CORPORATE TAX RATES IN THE CONTEXT OF MACROECONOMIC DETERMINANTS AS CRUCIAL ASPECTS OF EFFECTIVE CORPORATE TAXATION IN THE VISEGRAD GROUP COUNTRIES

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Abstract: The study examines the relationship between the effective tax rate, the nominal rate, and selected macroeconomic determinants. Correlation and regression analysis were used to analyze the impact of individual determinants and the nominal tax rate on the effective rate in the Visegrad Group countries from 2004 to 2022. The results of the analysis suggest different development directions of the standard tax rate in the Visegrad Group countries. While it decreased in the Czech Republic, the decline in Hungary and Slovakia was followed by an increase. In Poland, the standard tax rate remained almost unchanged. The results of linear regression demonstrated that in Slovakia, the Czech Republic, and Hungary the standard rate has a statistically significant impact on the effective tax rate. The result was not confirmed for Poland, where the standard rate was removed from the model due to the singularity problem.

Keywords: corporate tax rate, effective tax rate, Visegrad Group, regression analysis, least squares method.

1 Introduction

In most countries, corporate tax rates are set at relatively high levels. Such setting of tax rates goes hand in hand with a particularly complex tax system. Therefore, it is not surprising, that the issue of effective corporate taxation is quite debated, either in general or with regard to the effective collection of revenues related to this tax, as well as the simplification of the mentioned complex tax systems. On one hand, there are policymakers who argue in favor of reducing corporate tax rates to enable businesses become both more competitive and innovative. However, there are also opponents, who express concerns associated with the negative impact of potentially lower tax revenues on the state budget, which could lead to a disruption of balance and increased inequality. It remains questionable, how reducing corporate tax rates leads to an improvement in competitive advantage compared to other economies.

2 Theoretical overview

In most countries, corporate tax rates are very high and tax laws are designed intricately. These two factors lead to discussions on how to rationalize these systems. Representatives of government policies hold dual views. Some argue in favor of lower tax rates, as lower tax rates can make businesses more innovative and thus more competitive. However, on the other hand, there are opponents, who argue that reducing corporate tax rates would disrupt the balance of government budgets, which would have a negative impact and increase inequality. The key question, therefore, is whether corporate taxes do or do not have a real impact on the competitiveness of individual economies (Mukherjee, 2017). Tax policy is an integral part of a state's economic policy and has a significant impact on macroeconomic indicators. The corporate tax rate can influence indicators such as inflation, GDP, unemployment, exports and others. According to Shemrod (2004), foreign tax rates have a significant impact on the corporate tax of a given state. Clausing (2007) examines the factors influencing corporate taxation. These factors are related to macroeconomic conditions and may indicate the level of tax competition between countries. The study emphasizes that national companies may respond to tax burdens by shifting income to countries with lower taxes. As Segal (2022) states, investors use effective tax rates for their decisions and investments abroad, which express the actual taxation rate. Effective and statutory tax rates differ significantly. The effective tax rate is a stricter expression of the company's overall tax liability. It is also usually lower. Considering that effective rates are one of the most important factors in the decision-making of foreign investors regarding investments and locations, it is not surprising that the discussion in the scientific sphere on this topic is extensive (Gupta, 2007; Lietz, 2013; Lopo Martinez, 2017; Wilde and Wilson, 2018; Weybourne, 2021). (Mankiw, 2015), McNabb (2018), Delgado et all (2014) in their studies mention many arguments for and against increasing tax burdens and their subsequent impact on GDP growth/decline. A fundamental argument against is that higher tax burdens do not stimulate individuals to provide labor capital or firms to produce more. However, on the other hand, higher tax rates and the associated higher tax revenues provide individual governments with the potential to invest these resources, whether in improving education, infrastructure or science and research. This ultimately leads to increased production capacity in the economy. Empirical evidence obtained in recent years confirms the close connection between tax rates, tax revenues, and economic growth, thus refuting doubts about the existence of this relationship formulated by Easterly & Rebelo (1993) in their work. Their claims about the absence of this relationship are directly refuted by Arnold et al. (2011), who found that increasing corporate tax rates and the subsequent increase in corporate revenues lead to a reduction in GDP growth, pointing to a negative relationship between taxation, tax revenues and GDP growth. Lee and Gordon (2005) reached the same conclusion. On the other hand, reducing tax rates can stimulate investment and business expansion, increasing demand for goods and services and potentially causing short-term inflationary pressures due to supply exceeding demand. Previous studies have shown, that inflation increases the real corporate tax burden because the value of tax deductions decreases due to inflation. This increases taxable corporate income faster than inflation, leading to a higher tax burden (Gravelle, 1994). Lowering tax rates can encourage businesses to expand and hire new employees, potentially reducing unemployment rates. Companies would have more financial resources for expansion and new projects, requiring additional labor. On the contrary, tax increases may limit business development and lead to layoffs, as companies reduce costs, including labor costs, which may increase unemployment (Fedeli and Forte, 2012). Research shows, that lower corporate tax rates make EU countries more attractive for foreign direct investment. In addition, market size, market potential, access to the European single market, common language and neighboring relations are other factors that increase the attractiveness of these countries for investment (Delgado et al., 2014). A significant amount of literature shows, that lower corporate tax rates improve the attractiveness of countries and regions for foreign direct investment, especially in smaller and peripheral countries, that do not have other advantages such as location, market size or market access (Feld and Heckemeyer, 2011). Becker et al. (2012) examined the qualitative and quantitative effects of corporate tax on foreign direct investment and concluded, that corporate taxation has a negative impact on these investments. Due to factors such as globalization, tax competition between states or each country's simple internal tax strategy Slemrod, (2004) ; Mutti et al., (2019) ; Deveruex and Sorensen (2006) nominal rates have decreased significantly since the early 1980s, but the pace of decline has varied over the years and they also indicate that the decline will continue. New EU regulations, which set a minimum effective tax rate of 15%, have been in effect since February 1, 2024. The rate is intended for multinational companies operating in EU member states. This framework aims to bring greater fairness and stability to the tax environment in the EU and the world. The European Commission argues, that these rules represent a modern and better-adapted framework for today's globalized and digital world. The entry into force of the minimum tax rules, which member states unanimously agreed in 2022, formalizes the implementation of the so-called "2nd pillar" rules, which the EU approved as part of a global agreement on international tax

reform in 2021. Although, almost 140 jurisdictions worldwide have subscribed to these rules, only the EU has anchored them in legal norms (European Commission, 2024).

3 Methodology

The aim of this study was to analyze and evaluate the relationship between corporate tax rates (effective and nominal tax rates) and selected macroeconomic determinants in the Visegrad Group countries. Through our analysis, we aimed to answer the following research question: "Are corporate tax rates decisive in effective taxation?" The first part of the study tracks and evaluates the development of corporate tax rates (both nominal and effective) and corporate tax revenues. The second part focuses on compiling a correlation matrix and estimating econometric models for each Visegrad Group country separately. The goal of modeling and subsequent testing of the estimated models was to identify and quantify the statistical significance of selected macroeconomic determinants and the nominal corporate tax rate in relation to the effective corporate tax rate through regression analysis, specifically the method of least squares. Each model was tested to meet the basic assumptions of linear regression models. We tested residual normality (Jarque-Bera test, Shapiro-Wilk test, Shapiro-Francia test), heteroskedasticity (Breusch-Pagan test), autocorrelation (Breusch-Godfrey test, Box-Ljung test, and Box-Pierce test), multicollinearity (VIF factor), and model specification (Ramsey RESET test). The modeling and testing of regression analysis parameters were conducted using the RStudio program environment.

The presented study complements existing studies wrote by authors such as Andrejovská (2019), Puliková (2019), Kotlana et al. (2011), Arnold et al. (2011), Wahyuningsih et al. (2020), Mazák (2018), Zirgulius and Šarapovas (2016), Mateu et al. (2009), and Fernández-Rodriquez et al. (2023), who examined macroeconomic determinants in EU countries, while in our study, we supplemented the analysis with the annual change in GDP%, foreign direct investment as a percentage of GDP and used the GDP deflator % to express inflation. In our analyses, we focus on four countries, namely the Slovak Republic, the Czech Republic, Hungary and Poland, in the time interval from 2004 to 2022. The data necessary to perform these analyzes were obtained from the Eurostat, World Bank, and OECD databases.

After implementing the above-mentioned correlation and regression analysis, we will evaluate the results and the impact of individual variables on effective corporate tax rates. When evaluating the results, we will try to confirm or refute the following hypotheses:

Hypothesis 1: Corporate tax revenues had a decreasing trend during the COVID-19 pandemic.
Hypothesis 2: The effective tax rate positively correlates with corporate tax revenues.
Hypothesis 3: The effective tax rate is mainly influenced by the nominal tax rate.

Through regression analysis we analyzed the impact of selected macroeconomic determinants we chose and the standard corporate tax rate on effective corporate tax rates in the V4 countries individually. We worked with an econometric model in the following form:

$$EF_{i,t} = \beta_0 + \beta_1 * NOM_{i,t} + \beta_2 * GDP_{i,t} + \beta_3 * INF_{i,t} + \beta_4 * TAX_{i,t} + \beta_5 * FDI_{i,t} + \beta_6 * UN_{i,t} + \varepsilon_{i,t}$$

where the dependent variable is:

- $EF_{i,t}$ = effective tax rate of state i in year t (in %),

and the independent variables are:

- $NOM_{i,t}$ = nominal tax rate of state i in year t (in %),
- $GDP_{i,t}$ = annual growth rate of gross domestic product of state i in year t (in %),
- $INF_{i,t}$ = INF i,t = inflation of state i in year t (in % - annual growth rate of GDP deflator),
- $TAX_{i,t}$ = corporate tax revenues of state i in year t (in % - as a share of GDP),
- $FDI_{i,t}$ = foreign direct investment of state i in year t (in % - as a share of GDP),
- $UN_{i,t}$ = unemployment in state i in year t (in % - as a share of the unemployed to the total labor force).
- Other variables:
- β_0 = intercept (constant)
- β_1,.., β_6 = regression coefficients of the model, indicating the sensitivity of the change in the explanatory variable x to the explained variable y,
- $\varepsilon_{i,t}$ = *random error of the model.*

Table 1. illustrates the impact of selected determinants and the standard tax rate on the effective rate in selected studies compared to our assumptions.

Table 1 Comparison of results from conducted studies

	Author	Year	Results of the study	Our assumptions
Interannual change of GDP	Andrejovská	2019	+	+
	Kotlan et al.	2011	+	
	Clausing	2007	+	
Foreign direct investment	Benassy-Quéré	2005	+	+
	Arnold et al.	2011	-	
Inflation	Wahyuningsih et al.	2020	+	-
	Saibu et al.	2013	+	
	Korauš et al.	2018	-	
Unemployment	Zirgulius and Šarapovas	2016	+	-
	Bettndorf et al.	2009	+	
	Fedeli et al.	2012	-	
Tax revenues	Markusen	1995	+	+
	Matei et al.	2009	-	
	Devereux et al.	2007	-	
Standard rate	Fernández-Rodriquez et al.	2023	+	+
	Puliková	2019	+	

4 Results of study and discussion

4.1 Analysis of the standard (nominal) corporate tax rate progress in the V4 countries from 2004 to 2022

In Slovak legislation, the area of corporate taxation is regulated by Act No. 595/2003 Coll. on income tax as amended. The tax rate is currently set at 15% for taxpayers who have not exceeded taxable income of €60,000 for the relevant tax period and 21% for taxpayers whose income exceeds this amount. In Czech Republic, this tax is regulated by Act No. 586/1992 Coll. on income tax as amended for the relevant tax period. According to this law, all companies with headquarters in Czech Republic, as well as foreign companies, are required to pay tax on their

profits. Resident companies are required to pay corporate tax not only on income acquired within the Czech territory but also on income from worldwide sources. The rate for the tax period starting in 2024 is 21%, while for the previous period, it was 19%. The corporate tax rate in Poland is currently set at 19%. Taxpayers can also apply a reduced rate of 9%, but only for income other than capital gains and under the condition that they are considered small taxpayers. Residents are subject to worldwide taxation of their income unless there is a treaty between Poland and the respective country to prevent double taxation. Act No. 81/1996 Coll. on income tax for legal entities regulates the area of corporate taxation in Hungary. Taxpayers with permanent residence in Hungary are obliged to tax and pay corporate tax on their worldwide income. This represents the first type of unlimited tax liability. Conversely, limited tax liability applies to legal entities that are not residents. The law imposes an obligation on them to pay corporate tax on activities acquired within the state. The corporate tax rate in Hungary is currently set at 9%. Standard rates themselves do not have significant explanatory value. On the other hand, it is one of the simplest and most common ways of comparing taxation, whether of legal or natural persons. In general, it plays an important role in deciding on new investments in a given country. They are a key indicators that helps investors decide how to allocate their financial resources to develop their further business activities.

Table 1 Illustrates standard and effective corporate tax rates progress in V4 countries from 2004 to 2022.

	Slovak republic		**Czech republic**		**Hungary**		**Poland**	
	STR	ETR	STR	ETR	STR	ETR	STR	ETR
2004	19	16,5	28	24,6	16	17,7	19	17,1
2005	19	16,8	26	22,7	16	17,7	19	17,1
2006	19	16,8	24	21	17,33	17,7	19	17,1
2007	19	16,8	24	21	20	17,7	19	17,4
2008	19	16,8	21	18,4	20	17,7	19	17,4
2009	19	16,8	20	17,5	20	19,5	19	17,5
2010	19	16,8	19	16,7	19	19,1	19	17,5
2011	19	16,8	19	16,7	19	19,3	19	17,5
2012	19	16,8	19	16,7	19	19,3	19	17,5
2013	23	20,3	19	16,7	19	19,3	19	17,5
2014	22	19,4	19	16,7	19	19,3	19	17,5
2015	22	19,6	19	16,7	19	19,3	19	17,5
2016	22	19,6	19	16,7	19	19,3	19	17,5
2017	21	18,7	19	16,7	9	11,1	19	17,5
2018	21	18,7	19	16,7	9	11,1	19	17,5
2019	21	18,7	19	16,7	9	11,1	19	16
2020	21	18,7	19	16,7	9	11,1	19	16
2021	21	18,7	19	17	9	11,1	19	16,1
2022	21	18,7	19	17	9	11,1	19	16,1

Source: Own processing based on Eurostat data

In Table 2, we can see the development of the nominal corporate tax rate in the V4 countries during the observed period. The individual rates vary, as evident at first glance. A constant tax rate of 19% throughout the observed period can be seen in Poland. In the Czech Republic, we can see a declining trend. However, the development of the standard rate was not as clear in Slovakia and Hungary. Regarding Slovakia, in the first nine years, it remained constant at 19%. The following year, 2013, it increased of 4% and the standard rate was at 23%. This sharp increase aimed to compensate for the long-term declining trend of the clean effective tax rate. In 2014, there was a decrease back to 22%. This level remained unchanged until 2017, when there was a 1% decrease. The nominal rate was at 21%, which remained unchanged until the end of the observed period. In Hungary, the nominal rate was 16% in 2004 and 2005. It then increased to 17.33% in 2006, and subsequently to 20% in the following three years. In 2017, it decreased for the last time to 9%. It remained constant at this level until the end of the observed period. The standard corporate tax rate in the Czech Republic was 28% at the beginning of the observed period in 2004 and 26% in 2005. In the following years, the rate decreased by 2% annually. In 2006 and 2007, it was 24%. In 2008, there was another 3% decrease, specifically to 21%. From this year on, the rate changed twice. In 2009, it decreased to 20%. The following year, it decreased by another 1% to 19%. It remained constant at this level until the end of the observed period.

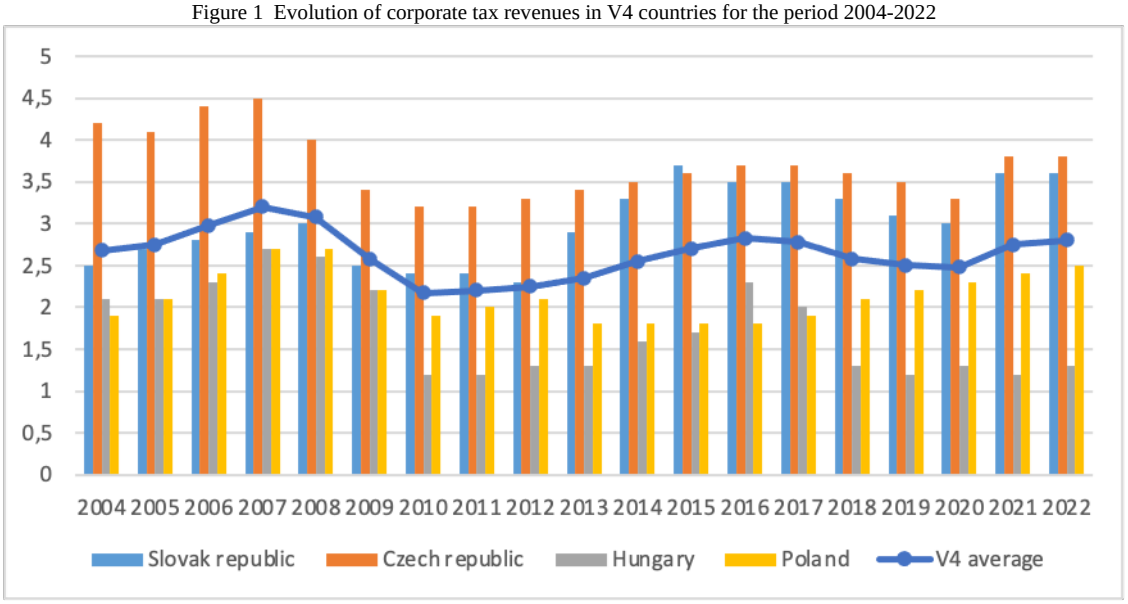
As we can see with the standard tax rate, with the effective rate, we can observe significant diversity at first glance. The highest effective rate in 2004 was achieved by the Czech Republic, at 24.6%. In 2005 it was at 22.7%. In the following two years, it decreased by 2.7%, to 21%. In the next year, 2008, there was a decrease back to 18.4%. From 2010 to 2020, the rate was constant at 16.7%. At the end of the observed period, in 2022 and the year before, 2021, it was at 17%. Hungary achieved the second highest effective rate in 2004, at 17.7% among the V4 countries. Its value changed in 2009, when we can observe an increase to 19.5%. A year later, there was a slight decrease to 19.1%. From 2011 to 2016, it remained constant, specifically at 19.3%. In all remaining observed years, the rate changed only once, in 2017, when it decreased by 8.2% to 11.1%. In third place, with the third highest rate in the first observed year and only 0.6 percentage points lower than Hungary, Poland achieved 17.1%. In the following years, the rate changed three more times, in 2009, when it slightly increased again to 17.5%. It remained at this level until 2019. That year marked a turning point and the rate started to decline. We can see an interannually decrease of 1.5% to 16%. The last change we can observe in 2021, a slight increase, specifically by 0.1%. The effective tax rate during the mentioned period was at 16.1%, the same value it achieved in 2022. The lowest effective tax rate in 2004 was achieved by Slovakia, at 16.5%. It increased annually to 16.8%, where it remained until 2012. In 2013, the largest increase in the rate occurred, by 3.5 percentage points. The following year brought a turning point, and the tax rate gradually started to decline. In the first year, in 2014, it decreased to 19.4%. In 2015 and 2016, there was a slight increase of 0.2 percentage points to 19.6%. This was followed by another decrease of 0.9%. As we can see, the rate reached 18.7%. It remained constant at this level from 2017 until the end of the observed period.

4.2 Analysis of corporate tax revenues in V4 countries from 2004 to 2022

One of the most important indicators in the field of taxation is tax revenues flowing into the state budget. Fig. 1 Revenues are expressed as a percentage of GDP in the respective year. Corporate tax revenues in Slovakia during the observed period ranged from 2.5% to 3.6% of the country's GDP. In general, we could say that the level of tax revenues is above the V4 country average. The most significant drop was recorded between 2008

and 2009 when revenues decreased by 0.5 percentage point, what was caused by the economic crisis, which also affected Slovakia. The most significant increasing trend can be observed between 2012 and 2015. In these years, there was an average annual increase in tax revenues by 0.4 percentage points. In 2022, the level of tax revenues was at 3.6% of GDP.

Figure 1 Evolution of corporate tax revenues in V4 countries for the period 2004-2022



Source: Own processing based on Eurostat data

In Czech Republic, the average development most reliably copies the trends in the V4 countries. Additionally, these revenues have consistently remained well above the average level of the observed countries. They peaked in 2007, before the mentioned economic crisis, reaching 4.5% of the country's total GDP. In 2008 and 2009, there was a repeated decline of 0.5 percentage points. From 2018 to 2020, a renewed downward trend was noted, primarily due to the COVID-19 pandemic, especially in 2020. However, it is important to say, that although the Czech Republic has been above the average of the V4 countries for a long time, as mentioned earlier, it has not managed to exceed the 4% level after the economic crisis, as it did in 2007 when corporate tax revenues accounted for up to 4.5% of the total Czech GDP for that year.

In Poland, an unexpected fact can be noted, that throughout the entire observed period revenues were below the average of our observed countries. However, it can be said that the development was quite similar until 2013, when a turning point occurred. Instead of the expected growth based on the average development of our sample, tax revenues stagnated at the level of 1.8%. They remained constant until 2018, when they slightly increased. This upward trend continued until the end of the observed period, with revenues reaching 2.5% of the country's total GDP.

Hungary, like Poland, has been below the average level of V4 countries for a long time in terms of corporate tax revenues. The most significant decline in this indicator, by one percentage point, can be observed between 2009 and 2010, when its level fell from 2.2% to 1.2% of the country's total GDP. From 2018 until the end of the observed period, we can observe recurrent increases and decreases within the range of 0.1 percentage points.

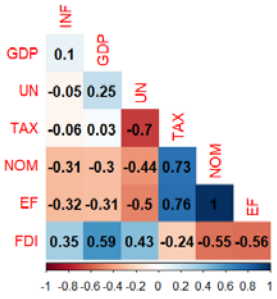
4.3 Analysis of relationships between the effective rate and selected determinants

Correlation Analysis of V4 Countries

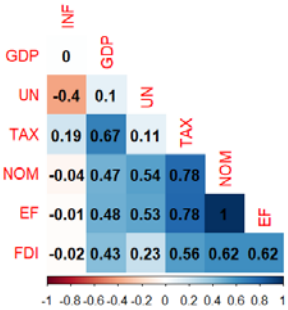
The correlation analysis shown in Figure 2, implemented for each country, reveals similar results to those we found in the development. A strong positive correlation is observed particularly between corporate tax revenues and both the standard and effective tax rates. A perfect, unitary correlation can be seen in all states between the standard tax rate and the effective tax rate. On the other hand, the results are not as similar in cases of negative dependence. The highest negative dependence in Slovakia is observed between the variables of unemployment and corporate tax revenues. In the Czech Republic, the highest negative correlation coefficient is between the variables of inflation and unemployment. In Hungary, the highest negative correlation is recorded between GDP and unemployment, while in Poland, it is between the effective tax rate and inflation.

Figure 2 Correlation Analysis of V4 Countries

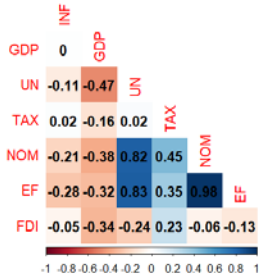
Correlation analysis – Slovakia



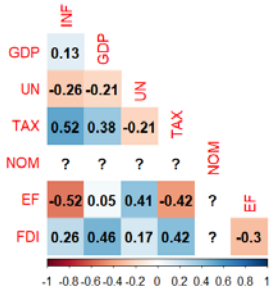
Correlation analysis – Czech Republic



Correlation analysis – Hungary



Correlation analysis – Poland



Source: Own processing based on Eurostat data

4.4 Regression analysis of the effective rate and selected determinants in V4 countries
Slovak Republic

The results of the regression analysis, through which we attempted to determine the impact of selected macroeconomic determinants and the nominal corporate tax rate on the effective corporate tax rate under the conditions of the Slovak Republic are presented in Figure 3.

Figure 3 Regression Analysis Results - Slovak Republic

	Estimate	Std. Error	t- Value	Pr (>|t|)	
(Intercept)	*0,291818*	*0,357671*	*0,816*	*0,430*	
GDP	*-0,002101*	*0,005956*	*-0,353*	*0,730*	
FDI	*0,004464*	*0,0100121*	*0,441*	*0,667*	
Inflation	*-0,010775*	*0,00605*	*-1,781*	*0,100*	
Unemployment	*-0,022*	*0,007857*	*-2,800*	*0,016*	*
Tax revenues	*0,052525*	*0,087318*	*0,602*	*0,559*	
Standard rate	*0,877067*	*0,025104*	*34,937*	*1,93E-13*	***
F - test	*p value = 1,464E-15*				
Normality of residuals	*Jarque - Bera test normality, p- value= 0,548*				
	Shapiro - Wilk normality test, p- value= 0,3188				
Heteroskedasticity	*Breusch - Pagan test, p- value= 0,08968*				
Autocorrelation	*Breusch - Godfrey test, p- value= 0,4005*				
	Box- Ljung test, p- value= 0,5058				
	Box- Pierce test, p- value= 0,5378				
Multicollinearity	*VIF value < 10 for all variables*				
Specification of the model	*Ramsey RESET test, p- value= 0,8946*				
Coefficient of determination	*$R^{\wedge 2}$ = 0,9981*				
Significance level	*0 ' *** '0,001 ' ** '0,01 ' * ' 0,05 ' . ' 0,1 ' ' 1*				

Source: Own processing from RStudio software

When closely analyzing the model for Slovak Republic shown above, we firstly focused on whether it can be considered significant entirely. The p-value of the F-test was 1.46E-15, which is lower than the significance level we set at $\alpha = 0.05$. All subsequent tests and results were compared to this established significance level. After testing the basic assumptions of the model, we can conclude that the residuals come from a normal distribution and we do not observe problems with heteroskedasticity or autocorrelation. Since the VIF values for all variables were less than 10, we also excluded the presence of multicollinearity. The p-value of the Ramsey RESET test confirmed that the model is correctly specified.

The results of the regression analysis confirmed the significant impact of two variables: unemployment and the standard tax rate expressed as a percentage. The beta coefficients quantify that if unemployment in Slovakia increased by 1%, the effective corporate tax rate would decrease by 0.022%. If the standard

corporate tax rate in Slovakia increased by 1%, the effective corporate tax rate would increase by 0.877067%.

Czech Republic

The second model (Figure 4) was created for the Czech Republic. Based on the relevant tests, it can be concluded that the residuals do not come from a normal distribution. However, since normality is one of the least critical assumptions, we decided to ignore this fact. The problem of heteroskedasticity and autocorrelation was not confirmed in the model. Based on the VIF factor values, we can conclude that the model does not have a problem with multicollinearity and the Ramsey RESET test confirmed the correct specification of the model.

Figure 4 Regression Analysis Results - Czech Republic

	Estimate	Std. Error	t- Value	Pr (>|t|)	
(Intercept)	0,392074	0,277104	1,415	0,1825	
GDP	0,007478	0,008995	0,831	0,4220	
FDI	-0,00496	0,014206	-0,347	0,7348	
Inflation	0,02007	0,007498	2,677	0,0202	*
Unemployment	-0,008219	0,015359	-0,535	0,6023	
Tax revenues	-0,059412	0,128938	-0,461	0,6532	
Standard rate	0,870116	0,018993	45,812	7,64E-15	***
F - test	p value = 2,2E-16				
Normality of residuals	Jarque - Bera normality test, p- value= 2,2E-16				
	Shapiro - Wilk normality test, p- value= 0,001044				
Heteroskedasticity	Breusch - Pagan test, p- value= 0,9223				
Autocorrelation	Breusch - Godfrey test, p- value= 0,4939				
	Box- Ljung test, p- value= 0,7135				
	Box- Pierce test, p- value= 0,734				
Multicollinearity	VIF value < 10 for all variables				
Specification of the model	Ramsey RESET test, p- value= 0,1358				
Coefficient of determination	$R^{\wedge 2}$ = 0,9991				
Significance level	0 ' *** ' 0,001 ' ** '0,01 ' * ' 0,05 ' . ' 0,1 ' ' 1				

Source: Own processing from RStudio software

According to the results of the regression analysis, which are displayed in Figure 4, we can observe a statistically significant impact of two variables: inflation and the nominal tax rate. In this case, the beta coefficient defines that if inflation in the Czech Republic increased by 1%, the effective tax rate would increase by 0.02007%. Similarly, if the nominal tax rate in the Czech Republic increased by 1%, the effective tax rate would rise by 0.870116%.

Figure 5 Regression Analysis Results - Hungary

	Estimate	Std. Error	t- Value	Pr (>|t|)	
(Intercept)	5,347894	1,086235	4,923	0,000352	***
GDP	0,034731	0,076204	0,456	0,656699	
FDI	-0,004284	0,007024	-0,61	0,553269	
Inflation	-0,070183	0,059671	-1,176	0,262336	
Unemployment	-0,003372	0,197524	-0,017	0,986659	
Tax revenues	-0,592255	0,573563	-1,033	0,322159	
Standard rate	0,787409	0,114692	6,865	1,73E-05	***
F - test	p value = 2,15E-08				
Normality of residuals	Jarque - Bera normality test, p- value= 0,907				
	Shapiro - Wilk normality test, p- value= 0,4234				
Heteroskedasticity	Breusch - Pagan test, p- value= 0,1569				
Autocorrelation	Breusch - Godfrey test, p- value= 0,05257				
	Box- Ljung test, p- value= 0,1288				
	Box- Pierce test, p- value= 0,1597				
Multicollinearity	VIF value < 10 for all variables				
Specification of the model	Ramsey RESET test, p- value= 0,2564				
Coefficient of determination	$R^{\wedge 2}$ = 0,9695				
Significance level	0 ' *** ' 0,001 ' ** '0,01 ' * ' 0,05 ' . ' 0,1 ' ' 1				

Source: Own processing from RStudio software

Hungary

The third in line was the model created for Hungary (Figure 5). Based on the comparison of the p-value of the F-test, we concluded, that the model is statistically significant. When testing the basic assumptions of the linear regression model we found, that the residuals come from normal distribution, the model does not show heteroskedasticity, autocorrelation or multicollinearity. Finally, we performed the Ramsey RESET test to confirm the correct specification of the model.

From the results of the regression analysis we can observe a significant impact of only one variable, which is the standard tax rate. The interpretation of the beta coefficient is as follows. If the nominal tax rate in Hungary increase by 1%, the effective rate would increase by 0.787409%.

Poland

The last model was made for Poland. Based on the assumption testing we identified a singularity problem, indicating perfect

multicollinearity in the original model. We observed this issue during the correlation analysis. To address the problem, we decided to remove the standard tax rate variable from the model. After this adjustment we subjected the modified model to tests for normality, heteroskedasticity, autocorrelation, multicollinearity and the RESET test, which serves to verify the correct functional form of the model. After removing the variable all assumptions of the model, except for the normality of residuals, were met. The results of the correctly specified model are provided in Figure 6.

Figure 6 Regression Analysis Results - Poland

	Estimate	Std. Error	t- Value	Pr(>|t|)	
(Intercept)	17,66291	0,93796	18,831	8,11E-11	***
GDP	0,11385	0,05711	1,994	0,068	.
FDI	-0,17806	0,09338	-1,907	0,0789	.
Inflation	-0,04646	0,04102	-1,133	0,278	
Unemployment	0,06008	0,02668	2,252	0,0423	*
Tax revenues	-0,3214	0,47779	-0,673	0,5129	
F - test	p value = 0,04021				
Normality of residuals	Jarque - Bera normality test, p- value= 0,111				
	Shapiro - Wilk normality test, p- value= 0,0396				
	Shapiro - Francia normality test, p- value= 0,03699				
Heteroskedasticity	Breusch - Pagan test, p- value= 0,8493				
Autocorrelation	Breusch - Godfrey test, p- value= 0,2146				
	Box- Ljung test, p- value= 0,3408				
	Box- Pierce test, p- value= 0,3778				
Multicollinearity	VIF value < 10 for all variables				
Specification of the model	Ramsey RESET test, p- value= 0,1034				
Coefficient of determination	R^2 = 0,5556				
Significance level	0 ' *** ' 0,001 ' ** ' 0,01 ' * ' 0,05 ' . ' 0,1 ' ' 1				

Source: Own processing from RStudio software

Results of the regression analysis confirmed the significant impact of three variables: GDP, FDI, and unemployment. However, we will not consider the GDP and FDI variables since

they are significant at the significance level of $\alpha = 0.1$, which is higher than our predetermined significance level of $\alpha = 0.05$. The interpretation of the beta coefficient is as follows. If unemployment in Poland increase by 1%, the effective tax rate would increase by 0.06008%.

Evaluation of results and discussion

In conclusion, the analysis of corporate tax rates showed different trends in the observed countries. Throughout the entire period Slovakia had an increasing trend, Poland remained constant, the Czech Republic showed a decreasing trend, and Hungary had an increasing trend until 2007, followed by a decreasing trend from 2008 to the present. Hungary has the lowest statutory tax rate at 9% and an effective tax rate of 11.1%, among the countries we observed. When comparing the development of corporate tax revenues in the V4 countries before and during the COVID-19 pandemic (years 2020 to 2022), we observed a decreasing trend in three out of the four countries. Conversely, Poland showed an increasing trend. This phenomenon may be associated with above the average government support for companies during the pandemic years. The validity of hypothesis H1 "Corporate tax revenues had a decreasing trend during the COVID-19 pandemic" was confirmed for Slovakia, the Czech Republic and Hungary. However, we cannot claim this in relation to Poland.

The second analysis performed was a correlation analysis, which confirmed hypothesis H2 "Effective tax rate positively correlates with corporate tax revenues." Based on the correlation coefficients (Table 3), we can conclude that the validity was confirmed in three out of the four observed countries, specifically in the Czech Republic, Slovakia and Hungary. The positive impact of corporate tax revenues on the effective tax rate was confirmed in the study by Markusen (1995), contradicting studies by Matei et al. (2009) and Devereux et al. (2007).

Table 3 Correlation coefficients of the effective tax rate and corporate tax revenues of the V4 countries

	Slovak Republic	Czech Republic	Hungary	Poland
Corporate tax revenues	0,76	0,78	0,35	-0,42

Source: Own processing from RStudio software

The final part of the analysis involved modeling using regression analysis conducted through the method of least squares to identify the statistical significance of selected macroeconomic determinants and the nominal corporate tax rate in relation to the effective corporate tax rate in the Visegrad Group countries during the period from 2004 to 2022. Here, we can note that hypothesis H3 "The effective tax rate is mainly influenced by the nominal tax rate" is also confirmed (Table 4).

Table 4 Results of regression analysis of V4 countries

Estimate	Slovak Republic	Czech Republic	Hungary	Poland
GDP	insignificant	insignificant	insignificant	insignificant
FDI	insignificant	insignificant	insignificant	insignificant
Inflation	insignificant	significant	insignificant	insignificant
Unemployment	significant	insignificant	insignificant	significant
Tax revenues	insignificant	insignificant	insignificant	insignificant
Standard rate	significant	significant	significant	NA

Source: Own processing from RStudio software

All of the models mentioned above, except for the model based on data from Poland, examine the relationship between the standard tax rate and selected determinants, including the year-on-year change in gross domestic product, corporate tax revenues, unemployment, inflation rate, foreign direct investment and the effective tax rate. In each of these models, except for the Polish model, the standard tax rate appears to be significant. Puliková (2019) arrived at similar results regarding the nominal tax rate. Her study suggests, that the effective tax rate is most influenced by the nominal tax rate, although the dependency is smaller than expected. Fernández – Rodríquez et al. (2023) reached similar conclusions. Conversely, completely insignificant variables in all four models are the year-on-year change in gross domestic product, foreign direct investment and corporate tax revenues. In contrast to our results, the findings of Andrejovská (2019) are in contradictory. In her study she confirmed GDP as the most significant variable with a positive relationship. Several authors, such as Kotlan et al. (2011) and Clausing (2007) demonstrated the same positive relationship between effective tax rates and GDP. The results of our analyses regarding the negligible impact of corporate tax revenues confirm the claims of Markusen (1995), Matei et al. (2009), and Devereux et al. (2007). As mentioned earlier, another statistically insignificant variable is foreign direct investment. This assertion was also confirmed by Benassy-Quéré et al. (2005) in their study. The inflation rate is significant for the model based on data from the Czech Republic. The significance of this variable in relation to effective taxation was confirmed by Wahyuningsih et al. (2020) in their work. They concluded that the relationship between the inflation rate and effective taxation is positive. Each increase or decrease in inflation causes an increase or decrease in taxation. Inflation and tax burden move

in the same direction but to different extents. This assertion was also confirmed by Saibu et al. (2013) in their study. Korauš et al. (2018), however, arrived at opposite conclusions. The last macroeconomic indicator entering the model is unemployment, which is statistically significant for models based on data from Slovakia and Poland. Our results confirm the conclusions of Fedeli et al. (2012) and Andrejovská (2019).

5 Conclusion

There is a significant debate surrounding the issue of the positive or negative impact of corporate tax on the economy, whether in general or concerning the effective tax rates, as they express the actual taxation level. Based on our analysis, we can observe three different trends in the development of the standard tax rate. In Poland, the level remained constant at 19% throughout the observed years. In the Czech Republic, there was a gradual annual decrease from 28% in 2004 to 19% by 2022, while in Slovakia and Hungary, the development was less clear-cut, with alternating increases and decreases. In Slovakia, there was an increase from 19% in 2004 to 23% by 2012, followed by a decrease to 21% by 2022. In Hungary, there was an increase from 16% in 2004 to 20% by 2009 followed by a subsequent decrease to 9% from 2017 to the present. Such ambiguous developments were also characteristic for effective tax rates (ETRs). Interestingly, despite the constant standard tax rate in Poland, its ETR decreased by 1 percentage point over the

observed period. In other countries, ETRs mirrored STRs. The highest level of ETR among the observed countries was in the Czech Republic in 2004 at 24.6% and the lowest level, as with STRs, was in Hungary from 2017 at 11.1%.

Regarding corporate tax revenues, they exhibited a declining trend during the COVID-19 pandemic. Evaluating the effective tax rate and its relationship with the nominal rate and the macroeconomic determinants mentioned above through regression analysis, specifically the least squares method, revealed that in Slovakia two variables significantly impacted the effective tax rate, unemployment and the nominal tax rate. For the model created in the Czech Republic it was the inflation rate and the nominal rate. The nominal rate was the only significant variable identified for the model compiled from data in Hungary. For the model made for Poland we had to remove this variable due to multicollinearity issues. The only significant variable concerning the effective tax rate was the unemployment rate. The differences found in the analysis of the Visegrad Group countries also speak to the existence of tax competition among them. Each of these analyzed countries strives to attract foreign investors, thereby creating more jobs, reducing unemployment and increasing economic growth and prosperity in the country.

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Primary Paper Section: A

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