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How Important is the Structure of the EU Economy to the VAT Collection?*

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Abstract

VAT is one of the most important sources of the public revenues in the EU Member States; therefore, it is crucial to determine the factors of VAT collection. So far, only a few researchers analyzed the influence of individual economic sectors on the indicators of VAT collection, namely Compliance and Policy gaps. Therefore, the authors used the autoregressive distributed lag (ARDL) and Error Correction (EC) models to study the relationship between eleven economic sectors, the VAT Compliance Gap and the VAT Policy Gap, which were selected as the dependent variables. The research focused on twenty-five EU member states, and the examined time period was from 2005 to 2020. The results showed that the Compliance Gap is affected increasingly by the Construction and Arts sectors and decreasingly by the Agriculture and Manufacturing sectors. The Policy Gap was increasingly affected by the Real Estate, Public Administration, and Financial Services sectors. These findings established which economic sectors should receive 'special attention' from tax administrations in the EU countries to tackle tax evasion, and which are the most critical in making strategic decisions regarding tax legislation.

Keywords: value added tax (VAT), dynamic panel data model, VAT compliance gap, policy gap, economic sectors

JEL Classification: H26, H83, M42

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1. Introduction

Value Added Tax (VAT) is an indirect tax calculated according to the value added to goods or services at each stage of production and distribution; hence, VAT revenues are relevant to the size and share of each economic sector in the economy. This becomes more complicated when analysing an international "federal-like" economic system like the European Union (EU). The relative size of each productive sector is different in each EU member state and may increase or decrease depending on current economic conditions. The institutional environment, overall economic structure of the EU member states, size of intracommunity trade, and unforeseen factors such as financial crises and the COVID-19 pandemic influence the VAT collection. The loss of VAT revenue is of utmost importance for all EU member states because it directly impacts their fiscal policy, tax policy, macroeconomic stability, and economic development. In addition, VAT revenues collected by individual member states are one of the sources for the EU budget.

The analysis conducted by the authors was based on two components. The first is the consumption-side top-down approach, where VAT Theoretical Tax Liability (VTTL) is used to measure the *Compliance Gap* (which is the same concept as the VAT Gap computed in the European Commission Reports, CASE, 2013–2021) for all EU countries from 2005 to 2020. The *Compliance Gap* arises due to tax non-compliance or other related causes. The other component for interpreting the overall loss in VAT collection is the so-called *Policy Gap*, resulting from the choice of tax policy, especially the use of reduced VAT rates and exemptions. Together, these indicators can inform us about the performance of the VAT system, which is usually evaluated by the overall collection efficiency indicator known as the "*C-efficiency*" ratio. Because the authors know the existing interrelation between the *Compliance* and *Policy Gap*s, they believe that examining both gaps independently will yield more informative results for decision-makers than exploring only the *C-efficiency* ratio as a whole.

Having performed previous research on the subject of *Compliance and Policy Gaps* in the EU, the authors regarded it as necessary to investigate certain aspects more deeply, as the existent literature did not cover these issues properly. The questions that particularly arose stand behind the need for further investigation and are answered in this paper as follows:

- Which economic sectors in the EU have a statistically significant relationship with the *Compliance Gap* and in which direction do they influence it?
- Which economic sectors in the EU have a statistically significant relationship with the *Policy Gap* and in which direction do they influence it?

The authors reviewed the most recent international literature concerning the relationship between one or more economic sectors with the VAT Gap, VAT evasion, VAT revenues, and a general tax effort. To ensure the best possible results regarding the establishment of the existence of connections between the *Compliance* and *Policy Gap*s and economic sectors, the authors ultimately decided on using a different econometric approach from those adopted so far in the international literature; specifically, the auto-regressive distributed lag (ARDL) model and error correction (EC) model were applied. Finally, the paper concludes by analysing the results obtained from the chosen econometric method, aiming to show which EU countries' productive activities (sectors) have a statistically significant relationship with the *Compliance Gap* and the *Policy Gap*. These results can contribute to the design of targeted policy measures to improve the overall EU VAT collection efficiency.

This study offers an original and insightful perspective for policymakers as it solely focuses on the EU member states' economic structure and its effects on the efficiency of overall VAT collection (*Policy* and *Compliance Gap*s), thus providing a fresh contribution to the current literature. Another original aspect of the study is its use of the ARDL and EC models for econometric analysis of *Compliance and Policy Gaps*. Although Ueda (2017) used similar techniques in his econometric analysis and interpretation of the results (each particular variable has both short-term and long-term effects that correspond to the sign for the non-lagged and lagged variables), they are still slightly different from the approach adopted by the presented research.

2. Literature review

The EU *Compliance Gap* has been improving (i.e., decreasing) between 2005 and 2020 due to the various reforms and actions taken by the individual tax authorities and EU directives. Yet, it remains the main cause of tax revenue loss for many EU Member States. In fact, according to the findings of the 2022 CASE[1] Report on the EU VAT Gap (released annually by the European Commission), the total loss of VAT revenue in 2020 was over €93 billion. The most recent CASE Report shows the VAT *Compliance gap* of almost 61 billion EUR (CASE, 2023).

2.1 *Policy* and *Compliance Gaps* and overall VAT collection

One of the most widely accepted methodologies for the identification and interpretation of the efficiency of overall VAT collection is the use of *Policy* and *Compliance Gap*s. Firstly, the *Policy Gap* captures the effects of imposing multiple rates and exemptions on the theoretical

1 Center for Social and Economic Research.

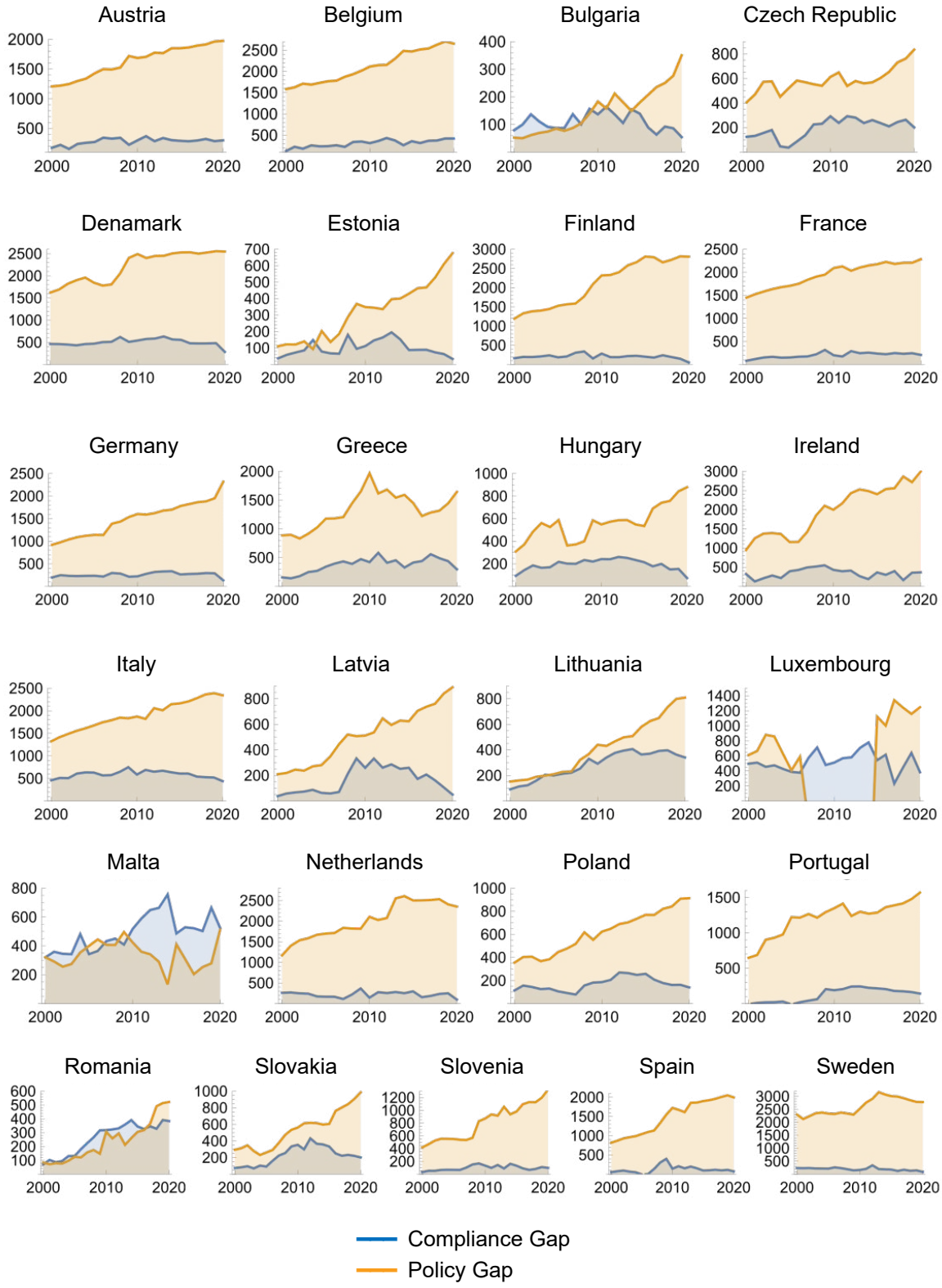
revenue that could be collected in a given VAT system. In other words, it is essentially a normalised measure of tax expenditures under VAT, measured relatively to a uniform VAT rate on all consumption of goods and services supplied, calculated under the assumption of full compliance (Keen, 2013). The additional VAT revenue that could theoretically be generated under the assumption of full compliance is called "Notional Ideal Revenue" (Case-Barbone et al., 2013). Due to the idealistic assumption of perfect tax compliance and a broad base that captures the entire final consumption, the term "Notional Ideal Revenue" and the practical interpretation of the *Policy Gap* draw criticism.

Nonetheless, the calculation of the *Policy Gap* is indispensable for the overall VAT collection research because it offers the opportunity to capture the loss in VAT liability due to the reduced rates and implementations of exemptions. Moreover, a more detailed breakdown of the *Policy Gap* could be used to address the extent to which the loss of theoretical revenue depends on policymakers' decisions. While the provision of public goods and services and financial services is mandatorily excluded from taxation based on EU legislation, other exemptions or the use of reduced rates are at the discretion of governments.

Secondly, the *Compliance Gap* reflects the difference between the amount of VAT that should have been theoretically paid based on the current VAT legislation, including the application of valid exemptions and rates (that is, VTTL) and the amount actually received by the government, expressed as a share of the former (Keen, 2013). Imperfect compliance may arise from VAT fraud, evasion, tax avoidance, and general non-compliance by VAT-registered firms (Baer, 2012; Keen and Smith, 2006).

According to Canıkalp et al. (2016) and Keen (2013), *Policy* and *Compliance Gap*s are interrelated. Usage of two different gaps can help analyse the effect of policy-making choices, tax compliance efficiency, and their interaction (Case-Barbone et al., 2013; Hutton, 2017; D'Agosto and Santoro, 2019). An overview of both gaps for the 25 EU member states that are considered in the section "Data and Methods" between 2005 and 2020, can be seen in Figure 1.

Figure 1: *Policy* and *Compliance Gaps* for the 25 EU member states (2005–2020)



Source: Eurostat and CASE, authors' calculations

The development of the *Compliance gap* for some countries that joined the EU in 2004 and later[2] shows that it increased after joining the EU and then gradually decreased. This happened due to the entry into the European single market and the spread of the so-called carousel fraud (CASE-Barbone et al., 2013), and subsequently, the *Compliance gap* started to decrease thanks to the measures taken to fight tax evasion (CASE-Poniatowski, 2023). The other member states exhibit a flat line of *Compliance gap* because they did not have such a problem with carousel frauds and experience mainly traditional tax evasions that do not change much over time (CASE-Poniatowski et al., 2018). A steadily growing *Policy gap* can be observed in some member states[3]. These states use a wide range of reduced VAT rates and exemptions (European Commission, 2021). Especially in the period after the financial crisis in 2008, the *Policy gap* grew also in other countries[4]. The reason is an increase in public spending and shifts in the structure of household consumption towards discounted/overall cheaper goods and services in the period after the economic crisis.

2.2 Economic Sectors and Overall VAT collection gap

The sectoral composition of a country's economy may have an essential impact on its VAT *Compliance Gap* (CASE-Poniatowski et al., 2018; CASE-Poniatowski et al., 2019; Christou et al., 2021). In this study, we compiled a variety of recent studies and papers that include one, several, or all economic sectors, and examined their relationship with different variables expressing the efficiency of VAT collection, VAT revenues, tax effort, evasion, non-compliance, and the VAT (*Compliance*) Gap.

Agriculture, forestry and fishing

Researchers often find the agricultural sector difficult to tax (Crivelli and Gupta, 2014; Thackray and Ueda, 2014; Godin and Hindriks, 2015; Dalamagas et al., 2019, Christou et al., 2021). Their results may vary depending on the countries under investigation, the econometric approach used (Piancastelli and Thirlwall, 2020), and the time period under investigation (CASE-Poniatowski et al., 2020, 2021).

Mining and quarrying, electricity, gas, water supply, waste management

This sector includes the mining industry in general, the units that produce, transmit, or distribute natural resources such as electricity, natural gas, etc., and sewage and waste disposal plants.

2 For example: the Czech Republic, Slovakia, Slovenia, Poland, Latvia, Hungary, or Estonia.

3 For example: Austria, Belgium, Ireland, France, or Germany.

4 For example: Spain, Greece, or Portugal.

Relevant research in the EU is scarce and mainly focuses on mining in Arab and African countries. Christou et al. (2021) showed that an increase in its share of GDP is associated with a reduction in the Greek VAT Gap, and Abdixhiku et al. (2017) also associate this sector with lower tax evasion.

Manufacturing

Recent studies on industrialization and manufacturing find that this sector is more receptive to tax collection than other sectors (Langford and Ohlenburg, 2016; Cevik et al. 2019). However, the 2020 CASE study on the EU VAT Gap did not find any clear and statistically significant relationship, while Lukáč and Simonidesová (2020) and Remeta et al. (2015), when investigating Slovakia, identified the manufacturing sector as the third most at-risk sector for tax losses.

Construction

The construction sector was identified in several studies as one of the sectors most prone to the loss of VAT revenue. The most prominent studies are those by Transparency International Latvia et al. (2017) for Latvia, Luzgina (2017) for Belarus, Hrdlička (2015) for Slovakia, and Thackray and Ueda (2014) for Estonia. Some studies do not find any statistically significant relationship between the construction sector and the VAT (*Compliance*) Gap (CASE-Poniatowski et al., 2021; Zídková and Pavel, 2016).

Wholesale and retail trade, transport, accommodation and food service activities

The 2018 CASE study stated that the VAT Gap increased as the share of retail trade in the economy increased (CASE-Poniatowski et al., 2018). Hrdlička (2015) finds similar results for Slovakia and the Czech Republic and Thackray and Ueda (2014) for Estonia. Christou et al. (2021) found that accommodation and food service activities increase the Greek VAT (*Compliance*) Gap. Abdihiku et al. (2017), who investigated tax evasion in transition economies (such as the countries of the former Soviet Union), found that this sector has the highest tax evasion.

Information and communication services

The 2020 and 2021 CASE reports on the EU VAT (*Compliance*) Gap showed that the effect of this sector on tax evasion is negative; that is, as the sector's share increases, the VAT Gap decreases (CASE-Poniatowski et al., 2020, 2021).

Financial and insurance activities

Activities such as financial services, banking, investment, and insurance are exempt from VAT in accordance with the provisions of the European Council Directive no. 2006/112/EC/28-11-2006 (further referred to only as 'VAT Directive"). According to Angelov and Nenkova (2019), treating financial services as exempt from VAT is common among EU member states, and creates serious economic distortions. On the other hand, the role of the financial sector has been

emphasized as providing valuable information for tax audits, thus significantly enhancing tax revenues (Rodríguez, 2020).

Real estate activities

Fedotov and Nevzorova (2020) investigated the size of the shadow economy in Russia and found that the real estate sector has one of the highest shares in the country's shadow economy. Abdihiku et al. (2017), investigating tax evasion in transition economies (such as the countries of the former Soviet Union), also found that the real estate sector ranked third in tax evasion. On the other hand, Alognon et al. (2020) note that an increase in the share of the real estate industry in GDP is associated with a lower VAT (*Compliance*) Gap, suggesting that this may be because real estate transactions usually involve significant amounts of money. Hence, the use of cash by economic agents in this sector is very difficult.

Professional, scientific, and technical activities; administrative and support service activities

Recent literature shows that the VAT (*Compliance*) Gap is positively affected by the growth of professional, scientific, and technical services (Cevik et al., 2019, Piancastelli and Thirlwall, 2020). Artavanis et al. (2015) found that tax evasion in Greece is closely related to this sectors' activities. Similarly, Šlahor and Barteková (2015) and Thackray and Ueda (2014) found that the VAT (*Compliance*) Gap is greatly increased by these sectors in Slovakia and Estonia, respectively.

Public administration, public defense, education, healthcare, and social work activities

For this sector, all government expenditures are exempt from VAT; hence, a distortion in the VAT tax system is produced (Eriotis et al., 2021; Christou et al., 2021). Similar results for Greece are found in Artavanis et al. (2015), where both the healthcarw and education sectors are linked to the shadow economy. Likewise, in the approach of Cevik et al. (2019), it is shown that the VAT collection is negatively affected by the consequent increase in education and healthcare services. Because this sector is exempted from VAT, it negatively affects *C-efficiency* through the *Policy Gap*.

Arts, entertainment, and recreation; other service activities; activities of households as employers and extra-territorial organizations and bodies

Alognon et al. (2020) reported that an increased share of the arts sector in the economy implies a higher VAT (*Compliance*) Gap, attributing this relationship to the high proportion of both cash payments for services in this sector and self-employment within it. The 2018 and 2019 CASE Reports showed that the degree of importance of the specific sector in the EU VAT (*Compliance*) Gap varies depending on the time period under investigation.

2.3 Econometric Models analysing the factors of VAT collection

Most researchers have analysed VAT Gaps using either Cross-Sectional or Panel Regressions with Fixed or Random effects. Zídková and Pavel (2016) used Cross-Sectional Regression to examine final consumption's impact on the VAT Gap. Aizenman. and Jinjarak (2008) employed a Fixed Effects Panel Estimation for the determining factors of *C-Efficiency*. CASE-Poniatowski et al. (2021) used a similar Fixed Effects methodology to determine the VAT (*Compliance*) Gap factors across European Economies. On the other hand, Christie and Holzner (2006) used Panel Regression with Random Effects and the Rate of Compliance as the dependent variable in their research on tax evasion. Reckon LLP (2009) also used a relative variable expressing the VAT (*Compliance*) gap as a percentage of GDP with a series of panel regressions.

An alternative approach is using a Dynamic Panel Data model, as Pesaran et al. (1998) suggested. In contrast to the Standard Panel Data model, a Dynamic Panel Model also includes lagged values of the dependent variable as regressors. An example of the use of Dynamic Panel models for analysing *Compliance* and *Policy Gap*s can be found in Ueda (2017), who uses data on a series of VAT (*Compliance*) Gaps, from 2000 to 2014, in 26 European countries and relates them to the Output Gaps of the economies.

Our article employs a relatively new and innovative research econometric methodology applied for the first time to study the *Compliance and Policy Gaps* in European Economies. Specifically, we employ a panel ARDL and EC model relating *Compliance* and *Policy* Gaps with the sectoral Gross Value Added calculated in current prices per capita. Rather than relying solely on the *Compliance gap* indicator as in Ueda (2017), we employ more up-to-date data and examine both the *Compliance* and *Policy* gaps.

3. Data and Methodology

3.1 Limitations

Our data have the following limitations:

- Accuracy of the *Compliance Gap* and *Policy Gap* relies largely on the quality of national accounts' figures and the precision of calculating potential VAT revenues, reference potential VAT revenues, and final consumption.
- There is one EU Member State with a negative *Policy Gap*, namely, Luxembourg.
- There is a lack of data in CASE reports for Croatia and Cyprus; therefore, we did not include them in our analysis.

Limitations of methodology:

- The endogeneity of the explanatory variables limits the performance of the ARDL and EC models; therefore, a weak exogeneity test was performed before the analysis.
- The existence of correlation errors limits the also limits the performance of the models; therefore, the appropriate number of lags in the model was chosen and verified based on the AIC and SBC information criteria.

3.2 Data

In order to determine the relationship between economic sectors and the efficiency of VAT collection, we used econometric models where the explained variables were *Compliance* and *Policy Gap*s. Following Eurostat standards, the total gross value added in the eleven individual sectors of the economy (some were 'merged' into one general category) served as explanatory variables.

We calculated the annual panel data of the *Compliance Gaps* for 25 EU countries in the years 2005–2020 in relative terms based on formula 1:

$$Compliance\,Gap = \frac{potential\,VAT\,revenue - current\,VAT\,revenues}{potential\,VAT\,revenue} \quad (1)$$

Potential VAT revenue is the amount of theoretical tax that could be collected at current VAT rates and exemptions. Data on final consumption by households and public institutions, as well as on intermediate consumption and fixed capital formation by exempt entities, are used to determine the theoretical tax base. This theoretical tax base is multiplied by the effective VAT rate in the given member state. A more detailed explanation of the calculation of theoretical VAT revenues can be found in CASE-Poniatowski et al. (2022). We used the VAT (*compliance*) gap expressed in percentage in the CASE-Poniatowski et al. (2022) to determine the *potential VAT revenues*. We computed the *compliance ratio* to complement the relative VAT gap of 100%. Then, we divided real VAT revenues by the *compliance ratio*. This gave us the *potential VAT revenues*, or, in other words, the theoretical VAT liability (VTTL). We did not analyse Croatia and Cyprus; as for these countries, we do not have the CASE report data for their VAT gap.

Data on *current VAT revenues* in individual member states in this period were sourced from the Eurostat, specifically from the national accounts database "Government revenue, expenditure and main aggregates" with an online data code: GOV_10A_MAIN. From this database, we used the D211 REC VAT receivable indicator. Using these data ensures their comparability, as all EU member states report them based on the ESA 2010 methodology.

The *Compliance Gaps* for the 25 EU Member States during the 2005–2020 period are shown in Table 1.

Table 1: *Compliance Gap* in relative terms (values in %) for 25 EU member states in the period 2005–2020

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	7.7	9.4	6.5	9.8	10.2	10.3	12.6	11.5	11.5	7.8	9.9	11.7	8.9	10.3	9.2	8.7	8.3	8.4	8.9	7.7	8.6
Belgium	6.8	11.4	9.1	12.3	10.8	10.5	10.8	9.0	12.8	13.4	11.7	13.1	14.9	13.1	9.6	12.6	10.9	12.2	11.9	13.1	14.0
Bulgaria	35.8	38.3	46.4	35.3	26.1	22.0	19.1	24.6	16.5	27.3	24.3	26.1	21.8	16.7	22.5	19.9	12.7	8.5	11.3	9.7	6.3
Czechia	24.5	23.7	24.1	26.3	7.0	5.0	10.6	14.5	18.3	19.8	22.7	18.2	21.3	20.2	17.7	18.4	16.0	13.1	14.1	14.2	11.9
Denmark	13.1	12.7	12.1	11.5	11.6	10.9	10.9	10.6	12.7	11.1	11.5	11.9	11.8	12.7	11.3	10.9	9.2	8.9	8.6	8.5	5.0
Estonia	9.1	12.6	13.4	14.2	20.1	10.5	7.0	5.8	15.8	9.4	10.6	12.5	12.6	14.2	10.5	5.8	5.6	5.2	4.0	3.3	1.8
Finland	7.2	8.4	7.9	8.0	8.7	6.6	7.0	9.6	10.3	5.2	8.9	5.6	5.4	5.9	6.1	5.5	4.8	6.1	4.8	3.6	1.3
France	4.3	6.2	7.8	8.3	7.1	7.0	7.5	7.5	9.3	13.5	8.7	7.4	11.7	10.0	10.3	9.4	8.8	9.3	8.5	8.6	8.0
Germany	10.4	12.8	12.3	12.1	12.3	12.2	10.9	12.6	11.7	9.0	9.2	10.5	11.7	11.9	11.8	9.2	9.4	9.3	9.4	9.0	4.8
Greece	15.8	13.0	13.9	18.4	19.0	21.9	22.8	22.5	20.3	26.1	22.7	30.2	24.9	28.4	22.0	25.9	24.9	29.1	25.6	23.4	19.7
Hungary	17.6	23.5	25.5	21.6	19.1	22.7	23.0	20.1	22.2	22.0	22.3	22.0	22.2	21.6	19.1	16.5	14.2	14.3	10.2	9.8	5.1
Ireland	13.8	5.8	8.3	10.3	7.4	11.6	11.6	13.0	15.0	19.4	16.3	15.6	15.6	10.6	7.1	12.6	10.2	12.8	5.3	10.3	12.5
Italy	25.2	27.2	26.5	30.5	30.9	29.9	26.3	25.9	28.8	33.9	26.3	29.4	28.7	30.0	28.6	26.9	26.5	23.3	22.6	21.8	20.8
Latvia	13.2	18.0	19.1	19.0	20.3	12.4	8.7	8.2	23.1	39.4	31.6	33.5	25.2	25.5	22.0	21.6	14.3	15.7	11.3	7.2	3.6
Lithuania	25.4	28.6	27.7	33.1	37.3	31.1	27.8	23.6	23.9	34.9	29.6	29.8	31.0	31.0	30.2	26.9	26.1	25.2	24.0	20.9	19.3
Luxembourg	15.0	14.7	12.9	12.7	10.5	8.8	8.5	10.7	12.6	8.7	8.8	9.1	8.7	9.9	10.2	9.2	10.1	3.9	7.0	9.7	6.0
Malta	33.2	33.8	32.2	31.9	36.6	25.8	26.5	29.5	28.6	26.9	31.0	32.0	33.4	32.5	33.6	24.1	25.1	22.9	20.6	26.0	24.1
Netherlands	12.8	11.9	10.7	10.1	7.4	6.9	6.4	4.2	7.7	12.8	5.4	9.9	9.3	10.0	9.0	10.1	5.3	6.0	7.1	6.9	2.8
Poland	25.3	29.4	26.8	26.0	25.4	17.7	13.7	10.4	17.1	23.2	20.5	20.8	27.0	26.6	244	24.6	20.3	15.7	13.2	12.7	11.3
Portugal	–0.7	1.1	1.8	1.9	2.6	-0.9	1.5	3.0	4.4	15.3	12.9	13.2	15.4	15.7	13.7	12.7	11.9	9.9	9.1	8.2	8.0
Romania	37.5	44.9	35.4	35.2	40.8	30.4	33.2	32.0	33.2	45.2	40.5	36.4	37.7	38.0	40.4	34.6	37.0	36.8	33.2	35.5	35.7
Slovakia	20.8	20.7	22.0	14.5	17.4	14.0	20.7	24.6	23.5	29.9	31.3	25.5	35.0	29.7	27.9	25.0	20.0	16.9	16.7	15.0	13.9
Slovenia	3.4	5.3	4.8	5.7	5.6	5.2	4.8	6.6	8.8	10.7	8.6	6.3	9.3	5.7	9.6	7.8	5.4	3.8	4.3	5.5	5.5
Spain	5.4	7.2	8.5	5.7	4.0	-0.4	0.2	8.8	20.9	33.4	10.7	15.1	11.5	13.3	10.0	6.0	6.1	6.6	5.5	6.1	4.7
Sweden	8.3	8.5	8.2	7.4	7.1	6.7	7.7	6.5	5.4	4.6	4.3	5.0	7.9	4.6	4.4	4.1	2.8	3.7	3.0	3.3	2.0

Source: Eurostat and CASE-Poniatowski et al, 2022, authors' calculations

The Policy gaps for the EU Member States are calculated based on Equation 2.

$$Policy\,Gap = \frac{reference\ potential\,VAT\ revenue - potential\,VAT\ revenues}{reference\ potential\,VAT\ revenue} \tag{2}$$

where *reference potential VAT revenue* is the "ideal" amount of tax that could be collected if the standard rate was applied to all final consumption and no VAT evasion existed, and *potential VAT revenue* has the same meaning as in the equation for the *Compliance Gap*.

We calculated *reference potential revenues* by multiplying the final consumption of households, non-profit organisations (NPISH), and government[5] by the standard rate in each member state for each year of the analysed period. Data on final consumption in individual member states were downloaded from the Eurostat's national accounts database "Final consumption expenditure of households, NPISH, and government volumes." Standard VAT rates in individual EU states were taken from the publication "Taxation Trends in the EU" published by the European Commission (European Commission, 2021).

We discovered that Luxembourg has had a negative *Policy Gap* for some years. This is apparently due to its non-traditional economic structure (a significant share of the financial sector provides its services outside the country) and the large share of final consumption by non-residents (CASE, 2015), which distorts the figure of *reference potential VAT revenues* (they are calculated to be lower because they do not include non-resident final consumption). The *Policy Gaps* of the 25 EU member states are presented in Table 2 for the full period under investigation – from 2005 to 2020. Due to the negative Policy Gap for several years, we excluded Luxembourg from the dataset as an outlier, and the models for the *Policy Gap* only contain observations for 24 Member States.

For comparability reasons and to ensure data homogeneity between the individual EU Member States, our econometric analysis uses *Compliance* and *Policy Gap* data in absolute values calculated per capita. The size of individual productive sectors in the economy, expressed as their gross value-added per capita, were used as explanatory variables. Data from the Eurostat database "Gross value added and income by A*10 industry breakdowns" were used for this aim. Economic sectors are classified under the Statistical Classification of Economic Activities in the European Community, Rev. 2 (Eurostat, 2008). For our analysis, we merged some sectors and finally arrived at 11 economic sectors, as indicated in Table 3.

5 After deducting the VAT included in the final consumption prices in the national accounts.

Table 2: *Policy Gap* in relative terms (in %) for 25 EU member states in the period 2005–2020

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	30.8	32.1	31.3	34.5	36.5	37.5	39.7	39.3	36.6	33.8	38.9	36.3	35.4	35.2	36.2	34.6	37.3	36.6	35.7	35.1	39.9
Belgium	45.0	46.2	47.6	45.9	44.4	43.6	41.1	41.2	43.0	46.9	45.2	44.5	46.3	46.2	47.7	48.7	48.0	47.8	47.4	48.7	50.1
Bulgaria	44.3	41.7	51.2	39.6	31.7	28.3	22.4	28.4	18.2	32.5	35.3	32.0	31.3	25.4	29.6	27.1	24.3	20.7	22.9	20.6	22.4
Czechia	34.5	32.7	24.7	38.1	24.5	28.2	35.3	29.0	32.4	24.6	30.8	26.0	27.7	32.3	25.1	27.2	31.8	32.6	31.6	32.7	37.0
Denmark	21.1	22.0	22.3	20.3	36.4	34.3	28.0	23.9	24.8	27.2	25.2	28.0	25.0	26.7	28.2	27.0	27.5	28.5	27.0	26.7	25.8
Estonia	21.4	20.8	18.3	18.8	11.2	21.4	12.3	14.2	20.1	26.7	24.8	22.7	20.5	22.4	21.6	22.1	22.6	21.4	22.3	23.9	26.6
Finland	35.7	37.0	35.6	36.6	37.8	39.7	39.0	33.8	26.3	16.0	40.9	33.9	36.5	36.1	39.3	43.1	41.7	39.9	39.6	38.9	38.9
France	36.3	40.2	40.9	38.1	36.6	33.4	32.6	33.4	36.9	36.1	38.2	30.6	35.5	32.4	38.1	34.4	35.3	29.5	31.9	32.9	38.9
Germany	30.5	33.6	35.6	37.0	37.7	38.1	36.2	38.4	36.5	37.8	38.2	36.6	37.2	37.1	37.7	37.1	38.4	38.4	38.1	38.0	45.2
Greece	53.5	49.3	43.5	46.9	49.4	52.1	50.3	48.4	49.8	55.3	58.9	58.9	57.9	59.5	58.0	57.1	51.3	53.2	51.8	52.6	58.3
Hungary	30.2	33.3	38.1	32.5	18.9	30.5	24.5	23.9	25.9	24.4	26.7	27.1	24.8	24.4	20.0	19.1	25.0	25.1	21.9	25.7	26.8
Ireland	33.8	34.3	35.3	35.2	30.7	29.3	27.7	29.9	38.2	51.2	47.7	51.8	53.5	52.6	48.7	49.5	49.1	48.9	48.4	47.8	56.1
Italy	47.5	45.8	44.6	50.2	52.2	49.5	47.1	48.7	49.8	53.7	48.5	49.0	52.0	53.0	55.1	55.3	56.4	54.9	57.1	56.7	60.5
Latvia	41.6	48.0	48.0	44.0	47.2	35.9	31.8	30.5	42.4	53.0	49.6	48.9	45.5	45.5	45.8	40.9	39.9	38.1	39.0	34.1	32.7
Lithuania	30.0	30.2	28.5	30.9	33.3	25.9	24.4	17.2	18.0	29.1	34.0	27.8	30.1	29.2	29.0	30.0	30.2	31.2	32.1	30.6	30.2
Luxembourg	17.4	12.7	13.9	12.4	2.8	4.7	11.6	-3.0	–21.3	–54.6	–39.2	–49.8	–40.0	–47.6	–50.0	2.7	10.0	6.9	12.4	17.2	18.6
Malta	41.1	39.1	37.2	37.9	44.2	37.5	39.3	38.2	35.1	39.6	39.7	37.4	38.0	34.4	30.2	30.6	27.3	26.4	22.7	26.1	34.6
Netherlands	16.8	17.8	20.5	20.7	14.4	26.1	23.1	19.4	21.0	26.9	23.4	23.3	22.4	30.2	29.0	36.0	31.3	32.7	33.8	24.6	23.6
Poland	44.1	43.1	43.0	43.2	42.8	42.7	41.5	40.6	40.2	41.3	40.7	39.6	40.8	41.4	41.9	42.3	43.0	42.0	40.7	41.5	42.4
Portugal	40.7	41.2	46.4	46.3	46.3	49.9	47.8	47.4	45.9	49.2	47.9	47.6	44.1	45.6	43.8	43.1	44.1	43.4	42.6	42.6	47.0
Romania	31.0	23.9	24.5	22.1	23.3	22.4	18.2	18.3	17.9	17.4	28.1	22.6	25.1	18.4	21.3	23.5	26.5	28.0	33.2	31.8	32.7
Slovakia	55.0	52.9	54.5	42.7	37.0	35.1	39.4	42.9	41.6	46.9	49.8	47.8	52.3	50.2	45.5	44.0	47.5	46.4	45.8	44.3	45.8
Slovenia	15.0	18.6	17.2	25.3	21.2	22.5	13.5	7.8	10.3	16.6	14.6	21.4	12.3	19.8	19.3	22.2	28.0	29.6	27.9	30.3	36.9
Spain	42.3	41.5	43.2	41.4	38.8	36.0	36.8	40.0	53.3	68.1	57.1	57.4	54.7	56.2	54.0	52.9	52.2	51.6	50.7	51.3	56.0
Sweden	44.7	43.9	43.7	44.1	43.6	42.4	40.5	39.9	39.6	41.8	40.0	40.3	40.1	42.5	42.2	41.0	40.1	39.0	39.2	38.8	39.0

Source: Eurostat and CASE, authors' calculations

Table 3: Description of explanatory variables (economic sectors)

Name of explanatory variable	Description – codes NACE Rev 2
ARTS & OTHER SERVICES	Merged category of the **codes R, T S and U** which includes Arts – entertainment and recreation, other service activities, activities of households as employers and extra-territorial
AGRICULTURE	Agriculture, Forestry and fishing under the **code A**. It includes exploitation of natural resources, plants, animals, comprising the activities of growing of crops, raising and breeding of animals, harvesting of timber and other plants, animals or animal products from a farm or their natural habitats.
CONSTRUCTION	Construction is **coded as F** and includes general construction and specialised construction activities for buildings and civil engineering works. It includes new work, repair, additions and alterations, erection of prefabricated buildings or structures on the site, and also construction of a temporary nature.
FINANCIAL	Financial and insurance services are labelled as the **code K** and include financial service activities, including insurance, reinsurance and pension funding activities and activities to support financial services.
INDUSTRY	Industry is a merged sector for the **codes B, D and E,** which are mining and quarrying, manufacturing, electricity, gas, steam and air conditioning supply and water supply; sewerage, waste management and remediation activities.
INFORMATION	Information and communication sector is classified by the **code J.** This section includes the production and distribution of information and cultural products, as well as data or communications, information technology activities and the processing of data and other information service activities.
MANUFACTURING	Manufacturing is under the **code C**. It the physical or chemical transformation of materials, substances, or components into new products, on condition that the activity does not fall into other code of NACE Rev 2. Substantial alteration, renovation or reconstruction of goods is generally considered to be manufacturing.
PROFESSIONAL	Professional, scientific and technical activities; administrative and support service activities are included in the **codes M and N.** These sectors contain: activities requiring a high degree of training and making specialised knowledge and skills available to users. Also, activities that support general business operations (legal, accounting, consulting, etc.) are included in this group.
PUBLIC ADMINISTRATION	This is a merged sector containing public administration, defence, education, human health and social work activities included in the **codes O, P and Q**
REAL ESTATE	Activities in real estate classified under the **code L,** these are activities of lessors, agents and/or brokers in one or more of the following: selling or buying real estate, rental real estate, providing other real estate services such as appraising real estate or acting as real estate escrow agents.
WHOLESALE	This is the merged sector containing wholesale and retail trade, transport, accommodation and food service classified under the **codes G, H and I.**

Source: Statistical Classification of Economic Activities in the European Community, Rev. 2 (Eurostat, 2008)

3.3 Methodology

The econometric analysis was based on panel regression using the autoregressive distributed lag (ARDL) and error correction (EC) models.

The first step in analysing panel data is to determine the order of integration because the relationship between panel variables only makes sense if the time series have the same order of integration (Pesaran, 2015). Therefore, the Levin, Lin, and Chu test of panel unit roots (shown in Table 4) was applied to the time series of dependent variables – the *Compliance* and *Policy Gap* – and also to time series of explanatory variables (Levin et al., 2002).

Table 4: Levin, Lin, Chu test of panel unit roots

Panel variable	y_t		Δy_t		I(*d*)
	stat.	prob.	stat.	prob.	
COMPLIANCE GAP	2.0200	0.9783	–15.541	0.0000	I(1)
POLICY GAP	0.4558	0.6757	–10.575	0.0000	I(1)
AGRICULTURE	0.2406	0.5951	–20.388	0.0000	I(1)
ARTS & OTHER SERVICES	5.0680	1.0000	–8.634	0.0000	I(1)
CONSTRUCTION	–0.4598	0.3228	–10.866	0.0000	I(1)
FINANCIAL	–0.9740	0.1650	–11.126	0.0000	I(1)
INDUSTRY	4.9677	1.0000	–12.873	0.0000	I(1)
INFORMATION	6.1913	1.0000	–6.048	0.0000	I(1)
MANUFACTURING	–1.1503	0.1250	–13.706	0.0000	I(1)
PROFESSIONAL	0.3496	0.6367	–8.099	0.0000	I(1)
PUBLIC ADMINISTRATION	0.3278	0.6285	–3.775	0.0001	I(1)
REAL ESTATE	0.3538	0.6382	–6.424	0.0000	I(1)
WHOLESALE	1.1282	0.8704	–10.296	0.0000	I(1)

Source: authors' calculations

Table 4 contains the results of these tests for the individual time series, as well as their orders of integration. The tests show that both explained time series, *Compliance Gap* and *Policy Gap*, are non-stationary I(1) at the 5% significance level. We can also conclude that, at the 5% significance level, all explanatory variables (economic sectors) are non-stationary I(1).

The basic model for panel data regression analysis is as follows:

$$y_{it} = c_i + \beta x_{it} + \varepsilon_{it}. \tag{3}$$

Due to the nature of economic data, which are often loaded with autocorrelation, this model is usually insufficient (Pesaran, 2015), and it needs to be transformed into a dynamic one by adding time-lagged explanatory and dependent variables. This dynamic model, which captures a short-term relationship between variables, is called the autoregressive distributed lag (ARDL) model and is mathematically expressed in Equation (4).

$$y_{it} = c_i + \sum_{j=1}^{p} \alpha_{ij} y_{i,t-j} + \sum_{j=0}^{q} \boldsymbol{\beta}_{ij} \boldsymbol{x}_{i,t-j} + \varepsilon_{it}\,, \tag{4}$$

where i represents the given country, t is time, $y_{i,t}$ is the explained variable, $X_{i,t}$ is a k-dimensional vector of explanatory variables, c_i is the constant, α_{ij} are the short-run parameters of the lagged explained variable, β_{ij} are the short-run parameters of the explanatory variables, and ε_{it} are the iid $(0, \sigma_{\varepsilon i}^2)$ across i and t, distributed independently of the regressors $\boldsymbol{X}_{i,t}$.

The long-term relationship is expressed by the error correction model (EC) given by Equation (5)

$$\Delta y_{it} = c_i + \sum_{j=1}^{p-1} \alpha_{ij}^{*} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \boldsymbol{\beta}_{ij}^{\prime *} \Delta x_{i,t-j} + \gamma_i (y_{i,t-j} - \boldsymbol{\beta}_i x_{i,t-j}) + \varepsilon_{it}\,, \quad \boldsymbol{\beta}_i = \frac{\sum_{j=0}^{q} \beta_{ij}}{1 - \sum_{j=1}^{p-1} \alpha_{ij}}. \tag{5}$$

The EC model decomposes the relationship of variables into short- and long-term. The long-term relationship is expressed in parentheses, where $\boldsymbol{\beta}_i$ are the estimated parameters of the long-term relationship. The estimation of the model was performed at the 5% significance level. The standard errors of the parameters were estimated using a robust covariance estimation method.

4. Results and Discussion

4.1 Results

The results in Table 4 show that all time series are non-stationary, type I(1). Therefore, we test the cointegration for the possibility of a long-term relationship between the analysed sectors. For the *Compliance gap*, the test did not reject the long-term relationship at the 5% significance

level ($t = -3.3456$, prob. = 0.0004). We reached the same result for the *Policy gap* ($t = -5.0605$, prob. = 0.0000). First, we analyse the short-term relationship between the panels using the ARDL model from Equation (4) and subsequently, the long-term relationship by the EC model from Equation (5).

The ARDL models (Table 5) were estimated at a 10% significance level. Due to possible multicollinearity, two models were estimated for the *Policy Gap* and one model for the *Compliance Gap*. From the econometric perspective, the estimated ARDL models express the short-term influence of the analysed sectors on *Compliance* and *Policy Gaps*. For all sectors, an effect can be noted either in the same year or with a time lag. An immediate effect, that is, an effect in the same year, can only be noted for the *Compliance Gap* in the *ARTS* and *CONSTRUCTION* sectors, while the *AGRICULTURE* and *MANUFACTURING* sectors act with a delay of 1–2 years. In the case of the *Policy Gap*, *FINANCIAL*, *PUBLIC ADMINISTRATION* and *REAL ESTATE* have an immediate effect; a delayed effect of any of the sectors was not proved.

Table 5: ARDL models from Equation (4) – Estimated short-term influence of economic sectors on gaps

	COMPLIANCE GAP		***POLICY GAP***			
	model		**model 1**		**model 2**	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
C	141.18	0.0000	78.6006	0.1997	181.4738	0.0001
COMPLIANCEGAP(–1)	0.5159	0.0000				
POLICYGAP(–1)			0.7810	0.0000	0.7965	0.0000
AGRICULTURE(–2)	–0.0052	0.0720				
ARTS	0.0032	0.0785				
CONSTRUCTION	0.0014	0.0170				
FINANCIAL			0.0073	0.0165		
MANUFACTURING(–1)	–0.0006	0.0436				
PUBLICADMINISTRATION					0.0014	0.0051
REAL ESTATE			0.0018	0.0978		
R-sq.	0.8432		0.9616		0.9611	
Adj. R-sq.	0.8309		0.9588		0.9583	
F-stat.	68.627	0.0000	344.645	0.0000	354.033	0.0000
Durbin-Watson stat	2.1271		2.1157		2.122	

Source: authors' calculations

The information on the size of the long-term influence of individual sectors can be found in Table 6, where the parameters β_{ij} were recalculated from the ARDL model from Table 5 to parameters β_i of model EC from Equation (5).

Table 6: EC Model from Equation (5) - Estimated long-term influence of economic sectors on gaps

Sector of economy	*Compliance Gap*	*Policy Gap*
AGRICULTURE	−0.0107	
ARTS	0.0066	
CONSTRUCTION	0.0028	
FINANCIAL		0.0335
MANUFACTURING	−0.0013	
PUBLIC ADMINISTRATION		0.0070
REAL ESTATE		0.0084

Source: authors' calculations

In Table 6, we see that in the long run, each euro of gross value added per capita in the *AGRICULTURE* sector reduces the *Compliance Gap* on average by EUR 0.0107 per capita, and each euro of value added per capita in the *MANUFACTURING* sector reduces the *Compliance gap* by EUR 0.0013 per capita. On the contrary, an increase in the *Compliance gap* by an average of EUR 0.0066 per capita is caused by the ARTS sector, and the *CONSTRUCTION* sector causes an increase in the *Compliance gap* by EUR 0.0028 per capita.

Concerning the *Policy Gap*, each euro of gross value-added per capita in the *FINANCIAL* sector increases it on average by EUR 0.0335 per capita. The *Policy gap* also increases by EUR 0.007 per capita due to the *PUBLIC ADMINISTRATION* sector and by EUR 0.0084 per capita due to the *REAL ESTATE* sector.

4.2 Discussion

The influence that a given sector has on the *Policy Gap* always depends on the structure of the tax rates and exemptions applied to the given sector. Therefore, it is rather a confirmation of what can be expected from the knowledge of the European VAT legislation. Conclusions

about the influence of individual sectors on the *Compliance Gap* are more interesting for tax policymakers and financial administrations because they can show in which areas measures against tax evasion need to be implemented. This study's results produced the following findings based on the econometric analysis in the previous section and have both short-term and long-term effects of the same direction/sign associated with them.

Impact of agriculture sector

We can see from the models in Tables 5 and 6 that a higher volume of agriculture in the economy reduces the *Compliance Gap* (i.e., improves VAT compliance) in both the short- and long-term. This result is somewhat at odds with previous research that argued that agriculture reduces VAT compliance (Crivelli and Gupta, 2014; Thackray and Ueda, 2014; Godin and Hindriks, 2015; Dalamagas et al., 2019; Christou et al., 2021). However, these studies used data from developing countries or countries with characteristics that differ from the EU average. In the EU, most farmers use subsidies and participate in the EU's Common-Agricultural-Policy programmes. Therefore, they declare their income truthfully since they can be audited for participating in said programmes. Therefore, it is unlikely that EU farmers are not sophisticated enough to pay VAT. Regarding the *Policy gap*, our results show that it (both in short run and long run) is unaffected.

Impact of arts sector

The arts sector is shown to increase the *Compliance Gap* in both models (see Tables 5 and 6), while not affecting the *Policy Gap*. This result can be attributed to the fact that the Arts sector is often connected to tax evasion, VAT fraud, and money laundering, as shown in Alognon et al. (2020), Helgadóttir (2019) and CASE-Poniatowski et al. (2018). In addition, this sector can be linked to the shadow economy (including piracy and counterfeiting), as self-employment, high unemployment rates, and the use of cash transactions are often observed in this industry (EENCA, 2020). All three are considered the main indicators of the shadow economy (Schneider and Buehn, 2018; Schneider and Medina, 2018).

Impact of construction sector

According to the results of both models, a larger construction sector increases the *Compliance Gap.* The increase in the *Compliance Gap* can be explained by the fact that tax evasion (illegal work and concealed revenues) frequently appears in construction industry activities, but also due to the frequent insolvency of construction companies (Allianz Research, 2020; Balina et al., 2021), which consequently do not pay VAT on their output. Similar results for the construction sector are found in Hrdlička (2015), Luzgina (2017), Thackray and Ueda (2014), and Transparency International Latvia et al. (2017). The *Policy Gap*, however, is found to be not affected by the construction sector in both the short and long term.

Impact of financial sector

According to our results, the financial sector does not influence the *Compliance Gap*. VAT is remitted to tax authorities by the suppliers of financial institutions, who are usually not fraudsters and honestly pay VAT on output. Moreover, this sector must provide information under banking regulations, which also helps tax audits (Rodrigez, 2020). The fact that the financial sector increases the *Policy Gap* is not surprising. Financial and insurance activities, which comprise the bulk of this sector, are exempt from VAT.

Impact of manufacturing sector

The manufacturing sector reduces the *Compliance Gap* in both the short- and long-term (see Tables 5 and 6), which can be explained by the fact that products in this sector are sold to other entrepreneurs and not to final consumers (intermediate goods). Hence, suppliers have no incentive to hide their sales; they have to issue tax documents to their customers to allow them to claim their VAT deduction. The manufacturing sector does not appear to influence the *Policy Gap*, which apparently results from the taxation of the most common products at the standard VAT rate.

Impact of public administration sector

The public administration sector is not affecting the *Compliance Gap*. It positively influences the Policy Gap (i.e., when public administration spending increases, the *Policy Gap* increases), both in the short and long term. This outcome is mainly attributed to public administration being exempt from VAT or excluded from taxation because it does not represent economic activity. Hence, a distortion in the VAT tax system is produced not due to evasion, but due to the application of VAT rules prescribed by the European Union. This finding is consistent with previous research (Christou et al., 2021).

Impact of real estate sector

Based on our results, the real estate sector increases only the *Policy Gap,* while it does not affect the *Compliance Gap.* The *Policy Gap* increases as real estate transactions are often exempt from VAT or are subject to reduced VAT rates, such as sales of residential buildings and flats or long-term real estate rentals.

5. Conclusions – Proposals to Reduce the VAT Gap

Since VAT collection is essential for the public budgets of EU member states, we focused our analysis on two components of the overall inefficiency in VAT collection: the *Compliance Gap* and the *Policy Gap*. In particular, we examined the influence of the size of individual productive sectors in the economy on these gaps. The conclusions that emerged may be useful

both during the painstaking effort to combat tax evasion and for the process of drafting relevant tax legislation.

We found out that the agriculture and manufacturing sectors reduce the *Compliance Gap*. For tax administrations, these results signal that there is probably no need to devote much attention and resources to tax audits by entities from these sectors. On the other hand, some sectors increase the *Compliance Gap* and are thus susceptible to tax evasion. The construction and arts sectors were placed in this group. Therefore, tax inspectors should focus on these areas of the economy.

Apart from the intensification of the tax audit processes, we feel that there is a need to establish and enhance transnational information-exchange policies between the individual EU member states so that successfully applied methods in one country can also be adopted by other EU members. Proper target setting and the use of appropriate methods of risk analysis are required for better results in VAT compliance. Correspondingly, the VAT collection mechanism must become more efficient, contributing to the maximisation of tax revenues. For these changes to produce results, one must not forget to consider the relationship of economic sectors that are closely linked to money laundering and the shadow economy in general. By minimising such schemes, the VAT revenue loss can be substantially reduced.

Regarding the *Policy Gap*, it is important to know which sectors adversely affect the collection of VAT due to the application of reduced rates and exemptions. This can be deduced from knowledge of the VAT regime for different types of goods and services. However, economic sectors can have different importance for the entire economy and, therefore, different impacts on VAT collection. Within the EU member states, we have found that the financial sector, real estate sector, and public administration increase the *Policy Gap*.

Reduced rates and VAT exemptions serve redistributive purposes and support certain industries. However, policymakers should also remember that their decisions about the VAT regime can significantly reduce VAT revenues that comprise public budgets. Therefore, before changing rates and special regimes, they need to make sure whether the existing tax legislation is not being ‘exploited’. The lack of clarity in legislation and the existence of complex provisions also inevitably contribute to the widening of the *Compliance Gap* (i.e., taxpayers make mistakes in calculating their tax liability) and should be maximally avoided.

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