

Technology and effective tax rates: innovative approaches to tax burden

Alena Andrejovska

Technical University of Kosice, Faculty of Economics, Department of Finance, Bozeny Nemcovej 32, Kosice, Slovak Republic, EU, alena.andrejovska@tuke.sk (corresponding author)

Ivana Andrejkovicova

Technical University of Kosice, Faculty of Economics, Department of Finance, Bozeny Nemcovej 32, Kosice, Slovak Republic, EU, ivana.andrejovicova@tuke.sk

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Abstract: The indicators of the effective tax burden on corporations present effective tax rates, taking into account the impact of all the design features mentioned in the legislation. The paper addresses the issue of effective taxation through the method of calculating EMTR and EATR with a focus on intangible assets in 2004, 2015 and 2023. The analysis determined the tax depreciated shield, which tracked the amount of tax savings on capital investment and the economic rent of the project with taxation, focusing on the magnitude of the financial benefit of the project with an aspect on taxation. The analysis showed that a 3% increase in the statutory rate over the study period, increased the effective average corporate rate on intangible assets by 13.56%. The annual tax saving achieved for 2023 on intangible assets was at 17.17% with a payback period of five years.

1 Introduction

Effective taxation is one of the key factors influencing a country's economic environment and its attractiveness for business and foreign investment. It involves corporate taxation of firms operating in each (domestic) territory and its setting can have far-reaching implications for the business environment, the inflow of foreign investment and the overall competitiveness of the economy. It also affects the management of organisations, particularly regarding resource allocation, investment strategies and the general financial policy of the company. To optimise their tax obligations and maximise revenues, companies often analyse the tax burden in other countries. And it is the effective tax rates that provide foreign investors with sufficient information on the tax burden of that country.

1.1 Literature review

As early as the 1960s, Jorgenson and Hall (1967) [1] pointed to an effective tax rate that includes a number of indicators, not just the statutory tax rate. The effective tax rate is simply the ratio of the tax burden to the tax base. Effective corporate tax rates consider the statutory tax rate, but also aspects of tax systems that determine the total amount of taxes effectively paid. The differences between the statutory and effective tax rates can be large in some cases. It may be the case that countries with a high statutory tax rate reduce the size of the tax base or reduce tax enforceability. The analysis of corporate tax highlights how tax competition works (Blechova, 2008) [2].

Effective average tax rates depend more strongly on the host country's statutory rate than on the effective marginal tax rate. A country with a high statutory tax rate may have a very low or even negative effective marginal tax rate, but the effective average tax rate will quickly increase with

profits if the statutory rate is high. Focusing on the effective average tax rate could explain why tax competition between EU countries seems to have taken the form of a reduction in the level of the statutory rate and why countries with a lower statutory rate, rather than a lower cost of capital, are likely to attract most foreign investment, especially from non-EU countries (Giannini and Maggiulli, 2002) [3].

Empirical studies have looked at the effective tax rate from different perspectives. They address the question of the impact of effective tax rates on the economic behaviour of firms, including their allocation, the issue of investment choices and profit reduction strategies, or they address the issue of tax competition between jurisdictions (Barrios et al., 2014) [4]. Dyreng et al. (2017) [5] tracked changes in effective corporate tax over a 25-year period. Statutory tax rates have remained relatively constant over the period, while effective tax rates have varied. This was because some firms were able to reduce their effective tax rates through tax planning strategies and took advantage of a bargain in the tax system. According to Kubatova and Jares (2011) [6], we divide the indicators of the effective corporate tax rate into fictitious and real. The fictitious indicators look ahead, i.e. into the future, and simulate for us the impact of the tax on the selected entities. Real indicators, on the contrary, look into the past and thus determine the amount of tax burden in a period that has already passed based on measured real data.

The effective average tax rate (EATR) is the ratio of the present value of taxes to the present value of profits. This can be calculated for any discrete investment project, including one in which a positive economic return is expected ex ante. The effective marginal tax rate (EMTR) is a special case of the EATR, where the project is simply divided evenly into phases until the last additional unit

represents zero after-tax rent to the investor (Abbas et al., 2013) [7]. EMTRs tell the tax burden for marginal investment projects by comparing the pre-tax and after-tax cost of capital of such projects (Auerbach, 1979; King and Fullerton, 1984) [8,9].

EMTR represents a marginal investment for which we can assume a pre-tax rate of return sufficient for the investor to conduct the project. This rate of return must be at least at the level of the real interest rate. If the result of the calculation is positive, i.e. if the investment is more profitable than marginal, we expect the after-tax profit to be positive in the future. It is important to compare the result with the EATR which includes the effect of the marginal personal effective tax rate (these are dividends or similar payments) (Modigliani, Miller, 1963) [10].

2 Methodology

The aim of this paper is to address the issue of effective taxation through a method of calculating EMTR and EATR focusing on intangible assets in 2004, 2015 and 2023. To calculate effective corporate tax rates, we used the methodology compiled by Devereux and Griffith (2003) [11]. The effective average tax rate (EATR) is defined as the ratio of the present discounted value of taxes over the present discounted value of a project's (investment's) pre-tax profits. The methodology also includes the calculation of the marginal tax rate (EMTR) as a special case where the after-tax economic rent is zero. The original calculation is based on an investment of one capital unit that is realised over one year and is subsequently sold at its residual value $(1 - \delta)(1 + \pi)$, where δ is the real economic depreciation and π is inflation. An overview of the variables that enter the calculations is given in Table 1. To calculate EMTR, the after-tax economic rent R must be zero (Devereux-Griffith, 2003) [11]. Subsequently, the required level of pre-tax net profit must be solved for. These changes are captured in the following relationship (1):

$$\tilde{p} = \frac{(1-A-\frac{F}{\gamma})(p-\pi+\delta(1+\pi))}{(1+\pi)\left(1-\tau'-(\tau-\tau')\left(\frac{(1-\delta)(1+\pi)^Y}{1+p}\right)\right)} - \delta \quad (1)$$

where A represents the present discounted value of depreciation, F represents the additional cost of raising finance from own or external sources, τ represents the statutory corporate tax rate, τ' is the tax rate in the special scheme. Present discounted value of depreciation - A , also called a tax shield.

For the calculation of the tax shield, the following relationship applies (2):

$$A = \tau \varnothing \left\{ \left(\frac{1}{1+\rho} \right) + \left(\frac{1}{1+\rho} \right)^2 + \dots + \left(\frac{1}{1+\rho} \right)^T \right\} \quad (2)$$

where ρ is the shareholder's discount rate. Since there is no personal taxation in this model, then the shareholder discount rate is equal to the nominal interest rate i , the

value of which has been estimated using the Fisher formula (3):

$$i = (1+r)(1+\pi) - 1 = (1+0.05)(1+0.02) - 1 = 0.071 = 7.1\% \quad (3)$$

This implies $\rho = i = 7.1\%$. We then calculate the EMTR as the ratio of the difference between the pre-tax rate of return on marginal investment \tilde{p} and the after-tax rate of return-on-investment r to the pre-tax rate of return on marginal investment \tilde{p} (4):

$$EMTR = \frac{\tilde{p}-r}{\tilde{p}} \quad (4)$$

EMTR includes in its calculation elements such as the tax base, the method of financing the investment, the method of depreciation of fixed assets, but also the level of inflation, etc. (all calculations in the work have been adapted to the Slovak legislation). We call the indicator \tilde{p} the cost of capital term. This indicator needs to be quantified for each investment separately, as investments may take different forms, financing or lead times. If depreciable assets are included in the investment, the depreciation rate, which affects the tax base, must also be included in the equation for calculating the EMTR. For intangible assets, the relationship takes a basic form (5):

$$\tilde{p} = \frac{(1-A)}{(1-\pi)(1-\tau)} \{ \rho + \delta * (1 + \pi) - \pi \} - \delta * e \quad (5)$$

An important part of the effective corporate tax calculation is the financing of the investment. Financing can be from a variety of sources - retained earnings, new deposits or financing through debt. In the calculation, we assume the absence of personal taxes, so the shareholder tax discrimination variability $\gamma = 1$. The gamma γ expresses the ratio of the funds raised from a given investment to the funds raised from an alternative investment. In the following cases, we present an adjustment of the equations for an intangible asset that is financed through debt (6):

$$\tilde{p}^{DE} = - \frac{(\rho-i(1-\tau))}{(1+\pi)(1-\tau)} \quad (6)$$

For the financing of an investment from a new deposit or through retained earnings, the relationship applies (7):

$$\tilde{p}^{NE} = \frac{\rho(1-\gamma)(1+e)}{\gamma(1+\pi)(1-\tau)} \quad (7)$$

Taxes and expected return on investment are closely linked. Countries with high effective marginal tax rates are less attractive to investors as their cost of capital is higher. Another category according to Devereux-Griffith (2003) [11] based on which the attractiveness of a location can be

determined is the EATR. The formula for calculating EATR is (8):

$$EATR = \frac{R^* - R}{p / (1+r)} \quad (8)$$

where R^* is the present discounted value of the untaxed economic rent received, R is the present discounted value of the after-tax economic rent received, p is the pre-tax profit (excluding depreciation) and r is the real interest rate. In this expression we must include the real rate of capital depreciation, i.e. economic depreciation, assuming that the net return to capital is constant, the expression takes the form (9):

$$EATR = \frac{R^* - R}{p / (r + \delta)} \quad (9)$$

First, the present value of the profit on the investment needs to be calculated. We calculate this value by discounting it at the real interest rate (10):

$$R^* = \frac{p - r}{1+r} \quad (10)$$

Since we know the values of p and r because they are given quantities, we can calculate R^* :

$$R^* = \frac{0.20 - 0.05}{1 + 0.05} = 0.1429 \quad (11)$$

The discounted value of the tax-free economic annuity is 14.29%. This economic rent needs to be taxed according to the tax system in the country to get the economic rent on the investment after tax R .

To apply the equations to conditions in Slovakia, we need to modify them. The basic relationship for intangible assets, using which we calculate the EATR has the form (12):

$$R = \frac{\gamma}{1+\rho} * \{[(p + \delta) * (1 + \pi) * (1 - \tau)] - [\rho + \delta * (1 + \pi) - \pi] * (1 - A)\} \quad (12)$$

The funding methods were indicated in the calculation of the EMTR. These are financing through retained earnings and new deposits or through debt. To arrive at the final calculation of the EMTR it is necessary to calculate the cost of these methods of financing the investment. The relationship for debt financing takes the form (13):

$$F^{DE} = \frac{\gamma * (1+e) * (\rho - i + i * \tau)}{1+\rho} \quad (13)$$

where $(1 + e)$ is the effective property tax rate paid during the direct investment activity. The rent derived from the investment is increased by the ratio of the discounted value of the difference between the shareholder discount rate and the nominal interest rate and the interest tax shield. For

financing through a new deposit, the relationship takes the form (14):

$$F^{NE} = - \frac{\rho(1-\gamma)(1+e)}{1+\rho} \quad (14)$$

2.1 Relationship between EATR and EMTR

The EATR is a derivation of actual cash flows and tax burden. The EMTR has applications in assessing incentives to save and invest. The relationship between these two variables can be expressed by the equation (15):

$$EATR = \frac{\tilde{p}}{p} EMTR + \frac{p - \tilde{p}}{p} \tau \quad (15)$$

As we can see, the effective average tax rate is a broader concept than the effective marginal tax rate. The formula shows that the EMTR is part of the average tax rate. This relationship indicates the location and size of the investment. The relationship is used when the alternatives for locating the investment are mutually exclusive. It is important for the investor to know what the tax rate is in each country. We refer to the value that EMTR acquires. EMTR and EATR are referred to as tax wedges, which express the rate of return on a taxed and untaxed investment.

Table 1 Description and name of the variables entering the calculations of the effective tax rate

Desc.	Variable	Desc.	Variable
A	discounted value of depreciation	e	property tax rate
π	inflation	v	method of valuation of inventories
δ	tax depreciation	γ	shareholder tax discrimination
F	additional fundraising costs	R^*	the present discounted value of the untaxed economic annuity received
τ	statutory corporate tax rate	R	the present discounted after-tax value of the economic rent received
τ'	special regime tax rate	p	profit before tax
ρ	shareholder's discount rate	\tilde{p}	return on investment before tax
i	nominal interest rate	r	real interest rate

Source: own processing.

2.2 Calculation of the effective corporate tax rate in Slovakia

The calculation of the effective corporate tax rate consists of several steps. First, it is necessary to calculate the tax shield for each type of tangible property. The calculation proceeds by quantifying the effective marginal tax rate, the economic rent of the project, the effective average tax rate and expressing the relationship between

the EATR and the EMTR. Internal and external parameters entered the calculations performed according to the ZEW (2022) [12] methodology. The internal parameters consisted of the corporate tax rate, the effective property tax rate.

Table 2 Development of property tax in Slovakia

Year	Nominal tax rate	Effective tax rate
1998 - 1999	0.11 %	0.07 %
2000 - 2003	0.11 %	0.08 %
2004	0.11 %	0.09 %
2005 - 2012	0.44 %	0.36 %
2013 - 2016	0.44 %	0.34 %
2017 - 2023	0.44 %	0.35 %

Source: ZEW (2022) [12].

The calculations are carried out for 2004, 2015 and 2023. 2023 is the year on which we have focused our attention. The years 2004 and 2015 are for comparison of the situation in the past when different tax rates were in force.

3 Results

Internal economic calculation parameters:

The corporate tax rate in effect in 2004 was 19%, in 2015 - 22% and in 2023 - 21%. The year 2015 is also characterized by a change in the depreciation policy in Slovakia. In this year, the number of depreciation groups and the number of years of depreciation within them changed. Therefore, we present the values of the effective tax rate also in this year. The effective property tax rate was in different amounts in these years (Table 2). In our calculations, we assumed the weighted arithmetic average method for inventory withdrawals. The depreciation period was determined according to the classification of the assets into depreciation groups. The amortization period for intangible assets was 5 years, industrial machinery 6 years, agricultural machinery and basic stock and draft animals 4 years, perennial crops 12 years, industrial buildings 40 years and agricultural buildings 20 years.

External economic parameters for the calculations:

The accounting depreciation rate δ is 15.35% for intangible assets, base stock, perennial cropping units, 3.1% for industrial and agricultural buildings, 17.5% for industrial and agricultural machinery and 0% for financial assets and inventories. The real interest rate was set at $r = 5\%$. This value of the real interest rate is fixed in the case of an open economy. We consider that one country cannot influence the real interest rate because it arises in the international capital market. This is the real interest rate in the case of an alternative investment, i.e. the deposit of funds in a bank. Another external economic parameter is the inflation rate π , set at 2% in all countries, and the pre-tax rate of return p , which is 20%. All the external economic parameters for the calculation come from ZEW

(2022) [12] based on which the calculation of the effective average and marginal corporate tax rate is carried out.

Tax shield:

The tax shield represents the present discounted value of depreciation, so before the actual calculation, it is necessary to know what depreciation conditions for each type of asset were in force in the year for which the calculation is made. For 2023, the straight-line depreciation is used for intangible assets and the depreciation period for this type of asset is 5 years. The annual depreciation rate is therefore 20% of the total value.

Table 3 Tax shield for intangible assets in Slovakia in selected years

Type of asset	Year	STR	Annual depreciation rate	Tax shield
Intangible assets	2004	19%	20.00%	15.54%
	2015	22%	20.00%	17.99%
	2023	21%	20.00%	17.17%

Source: own processing according to [12].

Table 3 shows the annual depreciation rates for each type of asset, which have not changed over the years, and the tax shield. The value of the tax shield for each type of asset was calculated according to relation (2). Assuming an investment in assets of EUR 1 million in 2023, the tax saving in the form of the tax shield for intangible assets is 17,17 % of the value of the assets, i.e. EUR 171 700. As intangible assets are depreciated over five years, this saving is spread over the five years of depreciation of the asset. Table 3 also shows the years 2004 and 2015 for a better comparison of the evolution of the tax rates and the tax shield. Different statutory tax rates were in effect in selected years. In 2004, the STR was 19% and in 2015 the STR was at 22%. For intangibles, the tax shield was 15.54% in 2004 when the STR of 19% was in effect. The change in STR in 2015 was an increase of 3% points from 2004. The increase in the tax shield was only 2.45%. In 2023, the STR of 21% was in effect. This was a decrease of 1% from 2015. The tax shield fell by 0.82%. When the STR declines, it declines at a greater rate than the tax shield declines. The use of the tax shield is most effective in asset-intensive industries, i.e., where there is a large amount of fixed assets that can be legally depreciated. Conversely, the service industry may have few assets that can be depreciated, and therefore the use of the tax shield is not as significant for these entities.

3.1 Effective marginal tax rate

The EMTR is the difference between the cost of capital spent on a given investment and the after-tax rate of return on an alternative investment. The higher the tax burden in a country, the higher the cost of capital, which affects the growth of the EMTR. The higher the EMTR, the less likely

Technology and effective tax rates: innovative approaches to tax burden

Alena Andrejovska, Ivana Andrejkovicova

it is that the investment will be realized, as it is too tax-intensive for the investor. EMTR values are monitored because of the location of the investment. Investors require the EMTR value to be as low as possible. As with all marginal variables, EMTR is the deciding factor when the effective marginal tax rate is zero. This means that the marginal value of capital equals its cost.

We calculate the EMTR as the ratio of the difference between the pre-tax rate of return on marginal investment (\tilde{p}) and the after-tax rate of return on investment r to the pre-tax rate of return on marginal investment \tilde{p} . First, the pre-tax rate of return on investment needs to be determined. This is calculated from relation (5). We also need to include in the calculation the method of financing the investment, hence relation (6)-(7). The after-tax rate of return is known. It has been determined as an external parameter at 5%. We then need to put the calculated values into relation (4) to calculate the effective marginal tax rate. If we consider financing through retained earnings or a new deposit, the intangible assets at EMTR reached 13.56% in 2023. When financing through debt, the EMTR values reached negative values because the real rate of return on the alternative investment entered the relationship for the calculation at 5%. If it had been set at 3%, neither EMTR value would have been negative. In the case of the investment in intangible assets, this indicator is -27,09 %. For the investor, negative values of the calculated EMTR are advantageous because they represent a saving compared to the alternative investment, i.e. depositing the funds in a monetary institution Table 4.

Table 4 Calculated EMTR values

Assets	Year	Intangible assets
Retained earnings and new deposit	2004	13.14%
	2015	13.80%
	2023	13.56%
Debt	2004	-21.35%
	2015	-30.29%
	2023	-27.09%

Source: own calculations according to ZEW (2022) [12].

3.2 Effective average tax rate

To know where to locate their investment, investors use the calculated EATR, which reflects the effective tax burden. This calculation includes not only the statutory tax rate, but also the financing of the investment, the components of the tax base, or the additional taxes and costs required to make the investment. This indicator is the most accurate for determining the tax burden, in view of the number of variables that enter the calculation.

To calculate the effective average tax rate, we first need to implement the calculation of the present discounted value of the untaxed economic rent R^* given in equation (10). Since the calculation involves external economic parameters that are known, the result is a discounted value of the untaxed economic rent of 14.29%. The next step is to calculate the after-tax economic rent given in relation

(12) for intangible assets, considering the financing of the investment from external resources (13) or own resources (14). Once the value of the discounted untaxed economic rent and the after-tax economic rent have been calculated, it is necessary to insert these values in relation (9).

Based on the calculations, the highest value of economic annuity has the lowest value of EATR. For intangible assets, the economic rent ranged from 0.0598 for 2023 to 0.0666 in 2004. As for the EATR, it ranged from 40.02% for 2004 to 43.62% in 2023, we must note that this is a method of financing from retained earnings. If we look at financing through debt, the rates will increase by 1.3 p.p. on average in Table 5.

Table 5 Economic rent of the project and EATR

Economic rent of the project	Assets	Year	Intangible assets
	Retained earnings and new deposit	2004	0.0666
		2015	0.0564
		2023	0.0598
Debt	2004	0.0792	
	2015	0.0710	
	2023	0.0737	

EATR	Assets	Year	Intangible assets
	Retained earnings and new deposit	2004	40.02%
		2015	45.38%
		2023	43.62%
Debt	2004	41.28%	
	2015	46.85%	
	2023	45.02%	

Source: own calculations according to ZEW methodology [12].

EATR values differ for intangible assets, the reason being the difference between accounting and tax depreciation rates. In calculating the EATR of intangible assets, we considered an accounting depreciation rate of 15.35%, while the annual tax depreciation rate for intangible assets was 20% in 2023. We can interpret the 2004 and 2015 results in the same way. Two parameters entered the calculations that were different in each year. The first was the statutory tax rate, which was 19% in 2004, 22% in 2015 and 21% in 2023. According to ZEW (2022) [12], Slovakia's EATR values in 2023 were approximately at the level of the EU28 average. The statutory tax rate, which taxed the income of business entities, was at 21%. The average EATR was 18.7%, 1.1% below the EU average. EATR for intangible assets was 17.1%. The calculated EATR values for the financing method of retained earnings and new deposit were 43.62% in 2023. The financing of the investment through debt reached a higher EATR value of 45.02%.

3.3 Relationship between effective average and marginal tax rates

The relationship between the effective average tax rate and the effective average tax rate reflects where to place the investment and to what extent. By comparing these two

Technology and effective tax rates: innovative approaches to tax burden

Alena Andrejovska, Ivana Andrejkovicova

calculated ratios, we can see to what extent the after-tax profit is reduced by tax. These tax wedges tell the rate of return on a taxed and untaxed investment. The calculation is carried out according to relation (15).

The results of the calculated values for the year 2023 (Table 6) talk about the ratio of EATR and EMTR for intangible assets. While for financing through debt, it shows lower rates. The difference between financing through equity and debt is about 7% already for all types of assets. Also, in the case of financing the investment through debt is intangible assets (11.54%).

Table 6 Economic rent of the project and EATR

Assets	Year	Intangible assets
Retained earnings and new deposit	2004	17.31%
	2015	19.62%
	2023	18.85%
Debt	2004	10.69%
	2015	11.97%
	2023	11.54%

Source: own calculations according to ZEW (2022) [12].

It is the combination of the effective average rate and the effective marginal rate that is the most appropriate way to make your investment in the most tax-efficient state in terms of taxes and the scale of the investment. The EATR ↔ EMTR relationship considers the cost of capital, accounting and tax letters, the inflation rate, the shareholder discount rate, as well as the statutory tax rate. It is necessary to take this relationship into account from the point of view of the return on investment to make it as optimal as possible. Many countries, including within the European Union, are trying to attract investors with low tax rates. As we have shown through calculations, it is not the statutory tax rates that are important for the efficient location of investment in an efficient scale. It is therefore necessary to look at corporate taxation in a broader context.

4 Conclusion

The statutory and effective corporate tax rate is an important factor for investors when deciding where to place an investment. Businesses try to find a country where they will pay as little as possible in corporate tax. However, the solution is not to find the country with the lowest statutory tax rate, but with the lowest effective tax rate. The analysis of the effective marginal and average corporate tax rate for 2023 in the Slovak Republic for intangible assets showed several facts. In 2015, there were several changes that significantly affected the level of the effective tax rate. The number of depreciation groups changed, as well as the classification of assets in it. The most recent change in the corporate tax rate in Slovakia was made in 2017, when it was changed from 22% to 21%, which has been in effect ever since. Based on this, we can conclude that the Slovak Republic and the intangible assets under review are becoming tax competitive and interesting for foreign

investors. However, we cannot forget that the European Union consists of countries with different levels of national tax systems, and it is the inconsistency of these tax policies that creates a competitive environment. However, the European Union has so far been unsuccessful in its attempts to introduce tax harmonization. Countries fear a loss of competitiveness and are therefore not open to such a change. It is questionable whether tax harmonization will ever be pushed through.

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Technology and effective tax rates: innovative approaches to tax burden

Alena Andrejovska, Ivana Andrejkovicova

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