}\left(\frac{1+\pi}{1+i}\right)^s\left(1-u\sum_{\tau=1}^{\infty}\frac{d_s}{(1+i)^\tau}\right)$$
$$-(1-u)\sum_{s=1}^{\infty}\frac{ib}{(1+i)^s} + (1-u)\sum_{s=1}^{\infty}\left(\frac{1+\pi}{1+i}\right)^s f_{t+s}^m = 0 \quad (6)$$

As above, assume that $f_{t+s}^m = f^m$, for every s, and it follows:

$$f^m - \delta = \frac{i-\pi}{1+\pi} + \frac{u\left[\left(\frac{i-\pi}{1+\pi}+\delta\right)\left(1-\sum_{s=1}^{\infty}\frac{d_s}{(1+i)^s}\right) - \frac{i-\pi}{1+\pi}b\right]}{1-u} \quad (7)$$

The right hand of (7) represents the cost of capital for the marginal investment. The first term is equal to the cost of capital in the absence of taxes and the second term is the "tax wedge". Note that, in the case of immediate depreciation $\left(\sum_{s=1}^{\infty}\frac{d_s}{(1+i)^s}=1\right)$ and with full equity financing (or no deductibility of interest on debt), the tax wedge on the marginal investment disappears, as one would expect. The effective marginal tax rate ($EMTR$) is given by $EMTR = \frac{f^m-\delta-\frac{i-\pi}{1+\pi}}{f^m-\delta}$, or:

$$EMTR = \frac{u\left[1-\sum_{s=1}^{\infty}\frac{d_s}{(1+i)^s} - rb\right]}{(1-u)r + u\left[1-\sum_{s=1}^{\infty}\frac{d_s}{(1+i)^s} - rb\right]} \quad (8)$$

where

$$r = \frac{i-\pi}{(i-\pi+(1+\pi)\delta)} \quad (9)$$

The next step will be to develop methods how to compute the EMTRs.

2.2 The King-Fullerton-approach

Following the standard approach by King and Fullerton (1984) equation (8) can be computed on the basis of legal provisions in the tax law:

$$EMTR_{KF} = \frac{u\left[1 - \sum_{s=1}^{\infty} \frac{e_s}{(1+i)^s} - rb\right]}{(1-u)r + u\left[1 - \sum_{s=1}^{\infty} \frac{e_s}{(1+i)^s} - rb\right]} \tag{10}$$

where the e_s denote the legal provisions for depreciation deductions. This forward-looking method has often been criticized for not taking into account the entire complexity of the tax law and the variety of special legal provisions that allow firms to lower their tax burden.

2.3 The GKS idea

This criticism is referred to in recent work by Gordon, Kalambokidis and Slemrod (2003), henceforth GKS, who propose an empirically based method of computing the $EMTR$. Their method approximates $\sum_{s=1}^{\infty} \frac{d_s}{(1+i)^s}$ on the basis of historical data. Denote as D_t the tax depreciation of a firm in period t. D_t is a result of investment in previous periods and can be written as

$$D_t = \sum_{m=1}^{\infty} d_m I_{t-m} \tag{11}$$

where d_m denotes the tax depreciation for m year old capital[2]. Dividing by I_t and assuming that investment grows at a constant rate ω leads to the expression

$$\frac{D_t}{I_t} = \sum_{m=1}^{\infty} \frac{d_m}{(1+\omega)^m} \tag{12}$$

GKS (2003b) assume that the tax law remains stable, that the investment growth rate ω equals the nominal interest rate i and that the asset structure is constant. Under these assumptions, the ratio $\frac{D_t}{I_t}$ equals the present value of depreciation deductions $\sum_{s=1}^{\infty} \frac{d_s}{(1+i)^s}$ for new investment. Thus, the ratio $\frac{D_t}{I_t}$ observed in the data can serve as an empirical approximation for future depreciation deductions available for new investment. The $EMTR$ can thus be written as:

$$EMTR_{GKS} = \frac{u\left[1 - \frac{D_t}{I_t} - rb\right]}{(1-u)r + u\left[1 - \frac{D_t}{I_t} - rb\right]} \tag{13}$$

If the tax law remains stable over time and if the assumption $i = \omega$ is satisfied, $EMTR_{GKS}$ can be compared directly to $EMTR_{KF}$ in order to check whether the assumptions made on depreciation allowances e_m are empircally correct.[3] Unfortunately, the tax law changes

[2] The time vector s denotes the future, m the past.

[3] If there are differences between $EMTR_{GKS}$ and $EMTR_{KF}$, these can only be due to differences in the

frequently and there is no reason why the investment growth rate should be equal to the nominal interest rate. In fact, in our data set, the investment growth rate is much lower than the interest rate. A lognormal regression over the period under consideration (1993-2002) yields a growth rate of $\omega = 1,44\%$ whereas the average bond yield is $i = 6,7\%$. We therefore have to relax the assumptions made in GKS.

2.4 Relaxing some GKS assumptions

2.4.1 Different investment growth

If $i \neq \omega$ the analysis becomes somewhat more complicated, since D_t/I_t as an estimator for future depreciation deductions is now biased depending on the difference between i and ω.[4] We may solve this problem as follows. The "true" depreciation allowances d_m of equation (12) can be divided into "regular" deductions e_m accounted for in the KF-measure and "special" deductions g_m:

$$\frac{D_t}{I_t} = \sum_{m=1}^{\infty} \frac{d_m}{(1+\omega)^m} = \sum_{m=1}^{\infty} \frac{e_m}{(1+\omega)^m} + \sum_{m=1}^{\infty} \frac{g_m}{(1+\omega)^m} \tag{15}$$

Here, we could simply isolate $\sum_{m=1}^{\infty} \frac{g_m}{(1+\omega)^m}$ in order to compute the impact of "special" deductions. The problem is that our real interest is the present value of special depreciation allowances for future investment, which is discounted at rate i which diverges significantly from ω. We therefore have to assume that special depreciation allowances are a constant share κ of the "regular" deduction e_m, so that (15) can be expressed as:

$$\frac{D}{I} = \sum_{m=1}^{\infty} \frac{e_m}{(1+\omega)^m} + \sum_{m=1}^{\infty} \frac{\kappa e_m}{(1+\omega)^m} = (1+\kappa) \sum_{m=1}^{\infty} \frac{e_m}{(1+\omega)^m} \tag{16}$$

The parameter κ can be interpreted as a measure of how much observed depreciation allowances deviate from allowances assumed in forward looking effective tax rate measures. κ can be estimated by:

$$\hat{\kappa} = \frac{D/I}{\left(\sum_{m=1}^{\infty} \frac{e_m}{(1+\omega)^m}\right)} - 1 \tag{17}$$

where $\hat{\kappa}$ is the estimator for κ, D are the actual deductions taken from our data sample and $\sum_{m=1}^{\infty} \frac{e_m}{(1+\omega)^m}$ is the modified King-Fullerton deductions term, where the discount factor i

depreciation allowances e_m and d_m. This can be seen by considering the difference in the tax wedge (TW) as calculated under the KF approach and the GKS approach. Under the assumption $i = \omega$, this difference is given by

$$TW^{KF} - TW^{GKS} = \frac{u(\frac{i-\pi}{1+\pi} + \delta)}{(1-u)} \left[\sum_{m=1}^{\infty} \frac{d_m}{(1+i)^m} - \sum_{m=1}^{\infty} \frac{e_m}{(1+i)^m} \right]. \tag{14}$$

[4] If $i > \omega$, D_t/I_t overestimates depreciation allowances (and thus underestimates the effective marginal tax rate) and vice versa.

has been changed to ω. Given this, we can establish an adjusted effective marginal tax rate.

$$EMTR_{adj} = \frac{u\left[1-(1+\kappa)\sum_{s=1}^{\infty}\frac{e_s}{(1+i)^s} - rb\right]}{(1-u)r + u\left[1-(1+\kappa)\sum_{s=1}^{\infty}\frac{e_s}{(1+i)^s} - rb\right]} \tag{18}$$

In order to calculate this adjusted effective marginal tax rate, two additional complications have to be taken into account: The first is that the tax law may change and the second is that the tax law treats different types of assets differently.

2.4.2 Changing tax law

The tax law, especially the provisions for depreciation deductions, is changed quite frequently. This has to be taken into account in our approach. For instance, if the present tax system contains more generous deductions than before, the estimator $\hat{\kappa}$ in equation (17) would be biased downwards. We therefore have to correct for tax policy changes, which can be done by writing our estimator $\hat{\kappa}$ as

$$\hat{\kappa} = \frac{D/I}{\left(\sum_{m=1}^{\infty}\frac{e_m}{(1+\omega)^s} + H\right)} - 1 \tag{19}$$

where $H = \sum_{m=1}^{\infty}\frac{h_m - e_m}{(1+\omega)^s}$ is a correction term which is computable on the basis of the tax law. The h_m correspond to the depreciation rules which were valid in the period when the investment was realized.

2.4.3 Investment structure

So far, we have analyzed the problem for a single type of asset. In reality the capital stock is composed of different asset types, each of which is treated differently in the tax law and has a different rate of economic depreciation. We therefore reformulate equation (19):

$$\hat{\kappa}_t = \frac{D_t}{\sum_{k=1}^{K}\sum_{m=1}^{M_k} h_{m,k} I_{t-m,k}} - 1 \tag{20}$$

where K is the number of assets and M_k is the number of periods in which the asset k is depreciated. Thus $\sum_{k=1}^{K}\sum_{m=1}^{M_k} h_{m,k} I_{t-m,k}$ can be understood as a virtual time path of depreciation deductions.

3 Empirical Evidence

In this section, we apply our method to German data. The basic idea of our approach may be summarized as follows. For the investment observed in the data[5], we calculate the path of tax depreciations which would arise if the depreciation rules assumed by forward looking measures of the effective tax burden were applied. We then compare this hypothetical path of depreciation to the tax depreciation observed in the data. The difference between the two is summarized in the parameter κ. We will then use our results on κ to assess the current effective tax burden on investment in Germany.

3.1 The data

We use data from the DAFNE database which includes balance sheet data of 22.000 German firms from different industrial and commercial branches covering the period from 1993 to 2002. In order to estimate κ we need data covering at least eight years without interruption, which corresponds to the depreciation duration of machines[6]. We have to exclude all firms which do not satisfy this condition. After all, 1495 firms remain in our dataset.

Table 1 provides a descriptive statistic of the data sample. The capital stock is measured in thousand Euro. For immaterials, tangible assets and inventories the fractions of the capital stock are given. The difference to 1 is the fraction of financial assets. The average firm has a leverage (= debt through total capital) of 45,5%.

	mean	**stand. dev.**	**median**
capital stock	495.956	3.755.774	93.700
immaterials	0,067	0,563	0,005
tangible assets	0,413	0,303	0,363
of which structures	0,375	0,370	0,234
of which machines	0,625	0,370	0,766
inventories	0,107	0,150	0,036
debt ratio	0,455	0,239	0,446

Table 1: Descriptive statistics

As explained in section 2, we have to take into account that the tax law has changed in 2001. Table 2 presents the difference between the former and the new deduction system.

[5] Since the capital stock in the balance sheet is only decreased by depreciation deductions, I_t can be constructed by:

$$I_t = K_t - K_{t-1} + D_t$$

The K_t and the D_t can be drawn from the balance sheet data.

[6] That means, that M_k is not higher than 7 for any of the asset types except for structures and buildings. Here, we assume that the whole stock of structures and buildings can be depreciated, i.e. that all buildings have been built in the last 25 years. We therefore might overstate the true depreciation deductions.

Asset type	**...-2000** (h_k)		**2001-...** (e_k)	
	type	years	type	years
Immaterials	linear (20%)	5	linear (20%)	5
Machines	degr. (30%)	4	degr. (20%)	2
	linear (8%)	3	linear (12,8%)	5
Structures	linear (4%)	25	linear (3%)	33
Inventories	-	-	-	-

Table 2: Deduction rules

3.2 Results

3.2.1 The estimation of κ

As pointed out in the theoretical section, we estimate the share of special deductions κ by constructing a virtual time path of tax deductions. With 1495 firms in our dataset we compute 3157 estimates of κ for the years 2000-2002 using equation (20), 1498 estimates for the year 2000, 982 for 2001 and 681 for 2002. Table 3 presents the most important parameters of the κ estimates.

mean	0,294
standard deviation	1,839
median	0,069

Table 3: estimation results

On average, the observed tax deductions of firms exceed those assumed by forward looking KF style measures by 30%. However, the high standard deviation and the smaller median suggest that we should take a closer look at the distribution of κ.

Figure 1 shows the distribution of κ in decile classes. Due to its construction, κ can take values between -1 and $+\infty$. The last column at the right side shows the number of κ with a value greater than $2,9$. At first glance, κ seems to have a normally shaped distribution around zero exhibiting a moderate right skewness.

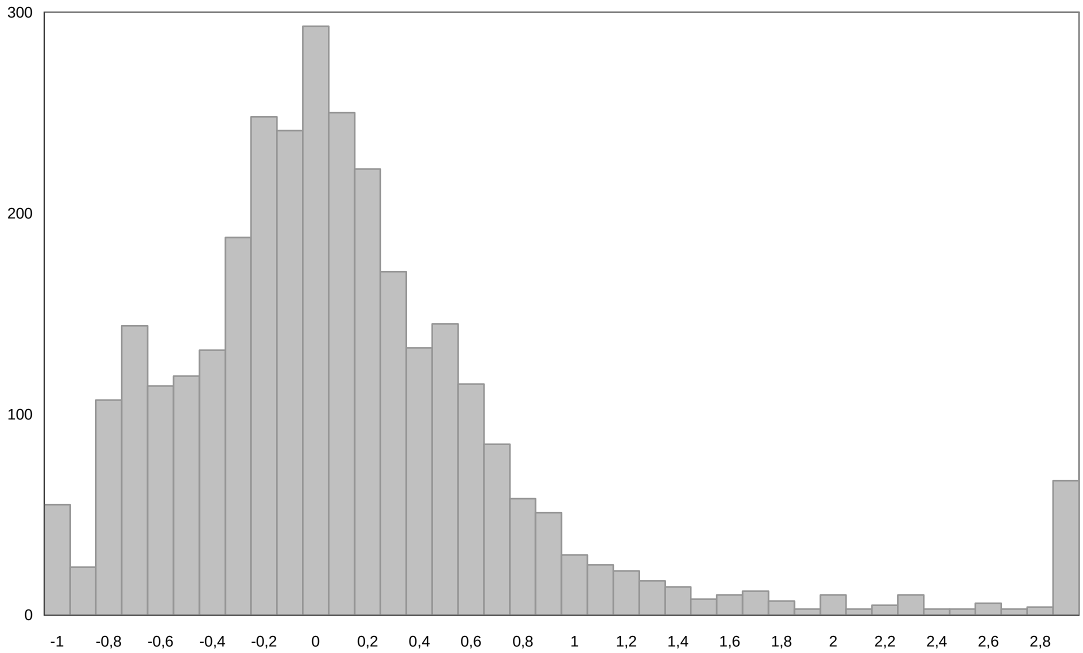

Figure 1: distribution of κ

Typically, arithmetic means of skewed distributions react strongly to the exclusion of extreme values. Figure 2 shows how the mean develops as a function of the number of extreme values excluded. The mean quickly falls below $0,1$ and then gradually converges to the median.

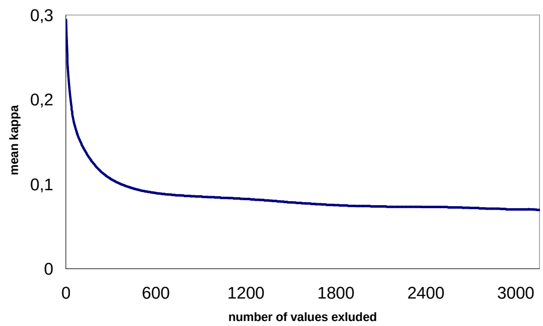

Figure 2: mean and number of excluded values

The average κ takes values between 0,294 and 0,069, depending on the number of excluded values. In economic terms, the average firms depreciates between 7% and 30% more than suggested by the forward-looking measures. On the basis of these estimates, we are now able to compute an adjusted EMTR.

3.2.2 The adjusted $EMTR$

In the following, the EMTR is computed with and without taking into account the correction parameter κ. For simplicity, we consider an investment project with an asset structure corresponding to the average asset structure in the sample (without inventories and financial assets)[7], which is presented in Table 4.

Asset type	Immaterials	Structures	Machines
Share	$14,0\%$	$32,3\%$	$53,7\%$

Table 4: Asset structure

The statutory tax rate u has been calculated by Spengel (2001) on the basis of statutory rates of the German corporate income tax ("Körperschaftsteuer") and the local business tax ("Gewerbeertragsteuer"). We adopt this value and set $u = 39,4\%$.

The assumptions on the economic depreciation δ correspond to average depreciation rates used by the German Council of Economic Advisers (Sachverständigenrat (2001))[8]. Given the structure of our hypothetical investment project, the total rate of economic depreciation is $\delta = 6,6\%$. The values for the nominal interest rate ($i = 7\%$) and the inflation rate ($\pi = 2\%$) are adopted as well.

Obviously, the share of debt financing b at the margin may differ from average debt financing. We therefore consider three different values of b: pure equity finance ($b = 0$), pure debt finance ($b = 1$) and mixed finance ($b = 44,4\%$), which corresponds to the average debt financing share of the whole capital stock in our data set.

Table 5 shows the effective marginal tax rate according to the conventional method ($\kappa = 0$) and with different κ ranging between the median ($\kappa = 6,9\%$) and the arithmetic mean ($29,6\%$).

	EMTR (%)	adjusted EMTR (%)			
b(%)	$\kappa = 0\%$	$\kappa = 6,9\%$	$\kappa = 10\%$	$\kappa = 20\%$	$\kappa = 29,6\%$
0	$34,2$	$31,0$	$29,5$	$24,1$	$18,1$
$44,4$	$18,7$	$13,9$	$11,5$	$2,8$	$-7,3$
100	$-15,1$	$-25,1$	$-30,2$	$-49,8$	$-75,2$

Table 5: EMTR with and without kappa

It becomes clear, that even with a relatively small κ of about 7% the effective marginal tax rate is considerably biased downwards. With a rising κ the bias incrases quickly.

3.3 Explanation of differences in κ across firms

As shown in the preceding section, the distribution of κ has a large variance. There seem to be firms which deduct much more than the KF style measures assume and others which apparently "play the rules". This raises the question of what determines the different levels of κ. Theoretically, there are several factors which might have an impact on depreciation

[7]Note that our results do not depend on the specific asset structure of the investment project. However, to illustrate our results we have to assume some structure.

[8]The calculations of the Council of Economic advisers are based on Spengel (2001), where the assumptions on economic depreciation and tax depreciation rates can be found.

behaviour. Firstly, there might be sector specific differences in κ because of sector specific depreciation allowances which are not captured by KF assumptions. Secondly, it is likely that firms will try less hard to use special depreciation allowances if they have other tax shields, such as a high level of debt or losses which are carried forward. Finally, it may be that depreciation behaviour depends on the structure of assets or the organizational form. In order to investigate these issues, we have run regressions where we use κ as the dependent variable and try to explain its value as a function of (1) the sector, (2) the organizational form and (3) the structure of the balance sheet.

3.3.1 κ and different sectors

Our data sample contains data points from firms in the following industrial and commercial sectors: agriculture (12 firms), mining (21), manufacturing (825), energy (620), construction (83), commerce (290), restaurants (5), transport (227), banking (24), real estate (813), public administration (8), education (6), health (80) and other public services (87).

Does the value of κ depend on the sector for which could exist special depreciation opportunities? Table 6 shows the regression results for κ with two time dummies and different branches as independent variables. As in every following regression result the time dummy for 2002 has a significant positive coefficient. This should not be overinterpreted, though, since the number of observations differ in each year. There are two sectors which exhibit highly significant regression values: agriculture and the banking sector.

Dependent Variable: KAPPA
Method: Least Squares
Sample(adjusted): 1 3157
Included observations: 3157 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONST	-0.022931	0.244355	-0.093845	0.9252
2001	-0.066345	0.075472	-0.879065	0.3794
2002	0.181596	0.085052	2.135110	0.0328
AGRICULTURE	2.096612	0.582236	3.600970	0.0003
MINING	0.173985	0.467988	0.371772	0.7101
MANUFACTURE	0.416398	0.253623	1.641798	0.1007
ENERGY	0.291185	0.256542	1.135039	0.2564
CONSTRUCTION	0.269710	0.317023	0.850759	0.3950
COMMERCE	0.333086	0.267844	1.243584	0.2137
RESTAURANTS	0.069376	0.852675	0.081363	0.9352
TRANSPORT	0.312924	0.273996	1.142072	0.2535
BANKING	2.214154	0.446086	4.963517	0.0000
REALESTATE	0.148961	0.253699	0.587155	0.5571
PUBLICADMIN	-0.253140	0.691211	-0.366227	0.7142
EDUCATION	-0.144642	0.784800	-0.184304	0.8538
HEALTH	0.059213	0.319091	0.185568	0.8528
PUBLICSERVICE	0.266222	0.313566	0.849014	0.3959

R-squared	0.018607	Mean dependent var	0.294143
Adjusted R-squared	0.013606	S.D. dependent var	1.839361
S.E. of regression	1.826804	Akaike info criterion	4.048384
Sum squared resid	10478.85	Schwarz criterion	4.081002
Log likelihood	-6373.374	F-statistic	3.720854
Durbin-Watson stat	1.448979	Prob(F-statistic)	0.000001

Table 6: κ and different branches

The high regression coefficients for these two branch dummies raise the question, if our estimated $\kappa > 0$ can be explained simply by special provisions for agricultural firms and banks. In this case the constant should be near to zero if one adds just the variables "AGRICULTURE" and "BANKS". As table 7 shows, this is not the case.

Dependent Variable: KAPPA
Method: Least Squares
Sample(adjusted): 1 3157
Included observations: 3157 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONST	0.247763	0.047420	5.224910	0.0000
2001	-0.056708	0.075070	-0.755406	0.4501
2002	0.196431	0.084501	2.324612	0.0202
AGRICULTURE	1.817761	0.528533	3.439258	0.0006
BANKING	1.938578	0.374438	5.177308	0.0000

R-squared	0.014633	Mean dependent var	0.294143
Adjusted R-squared	0.013383	S.D. dependent var	1.839361
S.E. of regression	1.827011	Akaike info criterion	4.044822
Sum squared resid	10521.28	Schwarz criterion	4.054416
Log likelihood	-6379.752	F-statistic	11.70229
Durbin-Watson stat	1.443698	Prob(F-statistic)	0.000000

Table 7: constant variable, agriculture and banking

3.3.2 κ and different organizational forms

The most frequent organizational forms in our data sample are "GmbH" (1763 firms), "AG" (1229) and "GmbH&Co KG" (69). Table 8 shows the regression results with respect to the three most frequent organizational forms in the data sample.

Dependent Variable: KAPPA
Method: Least Squares
Sample(adjusted): 1 3157
Included observations: 3157 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONST	-0.067945	0.190263	-0.357112	0.7210
2001	-0.077926	0.075507	-1.032047	0.3021
2002	0.168421	0.085095	1.979214	0.0479
AG	0.504702	0.194397	2.596251	0.0095
GMBH	0.262055	0.192200	1.363452	0.1728
GMBH&COKG	0.328384	0.289427	1.134598	0.2566

R-squared	0.007711	Mean dependent var	0.294143
Adjusted R-squared	0.006137	S.D. dependent var	1.839361
S.E. of regression	1.833708	Akaike info criterion	4.052456
Sum squared resid	10595.19	Schwarz criterion	4.063969
Log likelihood	-6390.802	F-statistic	4.897289
Durbin-Watson stat	1.435799	Prob(F-statistic)	0.000182

Table 8: κ and different organizational forms

The AG-dummy (for "Aktiengesellschaft") is highly significant and suggests that κ is bigger for AGs.

3.3.3 κ and the balance sheet structure

Finally we look at general characteristics of the balance structure. Table 9 presents the regression results with respect to the size of the capital stock (CAP_SIZE), the leverage, the ratio of tangible goods relative to the total capital and a dummy for the use of loss carry forwards[9].

Dependent Variable: KAPPA
Method: Least Squares
Sample(adjusted): 1 3157
Included observations: 3157 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONST	0.803359	0.085490	9.397163	0.0000
2001	-0.065468	0.074722	-0.876143	0.3810
2002	0.194011	0.084138	2.305873	0.0212
CAP_SIZE	4.24E-09	8.21E-09	0.516537	0.6055
LEVERAGE	-0.479279	0.142401	-3.365688	0.0008
TANGIBLE	-0.804076	0.110450	-7.280029	0.0000
LOSSCARRYFOR	0.150676	0.156839	0.960702	0.3368

R-squared	0.026275	Mean dependent var	0.294143
Adjusted R-squared	0.024420	S.D. dependent var	1.839361
S.E. of regression	1.816763	Akaike info criterion	4.034205
Sum squared resid	10396.98	Schwarz criterion	4.047636
Log likelihood	-6360.993	F-statistic	14.16633
Durbin-Watson stat	1.468853	Prob(F-statistic)	0.000000

Table 9: κ and the balance structure

Only the leverage ratio and the tangible goods ratio are significantly different from zero. How can these results be interpreted? First, the size of the capital stock or the use of loss carry forward provisions seem to have no importance to explain the value of κ.

Second, the fact that κ decreases when the debt ratio increases seems quite plausible. Since the cost of debt can be deducted from the tax base, a higher share of debt finance reduces the incentive to search for alternative tax shields.

Third, it seems difficult to explain, why a higher share of tangible assets reduces the use of special deductions. It is possible that immaterial capital goods can be faster depreciated than suggested in the KF assumptions. There may also be opportunities to depreciate losses related to financial assets which are not captured by standard KF assumptions.

3.3.4 Multicollinearity?

Our method to measure separately the impact of different factors raises the question of multicollinearity. Especially the clear results for the organizational forms and the balance structure might be linked somehow[10]. And, indeed, running regressions with the organizational form as dependent variable and the structural variables shows that these factors are not independent from each other.

The question remains which of the two types of variables is the one which drives the other. If we put the two types in one regression it turns out that the structural variables keep being highly significant whereas the organizational forms are not, as can be seen in table 10.

[9] Before using a quantitative variable we tested the dummy. Since it has no significant impact we abandoned the search in this direction.

[10] We tested for multicollinearity between the branch dummies and the structural variables, and the branches and organizational forms as well, but there are only weak linkages.

Dependent Variable: KAPPA
Method: Least Squares
Sample(adjusted): 1 3157
Included observations: 3157 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONST	0.524288	0.207983	2.520826	0.0118
2001	-0.071080	0.074906	-0.948925	0.3427
2002	0.184382	0.084456	2.183164	0.0291
AG	0.309799	0.194481	1.592956	0.1113
GMBH	0.226494	0.190657	1.187962	0.2349
GMBH&COKG	0.184650	0.287558	0.642131	0.5208
CAP_SIZE	3.49E-09	8.24E-09	0.423495	0.6720
LEVERAGE	-0.436490	0.144975	-3.010797	0.0026
TANGIBLE	-0.772908	0.113390	-6.816341	0.0000
LOSSCARRYFOR	0.161390	0.157613	1.023963	0.3059

R-squared	0.027291	Mean dependent var	0.294143
Adjusted R-squared	0.024509	S.D. dependent var	1.839361
S.E. of regression	1.816681	Akaike info criterion	4.035061
Sum squared resid	10386.13	Schwarz criterion	4.054249
Log likelihood	-6359.345	F-statistic	9.810332
Durbin-Watson stat	1.466332	Prob(F-statistic)	0.000000

Table 10: κ, organizational form and balance structure

This could be a hint that AGs do not have higher κ because of their organizational form but due to their specific balance sheet structure.

4 Conclusions

In this paper, we have developed a method of correcting conventional forward looking measures of effective taxation for real world complexities. Thus, our method offers an empirical test for the validity of assumptions on depreciation deductions used for the construction of forward looking measures. On the basis of our estimates of the "true" use of depreciation deductions, we are able to compute "adjusted effective tax rates" for marginal investment decisions.

We have applied our method to the DAFNE dataset of German firms. It turns out that depreciation deductions used by the median (average) firm exceed the depreciation deductions asumed by KF measures by 7% (30%) . If these estimates are correct, the KF concept systematically overestimates the effective tax burden on investment. To demonstrate the bias caused by the misestimation of depreciation deductions we have computed the effective marginal tax rates with different assumptions on the use of special deductions. It turns out that even small errors in the specification of the deductions pattern lead to considerable variations in the measures of effective taxation.

The regression analysis shows that κ rises with an increasing share of equity finance and an decreasing share of tangible assets. The banking and the agricultural sectors depreciate more than other branches.

These results suggest that the approach developed here might be a first step towards reconciling the different results of studies based on forward and backward looking indicators. The fact that backward looking indicators, in particular macro indicators, often find a lower effective tax burden on investment may partly be due to the failure of forward looking concepts to take into account all possibilities of firms to use deduction possibilities offered by the tax law.

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