LAFFER CURVE – A COMPARATIVE STUDY ACROSS THE V4 (VISEGRAD) COUNTRIES[*]

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Abstract. The essence of the Laffer curve is simple - it represents the relationship between the tax rate imposed by a government and the tax revenues. Tax revenues are the product of the tax rate and the tax base. For this article and based on the theory that underpins the Laffer curve, the application thereof is generalized, and the economic growth rate adopted instead of tax revenues. The purpose of this article is, on the basis of the theory that underpins the Laffer curve, to determine the optimal tax rate in the V4 countries and to compare the results across these countries. Data on the GDP growth rates and tax rates in the Visegrad countries (V4 countries) for the period 1995-2017 are collated and the regression method applied to them to determine the suitable parameter values. For this study, the V4 countries are looked at as a whole. According to the conclusion drawn, it can be stated that the relationship between the GDP growth rate and the tax rate is significant for the V4 countries, and that the parameters of the regression equations conform to the expected symbols. This implies that the Laffer curve conforms with the overall situation in the V4 countries. Further analysis of the optimal tax rate and the situation in each country showed that Poland and the Slovak Republic have the more appropriate tax rates, whereas the Czech Republic and Hungary need to appropriately adjust their tax rates.

1. Introduction

The formulation of tax policy is a test of political wisdom, whereby tax policy is often the beginning of a dramatic political debate. In general elections across western countries, tax reduction policies are often used as an important tool with which to win elections (Kubátová, 2013). Tax revenues can have a large impact on an

economy. An excessive tax burden can hinder economic growth and even increase social conflict (Novák et al., 2016). However, it is undeniable that taxes are indispensable in modern civilized countries and a cost society must pay (Rybáček, 2018). Since the introduction of the Laffer curve, the idea that increases in average tax rates lead first to an increase and then to a decrease in tax yields has played a significant role in the popular discussion about the size of the public sector (Patrick et al., 2013).

The purpose of this article is, on the basis of the theory that underpins the Laffer curve, to determine the optimal tax rate in the V4 countries and to compare the results across these countries. To this end, the application of the Laffer curve is generalized, and the economic growth rate adopted instead of tax revenues. Within this context, data on the tax rates and economic growth rates in the four countries for the period 1995-2017 were collated, the Laffer curve constructed and described for each country and the tax policies in the four countries subsequently compared. The economy of the V4 countries has been discussed by many authors in the past (Bacik et al., 2019; Gavurova et al., 2020; Bilan et al. 2017). For example, Šuleř and Machová (2020) focused on the financial situation of companies operating on the V4 markets and on predicting the further development of their financial situation.

2. Literature Review

A. Laffer presented the Laffer curve for the first time in an article published in 1978 (Wanniski, 1978). The essence of the Laffer curve is simple - it represents the relationship between the tax rate imposed by a government and the tax revenues. Tax revenues are the product of the tax rate and the tax base. A common argument for the shape of the Laffer curve runs as follows. If the tax rate is zero, tax revenues from that tax are also zero. However, if the tax rate is 100%, the tax revenues are also zero because no rational agent would generate a tax base for a 100% tax. It follows, that between these extremes, as the tax rate increases from zero to 100%, tax revenues will first increase, reach a maximum, and finally decrease (Trabandt and Uhlig, 2011). In an economy with a single tax, this implies that increasing the tax rate to increase tax revenues delivers diminishing returns and must eventually lead to a fall in tax revenues (Colombatto, 2015).

The Laffer curve has been used as the basis for a number of economic studies. Nutahara (2015) investigated the Laffer curve for Japan based on a neoclassical growth model. He found that while the labor tax rate is smaller than that at the peak of the Laffer curve, the capital tax rate is either very close to, or larger than, that at the peak of the Laffer curve. He also found that to maximize total tax revenues, the government should increase the labor tax rate, but decrease the capital tax rate. Miravete et al. (2018) studied commodity taxation and characterize the Laffer curve, a trade-off between tax rates and revenues, in non-competitive markets. They found that the strategic response of non-competitive firms to changes in taxation flattened the Laffer curve significantly. Dahlby and Ferede (2018) estimated tax base elasticities for Canadian provinces in order to compute the Marginal Cost of Public Funds (MCF) for three major taxes and to assess the revenue implications of tax rate changes. They found that in general, the corporate income tax has the highest and the sales tax the lowest MCF, and that four provinces were on the negatively sloped sections of their total revenues Laffer curves with respect to their corporate income tax rate. Bosi and Desmarchelier (2017) studied the relationship between the Laffer curve and the green paradox in the context of a Ramsey model with endogenous labor supply in which pollution increases consumer demand (through a compensation effect). They found that in the long run the conditions under which a Laffer curve and a green paradox emerge are mutually exclusive. Varela-Candamio and Morollon (2017) contrasted the Laffer hypothesis for the Spanish case under different spatial scenarios using microdata for 2009 provided by the country's Institute for Fiscal Studies. They employed a cross-sectional sample of tax filers, estimated by means of least squares. They found justification for the existence of a high level of fiscal decentralization. Arbel et al. (2019) constructed Laffer curves to evaluate the efficiency of local property tax collection based on a micro-level panel dataset for 2013-2016 obtained from the municipality of Jerusalem. Steinmüller et al. (2019) conducted a survey on corporate taxes around the world, using tax data from a large sample of countries to construct Laffer

curves in order to study effective tax measures. Feve et al. (2018) describe the Laffer curve for public debt as S-shaped and give an explanation as to why. It is clear from these and many other studies that the Laffer curve is a common method for studying the tax economy.

Tax revenues are closely linked to many factors, including economic growth, social stability and citizens' welfare, as well as have a great impact on individuals' incomes and decision-making behavior (Alavuotunki et al., 2019; Klieštik et al., 2018). For governments, tax revenues are an important source of revenue (Andreoni, 2019; Balcerzak et al., 2017). At the micro level, tax revenues affect everyone´s daily lives, thereby affecting the choices and decisions people make with regards to job choice, employment, savings, education, consumption and even retirement (Marečková, 2013; Čihovská and Hudec, 2018). At the macro level, tax revenues have a significant impact on economic development, investment structure, resource allocation and the social services industry (Bilicka, 2019; Popílková and Raušer, 2018). Tax policies can reflect national cultures and social values (Toossi and Zhang, 2019). Kabourková and Popílková (2017) examined the effect of the number of children on tax credit rebates from taxpayers' income tax. According to the achieved results, it was found that the largest tax credit rebates from taxpayers' income tax are achieved with a monthly gross salary of 600 EUR. As the taxpayer's gross wage increases, the effect of this tax credit decreases, which in turn increases the state's tax revenues. Many experts have conducted studies into tax revenues from varying points of view. Szigeti et al. (2019) analyzed the revenue mix of the Hungarian health insurance fund for the period 1994-2015 and discussed the policy implications of their findings. Liesegang and Runkel (2019) explicitly modeled multinational enterprises and a corporate tax system designed according to formula apportionment, which contributed to literature on fiscal equalization and corporate tax competition. Kabourková and Rousek (2010) describe the historical development of the tax system of the Czech Republic and compare this development with the currently applicable tax rates. Mao and Wu (2018) applied the propensity score matching method and the difference-in-differences design to empirically examine the impact of the government-mandated adoption of international financial reporting standards on a country's income tax revenues. Mourre and Reut (2019) assessed the size, composition and volatility of non-tax revenues in the European Union, and explored, by means of panel data analysis, whether macroeconomic and fiscal conditions can explain the observed heterogeneity in non-tax revenues across the member states. They found that the relative variability of non-tax revenues was around three times higher than that of tax revenues, thereby posing a significant source of fiscal risk that is often overlooked. Examination of fiscal conditions for self-government (municipality management) from the time of stability to the pandemic, and in the framework of strengthening investor protection can be found in the work Kelemen et al. (2021), and Polishchuk et al. (2019).

To estimate the effect of exchange rate volatility on tax revenues, Ofori et al. (2018) employed the Auto Regressive Distributed Lag (ARDL) technique after the yearly exchange rate volatilities had been generated using the GARCH (1,1) method. The results of their study suggested that exchange rate volatility had a deleterious effect on tax revenues both in the short-run and long-run, but that the effect was more pronounced in the long-run than the short-run. Langer and Korzhenevych (2018) estimated the effect of changes in the built-up industrial and commercial area on business tax revenues through cross-sectional instrumental variable estimations. Based on detailed data for Bavaria, they found that an increase in the municipal built-up industrial and commercial area would have a significant and positive tax-revenue effect.

The tax rate is the ratio at which a business or person is taxed. Tax rates are usually expressed as a percentage (Tennant and Tracey, 2019) and are an important factor affecting tax revenues (Chernick and Reimers, 2019). The ambition of most governments is to achieve a proactive fiscal policy through the reduction of tax rates. This does not necessarily imply that tax revenues will decrease accordingly (Gius, 2018). As a result, many experts conduct research into tax rates. Rousek and Králová (2010) performed an analysis of fiscal policy from the perspective of the revenue side. Taxes are a key item of revenue in the fiscal budget. There is differentiation between tax and non-tax revenues of the state. Wang et al. (2019) analyzed data about cigarette tax compliance from the first US-

based national collection of littered cigarette packs. They provided evidence that non-compliance was due to both cross-border shopping and cigarette trafficking. They proved that tax avoidance is linked to the distance to lower-tax borders. Annuar et al. (2018) analyzed time series data for the period 1996-2014 using the autoregressive distributed lag approach in order to investigate the impact of the reduction of the corporate tax rate on corporate tax revenues. They found that the corporate tax rate had a dual effect on corporate tax revenues over the study period. Parchet (2019) exploited the fact that jurisdictions located close to a state border have neighbors in another state and created an instrument for comparing the tax rate of neighboring jurisdictions with the state-level tax rate of the neighboring state. He used this instrument to identify how strategic personal income taxes were set by local jurisdictions in Switzerland and found that tax rates were strategic substitutes. Using new narrative measures for exogenous variation in marginal tax rates associated with postwar tax reforms in the United States, Mertens and Olea (2018) estimated that the short-term tax elasticities of reported income were around 1.2 based on time series for the period 1946-2012. Matikka (2018) used Finnish data to analyze the elasticity of taxable income and used changes in flat municipal income tax rates as an instrument for overall changes in marginal tax rates. It is clear that the tax rate is directly relative to tax revenues, which is important research finding.

3. Data and Methodology

The GDP growth rates and tax rates for the V4 countries (Czech Republic, Slovak Republic, Poland and Hungary) were collated for the period 1995-2017, as sourced from World Bank, Trading Economics. The development of GDP growth rates (Figures 1) and tax rates (Figure 2) in the V4 countries are presented below.
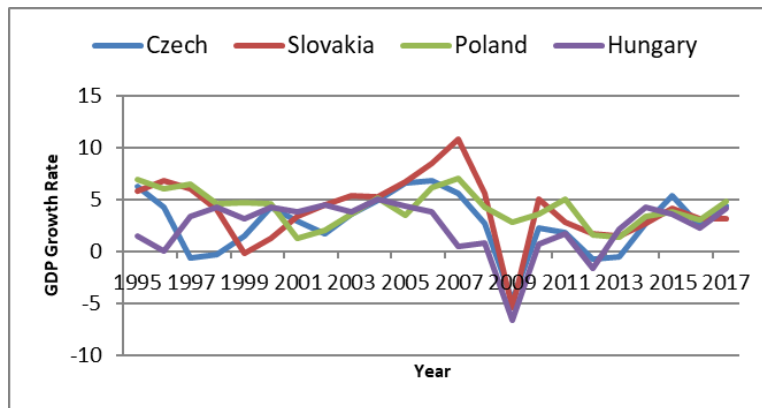

Figure 1. Development of GDP growth rates in V4 countries (1995-2017)

Source: Authors compiled

In Figure 1, it is evident that the GDP growth rate in the V4 countries fluctuated between 10% and -5%, reaching its lowest level in 2009. In Figure 2, it is evident that the tax rates in three of the V4 countries showed a downward trend, the exception being Hungary, which maintained a higher tax rate throughout the analyzed period. The country with the lowest taxes during the same period was the Slovak Republic. The relationship between the GDP growth rate and the tax rate across the V4 countries is presented in Figure 3.
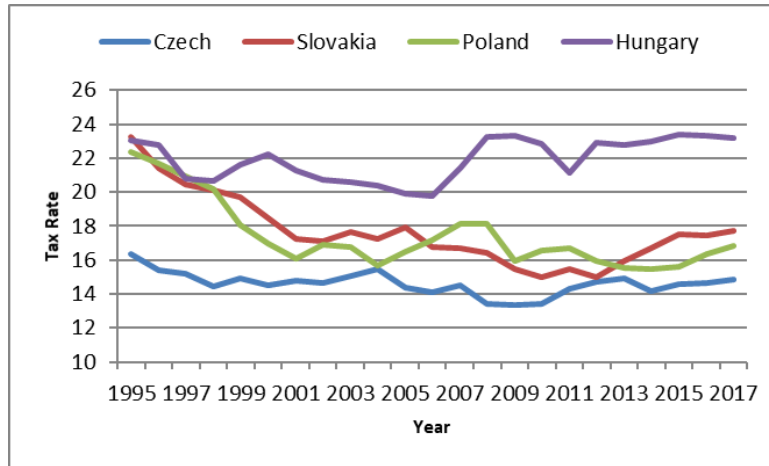
Figure 2. Development of tax rates in V4 countries (1995-2017)

Source: Authors compiled

In Figure 3, each point represents the GDP growth rate or tax rate of one of the V4 countries for the period 1995-2017. Intuitively, higher tax rates tend to be associated with lower GDP growth rates.
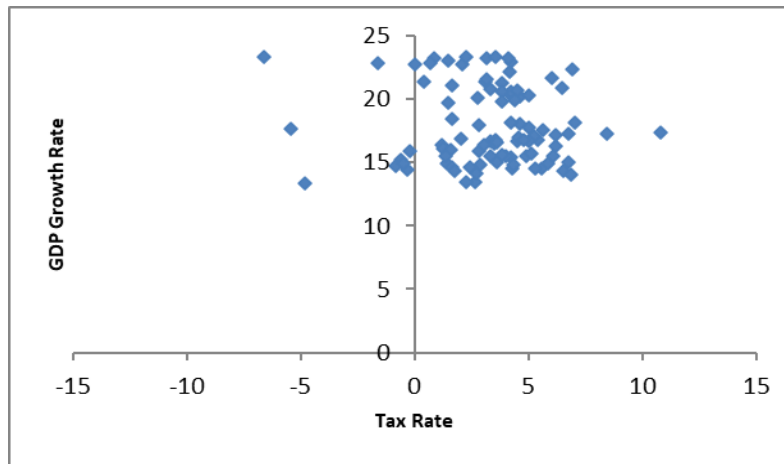

Figure 3. GDP growth rate and tax rate in V4 countries

Source: Authors compiled

The tax revenue and tax rate data for the V4 countries are listed in Table 1.

Table 1. Dataset of tax revenues and tax rates

Year	Czech Republic		Slovak Republic		Poland		Hungary	
	GDP growth rate (%)	Tax rate (%)	GDP growth rate (%)	Tax rate (%)	GDP growth rate (%)	Tax rate (%)	GDP growth rate (%)	Tax rate (%)
1995	6.221406	16.3390	5.843495	23.2554	6.951857	22.3936	1.489525	23.0570
1996	4.222815	15.3878	6.757147	21.4200	6.05658	21.6882	0.014155	22.7908
1997	-0.59466	15.1793	6.067543	20.4227	6.45955	20.9363	3.340164	20.7960
1998	-0.32872	14.4357	4.011814	20.1088	4.614648	20.1871	4.235848	20.6349
1999	1.432839	14.9401	-0.20507	19.6979	4.642211	18.0976	3.186896	21.6023
2000	4.266741	14.5169	1.210173	18.4666	4.559571	16.9937	4.20918	22.1991
2001	2.908765	14.8035	3.316468	17.2345	1.248005	16.0883	3.84051	21.2623
2002	1.652494	14.6155	4.522792	17.0747	2.041604	16.8739	4.528206	20.7452
2003	3.602989	15.0555	5.418716	17.6392	3.562472	16.7454	3.84862	20.6104
2004	4.906564	15.4908	5.258836	17.2455	5.13565	15.7017	5.004918	20.3621
2005	6.533469	14.3654	6.750961	17.9607	3.493659	16.5170	4.388215	19.9109
2006	6.853522	14.0829	8.452888	16.7546	6.179604	17.1859	3.851173	19.7817
2007	5.602644	14.5023	10.79958	16.7158	7.034802	18.1252	0.434762	21.3895
2008	2.682283	13.4418	5.629779	16.4063	4.249711	18.1635	0.855513	23.2500
2009	-4.80257	13.3608	-5.42254	15.4844	2.82026	15.9304	-6.59997	23.3235
2010	2.27342	13.4495	5.041717	14.9904	3.606928	16.5499	0.682378	22.8482
2011	1.777833	14.3139	2.8191	15.5015	5.017235	16.6912	1.657657	21.134
2012	-0.79984	14.6878	1.657149	14.9713	1.607907	15.9645	-1.6314	22.8920
2013	-0.48367	14.9464	1.490646	15.9224	1.391892	15.5623	2.093642	22.7502
2014	2.715116	14.1715	2.750335	16.6995	3.318448	15.4968	4.224654	22.9914
2015	5.309239	14.5558	4.174873	17.5444	3.838948	15.6189	3.536425	23.3941
2016	2.450542	14.6754	3.12541	17.4251	3.0626	16.3724	2.280798	23.3207
2017	4.352604	14.8773	3.188341	17.7448	4.805746	16.8101	4.137064	23.2162

Source: Authors compiled

The statistical data is presented in Table 2, which shows the essential features of the tax revenues and tax rates (minimum, maximum, average, median, variance and standard deviation). Microsoft Excel software was subsequently utilized to process the statistical data used in this article.

Table 2. Statistical data for tax revenues and tax rates

Variable	V4 Countries	
	GDP growth rate (%)	Tax rate (%)
Minimum	-6.59997406	13.36082326
Maximum	10.79957705	23.39414753
Average	3.312225903	17.9113379
Median	3.60495886	16.93386008
Variance	7.425407919	9.394793915
Standard Deviation	2.881186494	3.080557988

Source: Authors compiled

The general shape of the Laffer curve, as described above, is presented in Figure 4.
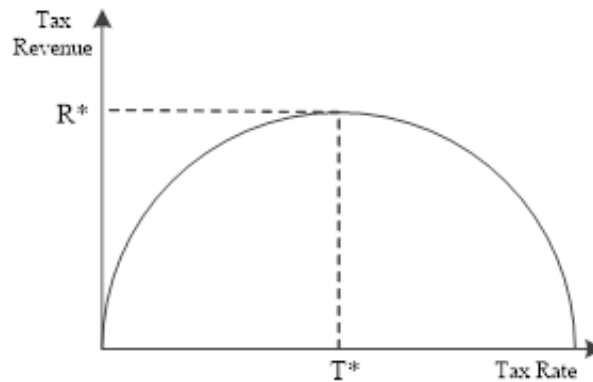

Figure 4. The Laffer curve

Source: Authors compiled

The horizontal axis expresses the tax rate and the vertical axis tax revenues. The curve expresses the non-linear relationship between the tax rate and tax revenues. The curve is shaped like a parabola, whereby T* represents the optimal tax rate and R* the corresponding tax revenues. To the left of the optimal tax rate (T*), a tax rate increase generates increasing tax revenues, whereas to the right of the optimal tax rate (T*), a tax rate increase generates decreasing tax revenues.

According to the shape of the Laffer curve, we can use binomial to fit it. The regression model can be expressed as follows:

$$TaxRevenue_{i,t} = \alpha * Tax_{i,t} + \beta * Tax_{i,t}^2 + \varepsilon_{i,t} \qquad (1)$$

In the above regression model, $TaxRevenue_{i,t}$ expresses the tax revenue of ith country in the tth year, $Tax_{i,t}$ expresses the tax rate of ith coutry in the tth year, $\varepsilon_{i,t}$ expresses the disturbance term. According to the theory underpinning the Laffer curve, tax revenues should be 0 when the tax rate is 0. In other words, the model should start at the point of origin, i.e. at the point at which the intercept on the vertical axis of the model is zero, namely $\varepsilon_{i,t} = 0$. α and β are unknown model parameters. The regression model should therefore be expressed as:

$$TaxRevenue_{i,t} = \alpha * Tax_{i,t} + \beta * Tax_{i,t}^2 \qquad (2)$$

In reality, other factors also affect government income, including bank interest rates (Gavurova et al., 2017). The model above can therefore only be used to show the tendency of tax revenues to first rise and then fall as tax rates rise. Based on the theory of the Laffer curve, a similar relationship (Lin and Jia, 2019) exists between the economic growth rate and the tax rate, which is a more suitable relationship for the study of the macroeconomic situation as controlled by fiscal policy. In light of this, the application of the Laffer curve was generalized, whereby the economic growth rate was adopted instead of tax revenues to determine the optimal tax rate. The generalized regression model of the Laffer curve can be expressed as follows:

$$GDPGT_{i,t} = \alpha * Tax_{i,t} + \beta * Tax_{i,t}^2 \qquad (3)$$

According to the methodology described in Section 3, the GDP growth rate was adopted instead of tax revenues in Formula 3 in order to construct the Laffer curve. The values for the GDP growth rates and tax rates were

obtained from the relative data for the V4 countries, as referenced above. Subsequently, it was important to acquire the parameters α and β. According to the definition of the model, the specific description of the two parameters under ideal conditions is presented in Table 3. If the two parameters conform to expectations, the existence of the Laffer curve is proven. To this end, all the data for the V4 countries were combined to construct one model with which to check conformity with the Laffer curve. The results were then subjected to a comparative analysis.

Table 3. Parameter declaration

Parameter	Explanation	Expected symbol
α	Parameter for tax rate	+
β	Parameter for the square of tax rate	-

Source: Authors compiled

Using SPSS statistics software (version 19), the least squares method was applied to carry out a regression analysis and to obtain suitable values for the corresponding parameters.

4. Results and Discussion

According to the description of the study design above, the V4 countries were regarded as a whole. All of the data for the V4 countries were entered into the statistical software for the regression analysis. The Anova table (see Table 4) illustrates the validity of the final result. The final formula for the Laffer curve for the V4 countries can therefore be expressed as follows:

$$GDPGT_{i,t} = 4.565 * Tax_{i,t} - 0.125 * Tax_{i,t}^2 \qquad (4)$$

In Table 4, the significance level of the F-value is 0.003<0.05 for the V4 countries, which shows that the regression equation is significant. The two parameters, which are 4.565 and -0.125, conform with the expectation symbol. This implies that the Laffer curve is valid for the situation in the V4 countries and that the relationship between the GDP growth rate and the tax rate is significant. The Laffer curve for the V4 countries can be presented graphically as follows:

Table 4. Anova for V4 countries

Model		Quadratic Sum	df	Mean Square	F	Sig.
1	Regression	83.227	2	41.614	6.251	0.003
	Residual	592.485	89	6.657		
	Total	675.712	91			

Source: Authors compiled

From Figure 5, when compared with the Laffer curves for the individual countries, it can be concluded that the shape of the Laffer curve for the V4 countries combined is more conform with the original shape. In addition, the regression equation for the V4 countries is significant. Within this context, it therefore makes sense to study the Laffer curve for the four countries as a group.
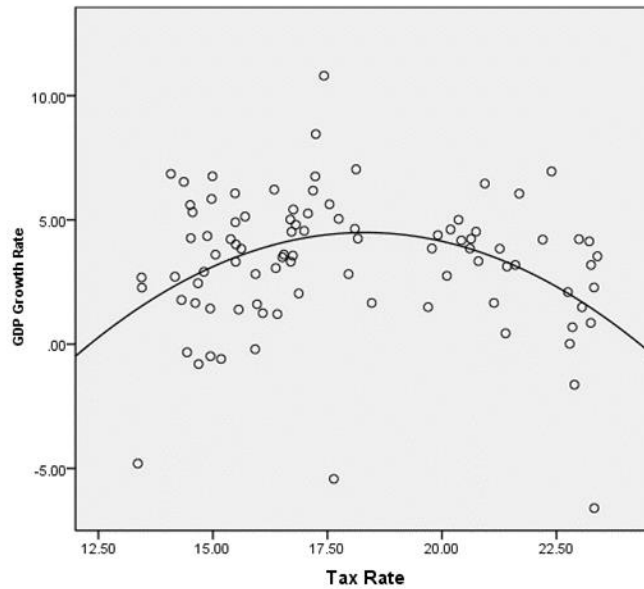
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Figure 5. Laffer curve for V4 countries

Source: Authors compiled

Having obtained the parameters with expectation symbols and the Laffer curve with inverted U-shape, the regression equation was utilized to estimate the value of the tax rate that can maximize the GDP growth rate. In order to obtain the optimal value of the tax rate, it was necessary to take the first derivative of Formula 3 and set it to equal 0.

$$\frac{\partial TaxRevenue_{i,t}}{\partial Tax_{i,t}} = \alpha + 2\beta * Tax_{i,t} = 0 \tag{5}$$

So,

$$Tax_{i,t} = -\frac{\alpha}{2\beta} \tag{6}$$

According to the parameters in the regression equation for the V4 countries, it was possible to calculate the optimal value of the tax rate, which equaled 18.26. When this result was checked against the tax rates in the V4 countries, it was found that the Slovak Republic had the most appropriate tax rate at 17.74489, closely followed by Poland at 16.81013, and that the Czech Republic needed to enhance its tax rate, and Hungary decrease its tax rate.

According to Mareček and Machová (2017), the GDP of each country is very important, because its value directly correlates with the amount of public debt within all EU states and thus also the V4. For this reason, government officials should take steps to strengthen economic development in various dimensions of economic life (Gavurova et al., 2021a; Gavurova et al., 2021b).

Conslusions

Tax rate and tax revenue data for the V4 countries for the period 1995-2017 were used to analyze the Laffer curve for the group. The formula is presented according to the shape of the Laffer curve, which is quadratic through the origin. Based on the theory underpinning the Laffer curve, we adopted the GDP growth rate instead of tax revenues. The collected data were summarized, described and presented in figures. For the study, the V4 countries were regarded as a whole, and the overall dataset used to conduct a regression analysis. On this basis, an assessment of the situation was carried out in order to determine the optimal tax rate and tax revenues.

According to the conclusion drawn, it can be stated that the relationship between the GDP growth rate and the tax rate is significant for the V4 countries, and that the parameters of the regression equations conform to the expected symbols. This implies that the Laffer curve conforms with the overall situation in the V4 countries. Further analysis of the optimal tax rate and the situation in each country showed that Poland and the Slovak Republic have the more appropriate tax rates, whereas the Czech Republic and Hungary need to appropriately adjust their tax rates.

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