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CAN HIGHER EDUCATION LEVELS IMPROVE TAX COMPLIANCE?

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ABSTRACT

This paper examines how governance and education affect VAT compliance in 25 EU nations between 2008 and 2022. The dependent variable is the VAT gap, which is the difference between expected and actual VAT revenue. GDP growth is included as a macroeconomic control, and governance metrics like regulatory quality and corruption control are examined alongside education indicators, such as primary, secondary, and tertiary enrollment. The research takes time and country-specific heterogeneity into account using fixed effects panel regression. According to the results, higher levels of education are linked to improved VAT compliance, indicating that education increases civic engagement and tax morale. While higher corruption is associated with increased VAT gaps, stronger regulations also improve compliance. Additionally, the findings show the way human capital, institutional quality, and economic conditions interact to shape fiscal outcomes. Findings further provide policymakers evidence that integrating social and institutional strategies can increase tax collection and decrease tax evasion.

Keywords: Public Finance, VAT Gap, Tax Compliance, Education, Governance, Europe

JEL Classifications: H1, H26, H20, I25, C23

Disclaimer: The views expressed in this paper are those of the authors and not necessarily those of the Bank of Greece.

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1. Introduction

The European Union's (EU) value-added tax (VAT) is a vital component of public finance, offering both national governments and EU-level budgets a steady and sizable source of income. It is a recommended taxation method for funding infrastructure development, social spending, and economic governance due to its effectiveness, transparency, and wide base (European Commission, 2022; Keen, 2013; Barbone et al., 2013). However, the VAT system in all EU member states still experiences large revenue losses in spite of its broad adoption and policy emphasis. The VAT gap, the difference between VAT revenues actually collected and the amount that should be raised with complete compliance, is the most notable example of this problem (CASE, 2019; Reckon, 2009; Keen & Smith, 2006).

This paper makes a novel contribution to the literature by empirically examining the relationship between educational investment and the VAT compliance gap across European countries. While tax compliance has been widely studied from legal, institutional, and behavioral perspectives, the role of general education as a structural determinant of compliance remains underexplored. Our study fills this gap by providing new cross-country panel evidence that links increases in school enrollment to reductions in the VAT gap. Methodologically, we employ a two-way fixed effects panel design that isolates within-country variation over time, allowing us to identify persistent, long-run institutional effects. Our contribution lies at the intersection of several strands of literature: public finance and tax evasion, the political economy of education, and behavioral institutional economics. To our knowledge, this is the first empirical study that investigates the educational determinants of VAT compliance at the macro level in a European context.

The VAT gap is not just a matter of technical accounting. Instead, it is a crucial sign of more serious systemic flaws, non-compliance, and inefficiencies in national tax systems. The ability of nations to finance vital public services can be severely hampered by large VAT gaps, which can result in deficits, lower investment in human capital, and widening regional fiscal disparities (Barbone et al., 2013; Reckon, 2009). Furthermore, ongoing deficiencies in VAT collection have the potential to erode public confidence in government agencies and increase feelings of injustice in the tax code. These factors

make tackling the underlying causes of VAT non-compliance a top priority for EU economic policy (European Commission, 2020).

The economic, institutional, and administrative factors that contribute to VAT gaps have been extensively studied in the past, but the social determinants of tax compliance, most notably, education, has received less attention. Economic productivity, institutional quality, and civic conduct are all significantly influenced by education (Becker, 1994; Hanushek & Woessmann, 2008; OECD, 2018). It has been demonstrated that higher levels of education boost people's desire to contribute to public goods, improve their comprehension of laws and obligations, and promote greater political engagement (Chetty et al., 2014; Moretti, 2004; Kirchler et al., 2008). These behavioral and cognitive results imply that, particularly in intricate systems like VAT, education may be crucial in influencing tax morale and voluntary compliance.

The empirical relationship between education and VAT compliance is still poorly understood, despite this theoretical connection. Studies that have already been done on VAT gaps typically focus on institutional governance, administrative capabilities, and macroeconomic indicators, frequently leaving out education as a direct explanatory factor (Hanushek & Woessmann, 2012; Kirchler et al., 2008). Furthermore, the educational factors taken into account, are frequently too generalized to capture the subtleties of how various educational levels may influence tax-related behavior. Given the variation in educational systems, enrollment rates, and mandatory education laws throughout the EU, this gap in the literature is especially troublesome. This research fills this gap by carrying out a thorough empirical examination of how educational attainment affects VAT compliance in 25 EU nations between 2008 and 2022. Enrollment in primary, secondary, and tertiary education are three distinct aspects of education that are investigated. A more detailed understanding of the relationship between early, intermediate, and advanced education and tax compliance behavior is made feasible by the inclusion of all three levels.

Recognizing the potential for confounding institutional effects, the study further includes two governance indicators, regulatory quality and control of corruption, as control variables. These variables serve to isolate the unique contribution of educational factors by accounting for the broader policy and administrative environment in which VAT systems function. Regulatory quality captures perceptions of the government's ability to formulate and implement effective regulations, while control of corruption

reflects the extent to which public power is exercised for private gain (Bird et al., 2008; Alm & Torgler, 2006). These governance dimensions are crucial in understanding the institutional constraints and incentives that shape both compliance behavior and tax enforcement effectiveness.

By taking into consideration the larger administrative and policy context in which VAT systems operate, these variables help to distinguish the distinct influence of educational elements. While control of corruption measures how much public power is used for private benefit, regulatory quality measures how well people believe the government can create and enforce regulations (Bird et al., 2008; Alm & Torgler, 2006). Understanding the institutional incentives and restraints that influence compliance behavior and the efficacy of tax enforcement requires an awareness of these governance aspects.

The paper is organized as follows: Section 2 provides an extensive literature review pointing out that several economic variables have been found to have a substantial impact on tax revenue efficiency and compliance patterns. Section 3 presents the data and the econometric methodology, while in Section 4 the empirical results and discussion are presented. Finally, in Section 5 some concluding remarks are summarized.

2. Literature review

Previous studies on VAT compliance have predominantly focused on administrative, institutional, and economic dimensions, emphasizing structural and macro-level determinants that shape taxpayer behavior. Several economic variables have been found to have a substantial impact on tax revenue efficiency and compliance patterns, including GDP growth, unemployment rates, income inequality, and macroeconomic instability (Keen & Lockwood, 2010; Reckon, 2009; Murphy, 2012; Bird et al., 2008). For example, governments frequently witness significant rates of VAT evasion during economic downturns or times of high unemployment.

Recent developments across the Eurozone highlight how technological and institutional reforms can materially impact VAT compliance. For example, efforts to modernize invoicing systems, enhance electronic reporting, and digitize audit processes

have demonstrably narrowed VAT gaps in several Southern and Eastern Member States. The European Commission's 2023 report shows that these interventions improved detection and deterrence of evasion. These technological enablers, however, are not sufficient in isolation, our findings suggest that structural drivers like educational attainment and civic norms remain essential for sustaining voluntary compliance. Together, digital tools and education provide a more durable foundation for VAT effectiveness across diverse governance contexts.

Recent studies highlight the increasing role of technological infrastructure in improving VAT compliance. The widespread adoption of point-of-sale (POS) systems, electronic invoicing, and real-time reporting mechanisms has significantly reduced opportunities for underreporting and tax evasion. These tools enhance the traceability of transactions and strengthen the enforcement capacity of tax administrations. For example, the European Commission (2023) notes that digital reporting and monitoring systems are associated with lower VAT gaps across Member States. Similarly, countries that have promoted electronic transactions and card payments have experienced measurable improvements in revenue collection. While our primary focus is on the institutional and educational determinants of compliance, we acknowledge that digitalization operates as a crucial complementary mechanism in modern tax governance.

Growing financial stress and increased discontent with the perceived efficacy or fairness of public institutions are major causes of these phenomena (Murphy, 2012; Keen & Lockwood, 2010; Alm et al., 1992). Economic instability lowers the normative need to comply and has a negative impact on taxpayer morale, which leads to a wider VAT gap (Keen and Lockwood, 2010). Moreover, increased income inequality exacerbates social fragmentation and erodes interpersonal and institutional trust, both of which are critical to sustaining voluntary compliance (Keen & Smith, 2006; Kirchler et al., 2008).

The institutional and governance-related factors that influence VAT compliance have been extensively studied in addition to economic factors. Governance metrics including regulatory quality and corruption control have become important explanatory factors, and strong institutional quality is regularly linked to smaller VAT gaps (Kaufmann & Kraay, 2008; Friedman et al., 2000; Rose-Ackerman, 1999; Torgler & Schneider, 2009). For instance, Kaufmann and Kraay (2008) contend that opportunities

for tax evasion significantly decrease in nations with well-developed regulatory frameworks and effective corruption reduction, resulting in a more transparent and equal tax system. On the other hand, Friedman et al. (2000) draw attention to the damaging effects of corruption in reducing the oversight powers of tax authorities, aiding tax evasion, and eroding taxpayers' faith in the legitimacy and equity of public administration.

Another well-established element affecting compliance is the efficiency of tax administration itself. Confusion and evasion behaviors among taxpayers tend to rise when tax systems are viewed as being excessively complicated, inconsistent, or unclear (Keen & Lockwood, 2010; Reckon, 2009). On the other hand, countries with more efficient tax systems that have clearer regulations and easier procedures tend to have better compliance rates (Keen & Smith, 2006; Kirchler et al., 2008). Simplified processes strengthen the sense of equity and efficiency in public funding while lowering compliance costs for both individuals and companies (Barbone et al., 2013). By decreasing errors, restricting discretion, and enhancing audit capabilities, administrative simplification and digitization initiatives in particular have been recognized as instruments for minimizing VAT evasion.

The period following 2015 represents a structural shift in VAT administration across the EU, largely due to accelerated digital transformation. Governments introduced mandatory electronic invoicing, real-time transaction monitoring, and broader usage of POS-linked systems, significantly enhancing the transparency of taxable activity. As noted in the European Commission (2023), such reforms are directly associated with notable reductions in the VAT gap, especially in countries that implemented digital reporting platforms or enforced electronic payments. These innovations not only improve detection and deterrence of evasion but also reduce compliance costs by streamlining reporting. This structural break complements our focus on institutional and educational determinants by highlighting how administrative modernization reinforces behavioral compliance over time.

In addition to structural and administrative perspectives, behavioral and psychological approaches have gained increasing relevance in explaining VAT compliance. Civic norms, social capital, and tax morale, the innate need to pay taxes, have all been emphasized in researches as key components of compliance behavior (Torgler, 2007; Alm & Torgler, 2006; Lewis, 1982). Perceptions of redistributive

fairness, government performance, and procedural justice all have a significant impact on tax morale. The intrinsic willingness of taxpayers to fulfill their tax duties rises when they believe that tax revenues are spent fairly and responsibly (Kirchler et al., 2008; Alm et al., 1992). This dynamic is intimately related to trust in institutions, as shown by Mauro (1998), Rothstein and Teorell (2008), and Torgler and Schneider (2009), who show that institutional trust promotes voluntary collaboration and lessens the perceived need for coercive enforcement.

The institutional, administrative, and economic factors that influence VAT compliance have been extensively studied, but one aspect, education, has received relatively little attention. There is still a dearth of empirical research that directly connects educational aspects to VAT compliance, despite the theoretical literature's constant emphasis on the significance of education in fostering civic behavior, institutional trust, and fiscal responsibility (Becker, 1994; Hanushek & Woessmann, 2008; OECD, 2018). Instead of being examined as a key explanatory mechanism in and of itself, education has frequently been viewed as a secondary control variable or included in larger measures of human capital development (Reckon, 2009; Barbone et al., 2013; Murphy, 2012).

However, there are conceptually well-established ways in which education may affect VAT compliance. First, a stronger grasp of the role that taxes play in promoting public goods is a result of higher levels of educational attainment being consistently linked to increased economic and civic literacy (Becker, 1994; OECD, 2018; Moretti, 2004). More educated people are more likely to recognize the redistributive role of taxes, see tax compliance as a civic obligation, and comprehend the dangers and consequences of tax evasion (Torgler & Schneider, 2009; Luttmer & Singhal, 2014). Higher education, in particular, cultivates the sophisticated analytical abilities and legal knowledge required to negotiate intricate tax systems and steer clear of both deliberate and inadvertent non-compliance (Hanushek & Woessmann, 2012; Slemrod, 2007).

Additionally, by fostering civic values, social trust, and ethical reasoning at a young age, elementary and secondary school help to shape long-term compliance behavior (OECD, 2018; Dee, 2004; Campbell, 2006). The ideas of legitimacy, authority, and collective responsibility that citizens develop because of these formative experiences are essential for voluntary compliance (Hanushek & Woessmann, 2008, 2012; Lewis, 1982). Furthermore, a fundamental education reduces errors and

misreporting that could otherwise lead to non-compliance by improving cognitive ability, which helps people absorb legal and administrative information (Barro & Lee, 2013; Chetty et al., 2014; Kirchler et al., 2008).

Additionally, there are very few empirical studies that examine educational enrollment as a time-sensitive, dynamic variable or differentiate across different educational levels. The majority of studies use static metrics, such as average years of education or total literacy indices, which may not account for changing trends in educational access and participation over time and across nations. An improved measure of tertiary education based on real young population estimates is included in this study, which fills that gap by combining panel data on elementary, secondary, and tertiary education enrollments across 25 EU nations from 2008 to 2022. By using panel data methods to account for both cross-sectional and temporal variance, this approach enables a more accurate and consistent evaluation of how changes in education impact VAT compliance across time and across nations. In order to separate the direct benefits of education from those based on institutional strength, the study adds institutional governance indicators—regulatory quality and corruption control—as control variables. A more comprehensive picture of how institutional integrity and human capital interact to influence tax behavior in the EU setting is provided by the study's joint evaluation of governance and educational aspects.

In conclusion, the educational component of VAT compliance has received little attention, despite the fact that the body of current literature has offered insightful information about the institutional and economic aspects of the issue. By specifically incorporating enrollment patterns and educational attainment into a thorough panel-data analysis of VAT compliance, this work offers a significant contribution. This paper adds to the body of knowledge by experimentally assessing the role of education in conjunction with institutional controls. It also provides practical findings for scholars and policymakers. Its conclusions are anticipated to promote more comprehensive and educationally informed tax policy design, supporting not only tax compliance but also more general objectives of social cohesion and civic engagement among EU member states.

3. Data and methodology

The study uses an unbalanced panel dataset that includes 25 EU countries and spans 15 years, from 2008 to 2022 ($n=25$, $T=15$). With an emphasis on the VAT gap (dependent variable), which is the difference between the amount of VAT revenue that governments actually collect and the amount that is anticipated to be collected, expressed in current euros, the study primarily examines the relationship between educational attainment levels and the outcomes of fiscal policy. The European Commission Reports are the source of the VAT gap values. The purpose of this research is to close the knowledge gap about the relationship between educational attainment and VAT compliance in various governance contexts.

The independent variables in the dataset were gathered from the World Development Indicators website. These variables include the percentage of students enrolled in postsecondary educational institutions (TERT) and the total number of students enrolled at the primary (PRMPL) and secondary (SECPL) levels. These factors aid in evaluating the educational backgrounds of students in the countries under study at various educational levels (see Table 1).

The study also includes control variables that represent expert and popular opinions on the quality of governance (also gathered from the World Development Indicators) in addition to these educational variables (see Table 1). These are the Control of Corruption Estimate (CORRPT) and the Regulatory Quality Estimate (REGQL), both of which are based on a conventional normal distribution with a range of -2.5 to 2.5. These rankings are the result of a combination of data sources, such as expert evaluations and polls of individuals and businesses. Organizations like the World Bank oversee this aggregate, guaranteeing that these metrics accurately represent the general opinions regarding the level of corruption and the quality of government regulation.

To further account for macroeconomic implications on VAT performance, the study also includes the annual GDP growth rate (GDPGR), which is expressed as a percentage change in real GDP (constant 2015 prices, in euros). In addition to indirectly influencing public trust and administrative capacity, economic growth can have a direct impact on the VAT gap by changing the size of the tax base and consumption. By accounting for GDP growth, differences in VAT compliance are shown to be

substantially connected with structural factors such as governance and education, rather than being the product of sporadic fluctuations in the economy.

Following data collection, the key variables: the VAT Gap and the number of pupils at primary, secondary, and tertiary education levels, were transformed into per capita terms. This crucial step was taken to eliminate distortions arising from differences in national population size, thereby ensuring valid comparability across the panel. By using per capita figures, the analysis shifts focus from absolute values to relative intensities, which is essential for the fixed effects estimator. This approach effectively controls for time-invariant country size, allowing the model to isolate the relationship between educational enrollment rates and tax compliance within each entity over time.

Then, we estimate the baseline specification using fixed effects Ordinary Least Squares (OLS), controlling for both country-specific and time-specific heterogeneity through the inclusion of country and year fixed effects. These are implemented using standard fixed effects procedures, which absorb unobserved heterogeneity without explicitly including dummy variables in the regression matrix. This allows us to capture within-country variation while netting out time-invariant and global temporal influences. Standard errors are robust to heteroskedasticity and clustered at the country level.

Where appropriate, interpolation was used in the case of missing values, while moving average and single and double exponential smoothing techniques were applied to predict the missing values of the variables of interest for recent years of the time period considered. The choice of the appropriate method was determined with the help of measures of accuracy such as Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD). The use of these statistics helps us to compare different forecasting fits and smoothing procedures, with smaller values indicating a better fitting model.

While concerns may arise regarding the potential distortion of stationarity and cointegration properties due to interpolation, the scale of imputation in this study is minimal and unlikely to affect the results meaningfully. The panel consists of 15 years across 25 countries, yielding a total of 2.625 observations across seven variables. Before interpolation, we had 2.619 complete observations, meaning only 6 values

(0.22%) were imputed. This negligible proportion ensures that any risk of artificially inducing trends, persistence, or biasing unit root and cointegration tests is virtually non-existent.

By using a balanced panel, a robust econometric analysis can be performed without the problems of missing data that might make interpretations more difficult. This dataset's European coverage allows for a thorough analysis of the relationship between educational levels, people's opinions of governance quality, and the VAT Gap.

$$MAPE = \frac{100\%}{n} \sum_{t=1}^n \left| \frac{A_t - F_t}{A_t} \right| \quad (1), \quad MAD = \frac{1}{n} \sum_{t=1}^n |A_t - F_t| \quad (2),$$

$$MSD = \frac{1}{n} \sum_{t=1}^n (A_t - F_t)^2 \quad (3)$$

where:

- *A_t* is the actual value at time *t*
- *F_t* is the forecasted value at time *t*
- *n* is the total number of observations

*** Table 1 here ***

Vat Gap Calculation

The VAT Gap is the difference between the theoretical VAT revenue (European Commission, 2022), known as the VAT Total Tax Liability (VTTL), and the actual VAT revenue collected by the government. It represents losses due to fraud, evasion, insolvencies, administrative errors, and legal tax optimization. According to the European Commission reports (European Commission, 2020), the VAT Gap is calculated as:

$$VATGap = VTTL - ActualVATRevenue \quad (4)$$

The VTTL is estimated using the “top-down consumption-side” approach, which accounts for VAT liabilities from final consumption, intermediate consumption, and gross fixed capital formation (GFCF). The formula for VTTL is:

$$\begin{aligned}
 VTTL = & \sum_{i=1}^N (rate_i \times Value_i) + \sum_{i=1}^N \sum_{j=1}^M (rate_{i,j} \times propex_{i,j} \times ICValue_{i,j}) \\
 & + \sum_{i=1}^N \sum_{j=1}^M (rate_{i,j} \times propex_{i,j} \times GFCFValue_{i,j}) \\
 & + netadjustments \quad (5)
 \end{aligned}$$

Where:

- $rate_i$ is the effective VAT rate for the i -th category of goods and services,
- $Value_i$ is the final consumption value for the i -th category,
- $rate_{i,j}$ is the effective VAT rate for the i -th category in the j -th sector,
- $propex_{i,j}$ is the proportion of output exempt from VAT in the j -th sector,
- $ICValue_{i,j}$ is the intermediate consumption value for the i -th category in the j -th sector,
- $GFCFValue_{i,j}$ is the gross fixed capital formation value for the i -th category in the j -th sector,
- $netadjustments$ includes additional adjustments for specific tax rules or exemptions.

VAT revenue (VR) can be decomposed into its components using the following formula:

$$\begin{aligned}
 VR = & VTTL \times VATCompliance \\
 = & effectiverate \times base \times \left(1 - \frac{VATGap}{VTTL}\right) \quad (6)
 \end{aligned}$$

The year-over-year relative change in VAT revenue is calculated as:

$$\frac{\Delta VR}{VR} = \frac{\Delta(\text{effectiverate})}{\text{effectiverate}} \times \frac{\Delta \text{base}}{\text{base}} \times \frac{\Delta \left(1 - \frac{VATGap}{VTTL}\right)}{\left(1 - \frac{VATGap}{VTTL}\right)} \quad (7)$$

Where:

- $\frac{\Delta(\text{effective rate})}{\text{effective rate}}$ represents the change in the effective VAT rate,
- $\frac{\Delta \text{base}}{\text{base}}$ represents the change in the tax base (value of goods and services subject to VAT),
- $\frac{\Delta \left(1 - \frac{VATGap}{VTTL}\right)}{\left(1 - \frac{VATGap}{VTTL}\right)}$ represents the change in VAT compliance.

The following formula combines all the components of the VAT Total Tax Liability (VTTL) and subtracts the Actual VAT Revenue (expanded into its full form) to calculate the VAT Gap. So VAT Gap is calculated as:

$$\begin{aligned} VATGap = & \left(\sum_{i=1}^N (\text{rate}_i \times \text{Value}_i) + \sum_{i=1}^N \sum_{j=1}^M (\text{rate}_{i,j} \times \text{propex}_{i,j} \times \text{ICValue}_{i,j}) \right. \\ & \left. + \sum_{i=1}^N \sum_{j=1}^M (\text{rate}_{i,j} \times \text{propex}_{i,j} \times \text{GFCFValue}_{i,j}) + \text{netadjustments} \right) \\ & - \left(\sum_{k=1}^P \text{collected VAT}_k + \text{refunds} \right) \\ & + \text{adjustments to revenue} \quad (8) \end{aligned}$$

Fixed Effects Model (Baseline)

We initiate our econometric analysis by employing the conventional Fixed Effects (FE) model, estimated via panel Ordinary Least Squares (OLS). This framework is well suited for macro-panel data, as it accounts for unobserved, time-invariant country-specific heterogeneity (α_i), as well as common shocks across time when time effects are included. By relying on within-country variation over time, this approach enables us to analyze how changes in the absolute values of education-related indicators are associated with changes in the VAT gap, independently of structural differences such as population size or GDP.

$$\begin{aligned} \mathit{vatgap}_{it} = & \alpha_i + \lambda_t + \beta_1 \mathit{prmpl}_{it} + \beta_2 \mathit{secpl}_{it} + \beta_3 \mathit{tert}_{it} + \gamma_1 \mathit{regql}_{it} + \gamma_2 \mathit{corrpt}_{it} \\ & + \gamma_3 \mathit{gdpgr}_{it} + \varepsilon_{it} \end{aligned} \quad (9)$$

Where:

- α_i : *Country-specific fixed effects*
- λ_t : *Year-specific fixed effects*
- ε_{it} : *Error term*
- vatgap_{it} is the *VAT Gap in country i at time t*

*** Table 2 here ***

According to Table 2 (descriptive statistics), the dependent variable, the VAT gap per capita, exhibits substantial variation across the 25 EU countries over the 15-year period, with a mean value of 296.15 euros, a standard deviation of 176.86, and a range from 74.51 to 1,552.96 euros. Significant variations in VAT compliance levels over time and across nations are indicated by this wide dispersion, indicating that the explanatory variables may be able to effectively explain variations in tax compliance.

In terms of the educational variables, the average number of students enrolled in primary school is 0.058, with a comparatively low standard deviation of 0.017, and the average number of students enrolled in secondary school is 0.081, with a slightly lower variation at 0.012. With a mean of 0.070 and a higher standard deviation of 0.020, tertiary enrollment per capita shows more differences in access to higher education between nations. By converting these metrics to a per capita basis, it becomes easier to

identify within-country effects over time and to make meaningful comparisons across nations with varying populations.

The governance indicators also display notable variation. The majority of EU nations are rated favorably, but there is still significant variation in opinions regarding the efficacy of governmental regulation, as evidenced by the average score of 1.18 for regulatory quality, which ranges from a low of 0.14 to a high of 2.04. Although it ranges widely from -0.38 to 2.44, control of corruption averages 0.99, reflecting the wide range of institutional integrity and anti-corruption efficacy among member states. As a macroeconomic control, GDP growth averages 1.80% with significant volatility, ranging from a peak of 24.62% to a sharp contraction of -14.84%. This variance is a result of including years that experienced significant economic shocks, like the global financial crisis and the post-pandemic recovery, which could have an impact on the dynamics of VAT collection.

***** Table 3 here *****

In Table 3, we present the correlation matrix. The results show that the correlations between the educational variables and the VAT gap are generally weak. In contrast to secondary school enrollment, which has a modestly positive correlation ($r = 0.0697$, $p = 0.178$), which suggests a negligible linear relationship, primary school enrollment exhibits nearly no association with the VAT gap ($r = -0.0094$, $p = 0.856$). A tentative inverse relationship between higher education participation and VAT non-compliance is suggested by the slightly stronger negative correlation between tertiary enrollment and the VAT gap ($r = -0.0898$, $p = 0.083$), which is statistically significant at the 10 percent level.

There are stronger relationships between the educational variables and the governance indicators. Potential structural differences in the distribution of educational resources in relation to governance effectiveness are reflected in the negative correlation between regulatory quality and tertiary enrollment ($r = -0.159$, $p = 0.002$) and the positive correlation between regulatory quality and primary and secondary enrollments ($r = 0.478$ and $r = 0.391$, respectively, both $p < 0.001$). The interplay between institutional integrity and educational patterns across nations is further

highlighted by the strong positive correlations between control of corruption and primary and secondary enrollments ($r = 0.555$ and $r = 0.389$, respectively, both $p < 0.001$) and tertiary enrollment ($r = -0.108$, $p = 0.036$).

The VAT gap and GDP growth have a weakly negative correlation ($r = -0.137$, $p = 0.008$), indicating that better VAT compliance is somewhat correlated with higher economic growth. Short-term macroeconomic fluctuations may have a limited impact on the structural determinants of the VAT gap, as evidenced by the small and mostly statistically insignificant correlations found between GDP growth and the governance or educational variables.

4. Empirical results

***** Table 4 here *****

With p-values of 0.000, the four diagnostic tests: Breusch-Pagan LM, Pesaran scaled LM, bias-corrected scaled LM, and Pesaran CD, are all highly significant. This suggests that there may be a correlation between VAT gaps in one country and those in other EU member states due to unreported shocks or overlooked factors. Given the European context, where economic integration, shared regulatory frameworks, and vulnerabilities to external shocks (like financial crises or pandemic disruptions) create interdependencies in fiscal and compliance outcomes, this dependence is not surprising.

From a methodological standpoint, these findings emphasize the need to use cross-sectional dependence-resistant panel data estimators. Inaccurate conclusions regarding the factors influencing the VAT gap and skewed standard errors may result from failing to take these correlations into consideration. Practically speaking, this supports the application of strategies like second-generation panel methods that specifically account for cross-sectional dependence or two-way fixed effects with robust standard errors. The data in Table 4 emphasizes that VAT compliance is not entirely understandable at the national level due to the high level of interconnectedness among EU economies, but rather is a part of larger regional and institutional dynamics.

***** Table 5 here *****

The Augmented Dickey-Fuller (ADF) unit root results in Table 5 show that, at levels, most of the series display non-stationary behavior, as most of the test statistics fail to reject the null hypothesis of a unit root under different model specifications (with constant, with constant and trend, and without both). VATGAP, PRMPL, SECPL, and TERT, for example, do not consistently reject the null across specifications, indicating that their levels are non-stationary. Given that institutional and macroeconomic factors frequently show persistence over time, this is in line with expectations. GDPGR is an exception, appearing stationary at levels because it rejects the null across specifications, especially when using the constant-only model ($p = 0.009$). The nature of growth rates, which typically oscillate around a mean rather than show a unit root process, is consistent with this outcome.

In most situations, stationarity is attained when the variables are differenced. The first differences of VATGAP, REGQL, and CORRPT, for instance, demonstrate strong significance across several specifications, indicating that these variables are integrated of order one, $I(1)$. Although the significance is somewhat sensitive to the inclusion of deterministic components like a trend, education-related variables (PRMPL, SECPL, and TERT) also show improved stationarity following differencing. When combined, the ADF tests indicate that most variables have non-stationary levels but turn stationary after initial differencing. The significance of performing cointegration analysis to determine whether a long-term equilibrium relationship exists among the variables is highlighted by this mixed order of integration (stationary GDPGR versus $I(1)$ behavior for the majority of others).

***** Table 6 here *****

Table 6 shows the Phillips–Perron (PP) unit root tests which confirm the general patterns identified in the ADF results, providing further evidence of mixed integration properties across the variables. With the notable exception of GDP growth, which is consistently stationary across all specifications at the 1% or 5% significance levels, the

majority of variables do not reject the null hypothesis of a unit root at levels, indicating non-stationarity. At the 10% level, tertiary education exhibits weak stationarity under the constant-only specification; however, this finding becomes unreliable when trend terms are included. In contrast, most variables become stationary at first differences because the null of a unit root is frequently strongly rejected.

In particular, corruption control and GDP growth are significant at the 1% threshold across multiple formulations, whereas the VAT gap and regulatory quality reach stationarity at the 5% level. When a deterministic trend is taken into account, secondary education also shows strong evidence of stationarity, rejecting the null at the 1% level. The dataset is characterized by a combination of I(0) and I(1) processes, according to the PP results, which are consistent with the ADF findings. This suggests that caution should be used when defining the model and that panel econometric techniques that take into account variables with different orders of integration are appropriate.

***** Table 7 here *****

To figure out if there is a long-term equilibrium relationship between the variables in the panel framework, the Kao residual-based cointegration test was used. With a p-value of 0.4495, the results, which are shown in Table 7, show that the ADF statistic (0.1269) is not statistically significant. This suggests that the variables in question do not have a common long-run equilibrium relationship, implying that the null hypothesis of no cointegration cannot be rejected. Stated differently, the dynamics of education, governance quality, and macroeconomic performance do not converge toward a stable long-run path in explaining variations in the VAT gap across EU member states, despite the possibility of short-term interactions. This outcome is supported by the regression output for the residual-based test that is included. The overall ADF test result indicates that this adjustment is not enough to support full panel cointegration, even though the coefficient of the lagged residual term [RESID(-1)] is negative and highly significant, suggesting some degree of mean reversion. Additionally, the conclusion that deviations from equilibrium are not systematically corrected over time is supported by the residual

variance and HAC variance estimates as well as the comparatively moderate R-squared value of 0.437.

When combined, these results imply that there is not a stable long-term equilibrium but rather that short- to medium-term factors dominate the relationship between educational attainment, governance indicators, and VAT compliance. This finding supports the focus on within-country variation over time rather than long-run cointegrating dynamics and supports the continued use of fixed effects estimation.

***** Table 8 here *****

The panel fixed effects regression results are presented in Table 8. The model is statistically significant overall (F-statistic = 12.83, $p < 0.01$), with an adjusted R-squared of 0.487, indicating that nearly half of the variation in VAT gaps across EU member states and years is explained by the included explanatory variables. The Durbin–Watson statistic of 1.38 suggests mild positive serial correlation, though within acceptable limits for panel settings.

Variables related to educational attainment show up as important predictors of VAT compliance. The coefficients for primary, secondary, and tertiary enrollment are all negative and statistically significant. In particular, a decrease in VAT gaps is linked to higher primary (-4312.7, $p < 0.01$), secondary (-2735.2, $p < 0.05$), and tertiary (-2117.5, $p < 0.05$) enrollment rates. This implies that educational advancements, regardless of level, increase compliance behavior and decrease opportunities for tax evasion, perhaps as a result of increased institutional trust, formalization of the labor market, and civic awareness.

Strong effects can be observed in governance indicators. Corruption is negatively signed (-107.5, $p < 0.05$), meaning that higher corruption perceptions are linked to larger VAT gaps, reinforcing the idea that institutional weaknesses undermine revenue collection. On the other hand, regulatory quality has a positive impact on compliance; its coefficient (164.9, $p < 0.01$) indicates that regulatory framework improvements help close VAT gaps.

Together, these governance effects underscore the critical role of institutional quality in shaping compliance outcomes. Among the macroeconomic controls, GDP growth exerts a negative and significant effect (-4.72, $p < 0.01$), indicating that stronger economic performance reduces VAT gaps. This aligns with the notion that buoyant economic conditions strengthen revenue collection efficiency, while downturns exacerbate compliance challenges.

Next, we provide three Stata-generated visual representations of the VAT Gap for the years 2008, 2015, and 2022 across the 25 EU nations. These maps highlight regional differences in tax compliance over time and space, and they show the entire VAT Gap in absolute terms. Readers can compare these snapshots to see trends in the effectiveness of VAT collection, pinpoint nations with consistently high or low gaps, and evaluate how tax compliance has improved or declined over time. These numbers give an intuitive grasp of how VAT gaps change throughout Europe and act as a supplementary visual aid to the econometric analysis.

*** Figure 1 here ***

*** Figure 2 here ***

*** Figure 3 here ***

5. Discussion and policy implications

The empirical analysis of VAT compliance in the European Union provides important findings into the structural drivers of the VAT gap and offers broader lessons for fiscal policy design. The findings reveal that educational attainment, governance quality, corruption, and macroeconomic conditions exert statistically significant effects on VAT compliance. These results underscore the multi-dimensional nature of tax compliance, which cannot be understood solely through the lens of enforcement but must instead be situated within broader social, institutional, and economic contexts.

The substantial and steady contribution of education at all levels—primary, secondary, and tertiary—to closing the VAT gap is one of this study's main contributions. This is consistent with the larger body of research on human capital,

which shows that education increases productivity, civic engagement, and economic outcomes (Becker, 1994; Moretti, 2004; Hanushek & Woessmann, 2008, 2012). In addition to cognitive abilities, education promotes civic engagement and social norms, both of which are essential for compliance behavior (Dee, 2004; Campbell, 2006). The findings are consistent with those of Alm and Torgler (2006), who emphasize how culture and tax morale influence compliance. People with higher levels of education are more likely to internalize civic responsibilities, such as paying taxes, and to believe that tax evasion is socially unacceptable. Furthermore, Chetty et al. (2014) demonstrate that education leads to better long-term results, supporting the notion that consistent educational spending can indirectly increase compliance by boosting tax morale.

The narrative presented by the governance indicators is equally compelling. The detrimental impact of corruption on VAT compliance supports long-standing claims in the literature that corruption erodes the legitimacy of tax systems and erodes public trust in the government (Mauro, 1998; Rose-Ackerman, 1999). According to Friedman et al. (2000), corruption makes businesses and individuals turn to the black market, which widens tax disparities. This is consistent with Kirchler et al. (2008)'s "slippery slope" framework, which holds that trust in authorities and deterrence are both necessary for voluntary compliance. Regardless of enforcement, citizens are less likely to voluntarily comply when they believe that institutions are corrupt. On the other hand, Kaufmann and Kraay (2008) and Rothstein and Teorell (2008), who stress that fair, efficient, and transparent institutions foster an atmosphere that is favorable to compliance, concur with the positive and important role of regulatory quality. In addition to lowering compliance costs, streamlining processes, cutting down on bureaucratic inefficiencies, and guaranteeing unbiased enforcement also strengthen the legitimacy and equity of the tax system.

These findings are further supported by the macroeconomic dimension. Stronger economic performance may increase compliance by expanding the tax base or decreasing incentives to engage in informal activity, as indicated by the negative coefficient of GDP growth on the VAT gap. As noted by Slemrod (2007), households and businesses may turn to evasion tactics to preserve consumption and profits during economic downturns, which would widen the VAT gap. The European Commission VAT Gap Reports (2020, 2022, and 2023) have emphasized this cyclical dynamic, demonstrating that VAT losses frequently increase during recessions and decrease

during recovery periods. Therefore, policymakers need to understand that macroeconomic performance and fiscal outcomes are closely related, and that countercyclical measures should incorporate measures to maintain compliance even during times of economic hardship.

These findings have important policy implications. First, education policy needs to be seen as a financial tool as well as a growth engine. Stronger compliance and fewer VAT gaps are two long-term benefits of investing in education quality and access. According to the OECD (2018), civic outcomes are shaped by education, and in the context of tax systems, this entails raising citizens' willingness to contribute to the public coffers.

Second, anti-corruption measures are still essential. The detrimental effects of corruption on tax compliance and revenue mobilization are unmistakably documented in the literature (Bird et al., 2008; Torgler & Schneider, 2009). According to Keen and Smith (2006), digitizing tax systems presents a promising avenue by enhancing audit capabilities and decreasing opportunities for discretionary interactions between taxpayers and officials. To reduce fraudulent activities like carousel fraud, a recurring issue noted by Barbone et al. (2013) and Keen (2013), the European Commission has already advocated for the adoption of real-time reporting and e-invoicing, which should be expanded further throughout member states.

Third, enhancing the quality of regulations must continue to be a top priority. VAT losses can be significantly decreased by implementing efficient regulatory frameworks that streamline compliance, lower expenses, and improve transparency. According to Rothstein and Teorell (2008), fair and consistent institutions are more successful at fostering trust and compliance than punitive measures alone. Therefore, EU policymakers should keep working to harmonize tax laws, lessen administrative burdens, and guarantee fair enforcement of them.

Finally, it is impossible to overlook the economic context. Fiscal policy must account for the fact that growth dynamics have an impact on VAT compliance. Governments should increase oversight during recessions and take into account policies that lessen the immediate compliance burden on faltering businesses, which will stop them from evading taxes. The VAT gap is also indirectly closed by more general policies that promote growth, as macroeconomic stability itself reinforces compliance.

By highlighting the fact that VAT compliance is a structural issue that encompasses more than just technical enforcement issues, this study adds to the current discussions surrounding the European tax gap (Reckon, 2009; Murphy, 2012; CASE, 2019). The findings are consistent with Keen and Lockwood (2010), who contend that institutional capacity and societal acceptance are just as important to the success of VAT as its design. They also support Luttmer and Singhal's (2014) finding that institutional trust and tax morale are just as important to compliance as enforcement.

In conclusion, reducing the VAT gap necessitates a comprehensive strategy that extends beyond conventional tax administration changes. Long-term improvements in compliance culture can be fostered by educational investments; institutional trust can be reinforced by anti-corruption initiatives and regulatory quality enhancements; and compliance incentives can be maintained by macroeconomic stability. Decades ago, Alm, Jackson, and McKee (1992) contended that social norms, trust, and enforcement all influence taxpayer behavior. The study's findings confirm the lesson learned in the European context: VAT compliance necessitates creating societies in which paying taxes is viewed as both a duty and a fair exchange with receptive, reliable institutions.

6. Conclusion

This paper examined the relationship between education and VAT compliance in the European Union, focusing on 25 member states over the period 2008–2022. Higher levels of primary, secondary, and tertiary school enrollment are significantly linked to smaller VAT gaps, according to the analysis, which used a two-way fixed effects panel model. These findings demonstrate the significance of education as a structural determinant of fiscal compliance as well as a driver of economic growth and productivity. In addition to traditional enforcement methods, education promotes a culture of voluntary tax compliance by enhancing civic engagement, cognitive ability, and awareness of legal obligations. The study emphasized the importance of institutional quality beyond education. The inverse relationship between economic growth and the VAT gap emphasizes the cyclical nature of tax compliance and implies that fiscal performance is strongly linked to macroeconomic stability. When combined, the findings imply that closing the VAT gap calls for an all-encompassing strategy. Macroeconomic policies should protect stability to strengthen compliance, institutional

reforms must target corruption and improve regulatory quality, and education policies should be viewed as fiscal strategies. Accordingly, long-term investments in governance and human capital that match financial incentives with social norms are the best ways to ensure VAT compliance in Europe, rather than relying solely on enforcement.

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Appendices

Table 1. Variables

Variable Type	Variables Used	Variables'		Source
		Stata Names	Explanation	
Dependent Variable	Vat Gap (current euro) (per capita)	VATGAP	Full explanation below* (transformed per capita)	European Commission
Independent Variables	Primary Education Pupils (per capita)	PRMPL	Primary education pupils is the total number of pupils enrolled at primary level in public and private schools. (transformed per capita)	World Development Indicators
	Secondary Education Pupils (per capita)	SECPL	Secondary education pupils is the total number of pupils enrolled at secondary level in public and private schools. (transformed per capita)	World Development Indicators
	Tertiary Education Pupils (per capita)	TERT	We obtained the Tertiary Education Enrollment Rate from WDI, which gives us a percentage, not the actual number of students. Since we wanted to estimate how many individuals are actually enrolled in tertiary education, we multiplied this percentage by the total population of young adults (ages 18–24), who are the typical age group for tertiary education. This gives us an approximate count of students enrolled, which is more useful for analyzing the scale of higher education participation across countries. (transformed per capita)	World Development Indicators and Calculations

Control Variables	Regulatory Quality: Estimate	REGQL	Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.	World Development Indicators
	Control of Corruption: Estimate	CORRPT	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.	World Development Indicators
	GDP growth (annual %)	GDPGR	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2015 prices, transformed (by authors) in euros €.	World Development Indicators

Source: Authors

Table 2. Descriptive Statistics

Variable	N	Mean	Std. Dev.	Min	Max
VATGAP	375	296.1507	176.8604	74.51	1552.96
PRMPL	375	0.0579	0.0174	0.0261	0.1162
SECPL	375	0.0809	0.0122	0.0591	0.1178
TERT	375	0.0698	0.0197	0.0109	0.1533
REGQL	375	1.1840	0.4459	0.1353	2.0405
CORRPT	375	0.9919	0.7932	-0.3814	2.4355
GDPGR	375	1.8019	3.9626	-14.8386	24.6156

***Note:** This table was generated using Stata 16 *sum* command

Source: Authors' Calculations

Table 3. Correlation Matrix

	VATGAP	PRMPL	SECPL	TERT	REGQL	CORRPT	GDPGR
VATGAP	1.0000						
PRMPL	-0.0094 0.8557	1.0000					
SECPL	0.0697 0.1778	0.0652 0.2077	1.0000				
TERT	-0.0898 0.0825*	0.0356 0.4918	-0.143 0.0055***	1.0000			
REGQL	0.0052 0.9195	0.4778 0.0000***	0.391 0.0000***	-0.1587 0.0021***	1.0000		
CORRPT	-0.0236 0.6484	0.5554 0.0000***	0.3893 0.0000***	-0.1081 0.0363**	0.8971 0.0000***	1.0000	
GDPGR	-0.1365 0.0081***	0.0958 0.064*	-0.0068 0.8959	-0.0794 0.1247	0.0374 0.4697	0.0045 0.9314	1.0000

***Note:** This table generated using Stata 16 *pwcorr, sig* command and presents pairwise correlations with significance levels. Correlation coefficients measure the strength and direction of linear relationships between variables.

(Significance levels *p < 0.1, **p < 0.05, ***p < 0.01)

Source: Authors' Calculations

Table 4. Cross-Section Dependence Test

Test	Statistic	Prob.
Breusch-Pagan LM	1053.654	0.000
Pesaran scaled LM	30.76781	0.000
Bias-corrected scaled LM	29.87495	0.000
Pesaran CD	14.14135	0.000

Null hypothesis: No cross-section dependence (correlation) in residuals

***Note:** This table presents diagnostic test results for cross-sectional dependence, generated using Stata commands. The Breusch-Pagan LM test was conducted using *xttest2*, while Pesaran's scaled and bias-corrected scaled tests were performed with *xtcsd, pesaran* and *xtcsd, pesaran abs* respectively. The Pesaran CD test results were obtained via *xttest3*.

Source: Authors' Calculations

Table 5. Augmented Dickey-Fuller (ADF) Unit Root Test

UNIT ROOT TEST RESULTS TABLE (ADF)

Null Hypothesis: the variable has a unit root

		At Level						
		VATGAP	PRMPL	SECPL	TERT	REGQL	CORRPT	GDPGR
With Constant	t-Statistic	0.2528	0.9407	0.0078	0.3351	0.9199	0.2907	0.0013
	Prob.	0.8825	0.0714	0.6276	0.1317	0.6624	0.9067	0.0086
		n0	*	n0	n0	n0	n0	***
With Constant & Trend	t-Statistic	0.5127	0.4912	0.1570	0.9984	0.6013	0.5010	0.0005
	Prob.	0.0545	0.0473	0.9513	0.2356	0.8462	0.1187	0.0225
		*	**	n0	n0	n0	n0	**
Without Constant & Trend	t-Statistic	0.5302	0.9686	0.4184	0.7609	0.0754	0.3377	0.0015
	Prob.	0.2042	0.5937	0.8065	0.8821	0.7603	0.9587	0.0026
		n0	n0	n0	n0	n0	n0	***
		At First Difference						
		d(VATGAP)	d(PRMPL)	d(SECPL)	d(TERT)	d(REGQL)	d(CORRPT)	d(GDPGR)
With Constant	t-Statistic	0.0106	0.5561	0.0436	0.5312	0.0501	0.0397	0.0000
	Prob.	0.0101	0.0585	0.3349	0.1127	0.0130	0.0843	0.0001
		**	*	n0	n0	**	*	***
With Constant & Trend	t-Statistic	0.0466	0.1146	0.1068	0.4248	0.1403	0.1248	0.0329
	Prob.	0.0621	0.8979	0.0248	0.4306	0.0136	0.2116	0.0006
		*	n0	**	n0	**	n0	***
Without Constant & Trend	t-Statistic	0.0005	0.3373	0.0022	0.1350	0.0117	0.0027	0.0000
	Prob.	0.0067	0.0801	0.0463	0.0093	0.0006	0.0148	0.0000
		***	*	**	***	***	**	***

Notes:

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

b: Lag Length based on SIC

c: Probability based on MacKinnon (1996) one-sided p-values.

***Note:** This table displays results from the Augmented Dickey-Fuller (ADF) Fisher Chi-square test, performed using EViews 13, **unit roots** command with **ADF** option.

Source: Authors' Calculations

Table 6. Phillips-Perron (PP) Unit Root Test

UNIT ROOT TEST RESULTS TABLE (PP)

Null Hypothesis: the variable has a unit root

		<u>At Level</u>						
		VATGAP	PRMPL	SECPL	TERT	REGQL	CORRPT	GDPGR
With Constant	t-Statistic	0.2528	0.1678	0.0081	0.3714	0.8793	0.2807	0.0015
	Prob.	0.9200	0.6687	0.3475	0.0969	0.6581	0.8828	0.0086
		n0	n0	n0	*	n0	n0	***
With Constant & Trend	t-Statistic	0.5127	0.4992	0.0000	0.9984	0.8447	0.6107	0.0001
	Prob.	0.4359	0.9356	0.9692	0.1376	0.8462	0.5951	0.0225
		n0	n0	n0	n0	n0	n0	**
Without Constant & Trend	t-Statistic	0.5697	0.4180	0.4184	0.9692	0.0961	0.3313	0.0015
	Prob.	0.1827	0.9204	0.5716	0.8555	0.7603	0.9554	0.0025
		n0	n0	n0	n0	n0	n0	***
		<u>At First Difference</u>						
		d(VATGAP)	d(PRMPL)	d(SECPL)	d(TERT)	d(REGQL)	d(CORRPT)	d(GDPGR)
With Constant	t-Statistic	0.0105	0.0024	0.0067	0.5312	0.0436	0.0395	0.0001
	Prob.	0.0229	0.7708	0.3848	0.1077	0.0130	0.0869	0.0000
		**	n0	n0	n0	**	*	***
With Constant & Trend	t-Statistic	0.0452	0.0057	0.0028	0.4880	0.1404	0.0924	0.0001
	Prob.	0.1370	0.9336	0.0008	0.4775	0.0016	0.2196	0.0001
		n0	n0	***	n0	***	n0	***
Without Constant & Trend	t-Statistic	0.0005	0.0001	0.0002	0.1641	0.0099	0.0024	0.0001
	Prob.	0.0074	0.2802	0.0463	0.0067	0.0006	0.0148	0.0000
		***	n0	**	***	***	**	***

Notes:

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

b: Lag Length based on SIC

c: Probability based on MacKinnon (1996) one-sided p-values.

***Note:** This table displays results from the Phillips-Perron (PP) Fisher Chi-square test, performed using EViews 13, *unit roots* command with *PP* option.

Source: Authors' Calculations

Table 7. Kao Residual Cointegration Test

	t-Statistic	Prob.
ADF	0.1269	0.4495
Residual variance	19838.54	
HAC variance	5178.095	

Augmented Dickey-Fuller Test Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.6228	0.0549	-11.3370	0.0000
D(RESID(-1))	-0.0947	0.0462	-2.0489	0.0413
R-squared	0.4368	Mean dependent var		-4.4269
Adjusted R-squared	0.4351	S.D. dependent var		128.8402
S.E. of regression	96.8387	Akaike info criterion		11.9901
Sum squared resid	3029008	Schwarz criterion		12.0134
Log likelihood	-1946.3920	Hannan-Quinn criter.		11.9994
Durbin-Watson stat	1.5155			

***Note:** This table presents results from Kao's residual-based cointegration test, conducted using EViews 13 *cointegration kao* command.

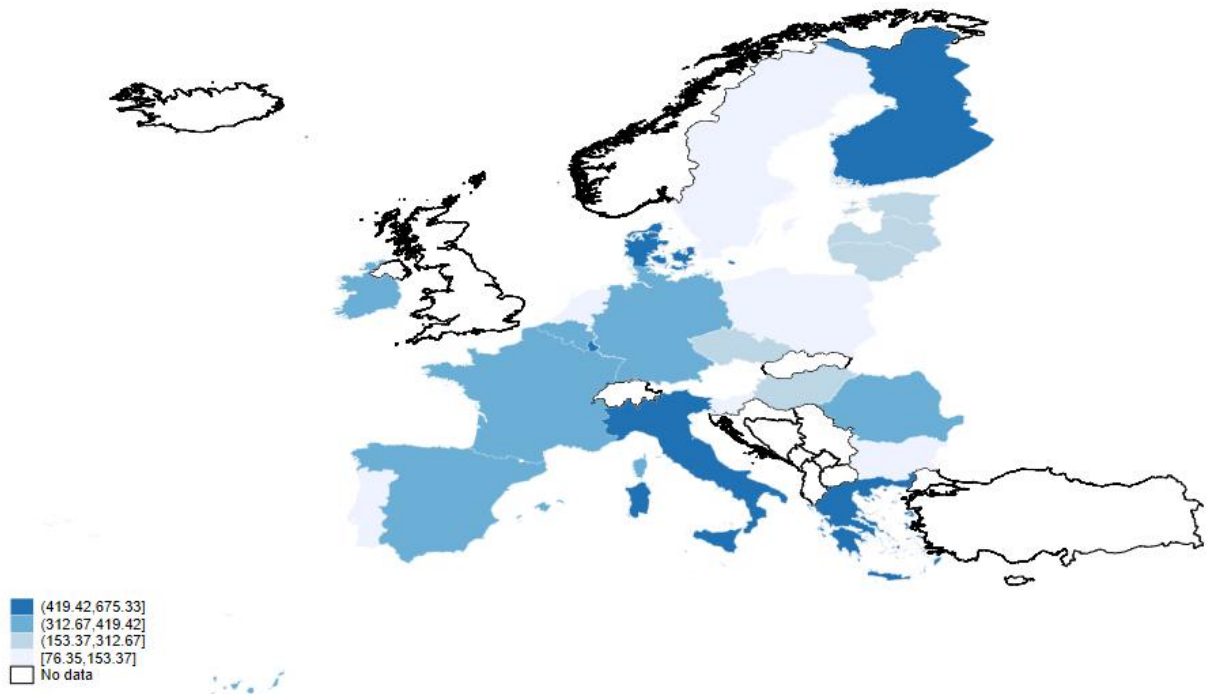
Source: Authors' Calculations

Table 8. Regression Analysis (Fixed Effects)

Dependent Variable: VATGAP				
Sample: 2008 2022				
Periods included: 15				
Cross-sections included: 25				
Total panel (balanced) observations: 375				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRMPL	-4312.7210	1493.9970	-2.8867	0.0041
SECPL	-2735.2140	1096.9880	-2.4934	0.0131
TERT	-2117.5210	853.3363	-2.4815	0.0136
CORRPT	-107.4565	52.1441	-2.0608	0.0401
REGQL	164.9314	57.0924	2.8889	0.0041
GDPGR	-4.7228	1.8050	-2.6165	0.0093
C	834.8063	158.1133	5.2798	0.0000
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.5281	Mean dependent var	296.1507	
Adjusted R-squared	0.4870	S.D. dependent var	176.8604	
S.E. of regression	126.6757	Akaike info criterion	12.6002	
Sum squared resid	5520077	Schwarz criterion	12.9248	
Log likelihood	-2331.5350	Hannan-Quinn criter.	12.7291	
F-statistic	12.8344	Durbin-Watson stat	1.3769	
Prob(F-statistic)	0.0000			

Source: Authors' Calculations

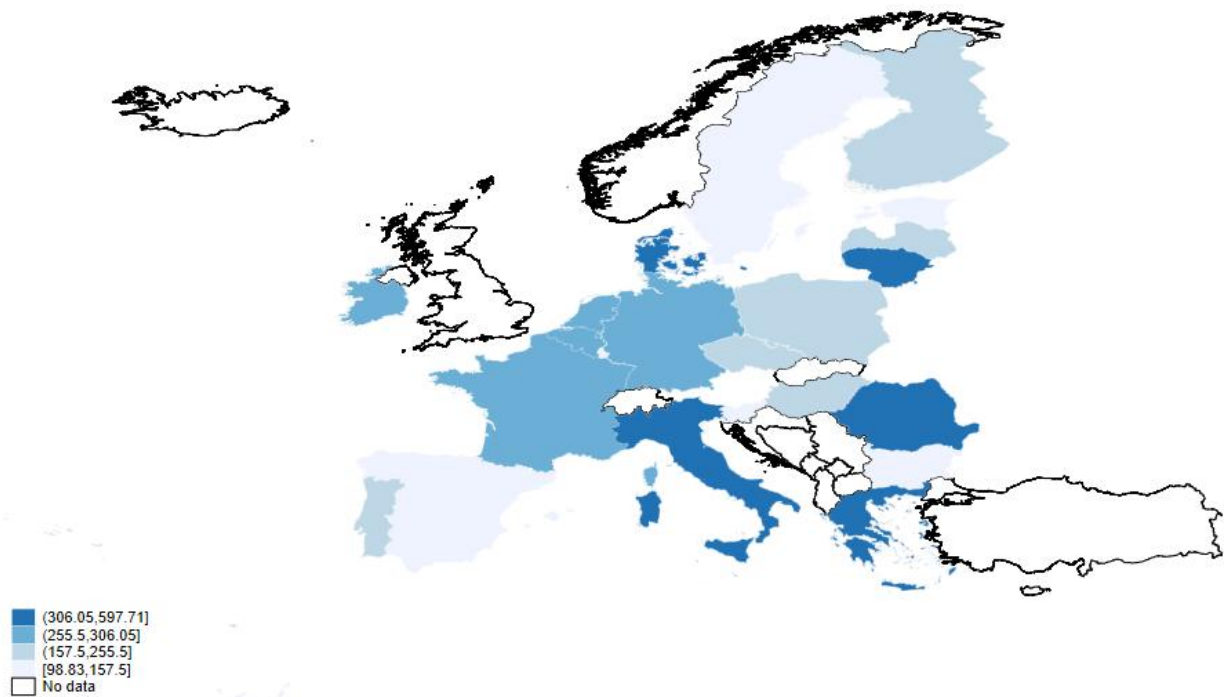
Figure 1. VAT Gap Per Capita (in billion EUR) 2008



****Note:** The map was generated using the *spmap* command in Stata, which facilitates the spatial depiction of cross-national economic indicators.

The shapefile used to construct this map was retrieved from Sevdari, Kristian; Marmullaku, Drin (2023). Shapefile of European countries. Technical University of Denmark. Dataset. <https://doi.org/10.11583/DTU.23686383.v1>

Figure 2. VAT Gap Per Capita (in billion EUR) 2015



****Note:** The map was generated using the *spmap* command in Stata, which facilitates the spatial depiction of cross-national economic indicators.

The shapefile used to construct this map was retrieved from Sevdari, Kristian; Marmullaku, Drin (2023). Shapefile of European countries. Technical University of Denmark. Dataset. <https://doi.org/10.11583/DTU.23686383.v1>

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