Measuring corporate marginal tax rates: looking forward or looking backward?

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Abstract

This paper considers the theoretical and empirical properties of forward and backward looking measures of the effective marginal tax rate. The main difference between forward and backward looking approaches is, that the first are based on the special provisions of the tax law and consider a hypothetical firm, whereas the latter are based on real data. The main advantage of data based backward looking measures is, that they capture true economic behavior, like substitution effects, which affect the marginal tax rate. To measure the impact of taxation on the effective burden on investment, an ACE-based backward looking measure is applied and tested. The results suggest that i) that the pre-reform tax system of Liechtenstein collects little revenue from taxing the normal return to capital, and ii) substitution effects occur. Since substitution effects are captured by the backward looking approaches, this finding supports the application of data based backward looking approaches.

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## Contents

1 Introduction ............................................. 2

2 The theoretical framework ............................ 4
   2.1 The Base Case ...................................... 5
   2.2 Debt Finance ........................................ 7

3 Empirical Evidence ..................................... 9
   3.1 The Liechtenstein Tax Reform ...................... 9
   3.2 The data ............................................ 11
   3.3 Total effects on tax revenue ....................... 11
   3.4 The effective marginal tax burden ................ 13
   3.5 Test of the substitution effect .................... 14

4 Conclusion ............................................. 17
1 Introduction

Almost all corporate tax reforms in the last have been implemented to stimulate investment and growth. In order to evaluate these reforms, it is important to measure the impact of taxation on the the effective burden on investment.

The standard approach to measure the impact of taxation on incentives to invest attempt to identify its impact on the cost of capital - the minimum pre-tax rate of return to an investment required by an investor (Jorgenson 1963; Hall/Jorgenson 1967). The approach of King/Fullerton (1984) followed this line, by developing measures of the effective marginal tax rate, based on the special provisions of the tax law, notably statutory tax rates and the legal definition of taxable income. This approach has been modified by Devereux/Giffith (1998a,b, 2003) to consider discrete investment decisions that may affect the composition of the capital stock. To asses more complex firm’s activities, a model firm approach was developed (OECD 1985). This approach was extended by the European Tax Analyser (Ja- cobs/Spengel, 1996, 2002), which allows to analyze a more a detailed model of a hypothetical firm that incorporates a a large number of accounting items from profit and loss account and balance sheet. There is however a trade-off between detail and general statement - the more specialized the the investment project, and the more specialized the nature of the tax regime, the less general will be the obtained effective tax rates (Devereux 2004).

An alternative line of literature relies on firm level data instead of parameters of the tax legislation to derive measures of the marginal tax rate (Gordon et al., 2003; Becker/Fuest, 2004). Those data-based approaches can be categorized as backward looking approaches, since the tax burden on the marginal investment is computed by comparing the tax revenue under the existing tax system to the tax revenue that would be generated by a neutral corporate tax (e.g. an R-based tax), which leaves the marginal investment untaxed. In contrast to this backward looking approaches, can the above mentioned approaches be termed as forward looking, since they are calculated on the expected burden on hypothetical investment projects (Sorensen, 2004).

To test for tax effects, researchers should construct the marginal tax rates on an information basis, which managers use in their actual decision making. Since investment decisions depend on current and expected future cash flows, a measure of the effective tax rate should in principle be forward looking if it is meant to capture the effect of taxes on the incentive to invest. However, it is difficult to capture all the provisions of the tax code which allows the firms to reduce their tax burden in a forward looking measure. Backward looking measures have therefore the main advantage, that the
impact of the special rules of the tax code will tend to be captured in the
data used to construct theses measures. If the tax law remains relatively
stable over the time, a backward looking measure may be a good proxy for
the ideal forward looking measure (Sørensen, 2004).

All the empirical work on the backward looking measures of marginal
tax rate refer on neutral R-based or S-based corporate tax systems. An
alternative neutral business tax, which imposes also no tax on marginal
investment, is the Allowance for Corporate Equity (ACE) system. Thus, a
backward looking measure can also be computed on the base of an ACE
system. An advantage of the ACE in comparison to the R-based tax is,
that the tax base has only to be modified slightly, which is easier to im-
plement, and also easier to simulate. An additional advantage is that the
tax base of an ACE is less volatile than that of an R-based tax. Thus it
is assumed, that marginal tax rates, which are based on an ACE, will be
also less volatile than the forward looking measures proposed by Gordon
et al. (2003) and Becker/Fuest (2003). However, the principal advantage
of backward looking measures is that those data based approaches cap-
tures adjustment reactions, like e.g. substitution effects, which affects the
marginal tax rate.

The purpose of the paper is twofold. First, the theoretical characteristics
of forward and backward looking measures are analyzed, and an ACE-
based backward looking measure is introduced. Second, the theoretical
characteristics of forward and backward looking measures are empirically
tested. In particular, a panel of tax return data from 2003 to 2008 is used
to simulate an ACE-based backward looking marginal tax rate. Beyond
this, it is tested whether substitution effects occur. Substitution effects do
not affect the reliability of backward looking measures, since those effects
are captured in the underlying data. However, it is difficult to model
substitution effects in forward looking measures.

The main finding is that the revenue effect that would be caused by switch
toward a consumption based tax system would be surprisingly low. This
indicates, that the comprehensive tax system collected little revenue from
capital income. Beyond this it has been shown, that the ACE system has
a stronger countercyclical effect than the comprehensive tax system. Since
the marginal effective tax rate varies with the business cycle, it is assumed
that substitution effects occur. In particular it is assumed, that a firm’s
demand for interest deductions declines, as the depreciation deductions
increase. The results of the fixed effects model support this hypothesis.
If this hypothesis is correct, the marginal effective tax burden is affected
by these adjustments. In backward looking measures, however, are those
effects captured in the data, and thus reflected in the marginal effective tax
burden. Since substitution effects are captured by the backward looking
approaches, this finding supports the application of data based backward looking approaches.

The remainder of the article is organized as follows. Sect 2 describes the basic concepts of forward and backward looking measures. In section 3 the modified GKS measure is applied to Liechtenstein data. In section 4 summarizes and concludes.

2 The theoretical framework

The first backward looking approach was developed by Gordon et al. (2003) (henceforth GKS) who measured the marginal tax burden on investment which is based between the actual tax revenue of the US tax system and the tax revenue that would be generated by a R-based tax. This approach was modified by Becker/Fuest (2003) (henceforth BF), who developed a measure which is based on less restrictive assumptions than the GKS approach. They found highly volatile marginal tax rates, where the fluctuation of the marginal tax rates is essentially driven by the fluctuation of the investment over business cycle, and it is correlated with macroeconomic fluctuations. Beyond this they compared the results to King/Fullerton (1984) (henceforth KF) marginal effective rates and found that the KF rates are much higher. This might be caused by the underlying assumptions on economic depreciation in the KF approach, which are not compatible with the tax depreciation observed in the data.

Becker/Fuest (2004) found, that their estimated depreciation deductions exceed the depreciation deductions assumed by KF-measures. If their estimates are correct, than the concept of KF concept overestimates the tax burden on investment. In detail, they found sector specific depreciation allowances that are not captured in the KF measure. Beyond this, they found that firms use less hard special depreciation allowances if they have high level of debt or losses which are carried forward. These empirical results support the hypothesis of the substitution effect, where a firms demand for depreciation deductions decreases, as the interest deductions increase (Angelo/Masulis, 1980). This finding is in line with the critique on forward looking measures, for not taking into account the numerous and partly sector specific details in the tax code which allows the firm to reduce their tax burden. Based on the findings of Becker/Fuest (2004) it is therefore assumed, that KF measures overestimate the marginal tax burden, if substitution effects occur.

Devereux/Klemm (2004) also compared different forward and backward looking measures of EMTR. They find strong similarities between the backward looking GKS and the forward looking marginal tax rate based on
However, the GKS measures tend to be more volatile, since it is based on real data, than measures, like the DG or KF measures, which are based on legal tax provisions. This finding is in line with Becker/Fuest (2003), who also report highly volatile GKS measures. In order to obtain a less volatile measure of the marginal tax rate, Gordon et al. (2004) proposed to correct for business cycles. It is assumed, that a GKS measure which is based on an ACE system would be less volatile than an R-based measurement. Thus, the theoretical approach of Gordon et al. (2003) is discussed and compared to an ACE-based backward looking measure, as well to a forward looking KF measure. In a first setting are personal taxes and debt finance ignored which is extended in subsection 2.2.

2.1 The Base Case

The model is based on the cost of capital approach as proposed by Hall/Jorgenson (1967). It is assumed, that a profit maximizing firm will invest until the present discounted value of the stream of return generated by the asset exceeds the cost of acquiring. The single-period maximization problem is max f(K) − (r + d)K, where r is the discount rate, and d is the rate of depreciation of the capital goods. The marginal investment condition is

\[ f'(K) - d = r \]

where \( f' - d \) is the annual net return to one unit of capital. In equilibrium this equals the investors’ marginal rate of return to savings r. If a corporate tax is introduced, the investment is taxed at the corporate tax rate u and depreciation deduction are allowed. The tax revenue in period t under this tax system \( TC_t \) is given by \( TC_t = u(f(K) - dK) \). Let z the present value of tax savings resulting from deductions, so that uz is the present value of tax savings resulting from one unit of new investment. Hence, only \( (1 - uz) \) units need to be raised to finance one unit of new investment. Similarly, only \( d(1 - uz) \) need to be raised in each future period to cover investment expenditure. With these increments, equation (1) becomes,

\[ f'(K) - d = \frac{(r + d)(1 - uz)}{1 - u} \]

which can be reformulated to

\[ f' - d = r + \frac{u(r + d)(1 - z)}{1 - u}. \]

The model is based on the neoclassical investment theory. Perfect information, perfect competition, zero excess profits on the marginal investment, an stable tax law and no risk are assumed. It is further assumed, that the firm has sufficient profits to use alls of the allowed credits and deduction in the earliest possible year.
The second term of the left hand side captures the extent of the tax distortion, measured as the difference between the net return on capital and the marginal rate of return of saving for the firm’s shareholders \( r \).

If the effective tax rate \( m \) is defined as that tax rate on net corporate income \( f' - d \), that leads to the same equilibrium value of \( f' \) given \( r \), \( m \) satisfies

\[
(f' - d)(1 - m) = r. \tag{4}
\]

From (2) and (3) follows for the equilibrium:

\[
m = \frac{u(r + d)(1 - z)}{(1 - u)r + u(r + d)(1 - z)}. \tag{5}
\]

In the case of an R-base tax, under which all investment expenditures are deductible from taxable income when occurred, \( z \) equals one, and thus the effective tax rate \( m \) equals zero, regardless of the value of \( u \) or \( d \).

The backward looking approach of GKS

The backward looking measure of Gordon et al. (2003) focus on measuring the tax collected under the status-quo tax system (\( TC_t \)) relative to an R-base tax that does not distort capital investments. In an R-base tax system are financial income from the tax base excluded, interest deductions disallowed and depreciation deductions are replaced by expensing for new investments (Meade, 1978). The tax revenue in period \( t \) under a hypothetical R-base tax system (\( TR_t \)) is given by \( TR_t = u(f(K) - I) \) and the difference of the status quo tax systems \( TC_t \) and the neutral R-base tax system \( TR_t \) is: \( TC_t - TR_t = u(l - dK) \). If the real investment grows at rate \( r \) and the tax law remains unchanged, \( TC_t - TR_t = u(r + d)(1 - z)K \). Thus the effective marginal tax rate is

\[
m_{GKS} = \frac{(TC_t - TR_t)/K}{(1 - u)r + (TC_t - TR_t)/K}. \tag{6}
\]

If the status-quo tax system would be equivalent to an R-base, \( TC \) would be equal \( TR \), so that \( m_{GKS} = 0 \), regardless of the value of \( u \) or \( d \) (Gordon et al., 2003).

The forward looking approach of KF

The King/Fullerton (1984) measure is a forward looking concept. On the basis of statutory tax rates and tax bases, KF 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. In doing so, this effective tax rate depends on the source of finance and the tax characteristics of the recipient of the firm.

\[
m_{KF} = \frac{u(r + d)(1 - z)}{(1 - u)(f' - d)}. \tag{7}
\]
This measure also equals zero in the case of an R-base tax, where $z$ equals one (Gordon et al., 2003). Since this measure depends on one specific investment, King/Fullerton (1984) proposed an weighted average, under the assumption that new investment is distributed among different asset types, industries, source of finance, and ownership characteristics in the same proportions as the current capital stock. They further assume, that all assets in a particular industry are financed in the same proportions.

### 2.2 Debt Finance

It is now assumed that firms finance a fraction $b$ of their investments with debt, and $1 - b$ from equity. The corresponding interest payments are tax deductible under the corporate tax, but interest income is taxable at some tax rate $\tau_b$ at the personal level in the status quo tax system. For simplicity is further assumed, that the tax law allowances are equal to economic depreciation at rate $d$. The opportunity cost of equity investors equals the return they could earn on bonds $r(1 - \tau_b)$, where $\tau_b$ is their personal tax rate on interest income from bonds. The marginal investment condition is

$$ (1 - u)[f' - rb - d] = (1 - b)r(1 - \tau_b). \tag{8} $$

In equilibrium follows

$$ f' - d = \frac{r(1 - \tau_b)(1 - b) + rb(1 - u)}{1 - u} = r(1 - \tau_b) + \frac{\Delta b}{1 - u} \tag{9} $$

where $\Delta b = ur(1 - \tau_b) - br(u - \tau_b)$. If $u > \tau_b$, the cost of funds is minimized, if $b$ is as large as possible. To compute the effective marginal tax rate $m$, identity (4) is modified

$$ (f' - d)(1 - m) = r(1 - \tau_b), \tag{10} $$

where $r(1 - \tau_b)$ represents the marginal rate of return from saving. From equation (9) and (10) follows

$$ m = \frac{\Delta b}{(1 - u)(f' - d)} = \frac{\Delta b}{(1 - u)r(1 - \tau_b) + \Delta b}. \tag{11} $$

In this case is the investment decision affected by personal and corporate taxes (Gordon et al., 2003).

*The backward looking approach of GKS with debt*

Under the GKS approach, the difference of tax collected under the status-quo tax system $TC_t$ relative to an R-base $TR_t$ is $TC_t - TR_t = u(I - dK - rbK) + \ldots$
Thus the effective marginal tax rate is

$$m_{GKS} = \frac{u(r + d)(1 - z)}{(1 - u)r + u(r + d)(1 - z)},$$

(12)

which equals \(m\) if and only if \(I = (r(1 - \tau_b) + d)K\). This is met when the growth rate in real investment equals the investors discount rate \(r(1 - \tau_b)\).

The forward looking approach of KF with debt

If the investment is partly financed with debt, the effective tax rate according to the KF approach is:

$$m_{KF} = 1 - \frac{r(1 - \tau_b)}{f' - d} = m.$$  

(13)

Gordon et al. (2003) conclude, that the KF, as well as the GKS approach measure the disincentive to invest due to taxes correct. However, the underlying assumptions differ and so the conditions which have to be fulfilled. For instance, requires the KF measure not, that the tax law remains stable over time. The GKS measure however, requires that growth rate in real investment equals \(r\), if the investment is financed by equity, and in the case of debt finance, the GKS measure is only correct if the growth rate in real investment equals the investors discount rate \(r(1 - \tau_b)\). Beyond this, exists in both approaches an inter optimum for \(b\), if investments are financed by debt.

Relaxing some GKS assumptions

Becker/Fuest (2004) modified the GKS measure and developed a measure with less strict assumptions concerning the growth rate, the continuity of the tax law and the investment structure. They propose to measure the effective marginal tax rate with

$$m_{BF} = \frac{u [1 - (1 + \kappa)z - rb]}{(1 - u)r + u [1 - (1 + \kappa)z - rb]},$$

(14)

where \(\kappa\) is a measure of how much observed depreciation allowances deviate from allowances assumed in forward looking measures, like the KF approach. \(\kappa\) can be estimated by

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

(15)

where \(D_t\) are the actual deductions from the data sample, \(I_t\) are the investments, \(k\) 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 interpreted is the virtual time path of depreciation deductions. The estimation of (15)
however, requires information about the asset structure of new investment and the corresponding depreciation rules.

A suitable measure for the effective tax rate depends first of all on the available data set. If the data set is limited, sophisticated measures can not be estimated. An alternative measure, which is based on the GKS approach, relies on the Allowance for Corporate Equity (ACE) system. This idea of neutral taxation was developed by Wenger (1983) and Broadway/Bruc (1984), which proposed to replace the deductibility of actual interest payments by an allowance for corporate capital (ACC). The ACE is slightly different as it maintains the current deductibility of actual interest payments and allows additionally a notional return on equity to be deducted from corporate profits. Since the tax advantage of the notional interest deduction is certain, the appropriate notional return of the ACE is the risk-free nominal interest rate, e.g. the rate on government bonds (Bond/Devereux, 1995).

Since the ACE system is a variant of the R-based tax, the $m_{GKS}$ could also be computed on the base of the tax revenue under an ACE ($TACE_t$) in given period $t$. Thus equation (16) can be rewritten as

$$m_{GKS_{bud}} = \frac{(TC_t - TACE_t)/K}{(1 - u)r + (TC_t - TACE_t)/K},$$

where $TACE_t = u(f(K) - dK - rb - \rho(1 - b))$, and $\rho$ is the risk-free nominal interest rate.

### 3 Empirical Evidence

In this section a short outline of the Liechtenstein Tax System is given (subsection 3.1), which provides a definition of the two central parameters of the backward looking measure - the tax revenue under the current and under an ACE-based system. The dataset is described (subsection 3.2) section 3.3 shows the total effects on revenue, the marginal effective tax burden is computed in section 3.4, and in section 3.5 the substitution effect is tested.

#### 3.1 The Liechtenstein Tax Reform

Historically, the Liechtenstein Tax Act dates back to the 1960s and the 1920s. With the revision of the Liechtenstein Tax Act (“Steuergesetz” - SteG), which became effective as of 1 January 2011, the government adapts the Liechtenstein tax system to the changing economic, political and legal environment of the 21st century. The tax system tries to ensure the competitiveness of
the Liechtenstein tax system in an international context while at the same time complying with the standards of the OECD and the EEA-agreement (Wenz/Linn, 2009).

Under the old tax law, legal persons were subject to a capital tax (“Kapitalsteuer”) on their equity with a tax rate of 0.2%. Additionally, a corporate income tax (“Ertragssteuer”) was levied on net earnings. The tax rate varied between 7.5% and 20%, depending on the return on equity and the amount of distributions made. Lacking legal rules for participation exemptions, administrative practice granted a deduction for participations when calculating the capital tax and the corporate income tax, in order to prevent double taxation of participations and distributed profits of a subsidiary. Additionally, a 4% coupon tax (“Couponsteuer”) was generally levied on dividend distributions.

The tax reform abolished the capital tax and the coupon tax, and completely revised both the tax rate structure as well as the determination of taxable income of the corporate income tax. The progressive corporate income tax rates of up to 20% has been replaced by a flat rate tax of 12.5% on taxable net profit. Taxable net profit is calculated based on the tax modified profit and loss statement prepared for commercial purposes according to the provisions of the Law on Persons and Companies (Personen- und Gesellschaftsrecht). Thus, in principle all earnings of corporate entities are considered taxable income unless exempt.

A number of items that are part of the income as shown in the commercial profit and loss statement are exempt in order to prevent national and/or international double taxation. In particular, all dividends received from domestic and foreign participations are exempt from corporate income tax, while costs associated with these participations, such as refinancing costs, remain fully deductible. Capital gains realized upon the sale of such participations are also exempt from taxation. This exemption does not apply to the extent prior impairments were deductible for tax purposes. Capital gains realized upon the sale of domestic real estate are exempt from taxation to the extent these capital gains are subject to the real estate capital gains tax. In an international context, even in the absence of a double tax treaty, income derived from foreign permanent establishments and rental and lease income as well as capital gains from foreign real property are exempt from tax (Wenz, 2009).

Additionally, an allowance for corporate equity (ACE) on the modified equity capital (equity in the balance sheets, reduced in particular by participations and net assets of foreign permanent establishments, in order to prevent a double use of this ACE) of 4% is granted. This ACE reduces the taxable income and may even increase losses incurred in the business in prior years (unlimited loss carryforward).
3.2 The data

The analysis is based on tax return files of 220 Liechtenstein firms from different industrial and commercial branches covering the periods from 2004 to 2006. The dataset is extended by an estimation for the periods 2003, 2007 and 2008. The sample corresponds to 9% of the total number of Liechtenstein corporations. With regard to the tax base, the sample covers about 85% of the total tax base, which indicates an overrepresentation of big corporations.

Table 1 shows the distribution of the corporate income tax base (CI) and corporate income tax revenue (CIT) according to the grouped corporate income tax revenues. 67.9% of the corporate income tax base is concentrated on the biggest 0.7% companies, which contribute 64.8% of the corporate tax revenue in 2005.

<table>
<thead>
<tr>
<th>CIT taxpayers</th>
<th>CI (incl. losses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>in %</td>
<td>in %</td>
</tr>
<tr>
<td>below 0 CHF</td>
<td>50.2%</td>
</tr>
<tr>
<td>1 - 10'000 CHF</td>
<td>29.1%</td>
</tr>
<tr>
<td>10'001 - 50'000 CHF</td>
<td>11.9%</td>
</tr>
<tr>
<td>50'001 - 200'000 CHF</td>
<td>5.4%</td>
</tr>
<tr>
<td>200'001 - 1'000'000 CHF</td>
<td>2.7%</td>
</tr>
<tr>
<td>1'000'000 CHF and above</td>
<td>0.7%</td>
</tr>
<tr>
<td>total</td>
<td>2,465</td>
</tr>
</tbody>
</table>

Source: Liechtenstein Tax Administration.
Own calculations with the micro simulation model microLIE-CIT.

For the fiscal year 2008, tax receipts from corporate income tax decreased by 29% to around CHF 140.1 million, capital tax increased by 8.8% up to a level of CHF 18.2 million (table 2). The variations of the corporate income tax revenues, however, are captured in the sample; the estimated corporate income tax revenue deviates in maximum +/- 5% from the actual corporate income tax revenues (see figure 1).

3.3 Total effects on tax revenue

To evaluate the revenue effects, the revenues of the pre-reform tax act (LTA10), the revenues of the pre-reform with a flat tax of 12.5% (LTA10 flat tax), the revenues of the reform without ACE (LTA11 wo. ACE), and the revenues of the reform (LTA11) are estimated (see table 2). The calculation shows, that the average tax relief for legal persons was approximately
CHF 7.8 million which accounts for approximately 5% of the revenues from capital tax plus corporate income tax of the time period 2003-2008\textsuperscript{2} This implies that the current tax system collects little revenue from taxing the normal return to capital.

Table 2: Total effects on tax revenue

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>capital tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTA10</td>
<td>106.0</td>
<td>123.1</td>
<td>139.4</td>
<td>194.9</td>
<td>203.9</td>
<td>135.3</td>
</tr>
<tr>
<td>LTA10 flat*</td>
<td>118.6</td>
<td>137.8</td>
<td>150.8</td>
<td>206.8</td>
<td>216.4</td>
<td>145.9</td>
</tr>
<tr>
<td>LTA11 wo. ACE*</td>
<td>131.0</td>
<td>151.5</td>
<td>167.1</td>
<td>227.6</td>
<td>239.0</td>
<td>162.5</td>
</tr>
<tr>
<td>LTA11</td>
<td>112.8*</td>
<td>131.4</td>
<td>144.7</td>
<td>200.7</td>
<td>210.6</td>
<td>129.7</td>
</tr>
</tbody>
</table>

* est. values. Source: Liechtenstein Tax Administration, own calculations.

\textit{Business cycle effects}

Figure\textsuperscript{2} shows the tax base effects for the years from 2003 to 2008. A switch to the ACE-system would have reduced the tax base in some but not all years. Moreover, the tax base of an ACE-system is less volatile than that of the LTA10. Differences in the LTA10 and LTA11 tax base arise in years, when

\textsuperscript{2}In the fiscal years 2003 and 2004, the introduction of an ACE would had even let to an increase in tax revenues.
the return on investment is high, which was the case, for instance in 2007 and 2008. The countercyclical effects of an ACE-system are thus stronger, since the tax base of an ACE-system is lower in cyclical downturns.

![Tax base graph](image)

**Figure 2: Business cycle effects**

### 3.4 The effective marginal tax burden

To calculate the effective marginal tax burden as proposed in equation (16), the tax revenue under an ACE system (LTA11), according to the revised Liechtenstein Tax Act (SteG), has to be computed. In doing so, taxable net profit is calculated based on the tax modified profit and loss statement prepared for commercial purposes, whereas the exempt are deducted. The ACE is computed on the modified equity capital multiplied by risk-free nominal interest rate, which is assumed to be at 4% in 2011. Since the dataset contains also informations about the tax revenue under the old tax law (LTA10), and the capital stock (K), the marginal tax rate can be computed without making additional assumptions, e.g. about the virtual time path of depreciation deductions, as proposed by Becker/Fuest (2004).

As pointed out in the theoretical section, the application of (16) requires, that the growth rate in real investment equals the investors discount rate \( r(1 - \tau_b) \). The fulfillment of this condition, which follows from the equilibrium condition, depends on the the growth rate of investment, the personal tax rate of the investor \( \tau_b \), and the marginal rate of return of saving for the firm’s shareholder \( r \). Since the fulfillment of this condition depends on several individual parameters, it is assumed for reason of simplicity, that the condition is fulfilled.

The ratio of the notional interest can be varied in the Liechtenstein Finance Act. The rate, which is assumed to reflect the risk-free nominal interest rate, should be roughly based on long-term interest on capital, e.g. 10-year Swiss government bonds.
Figure 3 shows the effective marginal tax rates of the LTA10 with corporate income and capital tax, and LTA10 with corporate income tax. The effective marginal tax rates differ in level, because the capital tax increases the marginal effective tax rate.

The effective marginal tax rate shows little variation over time, as it was expected. However, figure 3 shows several turning points, which have to be further explored. There seems to be time variant effects, which affect the marginal effective tax rate. It is assumed, that the variances in the marginal effective rate are based on the substitution effect (Angelo/Masulis, 1980). According to this hypothesis, a firm’s demand for interest deductions declines, as the depreciation deductions increase.

3.5 Test of the substitution effect

It is assumed, that the investor seeks to maximize the value of the firm by reducing the tax burden \( T \) of the firm. Since \( T = u(f(K) - rbk - d - l) \), the regression model of the firm’s demand for interest deductions \( rbk_{it} \) depends on the depreciation deductions on assets \( (d_{it}) \), financial investment depreciation \( (d_{fi}^{fi}) \), loss carry forward \( (l_{it}) \) and corporate income \( (f(K)_{it}) \). Thus the basic equation to estimate the substitution effect is

\[
rbk_{it} = \beta_0 + \beta_1 d_{it}^{fi} + \beta_2 d_{it} + \beta_3 l_{it} + \beta_4 f(K)_{it} + \eta_i + \epsilon_{it} \tag{17}
\]

where \( i \) indexes firms, \( t \) indexes time, the \( \beta \)’s are parameters to estimate, and the error term \( \eta \) includes both an individual random effect and a term \( \epsilon \) that is assumed to be independent of the explanatory variables.

Table 3 reports the results of OLS, fixed effects and random effects regressions explaining the substitution effect between interest deductions and depreciation deductions, where the pooled regression model serves as baseline for comparison. The results show, that depreciation has a negative impact on interest deduction at the 1% significance level. This negative relationship is robust for different empirical models. The point estimates ranges from -2.695 to -1.841, suggesting that the interest deductions decrease by about 2.695 to 1.841 when the depreciation level increases by 1. The other variables have no significant impact except the corporate income, which has an positive income and is significant at the 1% significance level.

To identify which empirical methodology - pooling, random effect or fixed effect regression - is most suitable, two statistical tests are performed. The first is the Lagrange multiplier (LM) test (Breusch/Pagan, 1980) of the random effect model. The null hypothesis of the one-way random group effect model is that variances of groups are zero. If the null hypothesis is not rejected, the pooled regression model is appropriate. The Breusch-Pagan
Table 3: OLS, fixed effects and random effects regressions

<table>
<thead>
<tr>
<th></th>
<th>POOL</th>
<th>interest deduction fixed effects</th>
<th>random effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>depreciation</td>
<td>-1.840975 ***</td>
<td>-2.694588 ***</td>
<td>-2.283944 ***</td>
</tr>
<tr>
<td></td>
<td>(.105109)</td>
<td>(.177325)</td>
<td>(.1308869)</td>
</tr>
<tr>
<td>fin. inv. depreciation</td>
<td>-1.806353 ***</td>
<td>.0995802</td>
<td>.0215874</td>
</tr>
<tr>
<td></td>
<td>(.4198201)</td>
<td>(.2271693)</td>
<td>(.2300087)</td>
</tr>
<tr>
<td>loss carry forward</td>
<td>-.1147945</td>
<td>-8.837477</td>
<td>-7.559972</td>
</tr>
<tr>
<td></td>
<td>(.8448682)</td>
<td>(.558623)</td>
<td>(.5576971)</td>
</tr>
<tr>
<td>corporate income</td>
<td>.8263817 ***</td>
<td>.8100887 ***</td>
<td>.826033 ***</td>
</tr>
<tr>
<td></td>
<td>(.0156032)</td>
<td>(.026773)</td>
<td>(.0205401)</td>
</tr>
<tr>
<td>sector</td>
<td>10484.55</td>
<td>(dropped)</td>
<td>-12778.21</td>
</tr>
<tr>
<td></td>
<td>(15218)</td>
<td></td>
<td>(27324.21)</td>
</tr>
<tr>
<td>cons</td>
<td>-765702.1</td>
<td>637670.7 **</td>
<td>922770.3</td>
</tr>
<tr>
<td></td>
<td>(960762.9)</td>
<td>(207869.7)</td>
<td>(1719756)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>R²</th>
<th>N (observations)</th>
<th>F(5,1140), F(4,922)</th>
<th>Wald $\chi^2(5)$</th>
<th>LM test $\chi^2(1) = 1715.43$***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.7501</td>
<td>1146</td>
<td>684.31 ***</td>
<td>231.44 ***</td>
<td>1711.56 ***</td>
</tr>
</tbody>
</table>

Notes: POOL = simple OLS on pooled specification, stand. errors in parentheses, * statistically significant at least at 10% level, ** significant at least at 5% level, *** significant at least at 1% level. For the random effects and fixed effects models $R^2$ refers to the overall $R^2$. The Langrangian Multiplier test (LM test) is used to test the random effect model versus the pooling regression. The Hausman specification test is used to test the fixed effects versus the random effects model. Source: Liechtenstein Tax Administration, own calculations.
Figure 3: Effective marginal tax rate

test rejects the null hypothesis that the variance of the random effects was zero ($\chi^2$ values of 1715.43 with 1 degree of freedom; see table 3), implying that either fixed or random preferred.

Second, the Hausman specification test (Hausman, 1978) is carried out to compare the fixed effect model and its counterpart random effect model. If the model is correctly specified and if individual effects are uncorrelated with independent variables, the fixed effect and random effect estimators should not be statistically different. The statistics are reported in table 3 and the null hypothesis is rejected at the 1% significance level. The result suggest, that the fixed effects model is the better choice than the random effects model.

For both the random effects and the fixed effects model, the estimated coefficient on depreciation is significant at the 1% significance level in both cases. The estimated coefficient of the fixed effects model is with -2.965 higher than that of the random effects model (-2.284).

This result suggest, that the substitution effect is observable in the data. Since substitution effects are captured by the backward looking approaches, this finding supports the application of data based backward looking approaches.


4 Conclusion

In this paper, the theoretical and empirical properties of forward and backward looking measures of the effective marginal tax rate have been discussed. The main difference between forward and backward looking approaches is, that the first are based on the special provisions of the tax law and consider a hypothetical firm, whereas the latter are based on real data. The main advantage of data based backward looking measures is, that they capture true economic behavior, like substitution effects, which affects the effective marginal tax rate.

In practice, however, it is difficult to apply such a data based measures due to the data requirements. To deal with this limitations, an ACE-based backward looking measure was proposed to apply. Since the ACE-system is as well as the R-based tax a neutral tax system, the actual collected tax revenues and the estimated counterfactual tax revenues that would be collected under an ACE-based system can be used to measure the effective burden on investment.

The main finding is that the revenue effect that would be caused by switch toward a consumption based tax system would be surprisingly low. This indicates, that the comprehensive tax system collected little revenue from capital income. Beyond this it has been shown, that the ACE system has a stronger countercyclical effect than the comprehensive tax system.

Since the marginal effective tax rate varies with the business cycle, it is assumed that substitution effects occur. In particular it is assumed, that a firm’s demand for interest deductions declines, as the depreciation deductions increase. The results of the fixed effects model support this hypothesis. If this hypothesis is correct, the marginal effective tax burden is affected by these adjustments. In backward looking measures, however, are those effects captured in the data, and thus they are reflected in the marginal effective tax burden.

The results show however, that the particular settings of the tax system has to be taken into account to make proper choices of the applied methodologies to measure marginal tax rates.

References


REFERENCES

on Investment: Theory and Empirical Evidence for Germany, Techn. Ber., Department of Economics, University of Cologne, Germany.


REFERENCES


OECD (1985): Two Reports by the Committee on Fiscal Affairs on Quantitative Aspects of Corporate Taxation, Paris: OECD.


