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A Multifactor VAT Gap Comparative Analysis in the European Union

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Abstract

The present study attempts to address the multifactorial problem of the VAT GAP within the European Union (EU) area. Firstly, the study tries to extend the existing research on understanding the factors that affect the VAT GAP in European Union. The research design is based on a panel data analysis investigating whether and to what extent some macroeconomic and institutional indicators affect the VAT GAP in the EU countries. Secondly, a comparative analysis is carried out concerning subgroups of countries based on characteristics such as the average VAT GAP and the average level of the shadow economy. No previous study to the best of author's knowledge and through search in peer-reviewed databases has empirically explored the determinant factors of VAT GAP through this separation. The main findings of the study indicate that, in terms of the analysis of all EU countries, the factors that significantly affect the VAT GAP are the GDP per capita, the size of the shadow economy and the level of unemployment. Regarding the findings of the comparative analysis of two subgroups, this study concludes that the informal economy and unemployment affect more the VAT GAP of the less developed EU countries. On the other hand, for the developed ones, the VAT GAP is affected mainly by the unemployment.

Keywords

Vat Gap, Tax Evasion, Shadow Economy, European Union, Comparative Analysis

1. Introduction

One of the most basic problems of the countries of the European Union is the phenomenon of VAT evasion. This phenomenon acts as a brake on public reve-

nues but also on the fiscal policy of each country, limiting its economic potential and creating cracks in social cohesion. A typical example of the problem is that the European Union lost €134 billion in 2019 from uncollected VAT (Poniatowski et al., 2021).

The purpose of this study is to examine the effect of various factors and indicators on the VAT GAP in the 28 EU countries covering the period from 2012 to 2019. This period was characterized by the deep impact of financial crisis on the economy of the European Union countries. Thereafter, this study attempts to investigate the determinants of VAT GAP during this crucial period. Furthermore, the EU countries are divided into two subgroups, those with low average VAT GAP and shadow economy and in those with a high average VAT GAP and shadow economy, where a comparative analysis of the results is carried out. No previous study to the best of author's knowledge and through search in peer-reviewed databases has empirically explored the determinant factors of VAT GAP through this separation. The remaining of the study is structured as follows: The literature review, the research design, the results estimation, the VAT GAP comparative analysis, and the conclusion-policy implications.

2. Literature Review

There is extensive literature dealing with the VAT GAP both at the level of the European Union and at the level of individual countries. The common denominator of all these studies is the examination of the factors that influence the VAT GAP. The majority of these studies investigate the effect of macroeconomic and demographic indicators as well as governance indicators. For instance, Ciobanu et al. (2023) try to identify the main social, political and cultural factors that can influence the size of the VAT gap. In this sense, they performed a statistical analysis based on a panel regression to determine the impact of the determinants on the size of the VAT gap in the EU member states. They examined inflation, population growth, Gini index and GDP per capita. The results identified a negative influence on the VAT gap from the corruption perception index, imports of goods and services, inflation, consumption prices and the regulation quality index. In the case of the first three, the higher the value of the variable, the lower the value of the VAT gap, and the relationship between them is practically inversely proportional. Population growth, the Gini index, GDP per capita and government effectiveness positively affect the value of the VAT gap, which produces a significant increase. Exports of goods and services and trade of goods do not influence the VAT gap in the analyzed period.

Szczypińska (2019) tries to identify the factors shaping the VAT GAP in EU member states (except Cyprus and Croatia) for the years 2011-2015. She studies macroeconomic and demographic factors such as GDP, the population of each country, the GINI index, the percentage of small businesses, etc. She also examines factors related to the design and effectiveness of the tax system, such as the percentage of VAT rates, the number of VAT rates and the administrative costs of

the tax collection mechanism, as well as variables related to trust in institutions such as the Corruption Perception Index. She ascertains that the design of the tax system, the level but also the number of VAT rates, are not a key determinant of the VAT GAP. The reform of the tax system which implies a reduction of VAT rates or their dispersion does not necessarily contribute to a reduction of the VAT GAP. Information Technology (IT) expenditures in tax administration may improve efficiency in VAT collection. These costs help in the reliable data collection, data analysis and can help increase the detection of tax fraud. Countries that invest in IT systems in tax administration demonstrate lower levels of VAT GAP. Szczypińska (2019) also indicates that the quality and transparency of public institutions reinforce the citizens' trust in the state which in turn results to higher tax collection efficiency. Countries characterized by a high institutional culture do not face serious problems with the VAT GAP. Kitsios et al. (2023) in their paper try to deal with the digitalization as a critical parameter that can reduce VAT evasion. This paper argues that the use of digital technologies offers an opportunity to reduce fraud and increase government revenue. Using data on intra-EU and world trade transactions, they present evidence that: 1) cross-border trade tax fraud is non-trivial and prevalent in many countries; 2) such fraud can be alleviated by the use of digital technologies at the border and 3) potential revenue gains of digitalization from reducing trade fraud could be substantial. Reducing half the distance to the digitalization frontier could raise the median VAT revenue by 1.1% of GDP for low-income countries, 0.7% for emerging markets and advanced economies, and 0.4% for the EU. Median tariff revenue could increase by 0.4% of GDP for low-income countries, 0.2% for emerging markets, and 0.04% for advanced economies. These results only indicate potential revenue gains because reducing the distance to the digitalization frontier will likely require significant fiscal resources and the removal of institutional barriers.

Zídková (2014) also tries to examine the dependence of the VAT GAP in 24 EU member states (excluding Cyprus, Bulgaria and Romania) for the years 2002 and 2006 on various economic, social and fiscal factors. This study concludes that an increase in consumption as a percentage of GDP leads to an increase in the VAT GAP. Other variables that explain the size of the VAT GAP as determined in the regressions were the share of the shadow economy and the normal VAT rate. The higher these variables are, the higher is the VAT GAP. This evidence is consistent with Dalamagas et al. (2019) who claim that policy makers attempt to define the maximum and minimum values of direct and indirect tax rates in order to achieve optimal equity and/or efficiency goals. Under this consideration, policy makers may choose tax-rate ranges that are associated with high optimal direct and indirect tax rates which however raises the level of tax evasion. Instead, they may choose low optimal direct and indirect tax rates which are connected with low levels of tax evasion. On the other hand, GDP per capita, the share in intra-Community trade and the number of VAT rates have a

negative impact on the VAT GAP, meaning that if these rates increase the VAT GAP declines. Majerová (2016) attempts to examine the dependence of the VAT GAP on three indicators: the Corruption Perception Index, the rate of change of GDP and the level of the basic VAT rate. This study analyzes the data for EU Member States (excluding Cyprus) for the years 2000-2011. Majerová (2016) claims that the CPI Corruption Perception Index and the GDP growth rate are significantly correlated to the VAT GAP. Frunza (2017) examines whether the VAT GAP is affected by the existence of the shadow economy in the EU adopting in his empirical study as input the estimates of the size of the shadow economy from previous studies. The results show that the not collected VAT due to the shadow economy in the EU is estimated at 14% of the total VAT collected. An interesting conclusion of this study is that Southern and Eastern European countries appear the greatest contribution to uncollected VAT due to the size of their shadow economy. Lešnik et al. (2018) investigate the VAT collection gap for the country of Slovenia based on VAT tax returns submitted for the years 2010-2013. Macroeconomic factors as well as factors related to measures of the Slovenian tax authority are taken into consideration in this empirical study concluding that the tax gap decreases in conditions of economic growth. They also find that, measures implied by tax administration (number of tax audits) have a positive effect in the VAT collection. Raczkowski and Mróz (2018) tried to estimate the tax gaps of 28 EU member states and 7 additional countries as a percentage of the GDP. The basic finding of the research is that the level of the tax gap is determined individually for each country and is strongly negatively correlated with the GDP. Zídková et al. (2016) also tried to find correlations between tax evasion and tax moral, which is closely linked to shadow economy. Surprising their results showed negative linear correlation between them, as they assumed consistently which is contrary to other literature that the higher the tax moral the lower the tax evasion no matter whether represented by the extent of the shadow economy or the VAT gap.

Nerudova and Dobranschi (2019) attempt to find an alternative method of measuring VAT GAP in the EU taking into account in their analysis variables such as the Corruption Perception Index (CPI), the percentage of the shadow economy, the population, the number of documents to be completed for import of goods and the cost of imported goods. They find that CPI has a negative impact on VAT collection efficiency. The shadow economy also tends to increase VAT collection inefficiency. They also ascertain that the number of documents required to import goods has a negative impact on VAT compliance and increases the inefficiency of VAT collection. This study also points out that as the cost of imported goods increases, so does VAT compliance. Butu et al. (2021) also examined (among other indicators) the relation of the Corruption Perception Index (CPI) with VAT GAP among group of EU countries. The results showed that, CPI had opposite direction and significant correlation coefficients for all groups excepting the "Northern" group of EU countries and at EU level, as was expected.

This suggests the importance of CPI on VAT Gap levels. At EU level, less corruption is perceived by experts and business executives, which means a higher CPI index, would lead to a reduced VAT Gap by increasing the efficiency of VAT collection. On the other hand, there is a positive relation in the Northern countries, which means that when less corruption is perceived, the VAT GAP will increase, which may not always fold to reality. One explanation can be that the Northern States (Sweden, Denmark, and Finland) are among the most developed countries in terms of the value of gross domestic product per capita and are focused more on direct taxes than on VAT. Butu and Brezeanu (2021) again examined the impact of corruption and poverty on VAT Gap in Central and Eastern Europe. In all three models they used (OLS Fixed Effects & Random Effects), the variable Corruption Perception Index (CPI) had an opposite sign and is statistically relevant, except for the fixed effects model. Thus, in Central and Eastern European Union countries, the less corruption is perceived by business executives and experts, which is related to a higher value of CPI, which will determine a reduction of the VAT Gap, by improving VAT collection.

Eriotis et al. (2021) focus their research analysis on the VAT GAP in Greece for the years 1997-2018 taking into account social, economic and fiscal factors in their empirical analysis. They find that the ratio of VAT to total taxes and the number of tax audits have a negative correlation with the Greek VAT gap. Government consumption expenditure, the difference between the standard and the reduced VAT rate and the ratio of VAT to GDP are correlated positively with the Greek VAT GAP. Christou et al. (2021) also examine the influence of specific productive sectors of the Greek economy in VAT revenue collection, dividing it into fifteen categories for the period 1997-2018. They point out that only four of the fifteen economic sectors examined (the Catering and Accommodation Services sector, the Public Administration sector and the Agriculture sector), are related positively to the Greek VAT GAP. On the other hand, an increase in the share of the industrial sector in GDP is associated with a reduction in the VAT GAP. Anastasiou et al. (2020) estimated the extent of tax evasion in Greece for the period 1980-2018 in their study. For this estimation they chose to apply an indirect method of approach to the issue, based on the assumption that estimating the size of the shadow economy can lead to a safe measurement of the extent of tax evasion. More precisely, through the Currency Demand approach which is based on the basic assumption that activities under the shadow economy constitute a direct response of taxpayers to the increased tax burden and that cash is mainly used to conduct such transactions and of the wealth derived from them. The results showed a significant increase in tax evasion size during the period considered, while the model estimation showed that most tax evasion came from direct taxation. Overall, during the 1980-2018 period, the size of tax evasion increased by 275.94%. While in 1980, the tax evasion rate in the Greek economy was 3.74%, in 2018, it stood at 10.32%. According to the model estimates, the increase in the average tax burden leads to an increase in tax evasion in Greece.

Specifically, increasing the tax burden on the economy after 2010 increases the size of tax evasion. Finally, their results showed that the decrease in GDP per capita income after 2010, over the period of economic crisis in Greece, increases the level of tax evasion.

Lisi (2012) introduces the basic insights of the "slippery slope" framework into the benchmark macroeconomic model of the labor market in order to study the relation between tax compliance, tax evasion and unemployment. This paper shows that the firm's decision to evade taxes also depends on trust in tax authorities and affects one of the most important macroeconomic variables: the unemployment rate. In his study showed that a reduction in tax evasion increases market tightness and reduces the unemployment. Rashid et al. (2022) performed an empirical study that investigates the mediating role of socioeconomic conditions on the relationships between good governance and tax evasion from the perspective of both developed and developing countries. The study also demonstrated a negative impact of socioeconomic conditions on tax evasion in developed countries and a positive impact in developing countries. In addition, a significant mediating effect of socioeconomic conditions in developed countries was revealed, while there was no mediating role in emerging countries. The findings imply that socioeconomic conditions help reduce the level of tax evasion with good governance. The higher the level of good governance, the better the socioeconomic conditions, and the lower the tax evasion. Their study used several control variables to control socioeconomic diversity such as unemployment, inflation, and GDP per capita. Their results showed a significant correlation between tax evasion and the independent variables for developed and emerging economies. Lisi (2016) also deals with the correlation of tax evasion and unemployment. He showed that in a trustful society the underground economy and unemployment are low and growth is high. Conversely, in a distrustful society the underground economy is high, unemployment is reduced only in the short run, and long-run growth is low. A further contribution of this model regards a very controversial issue, the ambiguous relationship between the underground economy and unemployment. The unemployment and underground economy are negatively correlated. The shadow sector absorbs the namely unemployment in a distrustful society, whereas unemployment and underground economy are positively correlated in a trustful society. The paper's main conclusions are the following. First, the long-run relationship between growth and unemployment is negative. Second, only in the short run can the underground economy reduce unemployment. The relationship between the shadow economy and unemployment will be positive in the long run. Finally, the long-run effect of shadow economy on economic growth will be negative. Hence, in a distrustful society there can be no economic growth, since growth requires a reduction in unemployment and underground economy.

Corruption and the shadow economy are among the main influential factors

of VAT collection gap. There are studies which conclude that the lack of trust in state institutions is linked to corruption in state which in turn negatively affects the VAT GAP. For instance, Obydenkova and Arpino (2018) study how Europeans' trust in institutions is affected in relation to the financial crisis of 2008. The Corruption Perception Index is used as the main variable for corruption. The lower this index is, the more corrupted the country is considered to be. People in countries characterized by higher levels of corruption (lower Corruption Perception Index) tend to demonstrate, on average, lower levels of trust in national and European institutions. An increase in corruption over time is also associated with an even greater decrease in trust in state institutions. Graeff and Svendsen (2013) also deal with corruption and trust in institutions. They study how social capital affects economic growth among EU countries. Overall, they ascertain that a high level of corruption in a country results to lower social trust. High levels of trust in government institutions lead to a positive social capital while corruption is a typical example of negative social capital.

The present study tries to extend the existing research on understanding the factors that affect the VAT GAP in European Union during the financial crisis period of the last decade. Furthermore, to the best of the authors' knowledge, there is no any previous study to investigate empirically the determinant factors of VAT providing a comparative analysis of two subgroups of EU countries classified by the average VAT GAP and the average level of the shadow economy criteria.

3. Research Design

3.1. Research Model

The literature review indicates the VAT GAP problem is multifactorial and it is very difficult to fit every factor into one model. Factors being analyzed in previous literature are employed in our research empirical analysis for the 28 EU countries during the period 2012-2019. The basic regression model used in this empirical study is the following:

$$\begin{aligned}\text{VAT Gap}_i = {} & b_0 + b_1\text{GDP per capita}_i + b_2\text{GINI Index}_i \\ & + b_3\text{Perception of Corruption Index}_i + b_4\text{Shadow economy index}_i \\ & + b_5\text{Population}_i + b_6\text{Unemployment rate}_i + e_i\end{aligned}$$

where

b_0: The constant term;

b_i: The sensitivity coefficient of each dependent variable when the independent changes by one unit;

e_i: The error term.

The dependent variable is the VAT GAP (as a percentage of the total VAT tax liability) for each of the EU countries under consideration during the period 2012-2019. The independent variables of the research model are GDP per capita, GINI Index, Corruption Perception Index (CPI), Shadow Economy Index, Pop-

ulation and the Unemployment Rate (see **Appendix** for details).

3.2. Research Sample and Descriptive Statistics

Before proceeding to the estimation of the basic regression model, the descriptive statistics are presented for all the variables of this model.

Table 1 indicates that there are missing observations for some variables. This is a common problem to panel datasets. To overcome this problem, we adopt the unbalanced panel data analysis (Biørn, 2004; Castañeda & Victor, 2018). For all indicators there is a large deviation between minimum and maximum. This shows the wide variation in economic data between EU countries. More specific, the average VAT GAP for the study period is 14%. However, there is a large deviation between minimum and maximum that starts from 0.7% and reaches 40.6%. Also, in GDP per capita there is large deviation with a minimum annual income of €5.780 and a maximum of €100.890. Characteristically, the standard deviation from the average GDP per capita is €18717.77. The average value of the GINI index is 30, which shows that there is income inequality in the EU countries. Regarding the CPI index, its average value is 64.3, taking extreme values (from 36% - 92%). This shows that there are countries with a very high index (low sense of corruption) and countries with a low index (high sense of corruption). The average shadow economy rate is 22.1%, the observation with the maximum value is 33.6% while the minimum is 9.5%. At the same time, great deviation is observed in the unemployment rate between countries, which starts from 2% and reaches up to 27.5%.

4. Estimation Results

4.1. Pooled OLS Model

Table 2 presents the estimates for the basic regression model using the least squares method.

According to Table 2 estimation results, the Corruption Perception Index is

Table 1. Descriptive statistics.

Variable	Mean	Max	Min	Standard Deviation	Observations
Vat Gap	14.0%	40.6%	0.7%	0.09	220
GDP per Capita	28222.86	100890.00	5780.00	18717.77	224
GINI Index	30.00	40.80	20.90	3.850	223
Corruption Perception Index	64.30	92.00	36.00	14.60	224
Shadow Economy (% GDP)	22.1%	33.6%	9.5%	0.07	196
Population	18,179,028	83,019,213	417,546	23092347.57	224
Unemployment Rate	8.9%	27.5%	2.0%	0.05	224

Source: See **Appendix** for data sources.

Table 2. Least squares model results.

Least Squares Model		
Dependent Variable: VAT Gap		
Independent Variable	**Coefficient**	***p*-value**
Constant	0.342 (0.063)	0.000
Corruption Perception Index	−0.003* (0.001)	0.000
GDP per Capita	−3.47E−07 (0.000)	0.456
GINI Index	0.001 (0.002)	0.286
Shadow Economy (% GDP)	0.005 (0.139)	0.969
Population	2.93E−10 (0.000)	0.225
Unemployment Rate	−0.037 (0.115)	0.745
R^2	0.468	
Adjusted R^2	0.451	
F-statistic	27.028	
F-statistic Probability	0.000	
Durbin-Watson	0.158	

Note: *statistically significant at 1% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

the only statistically significant variable of the research model (p-value < 0.05). There is a negative correlation between the Corruption Perception Index and the VAT GAP which is not in agreement with previous studies conclusions. The Coefficient of Determination R^2 is equal to 0.468 indicating that the model explains the 46.8% of the variability of the dependent variable VAT GAP. The Adjusted R-squared is also 0.451. The F-statistic probability value is 0.000 < 0.05, indicating that the model as a whole seems to be statistically significant. Finally, the value of Durbin-Watson index is 0.158 which is close to 0 indicating a strong positive autocorrelation problem.

4.2. Random Effects Model

Table 3 presents the estimation of the random effects model.

Table 3 indicates that the shadow economy and the unemployment rate are the only statistically significant variables of our model (p-value < 0.05) which are correlated positively to the VAT GAP. This result is in line with the results of

Table 3. Random effects model results.

Random Effects Model		
Dependent Variable: VAT Gap		
Independent Variable	Coefficient	*p*-value
Constant	−0.008 (0.096)	0.935
Corruption Perception Index	−0.000 (0.001)	0.160
GDP per Capita	3.00E−08 (0.000)	0.964
GINI Index	7.61E−05 (0.002)	0.963
Shadow Economy (% GDP)	0.558** (0.252)	0.028
Population	5.40E−10 (0.000)	0.355
Unemployment Rate	0.828* (0.098)	0.000
R^2	0.425	
Adjusted R^2	0.406	
F-statistic	22.680	
F-statistic Probability	0.000	
Durbin-Watson	0.926	

Note: *statistically significant at 1% significance level. **statistically significant at 5% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

Lisi (2016) and Rashid et al. (2022). From the above regression results, the Coefficient of Determination R^2 is equal to 0.425 which means that the model explains the 42.5% of the variability of the dependent variable VAT GAP. The Adjusted Coefficient of Determination equals 0.406. The F-statistic probability value is 0.000000 < 0.05, indicates that the model as a whole is considered statistically significant. Finally, the Durbin-Watson index equals to 0.926 which is close to 1, indicating a strong positive autocorrelation problem.

4.3. Fixed Effects Model

Table 4 presents the estimation of the fixed effects model.

The results of Table 4 indicate that the statistically significant variables of our model are the constant term, GDP per capita index, informal economy rate and the unemployment rate which have a *p*-value < 0.05. Again, here, the unemployment plays a significant role in the VAT GAP, which is again in line with the

Table 4. Fixed effects model results.

Fixed Effects Model		
Dependent Variable: VAT Gap		
Independent Variable	**Coefficient**	***p*-value**
Constant	−0.519 (0.189)	0.006
Corruption Perception Index	−0.000 (0.001)	0.499
GDP per Capita	2.02E−06** (0.000)	0.026
GINI Index	0.002 (0.002)	0.245
Shadow Economy (% GDP)	2.883* (0.650)	0.000
Population	−5.56E−09 (0.000)	0.349
Unemployment Rate	0.572* (0.154)	0.000
R^2	0.945	
Adjusted R^2	0.933	
F-statistic	81.991	
F-statistic Probability	0.000	
Durbin-Watson	1.270	

Note: *statistically significant at 1% significance level. **statistically significant at 5% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

results of Lisi (2016) and Rashid et al. (2022). Also, the results for GDP per capita contradict with the conclusions of Raczkowski and Mróz (2018). All other fixed effects independent variables are statistically non-significant. The regression results for the fixed effects model show that the Coefficient of Determination R^2 equals 0.945 which means that the model explains the 94.5% of the variability of the dependent variable VAT GAP. The Adjusted Coefficient of Determination is equal to 0.933 and shows that the model explains a large amount of the variability of the VAT GAP. The F-statistic probability value equals to 0.000 < 0.05, indicates that the model as a whole is considered statistically significant. Finally, the Durbin-Watson index equals to 1.270 shows that our model seems to have a positive autocorrelation problem (but smaller than the other two methods).

4.4. Generalized Method of Moments—GMM Model

In addition to the three previous basic methods, the model was also estimated

with the Generalized Method of Moments. This method was chosen to be examined because it can be used both in time series data and cross-sectional data, as well as in panel data. It is also used when specific characteristics of the data used in a study (for example the geographic or economic characteristics of a country) may affect the results of an econometric model. It is also considered quite flexible as an estimation method in econometric models, as it can provide correct standard errors even if there is autocorrelation and heteroscedasticity in the econometric model. According to previous studies, the correlation between VAT GAP and the shadow economy is positive (Zídková, 2014; Frunza, 2017). This means that high levels of the shadow economy increase the VAT collection gap. However, this connection between them could also be attributed to the fact that the high VAT GAP is the cause of the high levels of the shadow economy. Therefore, it is possible that there is an endogeneity effect in our research since a high informal economy increases the VAT GAP but also a high VAT GAP can lead to a high informal economy. Usually when there is endogeneity in an econometric model, the estimates obtained by the other methods are inconsistent and biased. Also, GMM method seems to be appropriate in cases when the number of time periods used in the research is small and the number of entities is large. In our study these conditions apply since there is a small number of periods (8 years) and a relatively large number of entities (28 countries).

Estimation results in Table 5 indicate that Corruption Perception Index is the only statistically significant variable appearing small negative correlation with the VAT GAP. R^2 is equal to 0.439 which means that the model explains 43.9% of the variability of the dependent variable VAT GAP. The Adjusted Coefficient of Determination equals to 0.418.

4.5. The Most Appropriate (Best-Fit) Model

In order to choose the most appropriate (best-fit) model for our study, the Breusch-Pegan test is firstly carried out. If the least squares method is found to be inappropriate, then we run the Hausman test in order to examine whether the random or fixed effects method is most appropriate for estimating our model.

4.6. Breusch-Pegan Test

To examine whether the least squares method is the most appropriate for estimating the regression model, we will proceed with the Breusch-Pegan test, with the hypothesis H_0: The OLS method is more appropriate than Fixed/Random Effects. If the p-value < 0.05, we reject the null hypothesis and test whether the Fixed effects or Random Effects is a more appropriate regression estimation method.

Table 6 indicates that the least squares method is not appropriate for estimating the regression (p-value = 0.000, so we reject the null hypothesis) and therefore we should proceed to the Hausman test to examine whether the random or fixed effects method is most appropriate for estimating our model.

Table 5. Generalized method of moments model results.

Generalized Method of Moments		
Dependent Variable: VAT Gap		
Independent Variable	**Coefficient**	***p*-value**
Constant	0.350 (0.070)	0.000
Corruption Perception Index	−0.004* (0.001)	0.000
GDP per Capita	−3.74E−08 (0.000)	0.942
GINI Index	0.002 (0.002)	0.286
Shadow Economy (% GDP)	0.008 (0.157)	0.955
Population	−3.54E−10 (0.000)	0.183
Unemployment Rate	−0.142 (0.130)	0.272
R^2	0.439	
Adjusted R^2	0.418	
Durbin-Watson	0.169	

Note: *statistically significant at 1% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

Table 6. Breusch-Pegan test results.

Breusch-Pegan Test		
Hypothesis Tests		
Cross-sectional	**Time Series**	**Panel**
280.396	14.457	294.853
(0.000)	(0.000)	(0.000)

Note: The values in the parenthesis indicate the *p*-values. Source: See **Appendix** for data sources.

4.7. Hausman Test

The Hausman test is carried out in order to examine whether the random effects method is the most appropriate for estimating our model with the hypothesis H_0 =: The Random effects model method is more appropriate than the Fixed effects model. If the *p*-value > 0.05 we accept the null hypothesis and we will accept the Random Effects model as more appropriate. If the *p*-value < 0.05 we will reject the null hypothesis and apply the Fixed Effects model to estimate the regression.

According to Table 7 estimation results, we reject the null hypothesis (p-value = 0.000). Finally, we choose the fixed effects method as the most appropriate for estimating our model. Although the Hausman test shows clearly that the Fixed Effects Model is the most appropriate for our analysis, we also present the Random Effects Model estimations as a robustness check of out empirical findings by adopting alternative regression models.

4.8. Estimation Results Analysis

In the present study, we attempt to assess whether certain demographic and macroeconomic factors influence the VAT GAP. From the preceding analysis, we find that only three out of the six examined variables are statistically significant for determining the VAT GAP. The factor that most affects the VAT GAP is the percentage of the shadow economy (coefficient of shadow economy is around 2.88%). This result agrees with the conclusions of Zídková (2014), Frunza (2017) and Anastasiou et al. (2020) but contradicts with the results of Zídková et al. (2016). The shadow economy is also the main component of the compliance gap, one of the two coefficients of the VAT GAP (the other is the policy gap), so it was expected that this variable would play an important role as a determinant of the VAT GAP.

The VAT GAP is also significantly affected by the level of unemployment (coefficient of unemployment is around 0.57%), which is in line with the conclusions of Eriotis et al. (2021), Lisi (2016) and Rashid et al. (2022). And this result seems to be expected as the increase in unemployment results to a decrease in the disposable income of citizens and leads them to tax-invisible transactions, which increases the shadow economy and the VAT GAP.

The GDP per capita of each country seems to have a slightly positive but statistically significant influence on the VAT GAP. This result is contrary to what we would expect based to the previous literature. Raczkowski and Mróz (2018), Ciobanu et al. (2023), Zídková (2014) and Lešnik et al. (2018) show that GDP per capita has a statistically significant negative relationship with VAT GAP, i.e. an increase in GDP per capita in a country leads to a decrease in VAT GAP. We would normally expect GDP per capita to be negatively correlated to the VAT GAP as income growth prevents informal trade.

On the contrary, it appears that there is no statistically significant connection between the Corruption Perception Index (CPI) and the VAT GAP. This result makes sense because throughout the literature corruption and tax evasion are closely linked. For instance, this finding contradicts the results of Butu et al. (2021)

Table 7. Hausman test results.

Hausman Test	p-value
Cross-section Random Effects	0.000

Source: See **Appendix** for data sources.

and Majerová (2016) who indicate the strongly negative relationship between VAT GAP and the Corruption Perception Index (the more corrupt a country is, the lower the CPI index) and the conclusions of Balios et al. (2020b) who indicate that the more convinced are taxpayers that the state is credible and transparent the more tax evasion reduces. Furthermore, the GINI index is not found to be statistically significant. Instead, Eriotis et al. (2021) and Ciobanu et al. (2023) point out that income inequality in a country affects the VAT GAP. Population variable is also not statistically significant. Again, here the results contradict with the findings of Ciobanu et al. (2023).

5. A VAT Gap Comparative Analysis

The empirical research analysis moves two steps forward by dividing the initial sample into two sub-groups of countries based on the average VAT GAP and the shadow economy for the period 2012-2019. Based on the above skepticism, we develop two subgroups of EU countries:

Subgroup A: Sweden, Luxembourg, Finland, Cyprus, Croatia, Slovenia, Netherlands, Spain, Estonia, Austria, France, Denmark, Germany & United Kingdom.

Subgroup B: Ireland, Belgium, Portugal, Bulgaria, Hungary, Czech Republic, Latvia, Poland Malta, Slovakia, Lithuania, Italy, Greece and Romania.

Subgroup A has the lowest average VAT GAP for the period 2012-2019 (7%) and lower shadow economy average (19%). Conversely, the countries of Subgroup B have the highest average VAT GAP for the period 2012-2019 (20%) and the highest average shadow economy (25%). The difference in economic development between the two subgroups based on GDP per capita is also characteristic: Subgroup A has an average GDP per capita of €36,760 while Subgroup B has €19,685. So, it seems at a first sight that the most developed countries of the EU present lower VAT GAP and lower percentage of the shadow economy.

Tables 8-13 present the estimates for Subgroups A and B adopting the same research-statistical methodology applied in the main basic regression model.

Table 12 and Table 13 indicate that the *p*-value of both the Breusch-Pegan test and the Hausman test is less than 0.05, for Subgroup A. Therefore, the most appropriate model estimation method for Subgroup A is the Fixed Effects Model. The Coefficient of Determination R^2 (Table 10) is equal to 0.790 which means that the model explains 79.0% of the variability of the dependent variable VAT GAP. The Adjusted Coefficient of Determination R^2 is equal to 0.736 and shows that the model explains adequately the variability of the VAT GAP. The F-statistic *p*-value equals to 0.000 < 0.05 indicating that the model as a whole is considered statistically significant. Finally, the Durbin-Watson = 1.518 indicating that the model seems to have a positive autocorrelation problem. The only statistically significant coefficient is the unemployment rate. All other variables concerning Subgroup A (which are generally the most developed in Europe) are not statistically significant and have little impact on the VAT GAP.

Table 8. Least square model sub-sample results.

Least Squares Model				
Dependent Variable: VAT Gap	Sub-sample A		Sub-sample B	
Independent Variable	Coefficient	*p*-value	Coefficient	*p*-value
Constant	0.047 (0.044)	0.282	0.325 (0.080)	0.000
Corruption Perception Index	0.000 (0.000)	0.263	−0.002* (0.001)	0.006
GDP per Capita	−1.17E−06* (0.000)	0.000	−3.33E−07 (0.000)	0.677
GINI Index	0.003* (0.001)	0.009	−0.005** (0.002)	0.029
Shadow Economy (% GDP)	−0.264* (0.082)	0.001	0.659* (0.234)	0.005
Population	9.03E−11 (0.000)	0.525	5.65E−10 (0.000)	0.217
Unemployment Rate	0.0193 (0.075)	0.793	0.366* (0.140)	0.010
R^2	0.389		0.457	
Adjusted R^2	0.346		0.422	
F-statistic	9.125		12.815	
F-statistic Probability	0.000		0.000	
Durbin-Watson	0.582		0.226	

Note: *statistically significant at 1% significance level. **statistically significant at 5% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

For Subgroup B, Table 12 and Table 13 shows that the *p*-value of both the Breusch-Pegan test and the Hausman test is less than 0.05. Therefore, the most appropriate method for estimating the model is the Fixed Effects Model. The Coefficient of Determination R^2 (Table 10) is equal to 0.907 which means that the model explains 90.7% of the variability of the dependent variable VAT GAP. The Adjusted Coefficient of Determination R^2 is equal to 0.885 and shows that the model adequately explains the variability of VAT GAP. The F-statistic *p*-value equals to 0.000 < 0.05, indicating that the model as a whole is considered statistically significant. Finally, the Durbin-Watson = 1.301 indicating that model seems also to have a positive autocorrelation problem (as sub-group A). The variables

Table 9. Random effects model sub-sample results.

Random Effects Model				
Dependent Variable: VAT Gap	**Sub-sample A**		**Sub-sample B**	
Independent Variable	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**
Constant	0.005 (0.068)	0.933	−0.777 (0.142)	0.585
Corruption Perception Index	0.001** (0.001)	0.019	−0.000 (0.001)	0.407
GDP per Capita	−1.59E−06* (0.000)	0.000	1.00E−06 (0.000)	0.330
GINI Index	0.002*** (0.002)	0.109	−0.001 (0.002)	0.565
Shadow Economy (% GDP)	−0.392* (0.150)	0.010	1.084* (0.406)	0.009
Population	−8.83E−11 (0.000)	0.731	2.00E−10 (0.000)	0.878
Unemployment Rate	0.496* (0.090)	0.000	0.927* (0.151)	0.000
R^2	0.34		0.477	
Adjusted R^2	0.296		0.442	
F-statistic	7.45		13.842	
F-statistic Probability	0.00		0.000	
Durbin-Watson	0.994		0.958	

Note: *statistically significant at 1% significance level. **statistically significant at 5% significance level. ***statistically significant at 10% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data source.

GDP per capita, shadow economy rate & unemployment rate are found to be statistically significant regarding the countries with the highest average VAT GAP (Subgroup B).

By applying the Generalized Method of Moments (Table 11), the GDP per capita, the GINI index and the size of the shadow economy are statistically significant variables even they affect the VAT GAP to a very small extent, for Subgroup A. R^2 is equal to 38.0%. For Subgroup B, the Corruption Perception Index, the shadow economy rate & the unemployment rate are the statistically significant independent variables even they explain to a small extent the variability of the dependent variable (R^2 = 45.8%).

Table 10. Fixed effects model sub-sample results.

Fixed Effects Model				
Dependent Variable: VAT Gap	**Sub-sample A**		**Sub-sample B**	
Independent Variable	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**
Constant	−0.122 (0.196)	0.535	−0.561 (0.373)	0.135
Corruption Perception Index	0.000 (0.001)	0.462	−0.000 (0.001)	0.805
GDP per Capita	−1.40E−06 (0.000)	0.285	3.85E−06* (0.000)	0.004
GINI Index	0.002 (0.002)	0.164	0.003 (0.003)	0.199
Shadow Economy (% GDP)	1.019 (0.929)	0.275	3.588* (0.934)	0.000
Population	−4.96E−09 (0.000)	0.300	−2.65E−08 (0.000)	0.173
Unemployment Rate	0.449** (0.190)	0.020	0.766* (0.235)	0.001
R^2	0.790		0.907	
Adjusted R^2	0.736		0.885	
F-statistic	14.523		40.3061	
F-statistic Probability	0.000		0.000	
Durbin-Watson	1.518		1.301	

Note: *statistically significant at 1% significance level. **statistically significant at 5% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

In conclusion, by comparing the estimation results of the two subgroups, we ascertain that the determining factors appear a greater effect on the VAT GAP in case of less developed EU countries. More specifically, adopting the fixed effects method, we find that VAT GAP variability is explained better in case of Subgroup B rather than Subgroup A (90.7% for Subgroup B vs. 79.0% for Subgroup A). This result seems to be expected since in developed countries where the VAT GAP is relatively low, an increase in the shadow economy usually has a small impact on the VAT GAP. On the contrary, in the less developed countries, an increase in the shadow economy will have an increasingly large impact on the VAT GAP.

Table 11. Generalized method of moments model sub-sample results.

Generalized Method of Moments Model				
Dependent Variable: VAT Gap	Sub-sample A		Sub-sample B	
Independent Variable	Coefficient	*p*-value	Coefficient	*p*-value
Constant	0.072 (0.049)	0.140	0.304 (0.085)	0.000
Corruption Perception Index	0.000 (0.000)	0.709	−0.002* (0.001)	0.010
GDP per Capita	−1.04E−06* (0.000)	0.000	−6.00E−08 (0.000)	0.945
GINI Index	0.002** (0.001)	0.043	−0.004 (0.003)	0.119
Shadow Economy (% GDP)	−0.267* (0.089)	0.003	0.671** (0.280)	0.018
Population	9.94E−11 (0.000)	0.519	5.26E−10 (0.000)	0.297
Unemployment Rate	−0.017 (0.083)	0.839	0.344** (0.155)	0.029
R^2	0.380		0.458	
Adjusted R^2	0.330		0.415	
Durbin-Watson	0.634		0.235	

Note: *statistically significant at 1% significance level. **statistically significant at 5% significance level. The values in the parenthesis indicate the standard errors of the coefficients. Source: See **Appendix** for data sources.

Table 12. Breusch-Pegan test sub-sample results.

Breusch-Pegan Test		
Hypothesis Test Sub-sample A		
Cross-sectional	Time series	Panel
21.181	18.512	39.694
0.000	0.000	0.000
Hypothesis Test Sub-sample B		
Cross-sectional	Time Series	Panel
141.460	0.039	141.500
0.000	−0.841	0.000

Source: See **Appendix** for data sources.

Table 13. Hausman test sub-sample results.

Hausman Test	
Sub-sample A	***p*-value**
Cross-section Random Effects	0.000
Sub-sample B	***p*-value**
Cross-section Random Effects	0.007

Source: See **Appendix** for data sources.

6. Conclusion-Policy Implications

In conclusion, the purpose of this study is to analyze the phenomenon of tax evasion in VAT in the EU area and examine the effect of various factors on the VAT GAP in the 28 EU countries during the period 2012-2019. GDP per capita, shadow economy rate and unemployment rate variables are found to be statistically significant in affecting the VAT GAP. Instead, the GINI index, the Corruption Perception Index and the Population index are not proven to be statistically significant.

Respectively, carrying out a similar empirical analysis for two different EU subgroup countries, this study indicates that for the group of countries that present a high average VAT collection gap (which are the least developed countries of the European Union), the VAT GAP is statistically significantly affected by the shadow economy and unemployment. Regarding the countries with a lower average VAT collection gap (which are the most developed countries), the VAT GAP is statistically significantly affected only by unemployment. In general, unemployment rate seems to play a key role in the VAT GAP among EU countries both for developed and emerging economies. The results are similar to the results of Lisi (2012, 2016) and Rashid et al. (2022) that unemployment increases the tax evasion and shadow economy with consequence of the reduction of the economic growth.

It seems that one of the most important determining factors of VAT GAP in the EU is the shadow economy. Characteristically, 12 of the 28 EU countries have on average over 25% shadow economy. The crackdown of the shadow economy at the European level is therefore deemed necessary to reduce the VAT GAP. The adoption of a multilateral legislative framework on joint audits seems to be imperative against tax-evasion. Cross-border business activities might be investigated either for tax-avoidance or tax-evasion by joint tax audit team consisting of tax auditors from two or more countries (Burgers & Criclivaia, 2016). The implementation of the anti-tax evasion measures should also be intensified by adopting new technological methods and tools. More specifically, investments in technology may enhance audit tools in order to help the authorities both in the number of audits and in the depth of data analysis. Increase of public

expenditures in new technology equipment by tax administration may improve the efficiency of VAT collection (Szczypińska, 2019). Greater attention should also be paid to the quality of data analysis. Correct and comprehensive data analyses can increase the detection rate of tax fraud. Countries that invest heavily in IT systems in tax administration also result in lower levels of VAT evasion (Kitsios et al., 2023). For instance, efficient tax auditing information system may increase the reliability of tax administration, enhancing finally the taxpayers' tax compliance (Balios & Tantos, 2019). Artificial intelligence and big data on accounting and auditing may contribute to the development of new data-driven tax administrations by automating tax procedures, collecting and organizing tax information, increasing the taxpayer services and subsequently enhancing tax efficiency and transparency (Balios, 2021; Serrano Antón, 2021; Balios et al., 2020a). In addition, policies should be implemented focusing on the reduction of unemployment and underreported employment since it may increase the disposable income of taxpayers and finally reduce their motives for hidden-undeclared tax transactions.

Even though the empirical analysis of this research study has focused on the sample selection for the 28 EU countries during the period 2012-2019, the size of the research sample may be considered relatively small, since the investigated time period is short and the dataset is also incomplete on the VAT GAP for Cyprus and Croatia for the years 2012-2014. Furthermore, it should also be taken into account that during the considered period, several EU countries were in a financial crisis, which may have affected some indicators (e.g. unemployment). Thereafter, we may be cautious to some extent about the conclusions of this study. We consider that the present study may be repeated in the future, taking into consideration a greater number of years for the research sample, and other influential factors that would be of interest, such as how VAT GAP is affected by the level of VAT rates and by the number of tax audits in the EU countries. Finally, the United Kingdom left the EU in 2020 and is no longer committed to the implementation of the measures taken by the EU, it will be interesting to study the VAT GAP and its determinants before and after the country's departure from the EU.

Data Sources

European Commission: https://commission.europa.eu/index_en.
Eurostat Database: https://ec.europa.eu/eurostat/data/database.
Transparency International: https://www.transparency.org/en.
World Bank: https://www.worldbank.org/en/home.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Data Sources

The VAT GAP is the difference between the expected VAT revenue (or "VAT Total Tax Liability"—VTTL) and the amount actually collected, in absolute or percentage terms. The VAT Total Tax Liability is an estimated amount of VAT that is theoretically collectable based on VAT legislation and ancillary regulations. Data for both total VAT tax liability and VAT collected were retrieved from the annual European Commission reports. Available: VAT gap in the EU—Publications Office of the EU (europa.eu).

GDP per capita measures the average per capita income of the inhabitants of a country expressed in EURO. The source of the data is the Eurostat database. Available: Statistics|Eurostat (europa.eu).

GINI Index represents income inequality in a country. It measures the extent to which the distribution of income among individuals or households in an economy deviates from a perfectly equal distribution. A GINI index of zero represents perfect equality and 100 perfect inequality. The source of the data is the Eurostat database. Available: Statistics|Eurostat (europa.eu).

Corruption Perception Index (CPI) is an index that ranks countries based on perceived levels of corruption in the public sector, as determined by expert assessments and public opinion surveys. The index ranges from 0-100 where the higher the index the less corrupted a country considered to be. Data were retrieved from Transparency International. Available: 2019 Corruption Perceptions Index—Explore the…—Transparency.org.

Shadow Economy Index (the informal economy) is expressed as a percentage of GDP. Data were retrieved from the World Bank database. Available: Informal Economy Database (worldbank.org).

Population (Population): measures the population of each country on January 1st of each year. The data for this indicator were retrieved from Eurostat database. Available: Statistics|Eurostat (europa.eu).

Unemployment Rate is the number of unemployed people aged 15 - 74 as a percentage of the labor force based on the definition given by the International Labor Office (ILO). The source of the data is the Eurostat database. Available: Statistics|Eurostat (europa.eu).