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MEASURING VAT EFFICIENCY IN VISEGRAD GROUP COUNTRIES

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Abstract

Value added tax represents one of the main tax forms, because it generates the most revenue and greatly contributes to the budgets of many countries. The purpose of this paper is to determine the VAT efficiency level in Visegrad Group countries (Czechia, Hungary, Poland and Slovakia) for the period between 1995 and 2020. The average VAT efficiency in the Visegrad region was 0.51, and this indicator improved after these economies joined the European Union. The results of this empirical research show that gross domestic product per capita, final consumption and value added tax revenue have a positive impact on VAT efficiency, as measured by the C-efficiency indicator. On the other hand, the results demonstrate that an increase in VAT rate lead to a lower level of VAT efficiency in the examined countries. Finally, the EU accession of the Visegrad region had positive implications for the productivity and efficiency of their VAT systems. The results of this study suggest that the governments of the Visegrad Group countries should focus on increasing the GDP per capita growth rate and final consumption to stimulate VAT revenue. Additionally, the policymakers of these countries can increase VAT revenue by expanding the tax base in order to avoid the negative effect that increasing the standard VAT rate has on VAT efficiency.

Key words: VAT, efficiency, panel modelling, Visegrad Group countries

МЕРЕЊЕ ЕФИКАСНОСТИ ПДВ-А У ЗЕМЉАМА ВИШЕГРАДСКЕ ГРУПЕ

Апстракт

Порез на додату вредност представља један од главних пореских облика јер генерише највише прихода и даје велики допринос буџету сваке земље. Сврха овог рада је да утврдити ефикасност ПДВ-а у земљама Вишеградске групе (Чешка, Мађарска, Пољска и Словачка) за временски период између 1995. и 2020. године. Просечна вредност ПДВ ефикасности је износила 0.51 у Вишеградском

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региону, при чему је овај индикатор побољшан након придруживања ових економија Европској унији. Резултати емпиријског истраживања, добијени мерењем путем индикатора Ц-ефикасности, показују да бруто домаћи производ по глави становника, финална потрошња и приходи по основу ПДВ-а имају позитиван утицај на ПДВ ефикасност. С друге стране, резултати показују да повећање ПДВ стопе доводи до нижег нивоа ефикасности ПДВ-а у одабраним земљама. Коначно, придруживање Вишеградског региона ЕУ је имало позитивне импликације на продуктивност и ефикасност ПДВ система посматраних земаља. Емпиријски налази сугеришу да владе земаља Вишеградске групе треба да се фокусирају на већу стопу раста БДП-а по глави становника и на финалну потрошњу како би стимулисале приходе по основу ПДВ-а. Такође, креатори политика ових земаља могу повећати приходе од ПДВ-а ширењем пореске основице, како би се избегао негативан ефекат повећања стандардне ПДВ стопе на ефикасност ПДВ-а.

Кључне речи: ПДВ, ефикасност, панел моделирање, земље Вишеградске групе

INTRODUCTION

Tax collection represents an essential instrument of enabling economic stability and development (Majerová, 2016). In addition, it is the most important source of state budget revenue (Kubjatkova et al. 2021). Accordingly, increasing tax collection is crucial for economic growth and development (Gaspar et al. 2016), in line with the fact that the mobilisation of tax revenue is important for a country's development (Akitoby et al. 2018, Chang et al. 2020). Tax revenues should ensure the existence of adequate infrastructure, healthcare, education, culture, employment, social income distribution, and public safety. Dobrovič et al. 2021). In developed countries, direct taxes have a greater share in tax structure, and a higher contribution to the country's economic activity. Conversely, the tax structure of developing and underdeveloped countries is predominantly based on indirect taxes such as value added tax, sales tax and excises (Remeikiene et al. 2018). The taxation of consumption has become focused on value added taxes instead of sales taxes in most countries of the world (Sokolovska and Sokolovskyi, 2015). Furthermore, Caashin and Unayama (2021) point out that, if household consumption is very sensitive to changes in tax rates, policymakers should adjust the tax rate on consumption in order to manage aggregate demand. The role of consumption taxes is one of the most important issues in the debates about optimal tax structure related to efficiency and equity (Tóth et al. 2021). On a broader sample of data collected on 70 economies for a period of 40 years, Acosta-Ormaechea et al. (2019) confirmed that consumption taxes are more favourable for growth compared to income taxes. Kalaš et al. (2020) confirmed the long-run co-integration between VAT revenues and economic growth measured by GDP per capita. Value added tax has become the most common consumption tax in the world (Giesecke and Tran, 2012), and Keen (2013) indicates that VAT is adopted in more than

150 countries in the world, where the share of VAT revenues amounts to more than 20% of the global tax revenues. During the financial crisis of 2008, the importance of value added tax increased significantly (Adamczyk, 2015). Aizenman and Jinjarak (2008) point out that VAT is tax collected throughout the production chain.

Tax is paid only on consumption within the territory of the fiscal authority, so export goods are not subject to taxation, unlike imported goods (Gurrib, 2017). Similarly, VAT is a consumption tax based on the value added to goods and services at each stage of production (Cevik et al. 2019). Based on the aforementioned, the advantages of VAT can be manifested as: no cascading of indirect taxes, compatibility with international trade, and better control mechanisms to evade taxation (Alavuotunki et al. 2018). Final consumers are exposed to the tax burden resulting from *ad valorem* and *ad unit* taxes imposed on goods to a greater degree than sellers (Dobranschi and Nerudová, 2018). The aim of this research is to analyse VAT efficiency in the Visegrad region (Czechia, Hungary, Poland and Slovaka) in the period between 1995 and 2020. For this purpose, we used the CEF indicator as one of the most popular approaches to estimating VAT efficiency. The paper is divided into four segments, as follows. After the introductory segment, a review of literature on VAT efficiency is presented in order to contextualise our research, with special focus placed on the Visegrad Group countries. The segment *Methodological Framework* describes the sample and explains the methodology of calculating CER indicators. The last segment presents the final conclusions and recommendations for the policymakers of the Visegrad region, and includes the implications for further empirical researches.

LITERATURE REVIEW

VAT adoption has various effects, depending on the income level of the country, and this is especially true of developing countries where the prevalence of tax evasion is one of the main tax problems (Adhikari, 2020). The level of the VAT rate is important for consumption and price level, where the movement in VAT rate could have essential implications for inflation (Benkovskis and Fadejeva, 2014). Accordingly, Ufier (2014) confirmed that the presence of VAT causes lower inflation and government spending, as well as a higher degree of investment and growth. The VAT system has a positive implication for strengthening government discipline in collecting and managing tax revenues, as it implies that a government needs to direct public spending towards the productive sectors in order to realise rapid economic growth (Sok-Gee et al. 2017). The empirical study of Alm and El-Ganainy (2012) examined the relationship between value added tax rate and consumption in selected EU countries for the period between 1961 and 2015. Their findings show that value added

tax rate has a negative impact on consumption. On the other hand, Bikas and Malikonytė (2020) confirmed that government expenditure is the largest contributor to the VAT gap change, where a 1% growth in expenditure increases the VAT gap by 1.45%. VAT's C-efficiency shows the value of one percentage of the final consumption expenditure collected by each percentage point of the standard value added tax rate (Cnossen, 2015). When it comes to the structure of the VAT system, Kalyva et al. (2016) highlighted the economic arguments in favour of a simple value added tax system with a limited use of reduced rates. The uniform value added tax rate is very popular in non-European countries such as Australia, New Zealand, Canada, Singapore and South Africa (Abramovsky et al. 2017). Bostan et al. (2017) identified no significant relationship between VAT rate and VAT revenue, and a negative impact of VAT rate on fiscal efficiency in Romania for the period between 2006 and 2014. Zídková (2014) determined the existence of a positive relationship between final consumption and the total VAT gap in twenty-four EU countries. Empirical results showed that the total VAT gap increases by 1.07% if final consumption increases by 1%. Likewise, if GDP per capita increases by 1%, the total VAT gap drops by 1.24%. The empirical findings of Tagkalakis (2014) showed that an improvement in economic conditions enhances VAT efficiency, where a 1% increase in the GDP growth rate raises VAT efficiency by about 0.63%. Đorđević et al. (2019) determined a negative impact of value added tax rate on collection efficiency in the developing EU countries for the period between 1997 and 2017. Hodžić and Celebi (2017) investigated the C-efficiency in EU countries and Turkey between 2009 and 2013, and their findings show that the highest C-efficiency is recorded in Luxembourg (88%), while the lowest is recorded in Spain (36%), Italy (32.8%) and Greece (34%). In comparison with EU countries, in 2013, Turkey recorded a C-efficiency of 51.1%, which is similar to the C-efficiency of Austria (51.9%) and Czechia (50%). The research also shows a positive correlation between the value of the basic VAT rate, along with the number of preferential rates, and the scale of the tax gap. It implies that the tax gap is higher in countries with a higher standard VAT rate and a greater number of preferential rates (Kowal and Przekota, 2021). Analysing twenty-one OECD countries over a period between 1970 and 2018, Acosta-Ormaechea and Morozumi (2021) point out that an increase in VAT promotes long-term growth only if the value added revenues are raised through C-efficiency, but not if they are increased through the standard VAT rate. Wang et al. (2021) confirmed the existence of a significant relationship between GDP growth and tax rates in the Visegrad Group countries for the period between 1995 and 2017, while Hodroyiannis and Papaoikonomou (2020) indicated that VAT revenue and revenue efficiency increased through a greater application of card payments in the euro area in the period between 2000 and 2016. Baum et al.

(2017) determined the existence of a significant relationship between revenue collection and tax administrative capacity, while Mavungu Ngoma and Krsic (2017) did not identify any positive change in revenue related to tax administration. Ramírez-Álvarez and Carrillo-Maldonado (2020) point out that greater efficiency in taxation can be achieved by tax administration actions aimed at improving tax collection. A higher tax efficiency is crucial because it enables sufficient resources to cover public expenditure in the long term.

Since the aim of this research is to determine VAT efficiency in the Visegrad Group countries, the obtained results will be helpful to the governments of these economies during the creation and definition of tax policies. The contribution of this paper is reflected in the fact that policymakers can use these empirical findings as guidelines when profiling their VAT policy so as to generate and provide as much VAT revenue as possible with minim negative implications to the economy.

THE VAT SYSTEM IN VISEGRAD GROUP COUNTRIES

In the late 1980s, political and economic changes caused breaks in the territorial structure of post-socialist countries (Koišová et al. 2019). The Visegrad Group, or V4, implies the political and cultural alliance of four economies: Czechia, Hungary, Poland, and Slovakia). These countries are also members of the European Union and NATO. The goal of this alliance is to contribute to the establishment of European security, based on cooperation and coordination within existing European and transatlantic organisations (Visegrad Group, 2020). This region is trying to rise to the level of advanced EU countries, where Czechia is the most advanced of the economies within the alliance. Slovakia is classified as advanced, while Hungary and Poland are still emerging countries which are fiscally less stable than Czechia and Slovakia (Jędrzejek, 2016). The tax gap remains a challenge for many of the European Union member states, including the Visegrad Group countries (Frizis et al. 2017). During the crisis of 2008, VAT revenue losses sharply increased in Poland and Slovakia, while they remained at a relatively stable level in the Czech Republic and Hungary. In 2013, the greatest improvement in VAT was recorded in Slovakia, while the VAT gap was still increasing in Poland and Hungary (Rabatinova, 2016). The collection of VAT revenue represents, in the long term, the greatest part of the tax revenue within the budget of Slovakia (Meheš et al. 2019).

The introduction of VAT in the Visegrad region started in Hungary in 1988, and in 1993, VAT was introduced in Czechia, Poland and Slovakia. The introduced standard VAT rate was 25% in Hungary and Slovakia, 23% in Czechia and 22% in Poland. The interesting fact is that all these countries, except Slovakia, changed the standard VAT rate after a

decade, or longer. For example, Slovakia reduced the standard VAT rate from 25% to 23% after only a year, while other countries changed their standard VAT rates many years later. More specifically, the standard VAT rate in Czechia was reduced from 22% to 19% in 2004, and the standard VAT rate in Hungary was reduced from 25% to 20% in 2006. Poland is the only country which increased its standard VAT rate after the introduction of VAT into their tax system, and the rate was modified from 22% to 23% in 2011.

Value added tax was introduced in Poland in 1993 as a new construct which implied neutrality from the viewpoint of international exchange, and a number of stages in trading goods and services. Their effect on the final prices of goods and services is manifested through the elimination of cost accumulation (Kotlińska et al. 2020).

METHODOLOGICAL FRAMEWORK

The aim of this research is to identify which variables are essential to VAT collection in the Visegrad Group. The selected countries are Czechia, Hungary, Poland and Slovakia. The analysis covers the period between 1995 and 2020. We used the International Monetary Fund (IMF) and World Bank (WB) databases for data collection.

Table 1. Variable selection

Variable	Symbol	Calculation	Source
Gross domestic product per capita	GDPpc	GDPpc at constant price – annual growth rate	IMF
Final consumption	FC	% share of GDP	WB
Standard VAT rate	VATrate	Annual rate	IMF
VAT revenues	VATrev	% share of GDP	IMF
EU accession	EUac	0 – period before EU accession, 1 – period after EU accession	Dummy variable

Source: Authors' illustration

This research is focused on identifying CEF indicators and estimating the effect of the main components, such as gross domestic product per capita (GDPpc), final consumption (FC), standard VAT rate (VATrate), value added tax revenues (VATrev) and EU accession (EUac), which is a dummy variable. Based on Tanzi and Davoodi (2000), the CER indicator, as the traditional measure of VAT collection efficiency can be expressed as:

$$\text{CER} = \frac{VAT\ revenue/GDP}{Standard\ VAT\ rate} \quad (1)$$

Gross domestic product (GDP) is considered to be an important economic indicator because it best reflects the performance of each econ-

omy (Ivanová and Masárová, 2018). Since we aimed to examine the impact of economic development on tax collection efficiency, we used gross domestic product per capita growth rates. A higher value of the CER indicator implies a productive VAT tax system, while a lower value points towards tax evasion, weak tax administration or extensive exemptions. The main disadvantage of this measurement is the fact that the traditional indicator includes production, but not consumption.

Accordingly, Keen (2013) highlighted the C-efficiency ratio in order to provide a better estimation of VAT efficiency collection. The optimal value of the C-efficiency ratio is 100%, but in cases of reduced VAT rates and several exemptions, the value is below 100%. Deviations from a 100% C-efficiency can arise for two reasons. Firstly, they may manifest the extent to which the VAT design differs from a uniform tax on all consumption. Secondly, the implementation and administrative activity of the tax may be less than perfect (Gendron and Bird, 2020). This indicator can be defined as:

$$\text{CEF} = \frac{V}{PV} \tag{2}$$

$$\text{PV} = \text{svr x (FC} - \text{V)} \tag{3}$$

where V stands for realized VAT revenue, PV stands for theoretical VAT revenue, svr stands for the standard VAT rate, and FC stands for final consumption.

The explanatory variables are included on the basis of previous empirical studies (Sokolovska and Sokolovsky, 2015; Hodžic and Celebi, 2017; Đorđević, Đurović Todorović and Ristić, 2019 and Popa, 2021). VAT efficiency primarily depends on economic activity and consumption, which is consequently reflected in the collected revenues. Analysing the standard VAT rate is essential for VAT efficiency, because, if the standard VAT rate is determined to be at the appropriate level, policymakers can expect positive implications for revenue collection. Finally, the dummy variable EU accession is included in the empirical model to point out the importance of the Visegrad Group countries joining the European Union in terms of revenue collection. The inclusion of the dummy variable EU accession is a novelty compared to previous studies that have analysed VAT efficiency.

The study involves several hypotheses based on empirical research objectives, and they are as follows:

H_1 – The GDP per capita growth rate has a positive effect on VAT efficiency in the Visegrad Group countries;

H_2 – Final consumption has a positive effect on VAT efficiency in the Visegrad Group countries;

H_3 – A higher standard VAT rate leads to lower VAT efficiency in the Visegrad Group countries;

H_4 – A higher level of VAT revenue leads to higher VAT efficiency in the Visegrad Group countries; and

H_5 – EU accession improved VAT efficiency in the Visegrad Group countries.

This empirical study includes panel modelling, such as the random-effects model, and the fixed-effects model which accounts for the time and space dimensions. The random-effect model proved to be an adequate model to evaluate the impact of explanatory variables:

$$CEF_{it} = \beta_0 + \mu_i + \beta_1 GDPpc_{it} + \beta_2 FC_{it} + \beta_3 VATrev_{it} + \beta_4 VATrate_{it} + \varepsilon_{it} \quad (4)$$

EMPIRICAL RESULTS

Before we determined which variables are crucial for VAT efficiency, it was necessary to estimate the level of tax collection efficiency by value added tax in these countries. The next table shows the value of the CER indicator in the Visegrad Group countries for the period between 1995 and 2020.

Table 2. CER indicator – numerator production

Year	Czechia	Hungary	Poland	Slovakia
1995	37.87%	37.94%	43.02%	36.33%
1996	38.89%	39.88%	43.31%	38.45%
1997	37.11%	41.73%	42.51%	40.86%
1998	36.76%	43.65%	41.63%	40.87%
1999	38.99%	46.11%	42.35%	40.89%
2000	38.49%	42.26%	42.73%	42.14%
2001	38.05%	40.98%	41.49%	38.51%
2002	37.09%	42.26%	41.11%	43.28%
2003	36.83%	42.13%	41.15%	46.73%
2004	50.39%	43.82%	40.65%	54.88%
2005	50.61%	42.79%	43.54%	60.18%
2006	47.59%	38.53%	42.83%	56.43%
2007	48.61%	52.04%	44.53%	58.26%
2008	50.96%	50.57%	43.41%	57.39%
2009	49.66%	55.33%	44.09%	49.55%
2010	47.35%	44.93%	43.38%	50.47%
2011	49.33%	45.09%	42.65%	46.68%
2012	50.74%	49.48%	43.20%	40.51%
2013	50.37%	44.65%	39.47%	43.41%
2014	51.73%	47.38%	38.83%	44.83%
2015	51.96%	50.09%	39.71%	46.17%
2016	52.97%	49.18%	40.91%	45.25%
2017	54.67%	50.22%	44.43%	46.64%
2018	52.21%	51.15%	46.24%	46.65%
2019	54.37%	52.44%	46.06%	45.33%
2020	52.35%	51.26%	46.36%	43.28%

Source: Authors' calculations

In order to determine the productivity of VAT revenue in the Visegrad Group countries, the analysis includes the values of the CER indicator for the period between 1995 and 2020. It can be noted that VAT revenue productivity improved during the analysed period in all countries. Looking at the final year of the observed period, Czechia and Hungary achieved a CER indicator of 52.35% and 51.46% respectively, while Poland and Slovakia recorded a CER indicator below 50%. Comparing this to the values of the indicator recorded in 1995, we can see that VAT efficiency improved by 38.24% in Czechia, 35.11% in Hungary, 7.76% in Poland, and 19.13% in Poland. This implies that VAT revenue collection rose by 25.06% on average. In regards to the effect of accession to the European Union, the results reflected that the average CER indicator was 41.35% in the period before EU accession. After the observed countries joined the EU, the average CER indicator was 47.84%, which is a significant improvement compared to the period before the Visegrad Group countries became EU member states. In order to provide information on the CER indicator trends in the selected countries, we analysed annual changes in the period between 1995 and 2020. The results show that the annual change rate was 0.6% in Czechia, 0.58% in Hungary, 0.14% in Poland, and 0.35% in Slovakia, on average. The greatest change was observed in Czechia (+13.45%) and Slovakia (8.15%) in 2003. When the Visegrad Group joined the European Union, the CER indicator decreased by 2.94% on average. The main cause of the lower value of the CER indicator is the decrease in FC, which implies a lower amount of collected VAT revenues. More specifically, FC dropped by 1.34% in the Visegrad region in 2005, while the share of VAT revenues declined by 1.36% in Czechia, and 10.08% in Hungary. With the help of Poland and Slovakia, the CER indicator did not fall further due to better revenue collection in these countries. Analysing the effect of the financial crisis of 2008 and 2009, it can be concluded that the CER indicator decreased in Czechia (-2.31%), Hungary (-10.4%) and Poland (-0.71%), but not in Slovakia (+0.92%). One of the reasons for this is the fact that final consumption increased more than the GDP growth rate. The empirical findings show that the Visegrad region had an average FC of 3.4%, compared to the GDP rate which dropped by 3.57%, on average. Observing the previous five year, it can be said that the annual change of the CER indicator was 0.52%, which reflects the stability and reliability of revenue collection by value added tax in these countries. Since this indicator is less reliable for empirical analysis, we measured the C-efficiency indicator, due to the fact that it includes consumption as a numerator.

Table 3. C-efficiency – numerator consumption

Year	Czechia	Hungary	Poland	Slovakia
1995	41.31%	41.91%	47.52%	39.96%
1996	42.52%	44.30%	47.89%	42.18%
1997	40.41%	46.59%	46.89%	45.10%
1998	39.99%	49.00%	45.83%	45.11%
1999	42.65%	52.11%	46.69%	45.14%
2000	42.05%	47.25%	47.16%	46.66%
2001	41.51%	45.66%	45.65%	42.24%
2002	40.39%	47.08%	45.19%	48.06%
2003	40.08%	49.21%	45.25%	51.55%
2004	55.73%	47.91%	44.64%	61.26%
2005	55.99%	42.64%	48.16%	67.95%
2006	52.32%	58.09%	47.29%	63.21%
2007	53.56%	56.26%	49.37%	65.51%
2008	56.43%	62.22%	47.99%	64.42%
2009	54.84%	50.61%	48.82%	54.70%
2010	52.31%	50.81%	47.97%	55.82%
2011	54.73%	56.46%	47.29%	51.48%
2012	56.47%	50.77%	47.97%	44.08%
2013	56.34%	54.34%	43.41%	47.53%
2014	58.03%	57.92%	42.64%	49.25%
2015	58.33%	56.71%	43.70%	50.87%
2016	59.59%	56.28%	45.15%	49.75%
2017	61.76%	58.09%	49.49%	51.45%
2018	58.64%	59.34%	51.74%	51.46%
2019	61.38%	61.09%	51.51%	49.85%
2020	58.82%	59.49%	51.90%	47.38%

Source: Authors' calculation

After identifying the productivity of VAT revenue, we measured VAT revenue efficiency using the C-efficiency ratio in selected countries (Table). Similarly to VAT production, we can see that VAT efficiency rose in the Visegrad region in the period between 1995 and 2020. At the beginning of the observed period, i.e. in 1995, the average value of C-efficiency was 42.68%, with the highest value recorded in Poland (47.52%) and the lowest value recorded in Slovakia (39.96%). If we compare these values with the C-efficiency level in 2020, the results show an average value of 54.40% in the Visegrad region, which marks and improvement of 11.72%. Looking at the data for individual countries for the year 2020, it can be said that the highest improvement was recorded in Czechia (17.51%) and Hungary (17.58%), while C-efficiency increased by 4.37% in Poland, and by 7.42% in Slovakia. We already saw that EU accession had positive implications for VAT productivity in the Visegrad Group countries, and these findings can be applied to the VAT efficiency for this region. Namely, the average C-efficiency was 45.69% in the peri-

od before EU accession (1995-2004), but after these economies joined the European Union (2005-2020), the average C-efficiency was 53.59%, which marks a growth of 7.9%. Looking at the data for individual countries, Czechia reaped the greatest benefits of EU accession because its C-efficiency increased by 14.18%, which is far more than was the case with the other three countries. For example, Hungary and Slovakia increased their C-efficiency by 8.59% and 7.32%, while C-efficiency increased by only 1.5% on average. We can conclude that the highest values of the C-efficiency indicator were recorded in Czechia (58.82%) and Hungary (59.49%), while Poland's C-efficiency recorded a value of 51.9% at the end of 2020. On the other hand, the C-efficiency indicator was below 50% in Slovakia, and amounted to 47.38%.

Table 4. Descriptive statistics

Country	C-efficiency	GDPpc	FC	VAT/GDP	VAT rate
			Czechia		
Mean	0.52	2.27	68.51	6.55	20.77
Std. Dev.	0.08	3.32	1.74	0.69	1.18
Minimum	0.4	-6.18	65.18	5.61	19
Maximum	0.62	7.82	71.82	7.59	22
			Hungary		
Mean	0.53	2.58	73.66	8.51	25.11
Std. Dev.	0.06	4.01	2.88	0.79	2.10
Minimum	0.42	-6.57	68.76	7.28	20
Maximum	0.63	5.57	79.33	9.8	27
			Poland		
Mean	0.47	4.02	79.68	7.61	22.38
Std. Dev.	0.02	2.18	2.54	0.29	0.49
Minimum	0.43	-2.51	75.52	7	22
Maximum	0.52	7.15	85.15	8.1	23
			Slovakia		
Mean	0.51	3.58	75.29	7.15	20.73
Std. Dev.	0.08	3.56	2.07	0.54	1.81
Minimum	0.4	-5.57	71.37	6	19
Maximum	0.68	10.83	79.72	8.4	25
			Total		
Mean	0.51	3.11	74.28	7.46	22.25
Std. Dev.	0.06	3.09	4.63	0.93	2.33
Minimum	0.4	-6.57	65.18	5.61	19
Maximum	0.68	10.83	85.15	9.8	27

Source: Authors' calculations

Based on the results of the descriptive analysis, the Visegrad region achieved an average C-efficiency of 51%, where Czechia, Hungary and Slovakia recorded values above 50%. On the other hand, C-efficiency was 47% in Poland, which is below the average level of the Visegrad re-

gion for the observed period. The maximum value of the CER indicator was observed in Slovakia (68%) in 2005, while the lowest value was 36.33% in 1995. If we analyse the average growth of GDP per capita in the Visegrad region, we can conclude that it was 3.11%, wherein Poland and Slovakia recorded a growth rate above 3%, on average. The average share of final consumption was 74.28% of the GDP, where Poland had the highest level of FC (79.68%) compared to other countries in the Visegrad region. Looking at VAT performance in terms of collected revenues and defined rates, we can see that the mean share of VAT revenues was 7.46% of the GDP, while the average standard rate was 22.25%. Hungary had the highest mean standard VAT rate of 25.1%, which is more than the average VAT rate in the Visegrad region. Similarly, the average standard VAT rate of Poland is 22.38%, which is greater than the average of Czechia and Slovakia, where the VAT rate for the observed period was around 21% on average.

Table 5. Correlation analysis

Variables	CEF	GDPpc	FC	VATrate	VATrev	EUac
CEF	1.000					
GDPpc	0.086*	1.000				
	(0.037)					
FC	0.438*	0.113*	1.000			
	(0.000)	(0.000)				
VATrate	-0.314*	-0.032	0.102	1.000		
	0.001	(0.745)	(0.443)			
VATrev	0.429*	0.322*	0.157	0.217	1.000	
	0.000	(0.000)	(0.563)	(0.818)		
EUac	0.603*	0.166	0.218	-0.193*	0.264*	1.000
	0.000	0.145	(0.391)	0.049	0.006	

Source: Authors' calculations

After presenting descriptive statistics, we used correlation analysis in order to examine the type of relationship between the selected variables. The results show a significant relationship between the explanatory variables and the CEF indicator, where GDPpc, FC, VATrev and EUac have a positive effect on the CEF indicator. On the other hand, there is a negative correlation between VATrate and the CEF indicator, which implies that a higher VAT rate lowers VAT collection in the observed countries. The empirical findings suggest that a higher GDP per capita growth and final consumption improve VAT collection through higher VAT revenues, without increasing the VAT rate. If these governments lower the VAT rate, it could have positive implications for the CEF indicator in the observed economies.

Table 6. Panel unit root tests

Panels contain unit roots						
Panels are stationary						
Variables	LLC test	P-value	Breitung test	P-value	Harris-Tzavalis test	P-value
CEF	-3.26	0.126	-1.15	0.125	0.75	0.008
ΔCEF	-7.61	0.000	-5.47	0.000	-0.11	0.000
GDPpc	-5.52	0.158	-2.87	0.000	0.31	0.000
ΔGDPpc	-8.66	0.000	-6.56	0.000	-0.30	0.000
FC	-2.87	0.353	-1.73	0.042	0.78	0.032
ΔFC	-7.93	0.000	-4.14	0.000	-0.07	0.000
VATrate	-2.81	0.314	-0.39	0.347	0.79	0.043
ΔVATrate	-3.68	0.000	-3.71	0.000	0.03	0.000
VATrev	-2.54	0.219	-0.35	0.363	0.84	0.186
ΔVATrev	-9.21	0.000	-6.51	0.000	-0.16	0.000

Source: Authors' calculations

In order to provide information about stationarity, we applied the LLC, Breitung and Harris-Tzavalis tests to the sample of four panels (Czechia, Hungary, Poland and Slovakia).

Table 7. Different panel models

Variable	Random-effects model (1)	Fixed-effects model (2)	GMM estimator (3)
ΔGDPpc	0.131 (0.000)	0.425 (0.000)	0.115 (0.000)
ΔFC	0.245 (0.000)	0.183 (0.000)	0.122 (0.000)
ΔVATrate	-1.637 (0.000)	-1.628 (0.000)	-1.611 (0.000)
ΔVATrev	4.692 (0.000)	4.626 (0.000)	4.647 (0.000)
EUac	0.178 (0.000)	0.104 (0.026)	0.151 (0.000)
R-squared	0.729	0.538	
Model validity	0.000	0.000	0.000
Hausman test		6.54 (0.218)	
Arellano-Bond test for AR(1) in first differences		-0.26 0.043	
Arellano-Bond test for AR(2) in first differences		-1.37 0.171	
Sargan test		13.71 0.346	

Source: Authors' calculations

The results of the implemented tests show that all variables are stationary at first difference, at a significance level of 0.05. After identifying the level of stationarity, the following table shows various panel models such as the random-effects model and the fixed-effects model.

Based on the value of the Hausman test (0.218), it can be concluded that the random-effects model is an appropriately constructed model. The results of the random-effects model show a significant impact of the explanatory variables on the CEF indicators in the observed countries. More specifically, GDP has a positive effect on the CEF indicator, where a 1% increase in GDP per capita enables the CEF indicator to increase by 0.13%. Furthermore, FC has a greater impact on the CER indicator compared to GDPpc, where a 1% growth of this predictor enables the CEF indicator to grow by 0.25%. The predictor VATrev causes the most change in the CEF indicator, where a 1% increase in VATrev leads to a CEF indicator growth of 4.69% for the observed period. Finally, the EU accession of the Visegrad region had positive effects on tax revenues, and improved tax collection in terms of value added tax revenue. Conversely, the VAT rate has a negative impact on CEF, where a 1% increase in the standard VAT rate lowers the CEF by 1.64%. The reliability of these findings can be confirmed by a very high value of R-squared (0.729). Bearing in mind that the empirical model includes VAT revenues as an explanatory variable, which may trigger a potential endogeneity problem since VAT efficiency also affects VAT revenue collection, we additionally introduced the results of the GMM estimator in order to reach appropriate theoretical and empirical interpretations and conclusions. The results of the GMM estimator show the significant effects of the explanatory variables on VAT efficiency, which is similar to the results of the RE and FE models. The values of Sargan and serial-correlation tests show that there is no evidence of miss-specification and autocorrelation at conventional levels of significance.

The results of cross-country analysis indicate that the growth of selected predictors, with the exception of VATrate, increased CER indicators in the Visegrad region. More specifically, a 1% growth of GDPpc contributes to the increase of CEF indicators by 0.31% (Czechia), 0.23% (Hungary), 0.18% (Poland) and 0.18% (Slovakia). Furthermore, the growth of FC has a greater impact on the CEF indicator compared to GDPpc, which can be explained with the fact that indirect taxes, i.e. VAT, generate the most revenue in the budget of the observed countries. A higher level of VATrev enhances the CEF indicator in the Visegrad region, where a 1% increase in VATrev leads to improved VAT collection, by 5.18% (Czechia), 4.89% (Hungary), 3.97% (Poland) and 3.78% (Slovakia).

Table 8. Cross country modelling

Variables	Coefficient	Estimating effect to CEF
ΔGDPpc		+1%
Czechia	0.313	↑ 0.31%
Hungary	0.225	↑ 0.23%
Poland	0.185	↑ 0.18%
Slovakia	0.123	↑ 0.12%
ΔFC		+1%
Czechia	0.694	↑ 0.69%
Hungary	0.663	↑ 0.66%
Poland	0.554	↑ 0.55%
Slovakia	0.546	↑ 0.55%
ΔVATrate		+1%
Czechia	-2.465	↓ 2.47%
Hungary	-2.216	↓ 2.22%
Poland	-2.214	↓ 2.14%
Slovakia	-2.131	↓ 2.13%
ΔVATrev		+1%
Czechia	5.176	↑ 5.18%
Hungary	4.891	↑ 4.89%
Poland	3.968	↑ 3.97%
Slovakia	3.783	↑ 3.78%
EUac		Benefit of EUac
Czechia	0.299	↑ 0.3%
Hungary	0.168	↑ 0.17%
Poland	0.127	↑ 0.13%
Slovakia	0.094	↑ 0.09%

Source: Authors' calculation

Conversely, a higher level of VATrate lowers the CEF indicator in the observed countries, which implies that the governments of these countries should expand their tax base instead of increasing their VAT rates in order to collect more VAT revenues. These findings show that a 1% increase in VATrate reduces the CEF indicator in the Visegrad region by 2.47% (Czechia), 2.22% (Hungary), 2.14% (Poland) and 2.13% (Slovakia). Finally, these results show that the Visegrad region had positive implications for the European Union integration in terms of value added tax collection.

CONCLUSION

This paper investigated VAT revenue collection in Visegrad Group countries (Czechia, Hungary, Poland and Slovakia) for the period between 1995 and 2020. This empirical study measured the VAT systems in these countries in terms of productivity (CER indicator) and efficiency

(CEF indicator), and estimated the effect of predictors such as gross domestic product per capita, final consumption, VAT revenue and VAT rate on VAT efficiency. Bearing in mind that the Visegrad region joined the European Union in 2004, this research includes data from the periods before and after EU accession as a dummy variable. The results of the chosen random-effects model showed that GDPpc has a positive impact on the CEF indicator, where a 1% increase in GDPpc contributes to a 0.13% growth of the CEF. Similarly, FC positively affected the CEF indicator in the observed countries, where a 1% growth in FC improved the CEF by 0.25%. These findings confirmed that hypotheses H_1 and H_2 can be accepted, because GDPpc and FC have positive effects on the CEF. A higher level of VAT revenue leads to a greater level of CEF, where a 1% growth in VAT revenue raises the CEF by 4.69%. On the other hand, a change in VATrate has negative implications for the CEF, where a 1% increase in the standard VAT rate decreases the CEF by 1.64% in the Visegrad region. This means that hypotheses H_3 and H_4 can be accepted, because VATrev positively affects the CEF indicator, while VATrate negatively affects the CEF indicator. Finally, EU accession improved VAT efficiency in the Visegrad region, which implies that H_5 can be accepted. Empirical results show that the governments of the observed countries should focus on achieving the growth of GDP per capita and a greater final consumption in order to stimulate VAT revenue and generate a budget through indirect taxation. Bearing in mind the identified negative effect of the VAT rate on VAT efficiency, fiscal authority can increase VAT revenue by expanding the tax base in order to avoid the refusal impact of a higher VAT rate on revenue collection. In cases in which governments lower the standard VAT rate, countries could face a lower level of collected revenue in the short-term, but the long-term effect will be positive for the economy of the Visegrad region. The results of a cross-country comparison showed that a change in the selected variables leads to a greater change in VAT efficiency in Czechia and Hungary compared to Poland and Slovakia. Future research should focus on Central and South East European countries in order to measure the VAT efficiency in these economies and compare it with the Visegrad region.

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МЕРЕЊЕ ЕФИКАСНОСТИ ПДВ-А У ЗЕМЉАМА ВИШЕГРАДСКЕ ГРУПЕ

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Резиме

Порез на додату вредност представља један од најважнијих пореских облика у светској економији. У оквиру теоријске и емпиријске анализе ефикасности пореза на додату вредност, потврђено је да су земље Вишеградског региона (Чешка, Мађарска, Пољска и Словачка) побољшале наплату пореза на додату вредност након придруживања Европској унији. Мерење ПДВ ефикасности путем индикатора Ц-ефикасности показало је да емпиријски налази указују на то да бруто домаћи производ по глави становника, финална потрошња и приходи по основу ПДВ-а имају позитиван утицај на ПДВ. Емпиријска студија предлаже владама земаља Вишеградске групе да се фокусирају на већу стопу раста БДП-а по глави становника и финалну потрошњу како би стимулисале приходе на основу ПДВ-а. Истовремено, креатори политика ових економија могу генерисати веће приходе од ПДВ-а ширењем пореске основице у односу на повећање стандардне ПДВ стопе које доприноси смањењу ПДВ ефикасности.