DIFFERENT INSIGHT INTO THE VAT GAP USING MIMIC MODEL

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ABSTRACT

The paper focuses on the estimation of the MIMIC model for quantification of VAT gap. MIMIC model is a specific type of structural equation models, which treats the VAT gap as a latent unmeasurable variable whose emergence and size are influenced by causes and whose presence is reflected in indicators; causes and indicators must be measurable. The contribution of this model is identification of causes of VAT gap, that are potential sources of VAT collection inefficiencies. The MIMIC model was built on data from selected European countries and according to the model VAT gap has these significant causes: openness of economy, corruption perception index, general government expenditure, final consumption and e-government development index. Developed using data from European countries, the model can be applied on each of these countries for quantification of VAT gap. These outputs can support the recommendations leading to improved efficiency of VAT collection.

Keywords: VAT gap, determinants of VAT gap, efficiency of VAT collection, MIMIC model, structural equation model

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1 INTRODUCTION

Value added tax ("VAT") is one of the most important tax sources in most European countries. However, it is often connected with the risk of tax evasion. According to the estimates of the European Union ("EU") in 2020, the total VAT evasion loss was 93 billion euro, this means that every second of the year 2020 cost the public budgets of the EU member states around 3.000 euro (Baert, 2023). Tax evasion generally poses threats to the economic environment, the tax system and society. According to Novysedlák and Palkovičová (2012), tax evasion and tax avoidance ruins the economic environment because some entities gain an advantage that may in the long run encourage other entities to similar practices, even if tax evasion was not their first intention. Moreover, tax evasion is a major source of inequality, regardless of a country's redistribution objective (Argentiero et al., 2021).

When dealing with tax evasion and examining tax collection efficiency, the tax gap can provide valuable information. In the case of VAT, the VAT gap has become an indicator of

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VAT fraud (Moravec et al., 2021). VAT gap is defined as the difference between the amount of VAT that should be collected under the legislation and the VAT actually collected (Carfora et al., 2020). The VAT gap covers revenues lost due to tax frauds and also due to bankruptcies, taxpayer insolvency or tax liability miscalculations (Jonski & Gajewski, 2022).

When quantifying the VAT gap, econometric methods make it possible to consider more aspects, for example the quality of public sector institutions or the level of digitalization of the public administration. This paper while building multiple indicator multiple causes (hereinafter 'MIMIC') model considers variables such as unemployment, openness of economy, index of economy freedom, corruption perception index (hereinafter 'CPI'), general government expenditure, final consumption expenditure, e-government development index (hereinafter 'EGDI') as causes of the VAT gap. The existence of a VAT gap is evidenced by the growth of GDP (gross domestic product) per capita and VAT revenue (indicators).

Contribution of this paper is the MIMIC model with data from selected European countries, that model can be applicable to these countries.

2 LITERATURE REVIEW

For estimating the VAT gap and the tax gap in general, there are three approaches in the literature: the bottom-up approach, the top-down approach and methods based on econometric modelling (Alm, 2012; Kasnauskienė and Krimisieraitė, 2015; Poniatowski et al., 2020). The bottom-up approach is based on tax audits and direct interviews with taxpayers (Alm, 2012). According to Novysedlák and Palkovičová (2012) into bottom-up approach belong these methods: selection of a random sample of taxpayers and targeted controls based on risk analysis. Gajewski and Jonski (2022) alert, that tax authorities using the second mentioned method target taxpayers with the highest expected value of unreported tax liabilities, so such data source could lead to overestimation of the gap.

The top-down approach processes macroeconomic data and international accounts data that cover the entire national economy (Poniatowski et al. 2020). As data sources can be used data from statistical offices on the production of gross domestic product or supply and use tables which provide information on the production of individual industries but also on the consumption by these industries and sectors of the national economy.

In contrast to the other two approaches, the approach based on econometric modelling not only provides information about the size of tax evasion, but also identifies the factors and determinants that have influence on its size. On the other hand, the disadvantage is that the econometric model can only determine the development (year-on-year changes) of tax evasion over time; its value in the base period needs to be determined by another method (Kasnauskinė and Krimisieraitė, 2015; Schneider, 2005).

The MIMIC model was pioneered by Frey and Weck-Hanneman (1984), who used it to estimate the extent of the shadow economy in member states of Organization for Economic Co-operation and Development (hereinafter 'OECD'). Schneider et al. (2010) and Tedds (2005) also used it in connection with calculation of share of the shadow economy on GDP. Frey and Weck-Hanneman (1984) chose this method in response to the fact that all approaches used until that time assessed the extent of the shadow economy on the basis of just one indicator depending on the method used (the currency in circulation – the demand for currency approach) and moreover, they did not consider almost any other causes of the shadow economy. The MIMIC model was also used for research into the determinants of the VAT gap in Lithuania (Kasnauskienė and Krimisieraitė, 2015).

Using MIMIC model it is possible to include into the calculation of VAT gap variables such as e-government development index (hereinafter 'EGDI'), this variables have not been considered regards VAT gap calculation in several European countries yet.

3 METHODOLOGY

3.1 Variable selection

The following section introduces variables for the MIMIC model. Two types of variables are needed for this model, causes and indicators. Table 1 consists of candidate variables as causes and indicators, short explanation, source of the data and authors, who have already considered these variables regarding VAT gap.

Center for social and economic research (hereinafter 'CASE') included among the possible determinants of the VAT gap the unemployment rate as an indicator of taxpayers' liquidity difficulties (Poniatowski et al. 2018). The unemployment rate also expresses income inequality or poverty (Reckon, 2009). In this research, unemployment will be understood as an index of the economic cycle.

The openness of an economy is expressed as the share of the sum of imports and exports on a country's GDP. This variable was examined by Aizenman and Jinjarak (2008) and also more recently by Carfora et al. (2020). According to these authors, the openness of an economy has a positive effect on the efficiency of VAT collection, i.e., it reduces the VAT gap. According to the research by Pluskota (2022), the factor of the share of foreign trade (exports and imports) in GDP is significant for the whole EU.

Variable	Explanation	Author	Source
Causes			
Unemployment rate	Poverty, income inequality, index of the economic cycle	Poniatowski et al. (2018); Reckon (2009)	Eurostat
Openness of economy	Risk of carousel fraud, the openness of the economy	Zídková and Pavel (2016)	Eurostat
Index of economic freedom	Government quality, tax burden, open market	Godin and Hindriks (2015)	The Heritage Foundation
CPI	Government quality, corruption perceived	Reckon (2009); CASE (2013)	Transparency International
General government expenditure	Size of the public sector	Reckon (2009); Zídková and Pavel (2016)	Eurostat
Final consumption	Purchases of final consumers, potential VAT base	Zídková and Pavel (2016)	Eurostat
EGDI	Information technologies in government and tax offices	Poniatowski et al. (2020)	United Nations
Indicators			
Growth of GDP per capita	Reflection of tax evasion between taxpayers	Kasnauskienė and Krimisieraitė (2015)	Eurostat
VAT revenue on GDP	Level of VAT revenue in each country	Kasnauskienė and Krimisieraitė (2015)	Eurostat

Tab. 1 Candidate variables as causes and indicators

Openness of economy also brings an opportunity for missing trade, intra community fraud and carousel fraud (Frunza, 2019). In this case openness of economy has a negative effect on the efficiency of VAT collection.

The efficiency of the tax system is strongly influenced by the quality of the government which means mainly the formulation and implementation of various regulations but also the degree of independence of tax administration of political pressure (Godin & Hindriks, 2015). According to the findings of Chan and Ramly (2018), the redistributive effect of the VAT system also depends on the quality of the government structure, otherwise the VAT system could be highly regressive and widens income inequality.

The index of economic freedom has 12 principles for sustained progress and prosperity, many of which involve the quality of government, as described above (The Heritage Foundation, 2023).

CPI is another variable entering the model. CPI measures, how corrupt each country's public sector is perceived to be according to experts and businesspeople, higher CPI means lower perceived corruption in country (Transparency International, 2023). CPI is next to the Index of economy freedom another sign of quality of public institution. Reckon (2009) included CPI into its econometric analysis of VAT gap and it showed up as the variable with the strongest relationship with the size of the VAT gap, lower perceived corruption is connected to the lower VAT gap.

CASE also included CPI into its regression analysis of VAT gaps' determinants, but its results showed positive, however insignificant, relationship between VAT gap and CPI, it indicates that improvement in perception of corruption within a country is connected to the higher VAT gap (Barbone et al., 2013). CASE (Barbone et al., 2013) and Reckon (2009) reached opposite results about relationship between CPI and VAT gap.

For the purpose of the model, government expenditure is expressed as a share of GDP in each country. Reckon (2009) included government expenditure in his research into the causes of the VAT gap because it reflects both the total tax burden and also the size of the public sector with tax audits and other types of regulation. Zídková and Pavel (2016) included government spending as a share of GDP in their study on the causes of the VAT gap because it reflects the size of the public sector. They argue that a larger size of the public sector will lead to a reduction in the VAT gap.

Final consumption expenditure is the part of the expenditure that is spent mainly by households on goods and services that will be used to directly satisfy individual needs (Eurostat, 2016).

There are purchases by final consumers which can proxy potential VAT base (Zídková and Pavel, 2016). These purchases can be made in cash and as such they do not come under the scrutiny of the tax authority. A study carried out by Immordino and Russo (2018) shows that cashless payments negatively affect the VAT gap. Even for this reason, cash final consumption is much more problematic for VAT collection than intermediate consumption by manufacturing businesses, which can claim VAT deductions on their purchases (Zídková and Pavel, 2016).

EGDI is an index produced by the United Nations for its member states and it is to reflect how countries use information technology (United Nations, 2023). The use of this index helps to take into account advancing digitalization whose purpose is to eliminate tax evasion. CASE used Information Technology expenditures related to GDP in order to capture the effect of implementing innovative processes into tax administration, result of their research show a statistically significant negative effect of Information Technology expenditures on GDP on VAT gap (Poniatowski et al., 2020). Digitalization will allow the government to access and analyse the necessary information, which will increase the efficiency of tax collection (Alm, 2021).

GDP per capita will be used as the first indicator to reveal VAT collection inefficiency, in particular VAT evasion. Schneider et al. (2013) used this variable as an indicator when examining the shadow economy, arguing that the informal economy must necessarily be reflected in the formal economy that is captured by the statistical offices. Kasnauskienė and Krimisieraitė

(2015) examined the determinants of the VAT gap using the MIMIC model and used real GDP per capita as one of the indicators to eliminate the effect of inflation. For the purpose of the MIMIC model, the VAT revenue is expressed as the share of VAT collection in the GDP of each country, so it can be comparable with each other. This variable was chosen as a second indicator as tax noncompliance must necessarily be reflected in a decrease in VAT revenue (Kasnauskienė and Krimisieraitė, 2015).

3.2 MIMIC model

MIMIC model is based on the statistical theory of a latent (unobserved) variable which is measured using multiple measurable causes and indicators.

The MIMIC model is a specific type of structural equations model, consisting of two models: a structural model and a measurement model (Schneider et al., 2010). To estimate the variance of a latent variable, the MIMIC model uses unstandardized estimates, which means that the first indicator is always fixed at level 1 and is called the **reference indicator**. All the other estimates change by a given coefficient, if the **reference indicator** changes by 1 (Acock, 2013).

In addition to several measurable (observed) variables, there is also a latent variable in these two models, but in each model, it has a different "role". In the structural model, the latent variable is the dependent variable that is influenced by the measurable variables entering the model. The equation can be expressed as follows:

(1)

$$\eta_t = \gamma' x_t + \varsigma_t$$

Where x_t' is a (1*q) vector of time series x_{it}, $i=1,....,q$ containing potential causes of the hidden variable η_t and γ' is a vector of coefficients expressing the relationship between the hidden variable and their causes. ς_t expresses the error term.

In the measurement model it is true that the latent variable is independent, whereas the measurable variables entering the model are dependent on it.

(2)

$$y_t = \lambda\eta_t + \varepsilon_t$$

Where y' is a (1*p) vector of time series of indicators of the hidden variable, λ is a vector of regression coefficients. ε' is a vector of white noise.

The latent unobserved variable, the VAT gap in this case, is first linked to the observed indicator variables, all within the measurement model. And then the relationships between the latent unobserved variable and the observed explanatory variables (causes) in the structural model are examined.

Using Equation 1 in Equation 2, we obtain a multiple regression model where the explanatory endogenous variables y_{jt}, $j = 1,...,p$ are indicators of the latent variable η and the explanatory exogenous variables x_{it}, $i = 1,....,q$. The model can be expressed by the equation:

(3)

$$y_t = \Pi x_t + z$$

Where $\Pi=\lambda\gamma'$ is the matrix and $z = \lambda\varsigma + \varepsilon$. The error term zis a (p*1) vector of linear combinations of white noise ς and ε from the structural model and the measurement model.

In short, the first step is to confirm or reject the predicted relationship between the VAT gap (latent variable) and its causes and indicators. Once the relationship is confirmed by the MIMIC model, the MIMIC index will be calculated using the structural model equation, Equation 1. Equation 4 expresses the calculation; it is a modified Equation 1.

(4)

$$\tilde{\eta}_t=\gamma x_{1t}+\gamma x_{2t}..+\gamma x_{qt}$$

Where x_{1t} to x_{qt} express the variables of causes at the level of at least 5%. The MIMIC index only expresses the relative development of the latent variable, the VAT gap in this case. In order to calibrate the relative values into absolute values, a baseline variable obtained by another method must be used.

For conversion is used the following equation:

(5)

$$\hat{\eta}_t = \frac{\tilde{\eta}_t}{\tilde{\eta}_{base}} * \dot{\eta}_{base}$$

Where $\tilde{\eta}_t$ expresses the value of the MIMIC index at time t according to Equation 4. $\tilde{\eta}_{base}$ is the value of the MIMIC index in the base period and $\dot{\eta}_{base}$ is an estimate of the latent variable obtained by another method.

3.3 Data

The MIMIC model is built on panel data from selected European countries (a total of 26 countries) between the years 2002 and 2020. Due to data availability, the maximum time series was chosen to provide a sufficient database for the estimation of the MIMIC model. With regard to the availability of EGDI, which represents digitalization, the time series could not start earlier than 2002 and the aim was to get an overview of the VAT gap development up to the most recent possible year.

4 RESULTS

Table 1 presents the MIMIC models. In Model 1 all variables are included. The aim is to retain in the structural model only those variables that will be significant at least at the 5% level of significance. The stepwise selection eliminates statistically insignificant variables step by step, the whole process is shown in Table 1.

When deciding which model is the best possible, information criteria can be of help. In this research Akaike information criterion (hereinafter 'AIC') was used. The most appropriate model is the one with the lowest value of this criterion. Some other indicators of model quality

are also best in the final model. The comparative fit index (CFI) expresses how close a given model is to a perfect fit for the data used. It takes values from 0 to 1 and the higher number means the better model.

The interpretation of coefficients in structural model of MIMIC model is very similar to the interpretation of coefficients in regression analysis. Their value shows the resulting change in the VAT gap for a unit change in the cause variable, under ceteris paribus condition. In the following paragraphs the coefficients from structural model are interpreted according to the model 1, which consist all of the variable, significant and also insignificant. Final consumption is the strongest driver of the VAT gap. According to the model 1, if **final consumption** increases by 1 percent, then the VAT gap also increases by about 5.71 percent. **Final consumption** is significant at level 5%, so it remain in model 2 and also in final model, value of its coefficient fluctuates around 6 to 7%. ¨

Higher **unemployment** increases VAT gap, according to the model 1 if **unemployment** increases by 1 percent, then the VAT gap also increases by 0.01 percent. In model 2 coefficient of variable **unemployment** stays stable, however this variable had to be remove from the final model due to too high p-value.

Higher **openness of economy** also increases VAT gap, if **openness of economy** increases by 1 percent, then the VAT gap also increases by 0.02 percent. **Openness of economy** is significant on needed level of significance, value of its coefficient remain stable in model 2 and also in final model. There is no unified conclusion about effect of **openness of economy** on VAT gap, according to the Aizenman and Jinjarak (2008) its effect on VAT gap is negative, on contrary according to Frunza (2019) open economy create opportunities for carousel frauds and

	Model 1	Model 2	Model 3 *final model*
Structural	Coefficient (P-value)	Coefficient (P-value)	Coefficient (P-value)
Unemployment	0.01	0.01	
Openness of economy	0.02 ***	0.02 ***	0.02 ***
Index of economy freedom	-0.01		
CPI	-0.27 ***	-0.32 ***	-0.14 ***
General government expenditure	-4.44 ***	-5.3 ***	-4.53 ***
Final consumption	5.71 ***	7.08 ***	6.05 ***
EGDI	-2.01 ***	-2.44 ***	-2.20 ***
Measurement			
VAT revenue on GDP	1	1	1
Growth of GDP per capita	13.01 ***	10.89 ***	12.97 ***
Statistics			
CFI	0.851	0.80	0.86
Information criteria			
AIC	850.57	-838.84	-2517.93

Tab. 2 Model MIMIC for Europe-26 (author calculations in the STATA program), VAT revenue on GDP is used as a reference indicator

other VAT frauds, which have positive effect on VAT gap. This research confirms conclusion about positive effect of openness of economy on VAT gap.

Index of economy freedom has a negative effect on VAT gap, if **Index of economy freedom** increases by 1 percentage point, then VAT gap decreases by 0.01 percent. This variable is not statistically significant on needed level of significance. Due to too high p-value this variable had to be remove from model 2 and final model.

CPI has also negative effect on VAT gap. If **CPI** increases by 1 percentage point (it means less perception of corruption), then VAT gap decreases by 0.27 percent. **CPI** is also significant on needed level of significance, so it remains in model 2 and final model. Value of the coefficient remains stable. CASE (Barbone et al., 2013) and Reckon (2009) also examined the influence of CPI on VAT gap and they reached opposite results. This research confirmed results of Reckon (2009) about negative effect of CPI on VAT gap.

General government expenditure has also a negative effect on VAT gap, but this variable is much stronger. If **general government expenditure** or rather its share of general government expenditure on GDP increases by 1 percent, then VAT gap decreases by 4.44 percent. This variable is significant on needed value of significance, so it remains in model 2 and in final model, value of its coefficients fluctuates around 4 to 5.5 percent. As in the case of **openness of economy** there is no unified conclusion about effect of **general government expenditure** on VAT gap, this research confirms conclusion from research of Zídková and Pavel (2016) about negative effect of general government expenditure on VAT gap.

EGDI decreases VAT gap, compared to previous one it is not very strong variable. If **EGDI** increases by 1 percentage point, then VAT gap decreases by 2.01 percent. **EGDI** is significant variable on needed level of significance, so it remains in model 2 and final model. Value of the coefficient remains stable.

Table 2 Model MIMIC for Europe-26 (author calculations in the STATA program), VAT revenue on GDP is used as a reference indicator.

5 DISCUSSION AND CONCLUSIONS

In this research the MIMIC model for quantification of VAT gap was estimated. This model is applicable for 26 European countries. MIMIC index determines year-on-year changes in VAT gap according to the year-on-year changes in significant causes of VAT gap. For second step baseline variable is needed for conversion year-on-year changes in VAT gap into absolute values of VAT gap.

Contribution of the MIMIC model is identification of significant causes of VAT gap, these causes means potential sources of VAT collection inefficiencies. This contribution also hides a huge limitation of the research conducted, which is the omission of an important input variable. Such omission would lead to biased results of the MIMIC model. In order to avoid such omission, a literature search was made of studies on the causes or determinants of the VAT gap. The search included studies by foreign and domestic authors and also authors under the auspices of the European Union, such as CASE or Reckon.

Significant causes include final consumption, general government expenditure, openness of economy and EGDI. Recommendations for the further development of indirect tax policy should be based on statistically significant causes of VAT evasion. A recommendation arising from this research is to focus on the digitalization of tax offices, which can increase the efficiency of VAT collection. Digitalization can also simplify cooperation between tax offices at home and abroad, which could help to eliminate the economy openness factor as well. The paper shows a new insight on the VAT gap through modelling.

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