

An investigation of the influencing factors of value added tax collection effectiveness in EU Member States

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Received: October 27, 2022 • Revised manuscript received: July 18, 2023 • Accepted: September 23, 2023

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ABSTRACT

Tax evasion is reducing the revenues of public budgets of many European Union (EU) Member States (MS). To improve the effectiveness of tax collection, during the last decade authorities in several MS have taken measures to reduce the value added tax (VAT) gap (i.e., revenue received as a percentage of theoretical liability). In the Central and Eastern European region, VAT gap reduction measures have been implemented effectively in Hungary and Poland, whereas in Romania the effectiveness of these measures is very low: Romania has been the worst-performing EU MS in collecting VAT for more than 10 years. Our study analyses the factors influencing this VAT gap. Our analysis relied mainly on a fixed effects panel regression model, using for a balanced panel an individual and time fixed-effects with cluster-robust standard errors model, and for the unbalanced panel the fixed-effects regression with individual-specific slopes. Our results show that the size of the VAT gap is primarily influenced by five variables: the transparency index, the tax collection ratio, the law enforcement index, the VAT revenues ratio and the digitisation index.

KEYWORDS

tax evasion, efficiency, tax avoidance, tax fraud, tax gap

JEL CLASSIFICATION INDICES

H20, H21, H26

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1. INTRODUCTION

Tax revenues represent the largest share, at least 80–90% of the public budget revenues in Europe. According to Eurostat database, value added tax (VAT) is a crucial income source for the Member States (MS) in the European Union (EU), contributing between 14.0 and 33.8% of budget revenues in 2020. Croatia has the highest share of VAT while Italy has the lowest. As the level of taxation also varies among MS, the other important indicator is the ratio of VAT to Gross Domestic Product (GDP): here, too, there are significant differences among the MS, the smallest ratio being in Ireland (3.4%) and the highest in Croatia (12.6%). VAT revenues are indispensable in the EU, representing 12.2% of the central budget in 2017, with the MS meeting their VAT-based payment obligations at a uniform rate of 0.3%. Increasing the efficiency of VAT collection is not only in the interest of MS but also that of the EU as a collective institution.

Large-scale tax evasion is a major problem. The unpaid tax deprives the budget of important revenue, thus alternative revenues are needed to compensate for the missing resources, and this leads to the introduction of new types of taxes or to increases in the existing ones. Therefore, reducing tax evasion is beneficial for the budget, as higher tax revenues improve the budget balance.

Since VAT is a consumption-type tax, the budget revenue is directly determined by the rate of consumption and the tax evasion. The estimated tax base is determined by the aggregate value of household and government consumption expenditure. In the case of VAT, according to [James \(2015\)](#) the gap is a measure designed at estimating the performance of the VAT, reflecting the difference between VAT actually collected and the not a direct measure of VAT fraud, the VAT gap provides one of the best measures currently available to estimate revenue losses that arise from evasion and avoidance activities. The VAT gap indicates the efficiency of the tax collection activities in a certain state. In the case of VAT, tax evasion is influenced by several factors in addition to social norms, such as the level of taxes levied on the economy, the effectiveness of tax authorities' controls and the level of detection of tax evasion.

Over the past 10 years, authorities in various European nations have implemented measures to decrease the VAT gap. According to the VAT gap in the EU reports (2020, 2021) from the Polish Centre for Social and Economic Research (CASE), Hungary and Poland have seen success in reducing the VAT gap in the Central and Eastern European region. Romania was consistently the poorest performer (33%). Our study analyses the factors influencing the VAT gap in the EU MS, contributing to explore this issue with new panel regression models, involving new variables and extending the research period. Our analysis relied on the fixed effects panel regression models: Individual and Time Fixed-effects with cluster-robust standard errors for the balanced panel, and Fixed-effects regression with individual-specific slopes for the unbalanced panel.

2. LITERATURE REVIEW

We focused mainly on articles analysing the factors influencing VAT rates in, as well as on studies about the successful measures taken by Hungary and Poland.

[Turksen and Abukari \(2021\)](#) analysed OECD global tax principles and EU measures on tax crime. They showed that, overall, the EU has made substantial progress in meeting the OECD's



ten global principles on taxation, but some EU MS had different laws and procedures against the tax offences. Using the cross-country regression method, [Zídková \(2014\)](#) found that, between 2002–2006, the size of the VAT gap in the EU MS was positively correlated with the final consumption as a proportion of GDP, also positively correlated to GDP per capita, and negatively correlated with the ratio of VAT collected to GDP. These three factors accounted for 82% of the VAT deficit in 2006. Nevertheless, no correlation was found between the VAT rate and the level of the VAT gap in the EU MS ([Majerová 2016](#)). There was a negative relationship between the Corruption Perception Index and the VAT gap, and at the same time GDP growth may lead to an increase in the VAT deficit.

[Nikolaos et al. \(2021\)](#) employed the VAT revenue ratio (VRR) as the response variable to assess the Greek VAT Gap. They utilised econometric models based on time series data to examine twelve variables over a span of 21 years (1997–2018). The findings revealed that 5 of the 12 explanatory variables had a significant impact on the Greek VAT gap. Among these variables, the ratio of VAT to total taxes and the number of tax audits were negatively associated with the VAT gap, while the final government consumption expenditure, the difference between the standard and reduced VAT rates, and the gross value added/GDP ratio were positively correlated with the VAT gap. [Redo \(2018\)](#) compared VAT revenue growth and GDP growth in the Central and Eastern European EU MS over the 2000–2016 period and verified the European Commission's VAT deficit estimates. The author analysed the strength of the relationship between the annual change in nominal GDP and the annual change in nominal VAT. The Pearson correlation test showed a very strong positive relationship between the annual change in nominal GDP and the change in nominal VAT revenues. Empirical evidence confirmed by [Uryszek and Klonowska \(2022\)](#) showed that reducing the size of the tax gap for VAT could substantially improve the central government's budget balance and increase the fiscal sustainability.

Tax evasion also depends on prevalent social norms. According to [Alm \(2012\)](#), tax compliance cannot be fully accounted for by financial factors alone, particularly those influenced by enforcement levels. Alm concludes that tax evasion and avoidance are relatively similar across all taxes. Additionally, the existence of a social norm in tax compliance aligns with various perspectives that involve social customs, tax morale, altruistic sentiments, morality, guilt and alienation. [Abraham et al. \(2017\)](#) suggested that social norms exert a more pronounced negative impact on the extent of collusive tax evasion compared to the independent tax evasion. They argue that implementing policy measures, such as anti-corruption policies, that enhance tax morale can potentially yield significant positive outcomes on tax revenue, even in countries where third-party reporting is extensively employed. Although the two most important determinants of VAT gap are tax evasion and tax fraud, [Hoza and Zabka \(2021\)](#) argued that other factors also contribute to the high rate of uncollected VAT. They enumerated business cycles, the grey economy, taxpayers' liquidity problems and possible bankruptcy, as well as errors in the estimation methodology. Examining the efficiency of existing VAT collection systems in the EU, [Kowal and Przekota \(2021\)](#) found that the VAT gap was lower where the level of the standard VAT rate did not change much between 2000 and 2019 and there was no substantial difference between the basic rate and the effective rate. According to their research, if a reduced VAT rate is applied to too many products, the rate of tax evasion is much higher.

As we wrote earlier, over the past years, a notable progress has been made by Poland and Hungary in minimising the VAT gap. In Hungary, a three-part strategy was implemented that resulted in substantial success. The first approach involved the adoption of online cash registers,



the second approach was the Electronic Road Freight Control System (ERFCS), and the third was the online invoicing system (Tóth 2019). In its report on the use of digital devices in taxation, the Hungarian State Audit Office (Salamon et al. 2021) stated that these three measures doubled the VAT revenue collected between 2007 and 2019, and the central budget's share of VAT revenues increased to more than 30% in the 2012–2019 period. As a result of the digitisation, the Hungarian VAT gap decreased from around 20% in 2007 to 6.1% in 2020, which is below the average of both the EU MS and the Visegrád 4 countries. The effective VAT rate increased from 15.4% to 17.2% (a 11.7% change) between 2013 and 2015 with the introduction of online cash registers and electronic road control (Tóth 2019), and from 17 to 19.6% between 2017 and 2019 with the introduction of the online invoicing system (Baksay – Szőke 2020). Ván et al. (2022) suggested that online cash registers (OCRs) are vital in curtailing the extent of the shadow economy. The researchers analysed the influence of OCRs on reported turnover and tax liability in Hungary. By utilising a fixed-effects panel model, they discovered that the impact of OCRs varied based on the size of the enterprise, particularly in the retail, accommodation and food services sectors. Notably, smaller firms increased their reported turnover at a more substantial rate than the larger ones.

The results of the VAT gap reduction in Poland were studied by Simińska-Domańska (2019) in light of the effectiveness of the legal changes introduced in 2016. The new legislation made the effective reduction of VAT deficit possible and substantial success was expected from the introduction in 2019 of the central account register. Digitisation is an indispensable tool in the fight against VAT avoidance, but it can only be effective if it is accompanied by transparent law, adequate tax control and a well-designed penal system according to Szewczyk (2021), who also emphasised that the coronavirus epidemic contributed to tax evasion. However, the author concluded that improvements in information exchange and the development of standard EU digitisation solutions can be useful in achieving an increase in the efficiency of VAT collection. Sarnowski and Selera (2020) concluded that the bilateral agreements on enhanced cooperation to reduce tax crime are a more effective solution, at least in the short and medium terms, than legislation adopted at the EU level. Although the EU has done much to ensure the effective exchange of information and technology between MS, these measures are still insufficient and do not allow access to much relevant tax data. Several new initiatives, such as Eurofisc or Transaction Network Analysis, are particularly valuable, but these tools will only be partially effective without the proper involvement of all EU MS.

3. DATASETS AND METHODOLOGY

Saulnier and Munoz (2021) used panel regression to examine the possibilities of reducing the VAT gap in the EU. The variables used to explain the level of VAT gap were: Burden of Regulation index, VAT arrears, Tax administration spending on information and communication technology (ICT), Transparency Index, and the extent of organised crime. The factors influencing the VAT gap can be divided into three main groups: institutional, macroeconomic and demographic ones (Binder 2021). Binder believes that the institutional factors include, on the one hand, weaker tax compliance, which is usually accompanied by a higher VAT rate, and, on the other hand, several reduced tax rates and weaker legal and institutional efficiency. Macroeconomic factors include wealth distribution inequality, higher unemployment and



business cycles, while social factors include the level of corruption and public confidence in government.

Our study focused on analysing the yearly datasets of 23 EU MS, excluding Greece, Cyprus, Malta and Croatia due to insufficient data. The research spanned over a period of 13 years, from 2007 to 2019, which was a longer duration compared to [Saulnier and Munoz's \(2021\)](#) study that employed a cross-sectional approach and had data only from 2015 to 2019.

In our model the VAT gap was considered as the dependent variable. The data source was the EU Directorate-General for Taxation and Customs Union (TAXUD, [Poniatowski et al. 2020, 2021](#)). We used the explanatory variables applied by [Saulnier and Munoz \(2021\)](#), and in addition two similar variables (the Government Effectiveness Index and a Transparency Index). So, in total, 12 explanatory variables for the entire period were used to estimate the panel regression models. These are as follows (data source are in parentheses):

1. Proportion of wage costs in the budget of the tax authorities – Salary cost ratio (OECD Tax Administration, [OECD 2013](#))
2. Budget of the tax authority concerning the tax collected – Cost of collection ratio (OECD Tax Administration)
3. Corruption Perception Index (Transparency International)
4. Cost of tax collection as a share of GDP (OECD Tax Administration)
5. Ratio of VAT collected to GDP (World Economic Forum)
6. Burden of the regulation (World Economic Forum)
7. Transparency Index (World Economic Forum)
8. Enforcement of Law – Organised Crime (World Economic Forum)
9. Government Effectiveness (World Economic Forum)
10. Tax revenue to GDP ratio (World Economic Forum)
11. Arrears (OECD)
12. Digitisation index – Expenditure on information and communication technology (OECD).

The factors that determine the size of the VAT gap are acting through five channels ([Saulnier – Munoz 2021](#)): Channels of Administrative effectiveness, Tax policy, Burden of government regulation, and the Enforcement of the law.¹ The selected explanatory variables were linked to these channels. The Government effectiveness index, the Arrears, and the Digitisation index were assigned to the administrative effectiveness channel. The ratio of tax revenue to GDP and the ratio of collected VAT to GDP were defined as explanatory variables for the Tax policy channel, as the tax system and the VAT rate are different for each of the examined jurisdictions. The Burden of the regulation index, the cost of collection index, the ratio of wage costs in the budget of tax authorities and the ratio of tax collection costs to GDP index were assigned to the channel of the Burden of government regulation. Also, the fourth transmission channel (the enforcement of law) determining the size of VAT gap is related to the social norms, through the investigated Corruption Perception Index, the Organised Crime Index and the Transparency Index.

Because of a gap in the data series of one of the independent variables, two different panel regression models were used to identify the variables affecting the VAT gap. For a balanced

¹The study of the variables related to the Macroeconomic channel was not the subject of our research.



panel we used a regression model with both individual and time fixed-effects with cluster-robust standard errors and for an unbalanced panel a fixed-effects regression with individual-specific slopes was used.

We first examined the stationarity of the data sets using the Augmented Dickey-Fuller test, then the non-stationary data sets were stationarised through differencing, and then, retested. After testing for the stationarity, we checked its cross-sectional dependence with the Pesaran Cross Section Dependence test, which ensured that there was no cross-sectional dependence (correlation) between the residuals, as $P < 0.05$. We also tested the multicollinearity between the explanatory variables, excluding the pair-wise factors highly correlated with each other, with a correlation variance inflation factor over 4.

The testing of data sets was followed by the selection of the model for the balanced panel regression. According to the basic panel data regression model (Baltagi 2008; Greene 2018):

$$y_{i,t} = \alpha_i + \beta_k x_{i,t} + u_{it} \quad (1)$$

In equation (1): y – dependent variable, α – n entity-specific intercepts, β – coefficient for k explanatory variables, x – observed explanatory variable, u – one-way error component, $t = 1, 2, \dots, T$ – time periods, $i = 1, 2, \dots, n$ – entities and $k = 1, 2, \dots, K$ explanatory variables.

In matrix notation:

$$Y_i = Z_T \alpha_i + \beta X_i + U_i \quad (2)$$

where Y_i is $T \times 1$, X_i is $T \times K$, Z_T is $T \times 1$ and contains a constant term and a set of individual or group specific variables which may be observed and are taken to be constant over time; t , α_i is a scalar, U_i is $T \times 1$ and β a $K \times 1$ parameter vector.

The error term could be decomposed:

$$u_{it} = \mu_i + \varepsilon_{it} \quad (3)$$

where (Eq. (3)) μ_i – time-invariant unobservable individual-specific effect and ε_{it} – remainder disturbance which varies with entities and time.

Three basic panel regression models were tested using the Chow and Hausman test. If Z_i contains only a constant term, then ordinary least squares provide consistent and efficient estimates of the common α and the slope vector β and we have to use the Pooled OLS Model. If Z_i is unobserved, but correlated with $X_{i,t}$, then the least squares estimator of β is biased and inconsistent as a consequence of an omitted variable and we can use the fixed effect model. The Chow Test is designed to determine whether a Pooled OLS or fixed effect (FE) model is appropriate for panel estimation. For Pooled OLS, we assumed that the slope is the same for all groups in all periods, the extension of the Chow test verifies the null hypothesis, whether the slope (coefficient) of the explanatory variables is the same or not for all individuals for all k explanatory variables. The null hypothesis that $\beta_{i,k} = \beta_k$ was rejected because $P < 0.05$, so the fixed effect model proved to be more appropriate.

If the unobserved individual heterogeneity, however formulated, can be assumed to be uncorrelated with the included variables, then the model may be with a random-effects. In the random-effects model we can include time-invariant variable, as long as in the fixed-effects model these variables are absorbed by the α intercept.

Based on the Hausman test, we chose between the random effect model and the fixed effect model, based on whether or not the explanatory variables are correlated with the unique



errors (u_{it}). According to the null hypothesis of the Hausman test, there is no correlation between the observed and unobserved explanatory variables. Since this hypothesis had to be rejected ($P < 0.05$), the fixed-effects model should be used instead of the random-effects model. In the fixed-effects model μ_i were assumed to be fixed parameters to be estimated and the remainder disturbances stochastic with ε_{it} independent and identically distributed IID ($0, \sigma_\varepsilon$) were assumed to be independent of the ε_{it} for all i and t . Using the binary variables, the one-way fixed effects model becomes:

$$y_{it} = \alpha + \beta_1 x_{1,it} + \dots + \beta_k x_{k,it} + \gamma_2 E_2 + \dots + \gamma_n E_n + \varepsilon_{it} \quad (4)$$

where (Eq. (4)) y_{it} – is the dependent variable with i = entity and t = time, $X_{k,it}$ – independent variables with k -number of explanatory variables, β_k – coefficient for k independent variable, E_n – the entity n (since they are binary, we have $n-1$ entities included in the model), γ_n – the coefficient for the binary regressors (entities), ε_{it} – the remainder disturbance term.

Running a Wald-test checks if time fixed effects are needed. The null hypothesis that the dummies for all years are jointly equal to 0 was not accepted, so time fixed effects were needed in our model, so we could add time effects to the entity effects model to have a time and entity fixed effects regression model, with an error term:

$$u_{it} = \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where (Eq. (5)) λ_t – is the time-specific constant. The two-way fixed effects model with binary variables becomes:

$$y_{it} = \alpha + \beta_1 x_{1,it} + \dots + \beta_k x_{k,it} + \gamma_2 E_2 + \dots + \gamma_n E_n + \delta_2 T_2 + \dots + \delta_t T_t + \varepsilon_{it} \quad (6)$$

where (Eq. (6)) T_t is time as binary variable (dummy), so we have $t-1$ time periods, δ_t is the coefficient for the binary time regressors.

The Woolridge-tests null hypothesis for autocorrelation was rejected, so no first-order autocorrelation exists, but the modified Wald test showed a presence of heteroskedasticity. Heteroskedasticity will contaminate both μ_i and ε_{it} and it is hard to claim that it is in one component and not the other (Baltagi 2008). To correct the heteroskedasticity errors we must use heteroskedastic-consistent robust standard error terms. The Huber-White robust standard errors are equal to the square root of the elements on the diagonal of the covariance matrix.

In case of unbalanced panels and a relatively large number of necessary slope variables, we might estimate the treatment effect based on a specific subset of groups (Wooldridge 2010). The conventional fixed-effects estimator relies on the assumption of parallel trends between treated and untreated groups. It returns biased results in the presence of heterogeneous slopes, but the fixed effects individual slope (FEIS) model proposed by Rüttenauer and Ludwig (2020) can overcome this problem. Another fixed-effect regression model used for unbalanced panel data is the linear regression absorbing multiple levels of fixed-effects (Correia 2017). For estimating the variance components and standard errors of the coefficients the Maximum Likelihood Estimations (MLE) and the Minimum Variance Quadratic Unbiased Estimators (MIVQUE) are useful (Baltagi 2008).

The FEIS model introduces an individual slope estimator in Eq. (7), so the regression becomes:



$$y_{i,t} = \alpha_{i1} + w_{i,t}\alpha_{i2} + \beta_k x_{i,t} + u_{it} \quad (7)$$

with w – slope variables.

In matrix notation the regression shows:

$$Y_i = W_i\alpha_i + \beta X_i + U_i \quad (8)$$

where Y_i is $T \times 1$, X_i is $T \times K$ and U_i is $T \times 1$. W_i is a $T \times J$ matrix of slope variables and α_i a $J \times 1$ vector of individual-specific slope parameters for J slope parameters including a constant term. Because W_i includes a constant term, α_i contains the α_{i1} scalar from the conventional FE estimator. A specific case of the FEIS estimator: if W_i contains only a constant term, or $W_i = Z_T$, equation (8) will be reduced to equation (2).

4. RESULTS

There is a strong correlation between some of the explanatory variables classified for different transmission channels: for example, the digitisation index (Expenditure on information and communication technology) is inversely proportional to the evolution of the share of labour costs in the budget of the tax authorities. Owing to the multicollinearity test results we had to remove from our regression models two independent variables highly correlated with each other: Corruption Perception Index (correlated with Transparency Index) and Government Efficiency Index (interdependent with the Burden of Government Regulation index). We examined the dependent variable and the 10 explanatory variables, and the descriptive statistics are presented in Table 1.

During the testing of the variables, we concluded that none of the data sets were stationary, they needed to be stationarised through differencing. The type of panel regression model to be used was determined with the stationary data sets. Using the Chow test first and then the Hausman test, we concluded that we should use the fixed-effects regression model. After the dataset stationarising procedure we used five variables as regressors (Table 2) with an individual statistically significant P -value ($P < 0.05$). The digitisation index was included only in the unbalanced panel regression model due to insufficient data sets.

Regression equations were constructed with these explanatory variables. The basic regression model can be described in general terms as follows (Eq. (9)):

$$VATgap = \alpha + \beta_1 * variable_1 + \beta_2 * variable_2 + \dots + \beta_n * variable_n + \varepsilon \quad (9)$$

The econometric estimations and the tests for a balanced panel using a regression model with both individual and time fixed-effects with cluster-robust standard errors showed that the VAT revenues ratio and the transparency of government policy making index are the best explanatory variables for the VAT gap (Table 3).

Based on the results, the smaller the transparency of government policy-making index, and the lower the ratio of VAT collected to GDP, the larger is the VAT gap. This suggests that the VAT gap can be decreased not only increasing the VAT revenues ratio, but also by improving governmental transparency.

Since economic effects may only occur later, we also tested the leading values for the explanatory variables with the appropriate level of significance. We found only one moderately



Table 1. Descriptive statistics of variables

Dependent variable	Unit	Source	Mean	Std. deviation	Max.	Min.
VAT GAP	Percent of total VAT revenues	TAXUD	15.04	8.95	45.20	1.40
Explanatory variables						
Burden of government regulation	Index	WEF	46.04	9.67	70.71	27.14
Cost of collection ratio, %	Administration cost/ tax revenue	OECD	0.992	0.431	3.060	0.296
Administration expenses ratio	Administration expenses/ GDP	OECD	0.224	0.069	0.423	0.089
Tax collection ratio, %	Collected tax/GDP	Eurostat	36.81	6.35	49.90	22.70
Extent of organised crime	Index	WEF	79.21	12.83	97.86	8.29
Salary cost ratio, %	Salary cost as a percent of total operating budget	OECD	73.60	9.78	97.10	44.80
Transparency Index, %	Transparency of government policy-making	WEF	64.54	12.49	90.00	12.49
Vat revenues ratio, %	VAT revenues/GDP	Eurostat	7.49	1.21	10.30	3.40
Digitisation index, %	Expenditure on ICT/total operating budget	OECD	10.18	6.93	27.80	0.20
Arrears	Arrears/VAT revenue	OECD	19.32	19.31	89.80	1.30

Sources: TAXUD, OECD reports, WEF, Eurostat, own calculations.

Table 2. Econometric estimations – dependent variable is VAT gap, %

Explanatory Variables	Unit	Source	Significance	R-squared (%)
Digitisation index (–1)	Previous year expenditure on ICT/ total operating budget (%)	OECD	*	3.17
Extent of organised crime	Index	WEF	**	2.52
Tax collection ratio	Collected tax/GDP	Eurostat	***	13.10
Transparency	Transparency of government policy-making	WEF	***	10.80
Vat revenues ratio	VAT revenues/GDP	Eurostat	***	23.18

Note: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Sources: TAXUD, OECD reports, WEF, Eurostat, own calculations.



Table 3. Individual and time fixed-effects with cluster-robust standard errors model after econometric estimations – the dependent variable is VAT gap, %

Explanatory variable	Unit	M1
Transparency index	Transparency of government policy-making	–4.14385***
VAT revenues ratio	VAT revenues/GDP	–4.30298***
R-squared		46.47%

Note: * $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$.
Sources: TAXUD, OECD reports, WEF, Eurostat, own calculation.

Table 4. Fixed-effects regression with individual-specific slopes regression – dependent variable is VAT gap, %

Explanatory variable	Unit	M2
Tax collection ratio	Collected tax/GDP	–0.67402***
Digitisation index (–1)	Expenditure on information and communication technology/total operating budget	–0.10088**
Extent of organised crime	Index	–2.80374**
R-squared		42.57%

Note: * $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$.
Sources: TAXUD, OECD reports, WEF, Eurostat, own calculations.

significant leading variable, the digitisation index (–1). In this case, because of randomly missing data in the digitisation index datasets, for an unbalanced panel a fixed-effects regression with individual-specific slopes was used. We found an appreciable level of significance for the following regression (Table 4).

The M2 model for the unbalanced panel showed that three independent variables could be used to reduce the VAT gap with moderate explanatory power (R-squared). The higher tax collection ratio, the improvement of law enforcement and the increase of the tax administrations expenses on information and communication technology in the previous year all contributed to a decrease in the VAT gap.

5. CONCLUSIONS

The goal of our research was to identify the key variables that affect the level of the VAT gap and to identify modalities for increasing the efficiency of VAT collection in the EU MS. Our fixed effect panel regression models demonstrated that the size of the VAT gap is mainly influenced by five variables: the transparency index, the tax collection ratio, the law enforcement index (extent of organised crime index), the VAT revenues ratio and the tax administration expenditure on information and communication technology in the previous year. The R-squared



coefficient showed that the combination of the transparency index and the VAT revenues ratio explained the value of the VAT gap with the best deterministic value (46.47%). The fixed-effects regression with individual-specific slopes has also a deterministic value (42.57%), presenting that VAT collection efficiency is mainly determined by the tax collection ratio, the law enforcement and the delayed effect of expenditure on information and communication technology in the tax authority's budget.

The two fixed effect regression models revealed that in the case of the VAT gap the most important transmission channels are the tax policy channel (VAT revenues ratio, Tax collection ratio), the administrative effectiveness channel (digitisation index) and the enforcement of law channel related to social norms (extent of organised crime index and transparency index).

According to a study by Tóth (2019), the implementation of online cash registers in Hungary led to a reduction of 24% in the VAT gap between 2013 and 2015. By digitising the system, the Hungarian VAT gap has significantly declined from approximately 20% in 2007 to just 6.1% in 2020, which is lower than the average of both the EU MS and Visegrád 4 countries, as reported by Hungarian State Audit Office (2021). Hungary successfully reduced its VAT gap through the implementation of three measures: online cash registers, the Electronic Road Freight Control System (ERFCS), and the online invoicing system. These measures are strongly linked to digitization. Additionally, our panel regression model showed that investing in information and communication technology in the tax authority's budget had a delayed effect in reducing the VAT gap. The successful example of Hungary could serve as a model for Romania, where tax evasion rates are high, and IT investments can potentially increase the efficiency of tax collection.

ACKNOWLEDGEMENT

The research was supported by the Pallas Athéné Domus Educationis Foundation, Hungary, PADE 113/2019.09.23.

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