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TAX REVENUES AND TAX RATES IN THE CONTEXT OF MACROECONOMIC DETERMINANTS*

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Abstract. There is general agreement that taxes are a significant political tool making a macroeconomic impact. Therefore, alternative tax policies must be assessed to understand how they affect tax revenues. This paper focuses on quantifying the impact of tax rates and selected macroeconomic indicators on corporate tax revenues in European Union (EU) countries from 2002 to 2021. Data were drawn from the databases of the European Commission (2022), OECD (2022), ZEW (2021), and the World Bank (2022). Three models were estimated to evaluate the impact: the pooling model, the fixed effects model, and the random effects model. Cluster analysis grouped countries based on the similarity of their tax systems. Ward's method was used for comparison, and the similarity of countries was assessed using the Euclidean distance. The result of the cluster analysis was two groups of countries: the first group mainly included Eastern European countries, and the second group included Western European countries. We used panel data regression analysis to evaluate corporate income tax determinants in individual country clusters. The results confirmed the suitability of the random effects model. The study indicates that direct foreign investment is the most significant variable affecting corporate income tax in the first cluster. In contrast, in the second cluster, it is direct foreign investment, unemployment rate, and gross domestic product.

Keywords: corporate taxation; tax revenues; macroeconomic determinants; regression analysis

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1. Introduction

Corporate tax revenues are, on the one hand, an essential source of state budget income. Still, on the other hand, their overall amount is influenced by economic, social, and political factors, whose influence may change according to the intensity of the relationship between them. Each country strives to attract as many foreign investors as possible by creating an attractive economic, legislative, and tax environment that would be preferred over other countries. Governments of individual countries also try to achieve changes in corporate tax revenues through various governmental actions and legislative changes. However, we must consider that the level of corporate tax revenues also depends on the tax policy of neighbouring countries. Taxes should be regarded as not static but dynamic, and it is essential to note that various external factors influence their revenue development

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over time. Monitoring tax revenues is a frequently discussed topic nowadays, as we have recently been affected by many negative experiences, such as the pandemic crisis and the war conflict in Ukraine, which significantly depleted the budgets of individual countries. Both foreign and domestic studies confirm that to discuss tax revenues, we need to examine the crucial determinants that significantly affect these revenues and their components in individual countries.

2. Literature review

As mentioned above, several determinants influence the inflow of tax revenues. Due to their nature, these determinants can be divided into economic, legal, political, social, socio-historical, demographic, or even technological aspects. Montero and Parga (2023) emphasized that each government should legislate a tax policy that would positively impact economic activity, supporting healthy business growth and increasing tax revenues. Studies by Karpowicz and Majewska (2018), McNabb (2018), Ťahlová and Bánociová (2019), Cung and Son (2020), and Helcmanovská and Andrejovská (2021) focused on monitoring the impact of economic determinants on tax revenues in various world countries or groups of countries over different time intervals. In most countries, corporate tax rates are very high, and the taxation process is complex, leading to discussions on rationalizing these systems. Some argue that lower tax rates push businesses to be more innovative and, thus, more competitive. However, opponents claim that reducing corporate tax rates would disrupt government budget balances and increase inequality. The critical question is whether corporate taxes have a decisive impact on tax revenues (Fuest, Hugger & Wildgruber, 2022).

The correlation between tax rates and tax revenues interests all EU countries. Generally, the relationship between tax rates and tax revenues is complex and can change depending on various factors, including the elasticity of taxable income, taxpayer behaviour, and broader economic conditions. In certain situations, extremely high tax rates can lead to a decrease in tax revenues. On the other hand, the effective tax rate, which expresses the actual tax rate, is subject to variability resulting from applying specific tax deductions and credits available to corporations, modifying their overall tax liability (Todorovic, Dordevic & Cakic, 2022).

Corporations sometimes apply aggressive strategies, such as shifting profits to low-tax jurisdictions to reduce their effective tax rate compared to their incomes (OECD, 2015). A negative effect was confirmed when evaluating the impact of inflation on tax revenues. Dhaliwal et al. (2015) confirmed that during higher inflation rates, the average tax burden on companies increases, reducing the purchasing power of money, investments, and production, negatively impacting tax revenues. A negative effect is also confirmed by Bánociová and Ťahlová (2019) when examining tax revenues and unemployment rates, based on the assumption that the higher the unemployment rate, the more significant the decline in the profitability of the corporate sector, ultimately causing lower corporate tax revenues. Urbancová and Hudáková (2015) and Tosun (2017) examined employment and unemployment indicators as explanatory variables potentially affecting tax revenues, highlighting a significant link between the labour market and tax policy. Spataro and Crescioli (2023) think that lower tax rates for smaller companies can stimulate investment and business expansion. In their study, Garcia-Bernardo et al. (2023) refute previous claims that corporate tax rates do not affect unemployment. They found the opposite and confirmed that an increase in the effective average corporate tax rate significantly increases unemployment. Delgado Fernandez-Rodriguez and Martinez-Arias (2014), Vighová et al. (2023) and Saidin et al. (2023) considered the relationship between foreign investments, tax rates, and corporate tax revenues. All analyses have shown that direct foreign investments are sensitive to differences in tax rates. A positive two-way relationship was found between tax revenues and GDP.

Delgado, Fernandez-Rodriguez and Martinez-Arias (2014) showed that the GDP indicator level positively affects tax revenues. Dávila and Hébert (2022) examined economic determinants negatively or positively in relation to corporate tax revenues. Our effort in this paper is to determine the decisive factors for the level of tax revenues.

3. Materials and Methodology

This paper aimed to verify the impact of tax rates and selected macroeconomic indicators on corporate tax revenues in EU countries. Through the analysis, we aimed to answer the following research question: "Are revenues in new and old member states affected by the same variables, or are there differences between them?" The first part of the research focused on the impact of selected indicators on corporate tax revenues using panel regression, where three models were estimated: the pooling model, the fixed effects model, and the random effects model. Subsequently, a correlation analysis was conducted, a prerequisite for cluster analysis to ensure that the input variables are not correlated. In the second part of the paper, EU countries were grouped using cluster analysis, specifically Ward's method, based on the similarity of their tax systems. Cluster analysis was performed for 2021 with variables that did not show significant correlation: effective corporate tax rate, gross domestic product, unemployment rate, foreign direct investment, inflation, and corporate tax revenues. Two econometric models were then constructed to test the impact of selected indicators on corporate tax revenues.

The basis for the analysis is annual data from EU27 countries from 2002–2021. This period shows the development of individual indicators even before the new member countries joined the EU in 2004. The countries analyzed are current EU member states: Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Germany (DE), Estonia (EE), Greece (EL), Spain (ES), Finland (FI), France (FR), Croatia (HR), Hungary (HU), Ireland (IE), Italy (IT), Lithuania (LT), Luxembourg (LU), Latvia (LV), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), Slovakia (SK).

Numerous empirical studies have examined the factors that can affect tax revenues in EU countries. The selection of indicators for the analysis was conditioned by the authors: Clausing (2007), Bayer (2015), Karpowicz and Majewska (2018), Finocchiaro et al. (2018), Barro and Furman (2018), Puliková (2019), Nalyanya et al. (2020), Block (2021), Fernández-Rodríguez et al. (2023), who analyzed the impact of macroeconomic determinants on corporate tax revenues. They also claim that corporate tax revenues are influenced by both the level of statutory and effective tax rates and macroeconomic indicators affecting the investment environment.

Panel regression shows the relationships between corporate tax revenues and selected economic determinants (see Table 1 below).

Table 1. Overview and Description of Variables

Variable	Unit	Label	Source	Description
Dependent Variable				
Corporate tax revenues	% GDP	CIT	Eurostat, OECD	Taxes on the income or profit of legal entities, including holding gains (as a percentage of GDP).
Independent Variables				
Nominal rate	%	STR	European Commission	The highest statutory rates of corporate income tax (including surcharges).
Effective average tax rate	%	EATR	Eurostat, ZEW	Effective average tax rates of large corporations in the non-financial sector calculated using the Devereux/Griffith methodology.
Gross domestic product per capita	euros per capita	GDP	Eurostat	The ratio of real GDP to the average population in a given year at constant prices (2010).
Harmonized index of consumer prices	%	INF	World Bank	Harmonized index of consumer prices for international comparison of consumer price inflation, expressed as an annual average index and rate of change.

Foreign direct investment	% HDP	GDP	World Bank	Net inflow of foreign direct investment from non-resident investors, expressed as a percentage of GDP.
Unemployment	%	Unemp	World Bank	Annual unemployment rate by gender (men and women) and age (15-74 years), measured as a percentage of the workforce.

Source: Own processing

Table 2 lists studies examining the relationship between corporate tax revenue, the variables used in the analysis, and their predicted impact on corporate tax revenue.

Table 2. Expected Impact of Selected Variables on Corporate Income Tax

Author, Year	Variable	Relationship between Dependent and Independent Variables	Expected Relationship
Clausing (2007)		positive	
Weybourne (2021)	EATR, STR	negative	+
Delgado, Fernandez-Rodriguez and Martinez-Arias (2014)	GDP	positive	+
Clasuing (2007), Delgado, Fernandez-Rodriguez and Martinez-Arias (2014)	Unemp	negative	-
Delgado, Fernandez-Rodriguez and Martinez-Arias (2014)	FDI	positive	+
Andrejovská & Helcmanovská (2021)		positive	
Cung & Son (2020)	INF	negative	+

Source: Own processing

The analysis was based on the following hypotheses:

- The most significant variable affecting corporate tax revenues is tax rates.
- An increase in the unemployment rate has a positive impact on corporate tax revenues.

To confirm/reject the hypotheses, the following econometric model was created:

$$CIT_{it} = \beta_0 + \beta_1 EATR_{it} + \beta_2 STR_{it} + \beta_3 GDP_{it} + \beta_4 Unemp_{it} + \beta_5 FDI_{it} + \beta_6 INF_{it} + u_{i,t}$$

where:

the dependent variable is $CIT_{i,t}$, representing the average corporate tax income of member countries i in year t . The independent variables include STR : average statutory tax rate of member countries i in year t ; $EATR$: average effective tax rate of member countries i in year t ; GDP : average gross domestic product of member countries i in year t ; FDI : average foreign direct investment of member countries i in year t ; INF : average inflation rate of member countries i in year t ; $Unemp$: average unemployment rate of member countries i in year t . β_0 represents the intercept; $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ are the regression coefficients representing the change in the dependent variable for a unit change in the independent variable $CIT_{i,t}$.

The Chow test was used to test the suitability of the pooling model. Through the F-test and Lagrange Multiplier test, the pooled model was compared with the fixed effects model and the random effects model. The estimated model was tested for the basic assumptions of panel data regression models, specifically: stationarity of data (Madal and Wu unit root test), heteroskedasticity (Breusch-Pagan test), serial correlation (Breusch-Godfrey test), and cross-sectional dependence (Pearson CD test). Violations of assumptions can lead to biased results; therefore, the model's deficiencies must be addressed using the variance-covariance matrix.

4. Results and Discussion

4.1. Panel Regression Analysis of the Econometric Model for EU27

Three models were estimated to evaluate the impact of selected tax rates and macroeconomic indicators on corporate tax revenues in EU countries: the pooling model, the fixed effects model, and the random effects model. The individual models were subjected to basic assumption testing. Based on the results of testing time and individual effects ($p\text{-value} < 0.05$), we found that both effects are statistically significant and should be included in the model. We used the Chow test to select the appropriate model ($p\text{-value} = 2.2 \times 10^{-16}$). To assess the suitability of the fixed or random model, we used the Hausman test ($p\text{-value} = 2.2 \times 10^{-16}$), which confirms the rejection of the null hypothesis. The random effects model is inconsistent, so we proceed with the fixed effects model.

The fixed effects model was tested to see if it meets the basic assumptions for panel data regression models. Using the command `putrest`, we tested the stationarity of the data.

The $p\text{-value}$ ($p\text{-value} = 1.5 \times 10^{-8}$) lower than the significance level of 0.05 leads to the rejection of the null hypothesis of non-stationary data. Further statistical tests confirmed the presence of serial correlation ($p\text{-value} = 2.2 \times 10^{-16}$), cross-sectional dependence ($p\text{-value} = 8.4 \times 10^{-3}$) and heteroskedasticity ($p\text{-value} = 7.8 \times 10^{-11}$), which can lead to biased results and also to bias in statistical significance. Na odstránenie uvedených nedostatkov modelu a presnejšie odhadnutie výsledkov bola použitá variačno-kovariančná matica. The results after applying the variance-covariance matrix are shown in Table 3.

Table 3. Robust Results of the Fixed Effects Model

Variable	Estimate	Std. Error	t-value	p-value
EATR	0.0263	0.0201	1.3039	0.1929
STR	0.0263	0.0234	1.1256	0.2609
GDP	8.0×10^{-6}	1.4×10^{-5}	0.5523	0.5810
Unemp	-0.0234	0.0165	-1.4246	0.1549
FDI	0.0011	0.0023	0.4624	0.6440
INF	0.0320	0.0155	2.0720	0.0388*
R²		0.1006		
Model p-value		0.0047		

Source: Own processing based on results in RStudio

The determination index of the estimated model is at the level of 0.10064, which means that the model explains 10% of the variability of the variable CIT. Based on the p-value of the corresponding F-test, we can confirm the statistical significance of the model as a whole. The model contains one statistically significant variable, inflation, at the significance level of 0.05. The results suggest that if inflation increases by 1%, corporate tax revenues will increase by 0.03%. This phenomenon should occur with a probability of 99.96%. Other variables are statistically insignificant. According to the panel regression results for all EU countries, represented by a low determination index and only one statistically significant variable, we decided to perform cluster analysis, dividing countries into multiple clusters. The prerequisite for cluster analysis is uncorrelated input variables.

4.2. Correlation Analysis

In Table 4, we observe the values of the correlation coefficient, which range from -0.55 to 0.86. A value of +1 indicates a positive correlation and a value of -1 indicates a negative correlation.

Table 4. Correlation Matrix of Monitored Variables

	CIT	EATR	STR	GDP	Unemp	FDI	INF
CIT	1.00	0.20	0.07	0.39	-0.16	-0.26	-0.37
EATR	0.20	1.00	0.86	0.30	0.26	-0.27	-0.53
STR	0.07	0.86	1.00	0.17	0.12	-0.11	-0.55
GDP	0.39	0.30	0.17	1.00	0.02	-0.20	-0.30
Neemp	-0.16	0.26	0.12	0.02	1.00	-0.09	-0.33
PZI	-0.26	-0.27	-0.11	-0.20	-0.9	1.00	0.11
INF	-0.37	-0.53	-0.55	-0.30	-0.33	0.11	1.00

Source: Own processing based on results in RStudio

There is a strong dependency between EATR and STR (0.86), meaning that an increase in the effective corporate tax rate (EATR) will likely lead to a rise in the nominal (statutory) corporate tax rate (STR) or vice versa. We can also observe a moderately increased negative correlation (-0.55) between the nominal (statutory) corporate tax rate (STR) and inflation (INF). Almost zero correlation can be observed for the unemployment rate with each variable except inflation (INF), effective corporate tax rate (EATR), and our dependent variable (CIT), where the correlation coefficient ranges from -0.33 to 0.26. For the variable foreign direct investment (FDI), we can observe a moderate negative correlation to almost zero correlation with each variable except the relationship with inflation (INF), where the correlation coefficient has a positive low correlation (0.11). Higher but still in the norm, negative correlations can be observed between the variable inflation (INF) with each variable except for the higher-mentioned variable, foreign direct investment. This phenomenon may appear positive if the inflation rate is around the inflation target set by the ECB. On average, during the observed period in EU27 countries, inflation was 2.2%, which is very close to the inflation target of 2%.

On average, during the observed period in EU27 countries, inflation was 2.2%, which is very close to the inflation target of 2%. Regarding the explained variable (CIT), we observe only moderate dependencies. Moderate negative dependencies can be observed with the variables inflation (-0.37), foreign direct investment (-0.26), and unemployment rate (Neemp). The moderate negative dependence between CIT and Neemp can be explained by the fact that if the unemployment rate increases, i.e., there will be fewer employed people in companies, businesses will not be able to produce more products because of the lack of workforce, resulting in lower

revenues and ultimately lower corporate tax revenues. The highest dependence on our explained variable is observed with the gross domestic product (GDP), where the correlation coefficient is 0.39. The second highest dependence (-0.37) with our explained variable is associated with the variable inflation (INF). This dependence is negative, meaning that if inflation increases, corporate tax revenues should decrease. This impact may be driven by the fact that as inflation rises, companies set higher prices, and thus, their profits should be higher, leading to higher taxes. However, this only sometimes applies, as it also depends on demand and the purchasing power of residents. If consumers buy less during periods of higher inflation, business profits will be lower, reducing the tax companies must pay to the state. Based on the results of the correlation analysis, we concluded that for the use of cluster analysis, we will exclude the variable STR, which is highly positively correlated with the variable EATR. This ensures the fulfilment of the prerequisites for performing cluster analysis, i.e., non-correlation of input variables. In the panel regression, we can expect the highest dependency between the explained variable CIT and the independent variables GDP, INF, and FDI.

4.3. Cluster Analysis

The clustering of countries based on the similarity of their tax systems was carried out for 2021 to highlight the post-COVID period. Two additional variables, trade openness and the corruption index, were added to the analysis, which has a positive statistical impact on corporate tax revenues, according to Delgado, Fernandez-Rodriguez and Martinez-Arias (2014).

Among the agglomerative hierarchical clustering methods, we used Ward's method, which creates clusters of similar size and is most commonly used in practice. We first used clustering quality indicators to determine the number of clusters, which recommended three. Based on the similarity of the second and third clusters, we opted for a heuristic approach and decided to create two clusters. The resulting dendrogram is shown in Figure 1.

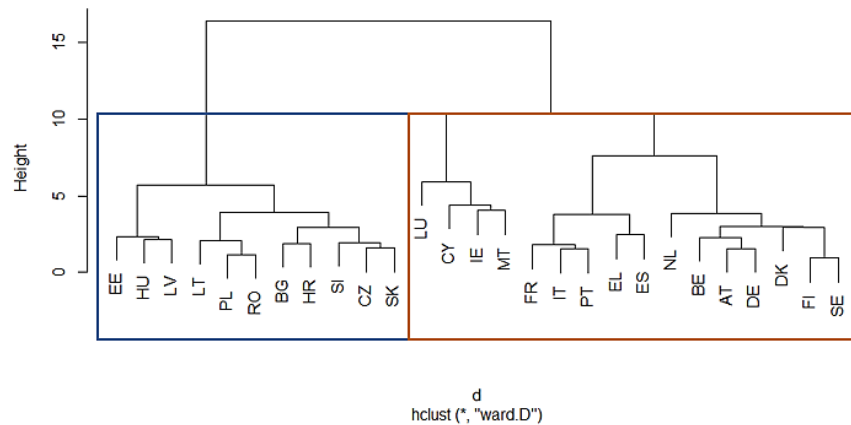


Figure 1. Cluster Dendrogram

Source: Own processing based on results in RStudio

The first cluster comprises 11 countries: Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Bulgaria, Croatia, Slovenia, Czech Republic, and Slovakia. This cluster consists of new EU member states, and the countries in the cluster belong to the eastern part of Europe. Most of these countries joined the European Union in 2004, except Bulgaria (2007), Romania (2007), and Croatia (2013). In Table 5, we can see the minimum and maximum values of variables in the first cluster.

Table 5. Minimum and Maximum Values of Variables in the First Cluster

Variable	CIT	EATR	GDP	Unemp	EXIM	FDI	CPI	INF
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Min. Values	0.3	9.0	6950	2.887	87.36	0.83	42	1.92
Max. Values	3.7	18.7	21310	8.683	187.83	19.21	74	5.11

Source: Own processing based on results in RStudio

Companies in Estonia paid the lowest corporate tax revenues in 2021. Estonia has had a unique taxation system since 2000, which has been effective in the long term. Conversely, the Czech Republic paid this cluster's highest corporate tax revenues. According to the tax complexity index, the Czech Republic ranks among the countries with the most complex tax system. Flagmeier et al. (2023) The effective corporate tax rate reached its minimum values in Bulgaria and the highest values in Slovakia.

Regarding GDP per capita, the lowest value was again in Bulgaria and the highest in Slovenia. Although the Czech Republic recorded the highest corporate tax revenues, the unemployment rate was lowest among Eastern European countries. Compared to the Czech Republic, Croatia had a 580% higher unemployment rate in 2021. The least open economy was Romania, and the most open was Slovakia, which participates the most in international trade. Slovakia is a small, open economy whose competitiveness depends on external links. Although Slovakia is the most open economy in Eastern Europe, the net inflow of foreign direct investment was the lowest among the countries of the first cluster. The highest net inflow of foreign direct investment was in Estonia, which has an effective tax system and the lowest level of corruption in Eastern Europe. Bulgaria had the worst score in the corruption index. Based on the results of the macroeconomic variables in the first cluster, we concluded that Estonia is the country that achieved the best results among the new member states for 2021.

The second cluster comprises 16 countries: Luxembourg, Cyprus, Ireland, Malta, France, Italy, Portugal, Greece, Spain, Netherlands, Belgium, Austria, Germany, Denmark, Finland, and Sweden. This cluster consists of old EU member states, except Malta and Cyprus, which joined the European Union in 2004. The countries in the cluster belong to the western part of Europe, except Cyprus, which is classified among Eastern European countries. In Table 6, we can see the minimum and maximum values of variables in the second cluster.

Table 6. Minimum and Maximum Values of Variables in the Second Cluster

Variable	CIT	EATR	GDP	Unemp	EXIM	FDI	CPI	INF
Min. Values	1.8	13.4	17610	3.499	60.84	-15.89	49	1.22
Max. Values	6.5	29	84490	14.795	388.12	25.14	88	3.14

Source: Own processing based on results in RStudio

The highest corporate tax revenues in the second cluster were paid by Cyprus. This country is classified among the new member states. However, the values of macroeconomic determinants are closer to those of the old member states. Cyprus is considered a tax haven, also known as an offshore financial centre. Low tax rates characterize tax havens. The corporate tax rate in Cyprus was the lowest in the second cluster, at 13.4%. Another feature of tax havens is a low population. According to the World Bank (2021), Cyprus had 2.4 million inhabitants in 2021. According to Elenes Platona (2022), tax havens are characterized by low transparency, a favourable tax system for foreign investors, banking secrecy, and low availability of company information. The lowest corporate tax revenues were paid by legal entities in Greece. Greece is characterized by higher corporate tax rates, which may be a reason for tax avoidance.

Other reasons for low taxes may be the high unemployment rate, which was the highest in the second cluster in Greece, at 14.795%, and the lowest GDP per capita of 17,610 euros. Greece belongs to the countries with low inflation, 1.22%, and the highest corruption in the EU, which may result from lower tax payments. Effective international trade requires an open economy of 8.946% in Greece. The highest effective corporate tax rate is in

Spain. Herranz and Turino (2023) state that real taxation in Spain needs to be higher and more efficient. The government could increase tax revenues by reducing corporate income tax rates. According to Oliveira (2022), Luxembourg is the wealthiest country in the EU based on the highest GDP per capita. During one year, it produced the most goods and services within the country. It is also one of the countries with the highest economic openness, 38.812%. The Ministry of Foreign Affairs (2022) states that the high openness of the economy is evidenced by the fact that all international companies are represented in Luxembourg, and half of the working people are citizens of neighbouring countries. Malta, one of the countries classified as a tax haven, recorded the lowest unemployment rate and the highest inflow of foreign direct investment. France had the lowest level of trade relations with other EU countries, at 6.084%. The net inflow of foreign direct investment in the Netherlands was negative (-15.89%). This trend continues from the previous year. Denmark and Finland are among the countries with the lowest corruption, where the corruption index reached 88 points. The highest inflation in the second cluster was in Germany, at 3.14%.

4.4. Panel Regression Analysis of the Econometric Model for the First Cluster

After dividing the countries based on their similarity into two clusters, we performed a panel regression analysis for each cluster for a more detailed analysis. Again, three models were estimated. The choice between the fixed effects and random effects model is based on the results of the Hausman test (p-value = 0.973). A p-value higher than the significance level of 0.05 leads to the rejection of the alternative hypothesis, and therefore, we continue with the random effects model in the further analysis. The results of the F-test (p-value < 0.001) further indicate that individual and time effects are significant and should be included in the analysis. The random effects model was tested to see if it meets the basic assumptions for panel data regression models. Based on the results of individual tests: Breusch-Godfrey test (p-value 0.00000); Pearson CD test (p-value = 0.011); Breusch-Pagan test (p-value = 0.00000); Madal and Wu (p-value 0.002), we found that the model has a problem with serial correlation, cross-sectional dependence, and heteroskedasticity. The data used in the analysis are stationary. To estimate robustness, we used the `vcocHC` command. This model transformation represents the best way to eliminate deficiencies in the model. The results are shown in Table 7.

Table 7. Robust Results of the Random Effects Model

Variable	Estimate	Std. Error	t-value	p-value
EATR	-0.0003	0.8365	-0.0060	0.3201
STR	0.0593	0.0579	1.0435	0.9952
GDP	4.0x10 ⁻⁵	5.7x10 ⁻⁵	0.7148	0.2967
Unemp	-0.0074	0.029877	-0.2463	0.8054
FDI	0.0048	0.0004	11.3580	2.2x10 ⁻¹⁶ ***
INF	0.0280	0.0190	1.4711	0.1413
R²			0.2053	
Model p-value			2.2x10 ⁻¹⁶	

Source: Own process; R-commander output

The p-value of the model lower than the significance level of 0.05 confirms the statistical significance of the model. Among the analyzed variables, direct foreign investment (PZI) is statistically significant at the 0.001 level. The regression coefficient estimate indicates that if direct foreign investment increases by 1%, corporate tax revenues will increase by 0.0048% of GDP. This result can occur with a 99.99% probability. This finding is

consistent with previous studies, specifically Monteiro (2011) and Clausing (2007). The other regression coefficients, however, are not statistically significant. The regression coefficient β_1 (EATR) estimate indicates that an increase in the effective tax rate by 1% will decrease corporate tax revenues by 0.0003% of GDP, representing a minimal change with a 68% probability. The increase in STR is associated with increased corporate tax revenues (opposite to EATR).

Another monitored macroeconomic indicator is gross domestic product, whose regression beta coefficient estimate is at the level of 0.000004, meaning that an increase in GDP per capita by 1,000 is associated with a decrease in the corporate tax rate by 0.000004% of GDP. The probability of this phenomenon is 70%. The regression coefficient β_4 is at the level of -0.007, representing a negative linear dependence and a positive impact on corporate tax revenues from the perspective of businesses. An increase in the unemployment rate by 1% is accompanied by a decrease in corporate tax revenues by 0.007% of GDP.

Based on the results of the panel regression analysis, the most significant statistical significance and positive linear dependence are exhibited by direct foreign investment. A positive linear dependence was also recorded for nominal (statutory) tax rate, gross domestic product, direct foreign investment, and inflation. The effective corporate tax rate and unemployment rate variables negatively impact corporate tax revenues. The result of the unemployment rate variable is consistent with all scientific studies listed in Table 2. The variable effective corporate tax rate is contrary to the studies by Clausing (2007), where the effective corporate tax rate positively impacted corporate tax revenues.

4.5. Panel Regression Analysis of the Econometric Model for the Second Cluster

The same panel data regression analysis was applied to the second cluster of countries. The resulting random effects model was chosen based on the results of the Hausman test (p-value = 0.8648). The model underwent the same tests as the model for the first cluster. Based on the results, it is possible to conclude that the pooling model is unsuitable. When comparing the pooling model with the fixed/random effects models, we found that these models are more appropriate for analysis. The Chow test (p-value < 0.001) and the Breusch-Pagan test (p-value < 0.001) showed that the effects included in the models are statistically significant.

The model was then tested for the assumptions of panel data regression models. The model has problems with serial correlation (p-value = 4.2×10^{-16}), cross-sectional dependence (p-value = 1.9×10^{-7}), and heteroskedasticity (p-value = 6.0×10^{-6}). The unit root test results (p-value = 6.1×10^{-7}) confirmed the stationarity of the used data. The estimate based on the variance-covariance matrix provides robust results, as shown in Table 8.

Table 8. Robust Results of the Random Effects Model

Premenné	Estimate	Std. Error	t-value	p-hodnota
EATR	0.0353	0.0185	1.9062	0.0566
STR	-0.0002	0.01450	-0.0119	0.9905

GDP	2.5x10 ⁻⁵	7.3x10 ⁻⁶	3.3700	0.0008***
Unemp	-0.0635	0.0193	-3.2996	0.0010***
FDI	0.0021	0.0003	7.9375	2.2x10 ⁻¹⁶ ***
INF	0.0395	0.0314	1.2583	0.2083
R²			0.25281	
Model p-value			2.2x10 ⁻¹⁶ ***	

Source: Own process; R-commander output

The first explanatory variable is the effective corporate tax rate. Looking at the p-value of the regression coefficient before and after the model adjustment, the statistical significance of the variable remained unchanged at the significance level of 0.1. The regression coefficient β_1 (EATR) indicates that if the effective corporate tax rate increases by 1%, corporate income taxes will increase by 0.035% of GDP. This situation would occur with a 94% probability. The nominal (statutory) corporate tax rate has the opposite impact on corporate income taxes. The regression coefficient β_2 is not statistically significant, and an increase in the statutory corporate tax rate by 1% would cause a decrease in corporate income taxes by 0.0002% of GDP. Among the most significant regression coefficients is β_3 (GDP), which is statistically significant at the 0.001 level. An increase in gross domestic product per capita by 1,000 euros would, with a 99% probability, increase corporate income taxes by 0.000025% of GDP. This regression coefficient and the regression coefficient β_4 represent the same statistical significance before and after the model adjustment. In the case of the regression coefficient β_4 , an increase in the unemployment rate by 1% is associated with a decrease in corporate income taxes by 0.0635% of GDP, representing a positive impact from the perspective of businesses. The last statistically significant regression coefficient β_5 indicates that an increase in the variable foreign direct investment by 1% is associated with increased corporate income taxes by 0.00021% of GDP. This regression coefficient was statistically significant at the 0.05 level before the transformation of the model, and after using the variance-covariance matrix, it is significant at the 0.001 level. The last macroeconomic determinant of corporate income taxes is inflation. The regression coefficient β_6 is not statistically significant. An increase in inflation by 1% has a negative impact on corporate income taxes, which would increase by 0.004% of GDP.

Based on the interpretation of the results of the panel data with random effects, the most statistically significant variables are gross domestic product, unemployment rate, and foreign direct investment. The positive impact from the perspective of businesses is represented by the unemployment rate, where an increase is associated with a decrease in the income tax companies must pay to the state. The nominal corporate tax rate also recorded a positive impact with a lower probability. The negative impact on corporate income taxes is represented by the variables effective corporate tax rate, GDP, foreign direct investment, and inflation.

To answer the research question: "Which macroeconomic variable most influences corporate tax revenues?" we obtained cluster analysis and panel regression results. In the case of the effective corporate tax rate (EATR), we observe a negative impact on corporate tax revenues in the countries of the first cluster, meaning that an increase in the variable EATR will reduce corporate tax revenues. In the countries of the second cluster, we observe a positive relationship between the effective corporate tax rate and corporate tax revenues. This means that in the countries of the second cluster, an increase in EATR will cause an increase in corporate tax revenues. The expected impact of EATR was confirmed only for the countries of the second cluster, which consists mainly of old member states and countries of Western Europe. In the case of the nominal (statutory) corporate tax rate (STR), a positive expected relationship between the rate and corporate tax revenues was confirmed for the countries of the first cluster. We can note that neither corporate tax rate is statistically significant, except for

EATR in the case of the second cluster, where the p-value is just above the significance level of 0.05. The statistical insignificance of the relationship between corporate tax rates and corporate tax revenues was also found by Kawano et al. (2012). The gross domestic product (GDP) is statistically significant only in the countries of the second cluster, where an increase in GDP by 1% is associated with a 99% probability of an increase in corporate tax revenues. In the case of the countries of the first cluster, the statistical significance was not confirmed, but the β coefficient has a positive sign, meaning that an increase in GDP will cause an increase in corporate tax revenues. This statement is consistent with studies and expected relationships. In both groups of countries, we also observe a negative relationship between the unemployment rate (Neemp) and corporate tax revenues. In the case of the countries of the second cluster, the statistical significance of this variable was confirmed. These statements are also consistent with studies and expected relationships. Direct foreign investments (PZI) have the greatest statistical significance, where an increase in PZI by 1% will cause an increase in corporate tax revenues by 0.0005% of GDP in the countries of the first cluster and by 0.0001% of GDP in the countries of the second cluster. This phenomenon will occur with a 99% probability. The last variable analyzed is inflation (INF). The results show a positive relationship between inflation and corporate tax revenues, contrary to the findings of Cung & Son (2020), who found a negative relationship between these variables. The statistical significance of this variable was not confirmed in either group of countries. Therefore, we can conclude that direct foreign investments are the most statistically significant variable affecting corporate tax revenues in both countries.

Based on the research question and the panel regression analysis, we verified the validity of our hypotheses. The hypothesis: "The most significant variable affecting corporate tax revenues is tax rates" can be rejected. Based on the analysis results, the most significant variable affecting corporate tax revenues in the first cluster is direct foreign investments (PZI). In the case of the countries of the second cluster, they are direct foreign investments (PZI), the unemployment rate (Neemp), and gross domestic product (GDP).

The second hypothesis: "An increase in the unemployment rate positively impacts corporate tax revenues." In the case of the countries of the first cluster, the statistical significance between the unemployment rate and corporate tax revenues was not confirmed, unlike in the case of the countries of the second cluster. In the case of statistical significance, an increase in the unemployment rate by 1% would cause a decrease in corporate tax revenues in the countries of the first cluster by 0.0007% of GDP and in the countries of the second cluster by 0.063% of GDP. From the perspective of businesses, we can confirm this hypothesis, as an increase in the unemployment rate positively impacts businesses that will pay less income tax to the state budget. From the perspective of the state, we would reject this hypothesis because an increase in unemployment means that the state finances the unemployed, for example, through unemployment benefits, increasing state expenditures, and the state's income from corporate tax revenues decreases based on the results of the analysis.

5. Conclusion

The conducted analysis and its results led to several conclusions. During the observed period, the new member states had lower tax burdens than the old member states of the EU. Although we observe a declining trend in corporate tax rates, corporate tax revenues did not decrease but mainly increased. The level of corporate tax revenues was, on average, 2.71% of GDP in the EU member countries during the observed period. In the old member states, the value of corporate tax revenues was, on average, 2.81% of GDP; in the new member states, it was lower by 0.20%. The cluster analysis results indicated that the macroeconomic variables of the EU member states are divided into Eastern and new member states, and the second group consists of Western and old member states. Direct foreign investments are the most statistically significant variable affecting corporate tax revenues in both countries. The impact of individual economic determinants on the mentioned groups of countries significantly differs as they depend on the governmental decisions of the respective state. Despite the European Union's efforts to harmonize and integrate corporate tax rates, we can observe noticeable differences between the EU member states. The differences also indicate the existence of tax competition among the EU member states,

which strive to attract foreign investors and thus create more jobs, reduce the unemployment rate, and increase the economic growth and prosperity of the country. Within this topic, the analysis could also be conducted on more macroeconomic indicators such as trade openness (export/import) or microeconomic indicators like capital intensity, size, number of businesses, indebtedness, and profitability of companies. A longer observed period can be introduced to gain an even better perspective on the development and impact of economic determinants on corporate tax revenues.

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