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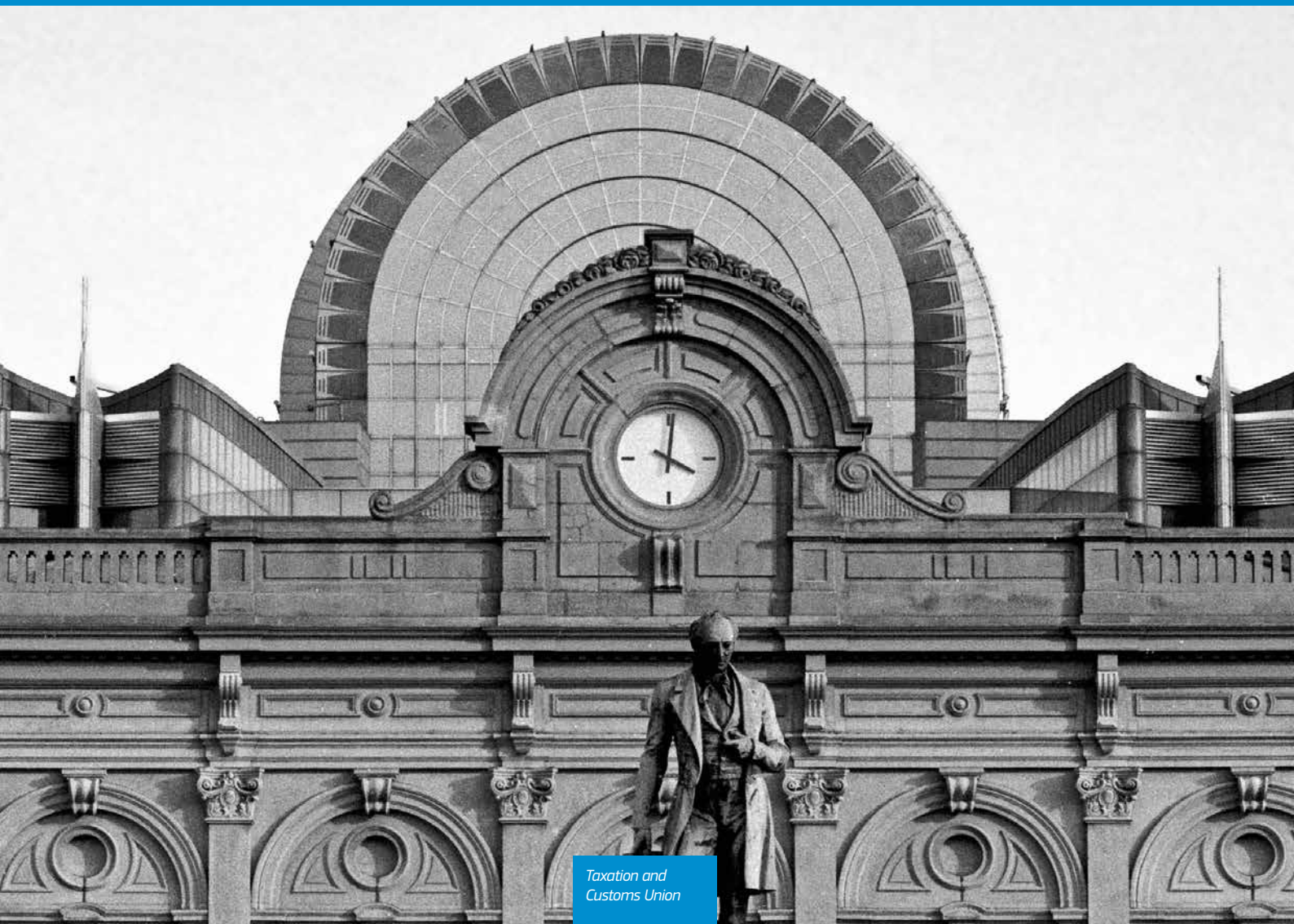
The Effect of Inflation and Interest Rates on Forward-Looking Effective Tax Rates



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THE EFFECT OF INFLATION AND INTEREST RATES ON FORWARD-LOOKING EFFECTIVE TAX RATES

ON-DEMAND ECONOMIC ANALYSIS UNDER FRAMEWORK CONTRACT
TAXUD/2013/CC/120
FRAMEWORK CONTRACT FOR THE PROVISION OF EFFECTIVE TAX RATES IN THE CONTEXT OF AN ENLARGED EUROPEAN UNION AND RELATED SUPPORTING SERVICES

SUBMISSION BY THE
CENTRE FOR EUROPEAN ECONOMIC RESEARCH (ZEW) GMBH

Contact:
Prof. Dr. Christoph Spengel
Centre for European Economic Research GmbH (ZEW) Mannheim
L 7, 1
D-68161 Mannheim
Tel: +49 621 181 1705
eMail: spengel@uni-mannheim.de

Prof. Dr. Jost Heckemeyer
Leibniz Universität Hannover, and
Centre for European Economic Research GmbH (ZEW) Mannheim
L 7, 1
D-68161 Mannheim
Tel.: +49 511 762 1 93 77
eMail: heckemeyer@steuern.uni-hannover.de

Mannheim
8 June 2016

Prepared by:

Prof. Dr. Christoph Spengel (University of Mannheim and ZEW)
Prof. Dr. Jost H. Heckemeyer (Leibniz Universität Hannover and ZEW)
Frank Streif (ZEW and University of Mannheim)

Centre for European Economic Research (ZEW) GmbH
L 7, 1
68161 Mannheim, Germany
www.zew.eu

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Executive Summary

1. Objective

Every year ZEW Mannheim computes measures of corporate effective taxation in Europe based on the Devereux/Griffith methodology.[1] The measures aim at comprehensively reflecting and consistently comparing the effective corporate tax levels in the different member states.

For the computation of the effective tax rates, assumptions on economic parameters have to be made - in particular on the values of the inflation and interest rate. Common assumptions on these variables are strictly necessary in order to compare effective levels of taxation across countries in a meaningful way.

In some cases these assumptions could interact with the effects of specific tax parameters on the effective tax burdens. For example, capital allowances become less effective in reducing tax burdens in inflationary environments. As a consequence, countries with high capital allowances appear more attractive when inflation is low.

This study aims at analysing and quantifying the effect of the real interest and inflation rate on effective tax measures.

2. Methodology and Study Design

The approach by Devereux and Griffith (1999, 2003) considers a hypothetical incremental investment undertaken by a company located in a specific country. Tax rules such as corporate and personal income tax rates, depreciation rules and the treatment of different financing sources can be implemented in the model to analyse the effect of taxes on the return of investments.

More precisely, the methodology of Devereux and Griffith allows considering two types of investment projects, i.e. marginal and profitable (infra-marginal) investments[2]:

For marginal investments, the *cost of capital* is the appropriate effective tax burden measure. It is defined as the required pre-tax real rate of return which the hypothetical investment in the company needs to yield in order to be worthwhile for the investor.

The *effective average tax rate* (EATR) instead measures the effective tax burden on profitable investments. In other words, the EATR reflects the effective tax rate levied on investments that generate economic rents and is used to identify the effect of taxation on discrete location choices.

This study explores the effects of the assumed interest and inflation rate on the cost of capital and the EATR at corporate level for domestic investments. For this, two approaches are chosen:

1. Changing the common values for the real interest and inflation rate used in the computations *for all member states equally*.

[1] The latest report (Spengel et al., 2015) covers the years 1998-2015 and includes Turkey, Macedonia, Norway, Switzerland, Canada, Japan and the United States beside the EU28 states. This report focuses on the EU28 member states.

[2] For more detailed explanations, especially on the system of formulae, please see section B of the annual report on effective corporate tax levels conducted by ZEW Mannheim (Spengel et al., 2015).

2. Using *country-specific* real interest and inflation rates according to the economic conditions in the member states in 2015.

3. Main Results

The study delivers qualitative assessments of the sensitivity mechanisms at work as well as quantitative results.

Tax systems are related with interest and inflation rates through various mechanisms which sometimes act in qualitatively different directions. Such a mechanism is, for example, that usually nominal returns are taxed rather than real returns. The Devereux/Griffith model incorporates these mechanisms of real world tax systems and allows for precise quantification.

The first quantitative approach of this study, i.e. changing interest and inflation rates equally for all countries, reveals the following insights:

- The level of cost of capital is not very sensitive to changes in inflation rate. For inflation rates of 1%, 2% and 10%, the average cost of capital is 6.0%, 6.0% and 6.4%, respectively.
- By definition, the level of cost of capital is sensitive to the real interest rate. For real interest rates of 1%, 5% and 10%, the average cost of capital amounts to 1.4%, 6.0% and 11.9%.
- Conversely, the EATR turns out to be much less sensitive to changes in the real interest rate and also inelastic to the inflation rate.
- The relative ranking among the countries is not very sensitive to varying the real interest and the inflation rate with respect to both the cost of capital and the EATR.

The second quantitative approach, i.e. applying country-specific interest and inflation rates, provides the following outcome:

- The average cost of capital falls to 1.3% compared to 6.0% in the base case. These figures are useful to inform about the real investments' profitability before taxes that is needed to make real investments more attractive than alternative capital market investments.
- However, by definition, the scaling of the cost of capital is mainly determined by the (assumed) real interest rates. Therefore, cross-country comparisons of the cost of capital are non-informative from a tax perspective when assuming different economic conditions.
- With respect to the EATR, the study shows that it is much less sensitive to country-specific real interest rates than the cost of capital.
- With country-specific inflation and interest rates in place, the average EATR rises to 23.5% compared to 21.1% in the base case. This indicates that average tax burdens are higher in times of low interest rates, which make future capital allowances less effective.

The broad range of figures produced in this study helps to illustrate and indicate the levels of effective tax burdens in different countries for a series of relevant situations. For comparing tax systems in the member states, common assumptions on interest and inflation rates are essential. Although there are no "universally true values" for effective tax levels in the member states, the analysis shows that the base case gives a good indication of the member states' effective tax levels and member states' relative position in a cross-country comparison.

1 Introduction

Every year ZEW Mannheim computes measures of corporate effective taxation in Europe based on the Devereux/Griffith methodology. The measures aim at comprehensively reflecting the member states' effective corporate tax levels.

The Devereux/Griffith model considers a firm conducting a hypothetical investment that takes place in one period and generates a return in the next period. The net present value of the investment is affected by the main provisions of tax systems at the corporate and shareholder level. At the corporate level, the most important provisions regard the corporate tax rate, capital allowances and the deductibility of the cost of finance.

For the computation of effective tax rates, a common inflation and interest rate are assumed. This assumption is useful because it allows a meaningful comparison of effective tax levels across countries and isolates the effects of tax parameters on effective tax levels.

However, in some cases the assumptions could be important for determining the relative attractiveness of member states' tax systems. For example, the report shows that capital allowances become less effective in reducing tax burdens in inflationary environments. As a consequence, countries with high capital allowances appear more attractive when there is low inflation than when there is high inflation. Moreover, using equal assumptions for all countries may hide the effects of interest and inflations rates on comparative effective levels of taxation if differentials across countries are large.

Against this background, it is worthwhile to explore the effects of different levels of interest and inflation rates on effective tax burdens. In addition, using country-specific economic values for these variables will provide complementary insights for specific situations and purposes. The report is structured as follows:

Section 2 briefly describes the Devereux/Griffith model and the underlying economic assumptions which are typically made. Also, it lays out the course of this study with respect to the different scenarios which are applied.

Section 3 presents how tax systems are constructed and what this means for the amount of taxes paid by companies when there are varying inflation and real interest rates. The presented mechanisms are also reflected in the Devereux/Griffith model. This section also elaborates on relevant specifities which are due to the model construction.

Section 4 presents and interprets the simulation results when varying the interest and inflation rate assumptions equally for all countries.

Section 5 assesses how effective tax burdens can be interpreted when applying country-specific inflation and interest rates. The section presents the respective results and puts them into context. And finally,

Section 6 concludes and summarizes the finding of the study.

2 Devereux/Griffith Model and Simulation Assumptions

The approach proposed by Devereux and Griffith (1999, 2003) considers a hypothetical incremental investment located in a specific country undertaken by a company resident possibly in the same country, but also possibly in another country. The hypothetical investment takes place in one period and generates a return in the next period. Tax rules such as corporate and personal income tax rates, depreciation rules and the treatment of different financing sources are implemented to analyse the effect of taxes on the return of the investment.

Given a post-tax real rate of return required by the company's shareholder, it is possible to use the tax code to compute the implied required pre-tax real rate of return, known as the *cost of capital*. The proportionate difference between the cost of capital and the required post-tax real rate of return is known as the *effective marginal tax rate* (EMTR). This approach is based on the presumption that firms undertake all (marginal) investment projects which earn at least the required rate of return.

A complementary approach is to consider discrete choices for investment and in particular a discrete location choice. Devereux and Griffith (1999, 2003) developed a measure of an *effective average tax rate (EATR)* to identify the effect of taxation on such discrete location choices.

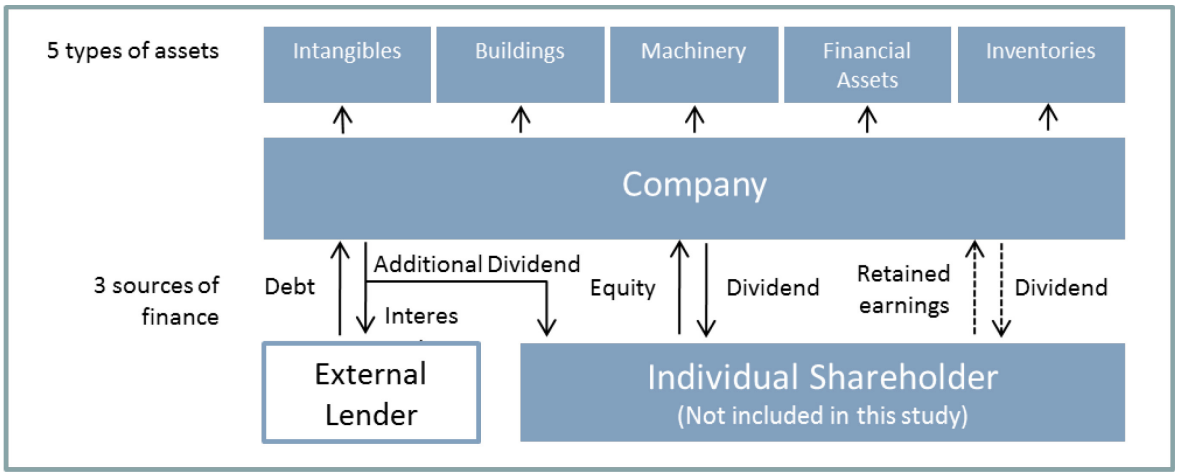
As a consequence, the methodology of Devereux and Griffith allows considering two types of investment projects, namely profitable and marginal investments. For marginal investments, the *cost of capital* and the *effective marginal tax rate* (EMTR) are the appropriate effective tax burden measures whereas for profitable investments it is the *effective average tax rate* (EATR).

There is a range of former studies which have applied the Devereux/Griffith model or have examined the theoretical foundations of the model (or earlier versions of it, i.e. the King/Fullerton model). Main works include the following:

- **Theoretical:** Devereux and Griffith (1999, 2003), Schreiber et al. (2002), King and Fullerton (1984)
- **Application to standard tax codes:** Spengel et al. (2008-2015), European Commission (2001), OECD (1991)
- **Special considerations (e.g. simulation of tax reforms):** Spengel et al. (2016a, forthcoming), Spengel et al. (2016b, forthcoming), Evers et al. (2015), Bräutigam et al. (2015), European Commission (2015), Endres et al. (2010), Spengel (2003), Devereux et al. (2002), Lammersen (2002), Ruding Committee (1992)

These works serve as useful reference for a deeper understanding of the model and its scope of application. At the same time, the present work aims at analysing the effect of some of the economic assumptions which have also been applied in these studies.
While the methodology is able to model cross-border investments, this study focuses on a domestic company which invests in its country of residence. The computations are made for all EU28 member states, comprehensively considering all relevant corporate taxes as of 2015. The respective investment and financial structure of the model is illustrated in Figure 1.

Figure 1: Structure of investment



To define the hypothetical investment project, the following assumptions are made:

- The pre-tax rate of return on profitable investment projects is assumed to amount to 20%;
- Investments in five different assets are considered: intangibles (purchase of a patent), industrial buildings, machinery, financial assets and inventories;
- The economic depreciation rates are 15.35% for intangibles, 3.1% for industrial buildings and 17.5% for machinery. Financial assets and inventories are not depreciated;
- There are three possible ways of financing the investment: retained earnings, new equity and debt;
- For a representing average over different forms of investment, equal weights are used for each asset type (20%). With respect to the financing of the company, the following weights are applied: 55% retained earnings, 10% new equity and 35% debt financing.

All these assumptions are in line with former studies. The specifications on the interest and inflation rates are subject to this study. Two approaches are chosen to analyse their effect on companies' effective tax burdens (Table 1):

1. The assumed common values for the interest and inflation rates are changed equally for all countries. Both lower and higher values than usually used are considered (Table 1).

2. Country-specific interest and inflation rates of year 2015 are implemented in order to capture an additional important factor that makes effective tax burdens differ across countries. The study draws on the official interest and inflation rate values of year 2015. (Table 6 in section 5).

Table 1: Sensitivity scenarios

Parameter	Base Case	Low Interest Rate	High Interest Rate	Low Inflation Rate	High Inflation Rate	Country-specific Interest Rate	Country-specific Inflation Rate	Country-specific Interest and Inflation Rate
Real Interest Rate	5%	1%	10%	5%	5%	Table 6	5%	Table 6
Inflation Rate	2%	2%	2%	1%	10%	2%	Table 6	Table 6

3 Main Sensitivity Channels in Tax Systems and in the Model

3.1 General

The sensitivity of the effective tax rates to the real rate of return and the inflation rate is multidimensional. In some cases, there are various effects which are countervailing and ambiguous in size depending on other economic variables and the tax code. Before going into the mechanisms in detail, some relevant general principles of national tax systems are brought to the readers' mind. These mechanisms generally hold for all tax systems. At the same time, they also show up in the Devereux-Griffith model.

Mechanism 1 **- Tax systems consider nominal returns rather than real returns:**

Corporate tax systems consider the nominal return of companies. This means that the taxable profit is determined by a corporation's nominal return minus its expenditures. The nominal return becomes larger with inflation given a constant real return. Consequently, tax systems do not differentiate if returns rise in real terms or just due to inflation. The Devereux/Griffith model reproduces this characteristic of tax systems.

Mechanism 2 **- Tax systems are often based on historical price values:**

Assets acquired by a corporation are depreciated over their lifetime. The depreciable amounts are based on the acquisition cost of the assets. The depreciation allowances over an asset's lifetime are usually limited by the historical price of the respective asset. This leads to an asymmetric treatment of returns and depreciation allowances: Returns are considered at their inflated values (see Mechanism 1) whereas depreciation allowances can only be deducted at historical (non-inflated) values.

Due to the asymmetric treatment of returns and depreciation allowances, the corporate tax burden increases with inflation both in absolute terms but also relative to the real return. This mechanism is also reflected in the Devereux/Griffith framework.

Mechanism 3 **- Interest payments are deductible from the tax base:**

If a corporation takes up debt to finance its investment, it can deduct the interest payments from the tax base. The higher the interest rate the higher the deduction and the lower the corporate tax burden.

More precisely, tax systems consider the interest rate which a corporation effectively pays, i.e. the nominal interest rate. It rises with inflation and so does the amount which is deductible from the corporate tax base. This is also mapped into the Devereux/Griffith model which considers the precise relationship between nominal interest rate (i), real interest rate (r) and inflation rate (π), i.e. $(1+i)=(1+\pi)(1+r)$.

Mechanism 4 **- The advantage of depreciation allowances depends on the discount rate:**

The higher the depreciable amounts during the first periods after acquisition the more favourable it is for tax purposes. However, this only holds when distant depreciation

allowances are valued lower than more close ones due to discounting. If the discount rate is zero, the timing of the depreciation allowances does not matter anymore.

In the Devereux/Griffith model, the discount rate is a positive function of the real interest and the inflation rate. If inflation rises, the discount rate increases. Consequently, the net present value of (future) depreciation allowances decreases with inflation. Neglecting other coinstantaneous mechanisms, the corporate tax burden rises with inflation due to the decreasing net present value of depreciation allowances.

***Mechanism 5* - The absolute level of non-income taxes is independent from macro-economic variables and the real return:**

Besides taxes on profits, national tax systems impose taxes on property, e.g. a tax on buildings. These taxes are independent from the realized return but relate to the acquisition cost of the respective asset, e.g. the price of a building. Consequently, the absolute amount of non-income taxes remains constant irrespective of changes in the profitability, the inflation or the interest rate. However, because income taxes do depend on these variables, the relative share of non-income taxes on the overall effective tax burden varies with these economic variables.

3.2 Cost of Capital

The cost of capital is the pre-tax real return that the model investment needs to yield to make the investor indifferent to the alternative investment. In the model, the alternative investment yields the real interest rate. Due to the definition of the cost of capital, the implied nominal and real return of the model investment is relatively low. Ultimately, the cost of capital implies an incremental "marginal" investment that exhibits a relatively low profitability.

The cost of capital has the following main sensitivity properties with respect to the real interest and inflation rate:

Return of the Alternative *and* Model Investment: If the return of the alternative investment (real interest rate) increases, the real return of the model investment also increases by definition. This is to make the investor indifferent between the model investment and the alternative investment. This relationship is strong and dominant.

Nominal Interest Rate *and* Discount Rate: A rising nominal interest rate (either due to the real interest or the inflation rate) increases the discount rate for depreciation allowances. As a consequence, the net present value of depreciation allowances decreases. This increases the cost of capital.

Nominal Interest Rate *and* Interest Deductibility: A rising nominal interest rate (either due to a rising real interest or inflation rate) increases the deductible amount of interest in case of debt financing. This counteracts an increase in the cost of capital due to a higher profitability of the alternative investment (in case the real interest rate rises) or a higher discount rate (in case either real interest or inflation rate rises).

Inflation *and* Taxation of Nominal Returns: Inflation increases the discrepancy between nominal and real returns. To end up with the same real rate of return when inflation is high, the nominal return needs to increase. This increases the effective tax burden, i.e. the cost of capital, because nominal rather than real returns are taxed. The effect is important for equity financed projects. For debt financed investments, the effect is marginalized by other effects.

3.3 EATR

The effective average tax rate (EATR) represents the percentage of taxes taken away from the net present value of a profitable investment. The EATR computations assume a model investment that yields a fixed real rate of return of 20%. The alternative investment only plays a role in so far that its interest rate determines the time discount rate for future income and expenditure streams of the model investment.

The EATR has the following main sensitivity properties with respect to the real interest and inflation rate:

Return of the Alternative *and* Model Investment: If the return of the alternative investment (real interest rate) increases, the profitability of the model investment decreases relatively to the alternative investment. This is because the model investment's profitability is fixed at 20%. The underlying mechanism in the Devereux/Griffith model works through the discount rate which is a function of the profitability of the alternative investment. Future returns are less valuable with a higher discount rate; that reduces the (relative) profitability of the model investment.

If the relative profitability is reduced, the tax base becomes smaller *ceteris paribus*[3] and the EATR decreases.

Nominal Interest Rate *and* Discount Rate: A rising nominal interest rate (either due to the real interest or the inflation rate) increases the discount rate for depreciation allowances. As a consequence, the net present value of depreciation allowances decreases. This makes the EATR to increase ceteris paribus.

Nominal Interest Rate *and* Interest Deductibility: A hike in the real interest or inflation rate increases (nominal) interest payments for debt financed projects. This decreases the tax base and, consequently, the EATR.

Inflation *and* Taxation of Nominal Returns: If the nominal profitability increases due to inflation, the tax base increases. That is because nominal returns are taxed and capital allowances are not inflation-adjusted. This increases the EATR when neglecting other coinstantaneous factors.

3.4 Summary and Comparison Between Cost of Capital and EATR

Interest and inflation rate exert influence on effective tax burdens through multiplex and often coinstantaneous channels. In addition, their influence often depends on the way of financing.

Furthermore, some of the mechanisms are differently shaped for the cost of capital and the EATR. This is due to their different conceptual design: The cost of capital implies an incremental "marginal" investment whereas the EATR assumes a more profitable investment.

However, both investments exhibit the same level of expenses. This means that high income flows in the case of a highly profitable investment (EATR) do not trigger any additional allowances compared to a lowly profitable investment. Therefore, the relative weight of allowances in the determination of the effective tax burden declines with the level of profitability. As a consequence, cross-country differences in depreciation schemes become more obvious when looking at the cost of capital than at the EATR. Conversely, allowances lose importance when the model investment is highly profita-

[3] One ceteris paribus condition is that deductions remain constant.

ble. It is then decisive at which statutory tax rate the relatively large tax base is taxed. As a consequence, different statutory tax rates across countries get more apparent in the EATRs than in the cost of capital.

Yet another point in which cost of capital and EATR differ is the importance of non-income taxes. The amount of non-income taxes is constant irrespective of the profitability of the investment because these taxes base on historic acquisition costs. Accordingly, the relative weight of these taxes is higher for weakly profitable investments (cost of capital) than for highly profitable investments (EATR).

4 Sensitivity Results 1: Common Values for Inflation and Interest Rate

4.1 Cost of Capital

Real Interest Rate
The cost of capital varies greatly with the real interest rate. This follows by definition because the model investment is directly benchmarked against the alternative investment which, in turn, yields the real interest rate. When the real return of the alternative investment rises, the real return of the model investment also needs to rise to make the investor indifferent between the two investments. This holds for both equity and debt financed projects.

Table 2: Sensitivity of average cost of capital to interest and inflation rate

Cost of Capital (%)	Overall Mean	Intangibles	Industrial Buildings	Machinery	Financial Assets	Inventories	Retained Earnings	New Equity	Debt
Base Case	6.0	6.4	5.6	5.6	6.4	6.0	6.7	6.8	4.7
Real Interest Rate: 1%	1.4	1.8	1.2	1.2	1.6	1.2	1.7	1.7	0.9
Real Interest Rate: 10%	11.9	12.3	11.3	11.3	12.5	12.0	13.1	13.2	9.6
Inflation Rate: 1%	6.0	6.4	5.6	5.5	6.2	6.0	6.5	6.6	4.8
Inflation Rate: 10%	6.4	6.2	5.9	6.0	7.9	6.2	7.9	8.0	3.7

Table 2 displays the average EU cost of capital for common real interest rates of 1%, 5% (base case) and 10% averaged across all assets and ways of financing.[4] With these real interest rate values, the cost of capital amounts to 1.4%, 6.0% and 11.9%, respectively. For equity financed projects, the real return before taxes always needs to be higher than the assumed real interest rate (i.e. the real return of the alternative investment). Consequently, the cost of capital is always above the assumed real interest rate in Table 2. This is not the case for debt financed projects because the real interest rate also determines the nominal interest payment which reduces the tax base. This latter effect prevails in the figures at hand.[5]

The averages over the EU member states mask substantial heterogeneity. In the base case, Estonia shows the lowest cost of capital with 5.17% whereas investments in Spain bear the highest tax burden with a cost of capital of 8.14%.

[4] Therefore, an overall mean figure in the first column is an average over 28*3*5=420 cases (28 countries, 3 ways of financing and 5 different assets).
[5] The costs of capital of equity and debt financed projects get more aligned with a higher real interest rate. A higher real interest rate implies a higher level of profitability which makes the interest deductions less important for determining the effective tax burden and, therefore, reduces the difference between debt and equity financing.

Despite the level shift in the cost of capital, only minor changes in the ranking of member states occur when varying the real interest rate (Table 3). The Pearson coefficient of the ranks' correlation for real interest rates of 1% and 5% (base case) is very high and amounts to 85.9%. For real interest rates of 10% and 5%, the ranks' correlation is 91.0%.

Table 3: Ranking of member states for average cost of capital for alternating assumptions

Country	Base Case	Real Interest Rate: 1%	Real Interest Rate: 10%	Inflation Rate: 1%	Inflation Rate: 10%
Austria	21	16	21	21	20
Belgium	9	2	18	8	11
Bulgaria	3	5	2	3	2
Croatia	4	4	3	4	3
Cyprus	14	18	10	13	17
Czech Republic	6	6	7	5	7
Denmark	17	21	17	17	21
Estonia	1	3	1	1	1
Finland	16	21	11	16	18
France	27	28	27	27	27
Germany	23	20	24	23	22
Greece	24	23	25	24	25
Hungary	18	24	16	18	14
Ireland	9	8	9	8	12
Italy	2	1	14	2	5
Latvia	11	17	5	11	8
Lithuania	5	15	4	6	4
Luxembourg	20	10	20	20	16
Malta	26	25	26	26	26
Netherlands	19	13	19	18	15
Poland	13	8	12	14	10
Portugal	22	19	22	22	22
Romania	8	12	6	10	6
Slovakia	12	10	12	12	13
Slovenia	7	7	8	7	9
Spain	28	27	28	28	28
Sweden	15	14	15	14	19
United Kingdom	25	26	22	25	24

Changing the real interest rate from 1% to 10% alters the implied level of profitability of the model investment significantly. With low profitability, the tax base for profit taxes is little and non-income taxes gain importance for determining the effective tax burden. Conversely, non-income taxes become less decisive when profitability is increasing. Nevertheless, the country ranking turns out to be quite sticky. Only coun-

tries with above average non-income taxes show some degree of sensitivity in ranks with respect to the average cost of capital (Belgium, Cyprus, Finland, Italy, Latvia, Lithuania and Luxembourg). In the case of Italy, the notional interest deduction is especially effective in reducing the tax base and the tax burden when profitability is low.

Inflation Rate

The level of the cost of capital is much less sensitive to changes in the inflation rate than the real interest rate. In fact, it reacts greatly inelastic even to a high inflation rate of 10%. For inflation rates of 1%, 2% (base case) and 10%, the average cost of capital is 6.0%, 6.0% and 6.4%, respectively (Table 2). Effective taxation increases with inflation because, first, nominal returns are taxed and, second, the net present value of capital allowances becomes smaller due to the increasing discount rate. However, for debt financed investments the effective tax burden decreases strictly with higher inflation. This is due to the increased (nominal) interest deductibility which goes along with higher inflation. As a consequence, differences in costs of capital between equity and debt are exacerbated with high inflation.

With respect to the ranking, countries do hardly change positions even with a high inflation of 10%.[6] Also, changes in ranking only appear when countries have very similar cost of capital which makes them prone to change ranks.

Overall, the model turns out to be very inelastic to inflation rates, even when applying such a high spread of possible inflation values.

4.2 EATR

Real Interest Rate

The level of the EATR is much less sensitive to the real interest rate than the level of the cost of capital. The conceptual differences between the cost of capital and the EATR are non-negligible and get apparent in this simulation. Changing the real interest rate does not alter the implied level of profitability, which is fixed at 20%. The real interest rate is "only" relevant for determining the time discount rate and the nominal interest rate.

Table 4 displays the average EU EATR for common real interest rates of 1%, 5% (base case) and 10% averaged across all assets. With these real interest rate values, the average EATR amounts to 23.6%, 21.1% and 18.4%, respectively. The EATR falls with a higher real interest rate because the profitability of the model investment decreases *relatively* to the alternative investment (whose return is the real interest rate). Less profitable projects have a lower effective average tax burden because with lower profitability the tax base becomes smaller, given that expenses remain unchanged.[7] This effect holds for both equity and debt financed projects. However, the effect is amplified for debt financing because the increased real interest rate also increases nominal interest deductions which, in turn, reduce the tax base even more. For a real interest rate of 1% the EATR amounts to 21.6% for debt financed projects, whereas for a real interest rate of 10% the EATR is only 10.0%.

[6] The Pearson coefficient of the ranks' correlation for inflation rates of 1% and 2% (base case) amounts to 99.7%; for interest rates of 2% and 10% the correlation coefficient is 95.9%.

[7] There is an additional coinstantaneous effect: The net present value of the capital allowances becomes smaller due to a higher discount rate. This is an opposing effect that, however, is marginalized by the described effect.

Table 4: Sensitivity of average EATR to interest and inflation rate

EATR (%)	Overall Mean	Intangibles	Industrial Buildings	Machinery	Financial Assets	Inventories	Retained Earnings	New Equity	Debt
Base Case	21.1	22.5	19.5	19.5	23.1	21.0	23.6	23.9	16.3
Real Interest Rate: 1%	23.6	25.1	22.6	22.6	24.8	22.7	24.6	24.7	21.6
Real Interest Rate: 10%	18.4	20.0	16.1	16.0	20.9	18.9	22.8	23.3	10.0
Inflation Rate: 1%	20.8	22.4	19.2	19.2	22.4	20.9	23.0	23.3	16.7
Inflation Rate: 10%	22.6	21.5	20.5	20.7	28.5	21.6	27.8	28.4	12.7

With respect to the cross-country comparison, the positions of the member states are very sticky (Table 5, column 1, 2 and 3). The Pearson coefficient of the ranks' correlation for real interest rates of 1% and 5% (base case) amounts to 99.3%. For real interest rates of 5% and 10%, the ranks' correlation turns out to be 98.3%.

Inflation Rate

Table 4 displays the average EATR in the member states for common inflation rates of 1%, 2% (base case) and 10%. With these inflation values, the average EATR over all assets and ways of financing amounts to 20.8%, 21.1% and 22.6%, respectively. The EATR rises with inflation because the nominal return increases. Since nominal returns are taxed and capital allowances are not inflation-adjusted, the tax base increases with inflation. This effect dominates when financing by equity. In addition, the net present value of capital allowances decreases with inflation through an increased discount rate. This further increases the EATR. However, the figures show that the sensitivity of the EATR to changes in inflation is very modest.

Nevertheless, a higher inflation rate exacerbates the difference between equity and debt finance. In fact, the EATR decreases with inflation for debt financed projects. The increased interest deductibility caused by a higher nominal interest rate outweighs all other effects which are dominant in the equity case. The average EATR for common inflation rates of 1%, 2% (base case) and 10% amount to 16.7%, 16.3% and 12.7% for debt financed projects (averaged across all assets).

With respect to the cross-country comparison, the positions of the member states are very persistent (Table 5, column 1, 4 and 5). Countries change a maximum of two positions when moving the inflation rate from 1% to 10%. The Pearson correlation coefficient is close to one for this simulation.

Table 5: Ranking of member states for average EATR for alternating assumptions

Country	Base Case	Real Interest Rate: 1%	Real Interest Rate: 10%	Inflation Rate: 1%	Inflation Rate: 10%
Austria	19	19	20	19	19
Belgium	24	25	22	24	23
Bulgaria	1	1	1	1	1
Croatia	9	11	7	9	9
Cyprus	6	6	8	6	8
Czech Republic	10	8	10	10	10
Denmark	16	17	16	16	16
Estonia	8	10	2	8	6
Finland	12	12	12	12	13
France	28	28	28	28	28
Germany	25	24	25	25	25
Greece	23	22	24	23	24
Hungary	13	13	13	14	12
Ireland	3	2	5	3	5
Italy	20	20	19	20	20
Latvia	4	4	4	4	3
Lithuania	2	3	3	2	2
Luxembourg	21	21	21	21	21
Malta	26	27	26	26	26
Netherlands	18	18	18	18	17
Poland	11	9	11	11	11
Portugal	22	23	23	22	22
Romania	5	5	6	5	4
Slovakia	15	15	15	15	14
Slovenia	7	7	9	7	7
Spain	27	26	27	27	27
Sweden	14	14	14	13	15
United Kingdom	17	16	17	17	18

5 Sensitivity Results 2: Country-Specific Inflation and Interest Rates

5.1 Background

This section takes country-specific real interest and inflation rates into account when computing the effective tax burdens for companies. Such an approach allows making more precise conclusions about the *de-facto* effective tax burdens in the member states. In light of the analysis of section 4, which showed that the level of effective tax burdens can vary depending on the assumed economic variables (especially the real interest rate), this can be a useful additional perspective.

It should be noted that for cross-country comparisons it is of limited use to depart from common assumptions on inflation and interest rates. Feeding in an additional factor which causes heterogeneity in the cross-country comparison confuses the effect of diverse economic conditions, on the one hand, and tax systems on the other hand. The approach should rather be seen as a complement to operating with common assumptions and not be drawn on in isolation when assessing the attractiveness of member states' corporate tax systems.[8]

Taking country-specific values into consideration can nevertheless be useful for assessing the attractiveness of real investments (i.e. model investment) compared to investments at the capital market (i.e. alternative investment). The higher the taxation of the model investment the fewer funds will flow into real investments but to alternative capital market investments instead. If taxation is high, the real investment needs to yield a relatively high pre-tax return in order to be more attractive than the alternative investment. This minimum required pre-tax return of the real investment, at which investors are indifferent, is defined as the cost of capital. All real investments with a lower return than the cost of capital will not be realized. Therefore, the higher the cost of capital the smaller the volumes of real investments in an economy.

It is noteworthy, that this argument does not evolve around the existence of cross-country competition for FDI (i.e. not around other states' tax systems and economic conditions) but holds from a closed economy perspective. If, for an example, country A exhibits cost of capital of 10%, all real investment possibilities exhibiting a pre-tax real return lower than 10% will not be conducted. To correctly identify this threshold in country A, it is useful to take exact inflation and real interest rates into account.

[8] There is another serious argument against cross-country comparisons with country-specific real interest rates: *International* investors/shareholders do not necessarily face different real interest rates for their alternative investment when they operate on the international capital market. Different real interest rates only prevail for local investors in different countries (see Feldstein and Horioka (1980) and Obstfeld and Rogoff (2000) for a broader discussion on the existence of heterogeneous real returns across countries in the presence of integrated capital markets).

5.2 Current Economic Conditions in the Member States

In reality, inflation and interest rates vary over time and across member states.[9] In the last years, *inflation rates* have fluctuated greatly between high and low levels reflecting the economic unsteadiness in the European Union and the global economy. Although inflation rates have increased during the post-crisis period, they are exceptionally low again in 2015.[10] On average, the inflation rate in the European Union was 1.0% in 2015. In the time period 2002-2015, the highest average inflation rate was 4.7% (in year 2007) while the lowest was 0.9% (in year 2014).

Table 6 shows in more detail the inflation rate for each member state in 2015. Whereas most countries experienced a low inflation rate, there were also several states with inflation rates above 2%.

Table 6: Country-specific interest and inflation rates 2015

Member State	Inflation Rate in %	Real Interest Rate in %	Member State	Inflation Rate in %	Real Interest Rate in %
Austria	1.9	-1.1	Italy	0.5	1.2
Belgium	1.2	-0.3	Latvia	1.0	-0.1
Bulgaria	1.1	1.4	Lithuania	0.1	1.3
Croatia	0.4	3.2	Luxembourg	3.6	-3.1
Cyprus	-1.1	5.7	Malta	2.4	-0.9
Czech Republic	0.9	-0.3	Netherlands	0.6	0.1
Denmark	0.9	-0.2	Poland	0.3	2.4
Estonia	1.2	2.7	Portugal	1.7	0.8
Finland	1.2	-0.5	Romania	1.8	1.6
France	1.0	-0.2	Slovakia	-0.3	1.2
Germany	2.1	-1.6	Slovenia	0.1	1.7
Greece	-1.1	11.2	Spain	0.8	1.0
Hungary	2.3	1.1	Sweden	1.9	-1.2
Ireland	2.1	-0.9	United Kingdom	0.6	1.1

The *real interest rate* shows a similar degree of fluctuation in the last years. However, there is a global long-run trend towards decreasing real interest rates which is also reflected in the member states' real interest rates in 2015.[11] On average, the real interest rate was 1.0% in 2015. In the time period 2002-2015, the highest average real interest rate amounted to 4.5% (in year 2009) while the lowest was 0.4% (in year 2007).

Although, real interest rates are low on average in 2015, there is some substantial heterogeneity. Table 6 shows in more detail the real interest rate for each member state. Greece and Cyprus experience real interest rates of 11.2% and 5.7%, whereas Luxembourg and Germany exhibit negative interest rates of -3.1% and -1.6%.[12]

[9] The report draws on the official figures of the European Commission in the Ameco database (update from 4th February 2016). The GDP deflator is used as inflation measure. Correspondingly, the real interest rate is based on the GDP deflator.
[10] See European Commission (2016) for a detailed economic analysis on the member states' inflation rates in 2015.
[11] See Bean et al. (2015) as well as Rachel and Smith (2015) for an economic analysis on low real interest rates.
[12] The Devereux/Griffith model also works for negative real interest rates. Both cost of capital and the EATR behave continuously at the 0% interest rate threshold.

5.3 Cost of Capital

It is informative to look at country-specific cost of capital in order to be informed about the required pre-tax rate of return for investments within a country. Similar to the results in section 4, the country-specific inflation rate has no noteworthy impact on the level of the cost of capital and the countries' ranking (Table 7 and Table 8). The following paragraphs therefore focus on the results for the real interest rate and combined results for real interest and inflation rate.

Table 7: Sensitivity of average cost of capital to country-specific interest and inflation rate

Cost of Capital (%)	Overall Mean	Industrial Buildings	Intangibles	Machinery	Financial Assets	Inventories	Retained Earnings	New Equity	Debt
Base Case	6.0	6.4	5.6	5.6	6.4	6.0	6.7	6.8	4.7
Specific Interest Rate	1.4	1.9	1.2	1.2	1.5	1.1	1.6	1.7	0.9
Specific Inflation Rate	5.9	6.4	5.6	5.5	6.2	6.0	6.5	6.6	4.8
Specific Interest and Inflation Rate	1.3	1.9	1.1	1.1	1.3	1.1	1.5	1.5	1.0

When looking at the real interest results (Table 7 and Table 8, column 3 and 6), it becomes obvious that the absolute level of the cost of capital is mainly determined by the *real interest rate*, not the attractiveness of tax systems. Shifts in the country-specific level of the cost of capital are due to economic conditions (i.e. the real interest rate) and not due to tax systems. The wide spread of the cost of capital across countries has, in most cases, nothing to do with the tax systems. Table 8 points this out by comparing the ranking of the interest rate specific cost of capital with the ranking of the interest rates itself (grey shaded column in Table 8). It turns out that the two rankings are highly correlated. The results depicted in Table 7 and Table 8 should therefore be interpreted most cautiously with respect to tax considerations.

Table 8: Ranking of member states for average cost of capital for country-specific interest and inflation rates

Country	Base Case	Country-Specific Interest Rate	Country-Specific Interest Rate Itself	Country-Specific Inflation Rate	Country-Specific Interest and Inflation Rate
		Cost of Capital	Interest Rate	Cost of Capital	Cost of Capital
Austria	21	4	4	22	4
Belgium	9	7	8	10	6
Bulgaria	3	17	21	3	17
Croatia	4	26	26	4	26
Cyprus	14	27	27	8	27
Czech Republic	6	8	8	5	8
Denmark	17	10	10	17	10
Estonia	1	24	25	2	25
Finland	16	9	7	15	9
France	27	14	10	27	14
Germany	23	2	2	24	2
Greece	24	28	28	20	28
Hungary	18	18	16	19	19
Ireland	9	5	5	13	5
Italy	2	13	18	1	13
Latvia	11	11	12	12	12
Lithuania	5	18	20	7	18
Luxembourg	20	1	1	21	1
Malta	26	6	5	26	7
Netherlands	19	12	13	18	11
Poland	13	25	24	14	24
Portugal	22	15	14	23	15
Romania	8	20	22	11	22
Slovakia	12	16	18	9	16
Slovenia	7	21	23	5	21
Spain	28	23	15	28	20
Sweden	15	3	3	16	3
United Kingdom	25	22	16	25	23

On average, the cost of capital is much lower than in the base case due to the low level of interest rates in the European Union (Table 7). For equity-financed projects, the cost of capital is higher than for debt-financed projects because the real interest rate also determines the nominal interest payment which in turn reduces the tax base. The figures show an interesting mechanism: Unlike conventional wisdom would suggest, the relative difference between equity and debt financing becomes larger for low interest rates.[13] This (only) holds because the profitability of marginal investments also declines when real interest rates fall. Interest deductions are very effective then because they are deducted from little income; for some countries (and for the interest rates which they exhibit) this holds even though the deductions themselves become smaller which would usually invite to draw the opposite conclusion.[14] Thus, the

[13] For the case of specific interest rates, debt bears on average a 47.1% lower tax burden than new equity whereas in the base case it is only 30.9%.

[14] Overall, the result is driven by 13 countries; for the other 15 countries the latter effect overwhelms and the debt/equity bias becomes smaller with lower interest rates.

debt/equity bias does not necessarily loose significance for little profitable projects in low interest environments.

5.4 EATR

Table 9 shows that the EATR is much less sensitive to country-specific real interest rates than the cost of capital. This is because the real interest rate is "only" relevant for determining the time discount rate and the nominal interest rate. With low interest rates, the EATR increases for both equity and debt financed investments due to the increase in both relative profitability of the model investment and interest deductions.

Table 9: Sensitivity of average EATR to country-specific interest and inflation rate

EATR (%)	Overall Mean	Industrial Buildings	Intangibles	Machinery	Financial Assets	Inventories	Retained Earnings	New Equity	Debt
Base Case	21.1	22.5	19.5	19.5	23.1	21.0	23.6	23.9	16.3
Specific Interest Rate	23.8	25.5	22.9	23.0	24.9	22.7	24.7	24.9	22.0
Specific Inflation Rate	20.8	22.4	19.2	19.2	22.4	20.9	23.0	23.3	16.7
Specific Interest and Inflation Rate	23.5	25.5	22.7	22.7	24.1	22.6	24.1	24.3	22.4

The cross-country comparison appears interesting when considering heterogonous inflation rates. Inflation matters because tax systems are not fully inflation-adjusted. Even if interest rates after inflation would be similar for international investors, inflation (i.e. the level of the nominal interest rate) matters because it has a direct impact on the absolute and relative amount of taxes paid by companies. If the nominal return increases due to inflation, the inflated part is taxed, even if pre-tax real returns remain constant. Rational investors should take this into account when making discrete investment decisions.

Highest inflation values in year 2015 can be found in Luxembourg, Malta, Hungary and Ireland. The cross-country comparison in Table 10 shows that all these countries move one position back when considering actual inflation rates. The changes appear relatively modest in these average figures since they get mitigated by the increased interest deductibility for debt financed projects when inflation is high. Related to this, Table 9 shows that with specific inflation and interest rates in place, the difference between equity and debt financing becomes smaller compared to the base case. This is because actual nominal interest rates are small on average which reduces the benefit of debt financing. In other words, the debt/equity bias attenuates *for highly profitable investments during low nominal interest times* like nowadays in the EU. Notably though, the analysis above on the cost of capital showed that this does not necessarily hold for weakly profitable investments.

Table 10: Ranking of member states for average EATR for country-specific interest and inflation rates

Country	Base Case	Country-Specific Interest Rate	Country-Specific Inflation Rate	Country-Specific Interest and Inflation Rate
Austria	19	20	19	21
Belgium	24	25	24	25
Bulgaria	1	1	1	1
Croatia	9	8	9	8
Cyprus	6	2	5	2
Czech Republic	10	11	10	11
Denmark	16	18	16	18
Estonia	8	9	8	9
Finland	12	13	12	14
France	28	28	28	28
Germany	25	24	25	24
Greece	23	17	21	16
Hungary	13	12	14	13
Ireland	3	4	4	4
Italy	20	21	20	20
Latvia	4	6	3	7
Lithuania	2	3	2	3
Luxembourg	21	23	22	23
Malta	26	27	27	27
Netherlands	18	19	18	19
Poland	11	10	11	10
Portugal	22	22	23	22
Romania	5	5	6	5
Slovakia	15	14	13	12
Slovenia	7	7	7	6
Spain	27	26	26	26
Sweden	14	16	15	17
United Kingdom	17	15	17	15

6 Conclusions

(1) Effective tax rates provided by the Devereux/Griffith methodology go beyond mere statutory tax rates in order to assess effective corporate tax burdens in different countries. The complexity, which the model is able to capture, makes assumptions about the economic conditions necessary. This study analyses the role of two key assumptions in the model, i.e. the real interest rate and the inflation rate.

(2) The analysis shows that the cost of capital is not very sensitive to changes in inflation rate. For inflation rates of 1%, 2% and 10%, the average cost of capital is 6.0%, 6.0% and 6.4%, respectively. However, for debt financed investments the effective tax burden decreases strictly with higher inflation.

(3) The study points out that the cost of capital is highly sensitive to the real interest rate. For real interest rates of 1%, 5% and 10%, the average cost of capital amounts to 1.4%, 6.0% and 11.9%, respectively. Beside shifts in the level of the cost of capital for all countries, the relative ranking among the countries is not much affected by the real interest rate.

(4) Unlike the level of the cost of capital, the level of the EATR turns out to be much less sensitive to changes in the real interest rate. For real interest rates of 1%, 5% and 10%, the EATR amounts to 23.6%, 21.1% and 18.4%, respectively. In addition, the relative ranking among the countries is very insensitive to the real interest rate, even less sensitive than in the case of the cost of capital.

(5) The EATR is not very sensitive to changes in inflation rates. For inflation rates of 1%, 2% and 10%, the EATR is 20.8%, 21.1% and 22.6%, respectively. Again, a higher inflation rate exacerbates the difference between equity and debt finance.

(6) Complementarily, the study implements country-specific inflation and interest rates for the year 2015. This unveils the effect of the current economic conditions in the member states on companies' effective tax levels. The average real interest rate and inflation rate were both 1.0% in 2015.

(7) The average cost of capital falls to 1.3% on average for country specific inflation and interest rates compared to 6.0% in the base case. Real investments need to yield less return when alternative capital market investments also yield little return. However, cross-country comparisons of the cost of capital are not informative from a tax perspective when assuming different economic conditions.

(8) The average EATR rises from 21.1% in the base case to 23.5% when implementing country specific inflation and interest rates. This is caused by the currently low levels of interest rates which makes future capital allowances less valuable. When only considering country-specific inflation rates (which are low in most member states in 2015), the average EATR falls from 21.1% to 20.8%. This points out that effective average tax burdens are lower in times of only weak inflation.

(9) The broad range of figures produced in this study helps to illustrate and indicate the levels of effective tax burdens in different countries for a series of relevant situations. There are no "universally true values" for effective tax levels in the member states. Nevertheless, the analysis suggests that the base case gives a reasonable indication of the member states' effective tax levels and member states' relative position in cross-country comparisons.

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Note:
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