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Anna Białek-Jaworska
Faculty of Economic Sciences, University of Warsaw, Poland
https://orcid.org/0000-0003-4520-8916, a.bialek@uw.edu.pl

Katarzyna Kulesza
Faculty of Economic Sciences, University of Warsaw, Poland
https://orcid.org/0009-0001-1049-3115, k.kulesza10@student.uw.edu.pl

Beata Rogowska-Rajda
Faculty of Economic Sciences, University of Warsaw, Poland
https://orcid.org/0000-0003-3879-3440, b.rogowska-raj@uw.edu.pl

Impact of SAF-T Reporting Implementation on the VAT Gap

Wpływ wprowadzenia jednolitego pliku kontrolnego na lukę w VAT

Abstract

This paper addresses the growing VAT gap issue in European countries from 2011 to 2020. It aims to determine whether the implementation of SAF-T reporting has resulted in a reduction of the VAT gap. For this purpose, the Difference-in-Differences method, with multiple periods, was employed in the study. Additionally, the panel study conducted later in the paper identifies the factors influencing the VAT gap. The results show that introducing SAF-T in Portugal, Lithuania, and Poland helped to reduce this gap. Furthermore, countries with higher ICT tax administration expenditures, a higher ratio of domestic turnover to intra-community supply of goods, where the SAF-T solution is implemented, have a lower VAT gap.

Keywords: SAF-T, VAT Gap, Value Added Tax.

JEL: F36 F38 K34

Streszczenie

W niniejszym artykule poruszono kwestię rosnącej luki w podatku VAT w krajach europejskich w latach 2011–2020. Jego celem jest ustalenie, czy wdrożenie systemu raportowania SAF-T przyczynia się do zmniejszenia luki w VAT. W tym celu w artykule zastosowano metodę różnic w różnicach z uwzględnieniem wielu okresów. Ponadto w analizie panelowej przeprowadzonej w dalszej części artykułu zidentyfikowano czynniki wpływające na lukę w podatku VAT. Wyniki pokazują, że wprowadzenie systemu SAF-T w Portugalii, na Litwie i w Polsce przyczyniło się do zmniejszenia tej luki. Co więcej, kraje o wyższych wydatkach na administrację podatkową w zakresie technologii informacyjno-komunikacyjnych (ICT) oraz wyższym stosunku obrotów krajowych do wewnątrzwspólnotowej dostawy towarów, w których wdrożono jednolity plik kontrolny SAF-T, charakteryzują się mniejszą luką w podatku VAT.

Słowa kluczowe: JPK VAT, luka w podatku VAT, podatek od wartości dodanej.

JEL: F36 F38 K34

1. Introduction

Taxes are one of the most important sources of revenue for the state budget. Without taxes, the government's tasks and policies could not be implemented. Consequently, a high level of enforceability is crucial for the state. Among all taxes, *Value Added Tax* (VAT) is the primary source of state budget revenues. In Poland, VAT revenues in 2021 accounted for approximately 44% of all state budget revenues (Statistics Poland, 2022). Hence, the VAT gap, referring to the difference between actual and theoretical tax revenues, results from improper application and, in most cases, deliberate non-compliance with tax law by taxpayers.

In Romania, Malta, and Italy, the VAT gap in 2020 exceeded 20 per cent, while the average VAT gap across the European Union (EU) was 6% (OECD, 2022). This indicates a significant loss of tax revenue, which has a substantial impact on the state budget. Given that the VAT gap is a problem in many countries, it is crucial to monitor it using estimates of its size and to take targeted steps to reduce it.

Member States are introducing measures to minimize the VAT gap. The EU is not passive in this regard, encouraging and, at times, obliging Member States to implement solutions that reduce the VAT gap. One of these is the SAF-T reporting system, in which active VAT payers report all sales and purchase transactions. By 2020, this solution had already been implemented in Portugal, Lithuania, and Poland.

This study aims to examine whether the introduction of SAF-T reporting has contributed to reducing the VAT gap. It applies a Difference-in-Differences (DiD) approach with multiple periods. The research sample includes 28 European countries from 2011 to 2020. The effects of introducing the SAF-T system are assessed in Portugal, Lithuania, and Poland, while the remaining countries act as controls. We hypothesize that the implementation of SAF-T reporting has led to increased VAT enforcement. Our results contribute to the literature by assessing the efficiency of SAF-T reporting in national tax systems. Identifying factors significantly influencing the VAT gap pinpoints areas that require government intervention. We also contribute by controlling for the share of intra-community supply of goods (ITA) in domestic goods turnover, as this has not been addressed to date. We analyze panel data from Eurostat, WITS, OECD, European Commission (EC) reports, and World Bank databases using the Arellano-Bond General Method of Moments (GMM).

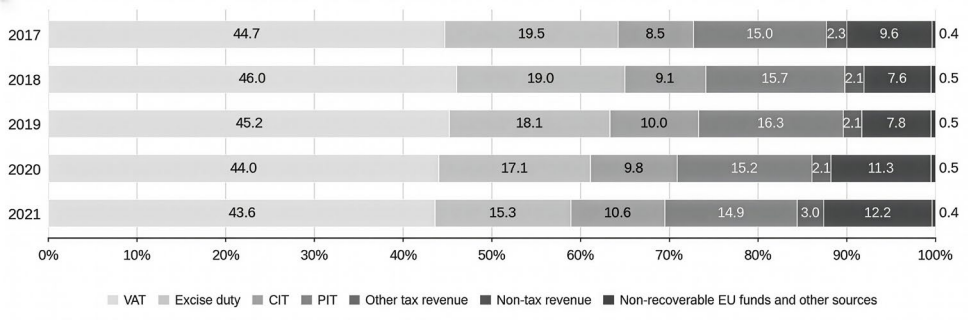
The remainder of this paper is organized as follows. The literature review provides an overview of the methodology for estimating the VAT gap and the potential VAT gap, and it examines studies that have investigated factors influencing the VAT gap. Next, we present the effects of introducing SAF-T reporting on the formation of the VAT gap, using the DiD with multiple periods and panel data estimators. Finally, we discuss the findings and present conclusions.

2. VAT gap

Value-added tax is classified as a turnover tax and a consumption tax, and is the most important tax in most countries. Between 2017 and 2021, it accounted for 43.6% to 46% of Poland's budget structure (Statistics Poland, 2022). A comparison with the share of budget revenues from other taxes in figure 1 shows the dominant role of VAT in shaping the state budget. For this reason, the VAT gap and the effectiveness of instruments to strengthen tax collection systems are of great interest. The VAT gap is defined as the difference between the theoretical VAT liabilities calculated under current legislation and the actual state budget receipts from the same (Majerová, 2016). The difference in VAT financial flows is the result of tax fraud, tax calculation confusion, insolvency and, above all, tax avoidance and evasion. It is therefore correct to say that the VAT gap is a measure of taxpayers' compliance with value-added tax rules and a measure of the efficiency of VAT collection (Tratkiewicz, 2016).

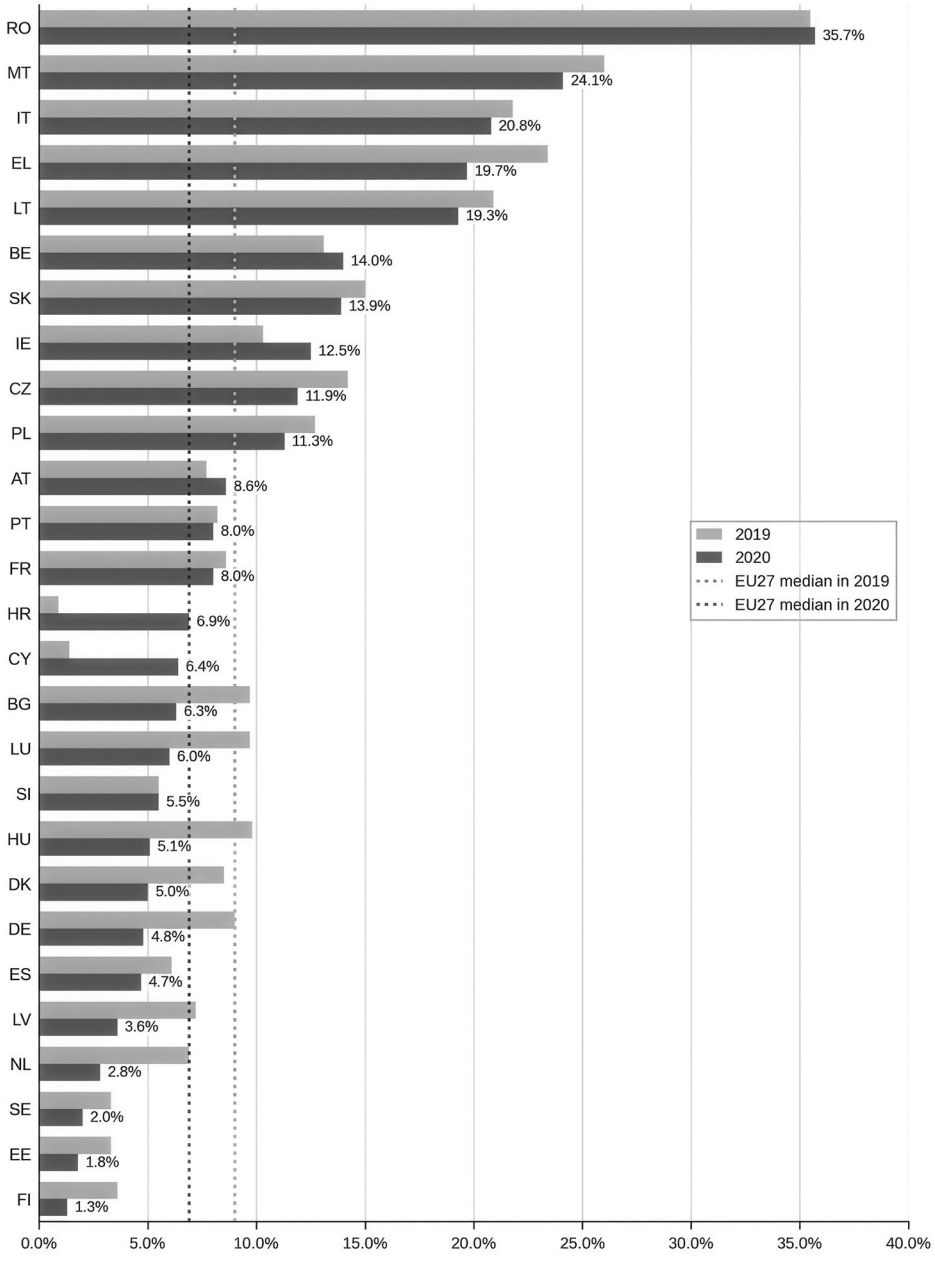
The figures released by the EC in 2022 confirm the VAT gap problem (see figure 2). The largest gap in terms of tax compliance is observed in Romania, where it accounted for ca. 35% of VTTL in 2020.

Figure 1.
Structure of state budget revenues in Poland



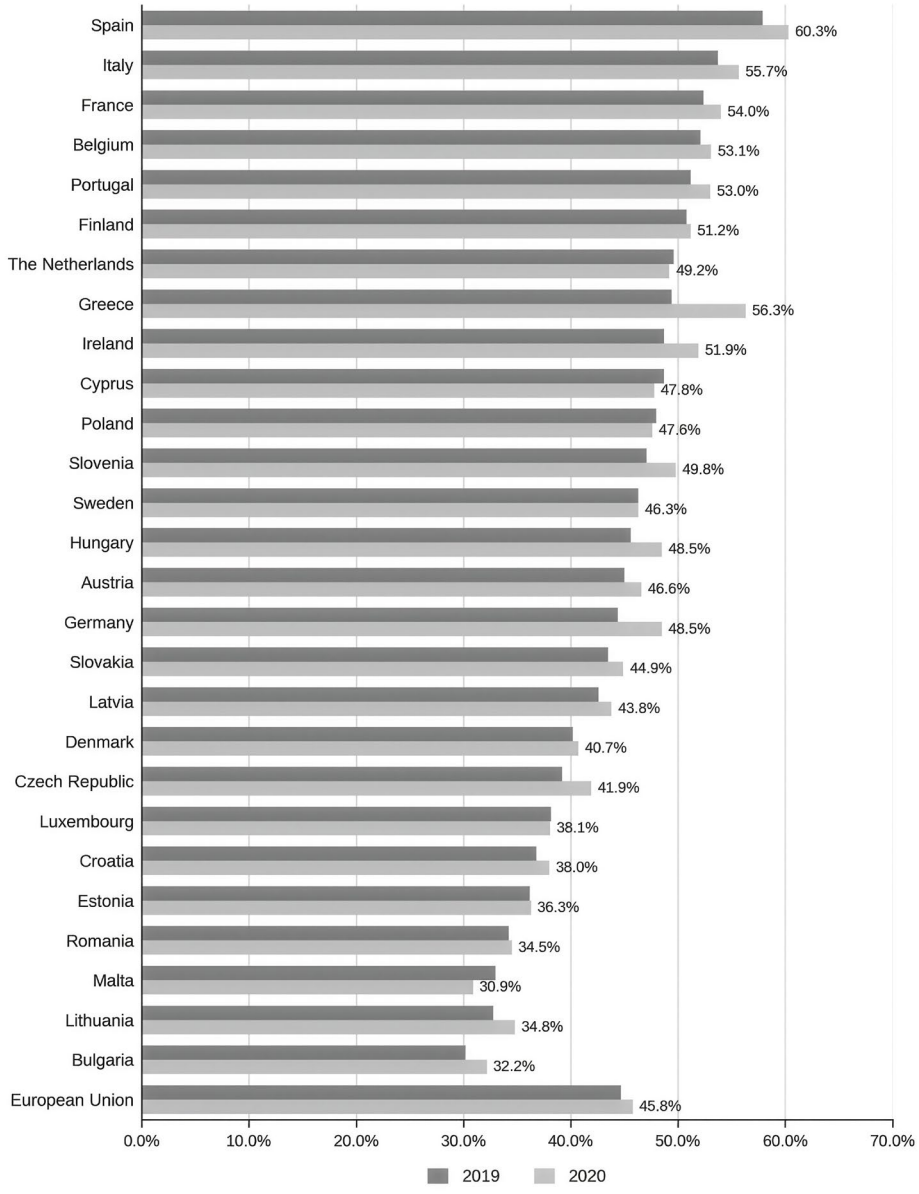
Source: author's compilation based on Statistics Poland (2022).

Figure 2.
VAT compliance gap by Member State (as percentage of VTTL, 2019 vs 2020)



Source: author's work based on Poniatowski et al. (2022).

Figure 3.
VAT policy gap by country



Source: author's work based on Poniatowski et al. (2022).

Other countries with worrying levels of the VAT gap are Malta, Italy, Greece and Lithuania. The smallest VAT gap is in Finland, which accounted for only 1.3% of potential VAT revenue in 2020. A comparable result is seen in Estonia, Sweden

and the Netherlands. Poland, unfortunately, still faces a high VAT gap-to-VTTL ratio of 11.3% in 2020.

However, compared to 2019, a decrease may indicate that the measures taken to reduce the VAT gap are yielding the desired results. The decrease in the median VAT gap of all Member States from around 9% in 2019 to around 6% in 2020 is cause for optimism. In addition to the VAT compliance gap, the literature also identifies a *VAT policy gap*, which measures the lost VAT revenue resulting from reduced VAT rates and exemptions (OECD, 2022).

The VAT policy gap in Europe ranges from 30% to 60%, with an average of approximately 45% in 2019 and 2020 (see figure 3). Spain has the largest VAT policy gap, followed by Italy, Belgium and France. The lowest policy gap, around 30%, is in Bulgaria. The size of the gap is determined by the scope of VAT exemptions in place.

Moreover, the EC ensures that countries most vulnerable to fraud introduce reform programs aimed at a comprehensive analysis of the VAT gap (Tratkiewicz, 2016). One of the first legislative proposals to tighten the VAT system was the introduction, followed by its later extension, of the reverse charge mechanism, primarily applied to intra-community acquisitions of goods and import transactions.

A measure taken to increase the fiscal efficiency of VAT in Poland was the introduction of purchase and sales reporting by active VAT taxpayers in the form of the Standard Audit File for Tax (SAF-T), which is equivalent to the EU SAF-T reporting system, and has been gradually implemented. Moreover, the SAF-T verification process was enhanced in 2017 with the introduction of automatic data verification (Bełdzikowski, 2018). A further step to streamline SAF-T file reporting was to merge it with the VAT return in 2020. Following this change, the SAF-T now consists of two parts: the recording and the declarative parts, which are sent together to the tax offices. The monitoring of purchases and sales is limited to turnover between active VAT taxpayers, excluding that exempt from VAT and those subject to VAT, as well as direct transactions with individuals, which are collectively recorded using fiscal cash registers. Online cash registers were introduced to counter abusive B2C (Business-to-Consumer) transactions. The Polish equivalent of the SAF-T reporting system differs in its reporting frequency from the solutions introduced in Portugal and Lithuania (Value-Added Tax Act, 2004). Other measures taken to tighten up the Polish VAT system were the introduction of a fraud clause, the lowering of the limit on the value of cash transactions, the introduction of the Clearing House Information and Communication System (STIR), the split payment mechanism, and the white list of VAT taxpayers (Bełdzikowski, 2018).

3. Literature review

Due to the complexity of the whole process, the issue of VAT gap estimation is not addressed in many empirical studies. The approach proposed by the CASE, compiled on behalf of the EC, is one of the most widely recognized methods for estimating

the VAT gap. A report detailing the study's methodology and the results of VAT gap estimation in European countries is published annually, with a two-year lag in data availability. The innovative method proposed by Konopczak (2020) enables ongoing monitoring of the VAT gap.

The main components of the VAT gap are potential VAT revenues and actual VAT revenues. When estimating the VAT gap, it is necessary to determine the method on which all further calculations are based. The literature distinguishes between two primary methods for estimating the VAT gap: top-down and bottom-up. The estimation of the VAT gap from the demand side characterizes the former. Potential VAT receipts are estimated according to the amount of VAT charged to final consumers. This method is based on viewing the situation through the lens of the economic taxpayer, who pays VAT at the time of purchase but is not entitled to deduct it. Economic taxpayers can therefore include non-business individuals and the government sector. To estimate potential VAT revenue, information is needed on private consumption, investment by government, local government, non-commercial institutions, and other sectors; intermediate consumption by government, local government, non-commercial institutions, and other sectors; restrictions on the right to deduct VAT; and the value of building plots and assets of exceptional value. A low cost of the whole calculation process characterizes the top-down method. However, its biggest disadvantage is the delay in accessing macroeconomic data, which is not published until at least two years after the fact. The bottom-up method, on the other hand, focuses on individual VAT payers and determines their tax liability. It compares the potential VAT revenue with the actual VAT revenue realized for a single payer. Estimating the tax liability of all taxpayers would be an expensive undertaking. For this reason, a random sample of VAT taxpayers is selected, and the findings are generalized to all taxpayers. Therefore, randomness in the selection of taxpayers for the sample is a key aspect. Undesirable mechanisms are typing mechanisms, as an active VAT taxpayer must have an identical probability of occurrence in the sample (Mazur et al., 2019).

The VAT gap estimated by CASE is based on a top-down method. The data sources for the estimation of VTTL include national accounts data on the tax base, as well as from registers and various surveys, which serve as the basis for estimating the model parameters. VTTL is estimated as the sum of final consumption of households, government, non-profit organizations serving households, intermediate consumption, gross fixed capital formation and other country-specific regulations, e.g. in Poland, the restriction on the right to deduct VAT on expenses incurred for the day-to-day use of a car (e.g. costs of fuel, spare parts, repairs, inspections, car washes). Due to the numerous components of VTTL, it is necessary to perform estimations approximately every year. Ten thousand parameters must be estimated annually for each tax system of an EU member state, which undoubtedly affects the time required to produce reports, which are published with a two-year delay. A lower reliance on data from sources other than national accounts characterizes the top-down method used. As a result, it is not necessary to model VAT liability at an intermediate level in the supply chain; it is only necessary to model VAT paid

without the right to deduct at the final stage of consumption. Finally, the VAT gap is presented as a share of VTTL:

$$VAT\ compliance\ gap(\%) = \frac{VTTL - VAT\ revenue}{VTTL} \tag{1}$$

where:
VAT compliance gap – VAT compliance gap,
VTTL – potential VAT revenue,
VAT revenue – actual VAT revenue.

The CASE report also presents a methodology for estimating the *policy gap*. The idea behind this gap is to represent the scale of VAT revenue lost due to reduced rates and exemptions in a given tax system. This indicator is calculated as the ratio of VAT revenue to the theoretical (hypothetical) VAT revenue that would have been generated if household final consumption and investment had been taxed at the standard VAT rate (OECD, 2022):

$$VAT\ policy\ gap(\%) = \frac{National\ ideal\ revenue - VTTL}{National\ ideal\ revenue} \tag{2}$$

$$National\ ideal\ revenue = VAT\ standard\ rate \cdot \sum_{i=1}^{N} FC\ value_i \tag{3}$$

where:
National ideal revenue – theoretical VAT receipts if final consumption taxed at the standard VAT rate,
i – a group of products and services,
N – number of product and service groups,
FC value – final consumption including consumption of households, government and non-profit institutions.

Konopczak (2020) proposed a method for quantifying the VAT gap, analogous to the CASE method, in which potential VAT revenues are juxtaposed with actual VAT revenues. However, the difference between the two is not analyzed further; rather, the elasticity of one variable with respect to the other is analyzed. The necessary factors for estimating theoretical VAT revenue are private consumption, government intermediate consumption and government gross fixed capital formation. These data are available on an ongoing basis, allowing the method to monitor the size of the VAT gap without significant delay. However, the VTTL calculation used is not sufficient for comparison with actual VAT revenues. The lack of proper data prevents the use of variables, such as intermediate consumption and gross fixed capital formation, for VAT-exempt sales by sectors other than the general government. Another simplification adopted by the author is the use of aggregated data and the corresponding effective VAT rates. The proposed method, therefore, compares changes in the elasticity of actual VAT revenue with those of potential VAT revenue. A cointegration analysis was employed to estimate the long-term elasticity using

the autoregressive distributed lag (ARDL) model, given limited data availability and the unambiguous direction of causality. This model enables the estimation of both short- and long-term parameters within a one-dimensional framework. The method presented enables ongoing reporting of gap changes, although some generalizations may affect the accuracy of the estimation (Konopczak, 2020).

The most important empirical studies on VAT fraud prevention in Europe include those employing top-down VAT gap estimation (Gajewski & Jonski, 2022), analyses of reverse charge mechanisms in Germany and Austria (Buettner & Tassi, 2023), and comparative studies on split payment mechanisms across several EU countries (Holá et al, 2022). Regarding the impact of SAF-T digitalization, evidence from the Czech Republic, Romania, and Italy shows that SAF-T and e-invoicing digitalization substantially reduces VAT fraud and enhances revenue collection (Moravec et al., 2021a; Moravec et al., 2021b; Lipniewicz, 2022). Previous empirical studies reveal that digitalization tools—including SAF-T, e-invoicing, reverse charge, and split payment mechanisms—are critical in reducing VAT fraud and closing the VAT gap in Europe. Despite varied forms of national implementation, the overall trend indicates significant improvements in revenue collection and fraud detection (Moravec et al., 2021a; Moravec et al., 2021b; Papis-Almansa, 2019; Stiller & Heinemann, 2024). Braml and Felbermayr (2021) and Stiller and Heinemann (2024) examine measures taken to counter VAT fraud and its impact on tax revenues, using trade data gaps as a proxy for fraud.

Previous studies have also examined the importance of tax administration efficiency for VAT enforceability. Increased spending on tax administration may primarily make it more efficient (Agha & Haughton, 1996). An increase in the tax administration's expenditure as a share of its revenue from 0.8% to 0.9% would increase VAT compliance by 1.2%. Additionally, a significant effect on the VAT gap is observed for IT spending, expressed as a proportion of total tax administration spending. A high level of digitalization in the tax administration leads to more effective tax audits, improves processes and data collection, and facilitates the production of analyses. Thus, the higher the public administration's expenditure on IT systems, the smaller the VAT gap (Szczypińska, 2019).

In the literature, research results also indicate a positive impact of imports subject to customs controls on VAT compliance. It has been shown that countries that import more (i.e. show a higher share of imports in final consumption) tend to have a higher overall level of tax compliance due to international border controls. Furthermore, in EU countries with a reverse charge system and no customs checks, the results have been inconclusive. In European countries with low-quality institutions, imports (goods purchased from outside the EU) negatively affect VAT revenues. The aggregate VAT gap in these countries is relatively high, reflecting low national-level VAT compliance. In contrast, in countries with high-quality institutions, imports help reduce the VAT gap (Morrow et al., 2022).

Within the institutional factors influencing the VAT gap, a distinction is made between the quality of institutions as measured by Kaufman's indicators (voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption) and the

Corruption Perception Index (CPI). Each of Kaufman's indicators is measured on a scale from –2.5 to 2.5, with higher values indicating higher institutional quality. Countries with high-quality institutions should have a lower VAT gap. Previous studies have verified the relationship between individual Kaufman indicators and the VAT gap in Eastern European countries. It was concluded that the quality of state institutions in most of the countries studied is related to the VAT gap, especially in terms of anti-corruption measures, and the quality of institutions is important. Other indicators reveal a significant relationship in only some countries (Olexová et al., 2022). Other studies have observed a weak relationship between the government effectiveness indicator and the VAT gap. In Eastern, Southern, and Central European countries, there is no statistically significant relationship between this variable and the VAT gap. Moreover, the results suggest that at the EU level, improvements in government effectiveness increase the VAT gap, a finding contrary to the results of previous studies (Butu et al., 2021). Given that the research results available in the literature are inconclusive, the analysis in the following section will also examine the impact of one of Kaufman's factors of *government effectiveness* on the VAT gap. The other factors used in the literature were excluded because of their high correlation with one another. A negative effect of CPI on the VAT gap was observed by Majerová (2016) and Szczypińska (2019). VAT enforceability is therefore more effective in higher-quality institutions and in contexts with greater trust in the state.

An important factor in the VAT gap is tax evasion and unreported sales, analyzed by Pietrzak et al. (2018). This problem manifests itself as abuse of VAT exemptions, underreporting of sales, or failure to record B2C sales. It was verified whether the larger scale of unreported sales increases the VAT gap. The analysis did not support this hypothesis, as a negative relationship was observed between the size of the VAT gap and the non-reporting of sales revenue. Hence, it was deduced that underreporting of sales revenue is a minor contributor to the VAT gap, compared to the other factors.

4. Research design

This study analyzes how the introduction of SAF-T reporting influences the VAT gap and identifies the factors that determine it. We have formulated hypothesis H0, that *the implementation of the SAF-T reporting solution into tax systems resulted in a lower VAT gap.*

The research sample included data from 28 European countries from 2011 to 2020, at which point three countries introduced the SAF-T solution: Portugal, Lithuania, and Poland. Data on VAT gaps and VAT revenues were obtained from the annual CASE reports. Data on GDP volume, imports, global imports (including intra-community acquisitions, ICAs), and total domestic turnover were obtained from the Eurostat database. The import data for the UK was obtained from the WITS database. Also included are the standard VAT rate and the number of VAT rates applied in European countries, as well as information from the EC's annual

reports on VAT rates implemented in member countries. The OECD database, specifically the Tax Administration reports, was used to obtain data on total expenditure, revenue, and IT expenditure for each country's tax administration. Kaufman's indicators were sourced from the World Bank database. Table 1 presents definitions of variables and data sources used.

To verify whether implementing the SAF-T system reduces the VAT gap, a DiD with multiple periods was employed, enabling examination of cases with more than two periods, taking into account the fact that an event may cover different units at different points in time. In addition, the proposed aggregation methods allow heterogeneity to be summarized along a specific dimension of interest or in terms of a single overall parameter describing the units' coverage of an event (Callaway & Sant'Anna, 2021). To apply this method, it is necessary to separate the control and treatment groups. In the study, the treatment group comprised countries that implemented SAF-T reporting at different times. This includes Portugal, Lithuania and Poland, where SAF-T has been in place since 2013, 2016 and 2018 respectively. Since SAF-T reporting in Poland covered certain groups of entrepreneurs in stages, the mandatory coverage of all entrepreneurs was considered to have occurred upon its introduction. The remaining countries, where SAF-T has never been introduced, constitute the control group.

Table 1.
Definitions of variables

Variable	Data source	Definition
vat_gap_gdp	Eurostat	VAT gap to GDP in EUR million
turnover _ita		Ratio of aggregate gross domestic turnover to aggregate intra-community supply of goods
vat_gap_vttl		VAT gap as a share of potential VAT revenue
stand_vat_rate	European Commission	The rate of standard VAT applicable in the Member State in a given year
number_vat_rates		The number of VAT rates implemented in the tax law
saft		Binary variable taking the value one if the country has a SAF-T system in place and zero otherwise.
notue_import	Eurostat, WITS (for UK)	Ratio of imports from outside the EU to total imports (including imports and intra-community acquisition of goods)
adm_ict_exp	OECD	Total IT expenditure share in total tax administration revenue
government_ effectiveness	World Bank	The quality of public services, the civil service and the extent of its independence from political pressures, measured on a scale from –2.5 (poor governance effectiveness) to 2.5 (strong governance effectiveness)

Source: author's work.

Furthermore, the analysis was conducted separately for VAT gaps presented in different measures, i.e., as a percentage of GDP and as a percentage of VTTL. The individual effects of regulation within groups over time will be analyzed first, identifying the impact of SAF-T in each of the three countries separately by year. Furthermore, the aggregated individual effects of introducing SAF-T will be analyzed

to examine its overall impact on the VAT gap. Average effects will be identified for each country subject to the regulation, allowing us to see the effect of the introduction and operation of SAF-T for all years since its introduction, separately for each group. Aggregating the average effects of SAF-T legislation over time, by exposure duration, will illustrate the effects of introducing SAF-T with varying exposure durations to the event. Finally, a calendar-time effect will be presented, allowing the aggregation of the averaged effects of introducing SAF-T across all countries for each year separately.

It was decided not to carry on the DiD analysis for the VAT policy gap due to difficulties in interpretation of its definition and measurement. As the VAT policy gap measures the lost budget revenue due to the implementation and correct application of all types of relief, VAT exemptions, and the introduction of reduced tax rates, an examination of the impact of introducing the SAF-T system requires a deeper analysis. The link between the increased restriction on reporting data on sales and purchases of active VAT taxpayers and the *facilities* offered by the government to taxpayers is noticeable in terms of the correct application of reduced VAT rates on sales. However, this requires a more detailed analysis of the file sent to the tax authorities.

A further part of the study will verify the direction of the impact of the various determinants of the VAT gap that have so far been identified in the literature: the Kaufman index of government effectiveness, imports vs global imports, the tax administration's ICT expenditures vs their total expenditure, the number of VAT rates and the value of the standard VAT rate. Additionally, it was decided to investigate the impact of ITA on the VAT gap. This topic has not been adequately addressed in many studies to date. Therefore, a variable representing domestic turnover relative to the value of the ITA was included in the study. The final, most important variable in the study is a binary variable identifying whether a scheme is used in the tax system along the lines of the European SAF-T solution. The study uses linear dynamic panel data estimation, which assumes that unobservable effects are correlated with the lags of the dependent variable at the panel level. The model employs the Arellano-Bond GMM estimator, which is specifically designed for dynamic panel data. It assumes no autocorrelation in idiosyncratic errors and requires that panel-level effects are not correlated with the first difference of the first observation of the dependent variable. Variables reflecting the size of the VAT gap relative to GDP or VTTL and the gap in tax policy in the model serve as explanatory variables. Three econometric models are therefore estimated, represented by the following general equation:

$$\begin{aligned} vat\_gap_{i,t} = {} & \beta_0 vat\_gap_{i,t-1} + \beta_1 saft_{i,t} + \beta_2 government\_effectiveness_{i,t} \\ & + \beta_3 stand\_vat\_rate_{i,t} + \beta_4 notue\_import_{i,t} + \beta_5 turnover\_ita_{i,t} \\ & + \beta_6 adm\_ict\_exp_{i,t} + \beta_7 financial\_freedom_{i,t} \\ & + \beta_8 number\_vat\_rate_{i,t} + v_i + \epsilon_{i,t} \end{aligned} \tag{4}$$

where:

vat_gap – depending on the model, denotes the VAT gap relative to GDP, VTTL or the VAT policy gap,

i – country,

t – year,

β – parameter to be estimated,

v – panel level effects,

ϵ – independent random errors.

To estimate the determinants of the VAT policy gap, the study period was shortened by two years. This is due to differences in how the policy gap results are presented in CASE publications. In the 2011 and 2012 reports, it was presented as an average for the periods 2000-2011 and 2009-2012, respectively. As it was impossible to obtain annual data, these years were omitted from the study.

Each control variable used can affect the VAT gap in different directions. The introduction of the SAF-T reporting system, which requires greater reporting of output and input VAT by taxpayers, and the recording of documents based on which VAT amounts have been determined, should help reduce the VAT gap. The same relationship is expected for the government effectiveness indicator. This indicator represents the effectiveness of government management. It also reflects the government's effectiveness in formulating and implementing sound policies, including tax policies. A higher tax rate may increase taxpayers' propensity to evade taxes. Thus, we expect that the higher the VAT rate, the higher the VAT gap. Moreover, the number of implemented VAT rates in force in the tax system may also contribute to an increase in the VAT gap. A higher number of rates may result in numerous errors and manipulations by entrepreneurs when determining the appropriate VAT rate for a given service or supply, potentially leading to underpayment of VAT to the state budget. A larger share of imports (purchases of goods from outside the EU) in global imports (including imports and intra-community acquisitions) should reduce the VAT gap resulting from customs controls carried out at national borders. The same impact is expected from the variable reflecting the ratio of domestic turnover to ITA. The greater the domestic turnover relative to intra-community turnover, the smaller the VAT gap should be, because intra-community transactions offer a wide scope for abuse due to their specificity. Increased ICT spending by tax administrations helps streamline tax systems, which enables faster interventions against potential taxpayer offences. The more functional tax systems are, the easier tax enforcement becomes. An increase in tax administration spending on ICT should reduce the VAT gap.

5. Results

To verify hypothesis H0 that *implementing the SAF-T reporting solution in tax systems reduced the VAT gap*, the results of a study examining the impact of SAF-T implementation in Portugal, Lithuania, and Poland on the VAT gap are presented. The study then aimed to identify the factors influencing the VAT gap. Table 2 (and

figure 4) shows estimates using the VAT gap as the explanatory variable relative to GDP, while table 3 (and figure 5) presents results for the VAT gap relative to VATTL. Countries impacted by the new SAF-T regulations include Portugal (*2013 group*), Lithuania (*2016 group*) and Poland (*2018 group*). The remaining EU countries serve as a control group, where the SAF-T system was not introduced before 2019. Table 2 provides the average effects of SAF-T regulation over time for each group.

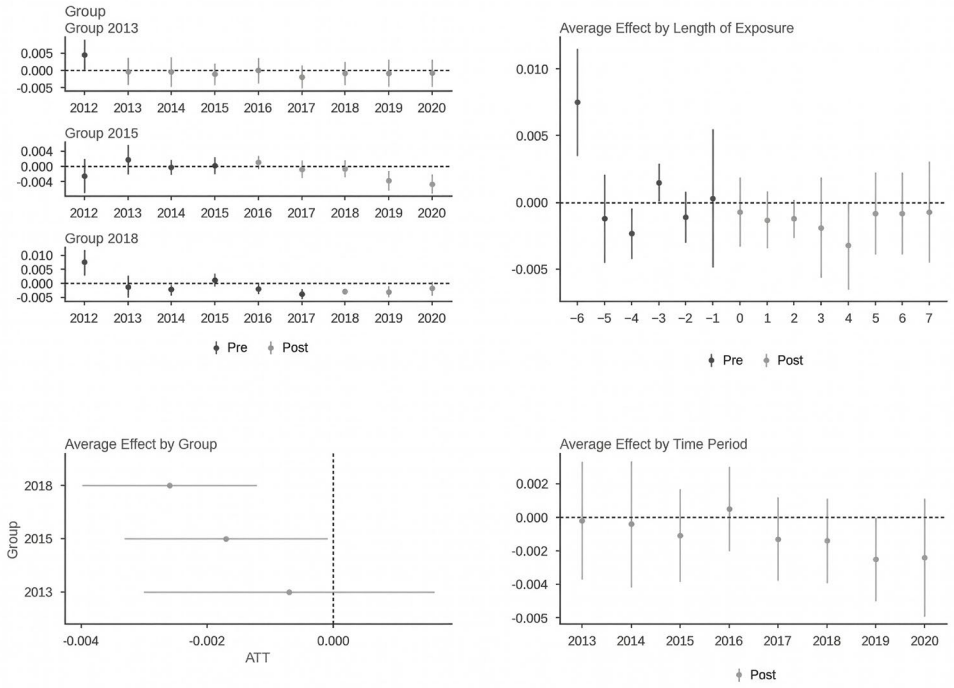
Table 2.
Impact of SAF-T reporting implementation on the VAT gap relative to GDP

	ATT effects over time for the group			Overall ATT summary based on calendar time		ATT dynamic effects	
	PT	LT	PL				
2012	0.0045 ** (0.0016)	−0.0025 (0.0016)	0.0075 *** (0.0016)			−6	0.0075 *** (0.0017)
2013	−0.0002 (0.0014)	0.0018 (0.0014)	−0.0012 (0.0014)	2013	−0.0002 (0.0014)	−5	−0.0012 (0.0014)
2014	−0.0004 (0.0015)	−0.0002 (0.0007)	−0.0022 *** (0.0007)	2014	−0.0004 (0.0015)	−4	−0.0023 *** (0.0008)
2015	−0.0011 (0.0011)	0.0002 (0.0008)	0.0012 (0.0008)	2015	−0.0011 (0.0011)	−3	0.0015 ** (0.0006)
2016	0.0000 (0.0013)	0.0011 (0.0006)	−0.0019 *** (0.0006)	2016	0.0005 (0.0010)	−2	−0.0011 (0.0008)
2017	−0.0018 (0.0012)	−0.0007 (0.0008)	−0.0038 *** (0.0006)	2017	−0.0013 (0.0010)	−1	0.0003 (0.0022)
2018	−0.0008 (0.0012)	−0.0006 (0.0008)	−0.0029 *** (0.0004)	2018	−0.0014 (0.0010)	0	−0.0007 (0.0011)
2019	−0.0008 (0.0014)	−0.0037 *** (0.0009)	−0.0030 *** (0.0007)	2019	−0.0025 ** (0.0010)	1	−0.0013 (0.0009)
2020	−0.0007 (0.0014)	−0.0046 *** (0.0009)	−0.0018 (0.0009)	2020	−0.0024 (0.0014)	2	−0.0012 (0.0006)
				Overall	−0.0011 (0.0007)	3	−0.0019 (0.0016)
	Overall ATT summary by group					4	−0.0032 * (0.0014)
PT 2013	−0.0007 (0.0010)					5	−0.0008 (0.0013)
LT 2016	−0.0017 ** (0.0007)					6	−0.0008 (0.0013)
PL 2018	−0.0026 *** (0.0006)					7	−0.0007 (0.0016)
Overall	−0.0017 *** (0.0006)					Overall	−0.0013 (0.0009)

Note: Standard errors in brackets below the coefficients. * p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Author's work.

Figure 4.
Impact of SAF-T reporting implementation on the VAT gap relative to GDP



Note: Group 2013 – Portugal, Group 2016 – Lithuania, Group 2018 – Poland.
Source: Author's work.

Negative coefficient estimates for the Average Treatment Effect on the Treated (ATT) variable were observed in each country after the introduction of SAF-T reporting, confirming that implementing it helps to reduce the VAT gap. In Portugal, the reduction in the VAT gap is already visible in the year following the implementation of SAF-T. In Lithuania, the effect is delayed; however, the VAT gap already decreased by 0.37 and 0.46 percentage points (p.p.) in 2019 and 2020, respectively. In contrast, the cumulative effect of SAF-T reporting in Lithuania reduced the VAT gap by 0.17 p.p. In Poland, a negative VAT gap was already observed before the introduction of mandatory reporting. The reason may be that in earlier years, the SAF-T file was already being used by large, medium-sized, and small enterprises. Moreover, the Polish legislator introduced other solutions aimed at reducing the VAT gap, such as the reverse charge mechanism, the introduction of joint and several liability, a fraud clause, a limit on cash transactions between entrepreneurs, and sealing packages (e.g. fuel, transport). Amendments to the Value Added Tax Act and the Penal Code were also of great importance.

The overall effect of SAF-T in Poland has been negative, with the VAT gap reduced by 0.26 p.p. In 2018, the VAT gap in Poland decreased by 0.29 p.p. and in 2019 by 0.3 p.p. Moreover, examining the dynamic effects, we observe a decrease in the VAT gap in

each consecutive year, and a 0.13 p.p. decrease confirms the overall effect. Furthermore, estimates of aggregate ATT on a calendar-time basis indicate that legislating with respect to the VAT gap has been effective, leading to a reduction from 2017 onwards.

To test whether the way the VAT gap is presented affects the results, the above analyses were also conducted for the VAT gap to VTTL (see table 3). Upon examining the obtained estimates, similar results were observed. In Lithuania, statistically significant average effects of the SAF-T regulation are also observed three years after it was adopted. In 2020, the VAT gap decreased by 3.23 p.p. The results are slightly higher compared to estimates of the VAT gap relative to GDP.

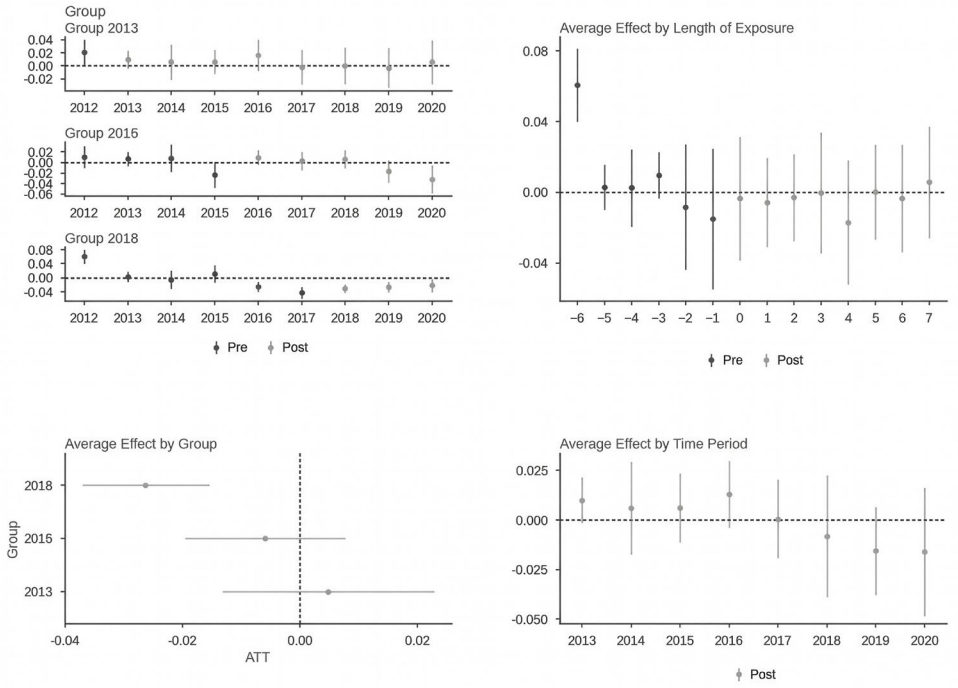
Table 3.
Impact of the introduction of SAF-T reporting on the VAT gap in relation to VTTL

	ATT effects over time for the group			Overall ATT summary based on calendar time		ATT dynamic effects	
	PT	LT	PL				
2012	0.0206 ** (0.0076)	0.0106 (0.0076)	0.0606*** (0.0076)			−6	0.0606 *** (0.0082)
2013	0.0099 (0.0051)	0.0069 (0.0051)	0.0029 (0.0052)	2013	0.0099 (0.0047)	−5	0.0029 (0.0051)
2014	0.0060 (0.0100)	0.0081 (0.0098)	−0.0059 (0.0098)	2014	0.0060 (0.0095)	−4	0.0024 (0.0088)
2015	0.0061 (0.0070)	−0.0230 ** (0.0094)	0.0120 (0.0094)	2015	0.0061 (0.0071)	−3	0.0095 (0.0052)
2016	0.0160 (0.0089)	0.0099 (0.0051)	−0.0251 *** (0.0051)	2016	0.0129 (0.0069)	−2	−0.0085 (0.0142)
2017	−0.0019 (0.0102)	0.0030 (0.0065)	−0.0429 *** (0.0063)	2017	0.0006 (0.0081)	−1	−0.0151 (0.0159)
2018	0.0001 (0.0105)	0.0061 (0.0063)	−0.0310 *** (0.0043)	2018	−0.0082 (0.0125)	0	−0.0037 (0.0140)
2019	−0.0035 (0.0117)	−0.0166 (0.0079)	−0.0266 *** (0.0057)	2019	−0.0156 (0.0090)	1	−0.0059 (0.0101)
2020	0.0057 (0.0126)	−0.0323 *** (0.0099)	−0.0214 ** (0.0074)	2020	−0.0160 (0.0132)	2	−0.0031 (0.0098)
				Overall	−0.0005 (0.0059)	3	−0.0003 (0.0137)
	Overall ATT summary by group					4	−0.0171 (0.0140)
PT 2013	0.0048 (0.0082)					5	0.0001 (0.0107)
LT 2016	−0.0060 (0.0062)					6	−0.0035 (0.0122)
PL 2018	−0.0263 *** (0.0049)					7	0.0057 (0.0126)
Overall	−0.0092 * (0.0049)					Overall	−0.0035 (0.0091)

Note: Standard errors in brackets below the coefficients. * p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Author's work.

Figure 5.
Impact of the introduction of SAF-T reporting on the VAT gap in relation to VTTL



Note: Group 2013 – Portugal, Group 2016 – Lithuania, Group 2018 – Poland
Standard errors are given in brackets below the coefficient estimates. *** Significance at 1%, ** 5%,* 10%.
Source: Author's work.

The difference is evident in the cumulative effects, which show a reduction of 0.6 p.p. in the VAT gap over the entire period. Different results were obtained for Portugal. The average effects of the SAF-T regulation indicate a reduction in the VAT gap since 2017. Compared to previous estimates, the effect is observed with a four-year lag. Additionally, the cumulative effects of introducing SAF-T indicate that the VAT gap increased from 2013 to 2020. However, the standard error window also extends to negative values, indicating uncertainty in the final determination of results. In Poland, on the other hand, a decrease in the VAT gap is also observed in the years before the introduction of the SAF-T solution. The reduction in the VAT gap is particularly evident in the years 2018-2020, during which it decreased by 3.1 p.p., 2.66 p.p., and 2.14 p.p., respectively. The overall impact of the SAF-T regulation in Poland on the VAT gap estimate relative to VTTL is higher, at -2.63 p.p. The dynamic effects reflect the decrease in the VAT gap in the years following the introduction of the SAF-T into the tax systems. Estimates of aggregate ATT based on calendar time show a reduction in the VAT gap only from 2018 onwards, one year later than for the VAT-to-GDP gap. The above considerations indicate that the way the VAT gap is measured affects the final estimates. This is particularly

evident in the average effects of SAF-T regulation over time across groups and the aggregate effects for each country. In addition, the estimates of the VAT gap relative to VTTL present a stronger effect of SAF-T implementation on the VAT gap.

The results of the study, conducted using panel data and the Arellano-Bond GMM estimator for each gap separately, are presented in table 4. The regression for the VAT gap on GDP and potential VAT revenue was drawn for all European countries over the period 2011-2020. In the case of the policy VAT gap, the period was reduced by two years (2011 and 2012) due to difficulties in obtaining data on its size. Furthermore, the number of study groups was reduced to 26 countries because no data on tax administration expenditure on ICT were obtained for Romania and Hungary for the period 2014–2020.

Table 4.
Determinants of the VAT gap

Variable	vat_gap_gdp	vat_gap_vttl	policy gap
L1. vat_gap_gdp	0.6510 ***		
	(0.0174)		
L.1 vat_gap_vttl		0.6901 ***	
		(0.0260)	
L.1 policy_gap			0.0827 ***
			(0.0168)
saft	**–0.0009 *** **	**–0.0196 *** **	**–0.1131 *** **
	(0.0002)	(0.0073)	(0.0136)
government_effectiveness	–0.0033 ***	0.0269 ***	0.0413 ***
	(0.0009)	(0.0088)	(0.0040)
notue_import	0.0143 ***	0.0396 **	–0.1382 ***
	(0.0028)	(0.0185)	(0.0351)
turnover_ ita	–0.0001 ***	–0.0002 **	0.0003 **
	(0.0000)	(0.0001)	(0.0001)
adm_ict_exp	–0.0244 ***	0.0121	0.0431 *
	(0.0017)	(0.0247)	(0.0222)
number_vat_rates	0.0011 ***	–0.0006	–0.0200 **
	(0.0003)	(0.0017)	(0.0084)
stand_vat_rate	0.0077	0.0205	1.9408 ***
	(0.0056)	(0.0652)	(0.1590)
Observations	206	206	158
Groups	28	28	26
Arellano-Bond test			
AR(1)	–2.7769	–3.065	–1.9715
p-value	0.0055	0.0022	0.0487
AR(2)	0.3563	0.6652	0.5091
p-value	0.7216	0.5059	0.6107
Sargan test	23.383	23.169	17.866
p-value	0.9936	0.9942	0.8806

Note: Standard errors in brackets below coefficients. * p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Author's work.

The regression results show that estimates of the variables *saft*, *government_effectiveness, notue_import, turnover_country_ita, admin_ict_exp*, and *number_vat_rates* significantly shape the VAT gap. This means that in countries where the SAF-T system is in place, and tax administrations spend more on ICT, the government is judged to be effective, domestic turnover exceeds sales within the EU (outside the country in question), and the VAT gap relative to GDP has narrowed. The introduction of the SAF-T system reduced the VAT gap by 0.09 p.p., while increased tax administration spending on ICT reduced it by 2.44 p.p. Higher government efficiency reduced the VAT gap by 0.33 p.p. In contrast, a higher share of imports outside the EU in global imports and a higher number of VAT rates in force increase the VAT gap relative to GDP by 1.4 p.p. and 0.11 p.p., respectively. The standard VAT rate is not significant.

Estimates of the VAT gap relative to VTTL confirm that the implementation of SAF-T and a higher proportion of domestic turnover relative to intra-community supply of goods reduce the VAT gap by 1.96 p.p. and 0.02 p.p., respectively. In addition, a higher share of imports outside the EU in global imports increases the VAT gap by 3.96 p.p. In contrast, contradictory results are observed for the *government_effectiveness* variable. In countries with higher government effectiveness, the VAT gap is larger by 2.69 p.p. Parameter estimates for the variables *adm_ict_exp, number_vat_rates, and stand_vat_rate* were statistically insignificant.

An increase in the policy VAT gap is caused by a higher standard VAT rate and higher-rated government efficiency. Moreover, an increase in tax administration efficiency also results in a 4.31 p.p. decrease in the policy VAT gap. The estimate of the number of VAT rates in force is puzzling, as it undermines the policy VAT gap. The result contradicts the expectation that countries with more different VAT rates would face an increase in the policy VAT gap, thereby reducing government revenue. The application of the SAF-T system, according to the estimation outcomes, reduces the VAT policy gap. The negative relationship with the *saft* variable indicates that in countries where the SAF-T system is implemented, the revenue potentially lost due to the validity of concessions, etc., is not high and decreases.

6. Discussion

To date, the impact of SAF-T reporting in tax systems has not been adequately addressed in the literature. This research contributes to the literature by the use of the DiD with multiple periods and panel data regression and finding no basis for rejecting the H0 hypothesis. The application of the SAF-T system results in a reduction of the VAT gap, expressed in both GDP and potential VAT revenue terms. The use of the SAF-T solution in the tax system gives tax authorities a cyclical view of taxpayer information, including sales and purchases subject to VAT. Therefore, the objective of increasing tax control and tightening the tax system has been achieved.

Moreover, the panel-data regression confirmed the negative impact of the domestic turnover-to-ITA ratio. The results confirm the conjecture presented by Morrow et al. (2022). In intra-community sales transactions, there is less control

over the whole process. According to article 42 of the Value Added Tax Act, intra-community supply of goods at a 0% rate must meet several criteria, such as the taxpayer's documentation including confirmations of export of goods from the force is country concerned and confirmation of the delivery of goods to the purchaser of another member state. The following are deemed to be such evidence: transport documents obtained from a third-party transporter, showing that the goods have been delivered to the purchaser on the territory of a member state or, in the case of transport organized by the vendor or the purchaser using their means of transport, a statement giving the specifications of the different items of cargo and a document identifying the purchaser (name, business or residential address), the address to which the goods are transported, information on the goods transported and their quantity, an acknowledgement of receipt of the goods, and the type and registration number of the means of transport. Commercial correspondence, insurance documents, or a document proving that a liability has expired, such as a confirmation of payment, can also constitute confirmation that the delivery has been finalized (Value Added Tax Act, 2004). The above indicates that the documentation required for intra-community supply of goods is primarily prepared by taxpayers. Self-preparation of documents by taxpayers fosters fraud. Moreover, the evidence prepared is not verified at the stage of reporting the transaction to the tax authorities and is only checked during possible tax audits. Thus, in countries where the intra-community supply of goods is smaller than the total national turnover, the VAT gap decreases.

A contradictory relationship was observed between imports (purchases of goods from outside the EU) relative to global imports (reflecting imports and intra-community acquisitions) and the VAT gap relative to GDP and VTTL. In line with Morrow et al. (2022), a higher share of imports burdened by numerous customs controls should reduce the VAT gap. However, from a practical perspective, not all customs authorities operate in the same manner. The European Court of Auditors released a report saying that the heterogeneity of customs inspections across the EU is a significant problem, leading to numerous abuses. It was noted that customs inspections differ mainly in timing and nature (document checks, physical examination of goods, and reporting after the inspection). Taxpayers, recognizing numerous shortcomings and differences in customs inspections, deliberately chose countries with less rigorous customs inspections to facilitate border crossings. The EC plans to harmonize EU customs inspections in the future to address these problems (European Court of Auditors, 2021).

Furthermore, several simplifications reduce the burden of customs inspections. For example, obtaining Authorised Economic Operator (AEO) status makes a trader a reliable supplier in the eyes of the customs authority. The examples cited may help explain the results, which show that a higher share of imports in global imports increases the VAT gap, both in terms of GDP and potential VAT revenue.

Ambiguous results were obtained for the Kaufman index of government effectiveness, which assesses it based on perceptions of the quality of public services, the degree of independence of the civil service, and the quality of policy creation and implementation. Previous studies have shown that a higher rating of a country for these criteria is associated with a negative correlation with the VAT gap (Olexová

et al., 2022; Butu et al., 2021). A higher rating for a country means that all the aforementioned aspects are implemented properly by highly competent state authorities, and this results in a decrease in the VAT gap. However, there is also evidence of a weak relationship between government efficiency and the VAT gap (Butu et al., 2021). Also, the study does not provide clear results for identifying a specific direction of the relationship. The VAT gap relative to GDP estimates confirms a significant negative correlation between government effectiveness and the VAT gap.

In contrast, the results for the VAT gap relative to potential VAT revenue indicate a positive correlation, and thus countries with a higher share of the VAT gap in GDP, due to more efficient state institutions, are more effective in reducing the VAT gap to a certain extent relative to potential VAT revenues. Beyond this point, the relationship changes direction. This indicates that the relationship between the efficiency of state institutions and the VAT gap is non-linear.

Moreover, an important aspect is the performance of tax administrations, particularly their streamlining. Today, digitalization of processes plays a key role. Thanks to the tax administrations' higher spending on ICT development, it is possible to improve services intended for taxpayers, e.g., by digitalizing the filing of all tax applications and returns, as well as the detection of tax misconduct risks, which is becoming more efficient (Szczypińska, 2019; Agha & Haughton, 1996). The results of the regression on the VAT gap as a share of GDP confirm that countries with a higher share of ICT expenditure in total government expenditure exhibit a significant decrease in the VAT gap. In contrast, an analogous regression conducted for the VAT gap, presented as potential VAT revenues, does not confirm previous conclusions. This may be due to difficulties in obtaining data on tax administration expenditure for ICT purposes in some European countries. Further research in this area is therefore advisable.

It was assumed that the higher the number of VAT rates, the higher the VAT gap. Despite special guidelines or the existence of bodies that specialize in determining the appropriate VAT rate for a given good (in Poland, the institution performing this function is WIS – Binding Rate Information), taxpayers may manipulate VAT rates when taxing sales. Typically, this manipulation involves applying an underestimated VAT rate, resulting in the incorrect amount of VAT due being remitted to the tax office and thereby reducing VAT budget revenue. Research by Agha and Haughton (1996) confirmed the existence of such a relationship. However, the estimates from this study do not confirm a significant relationship between the VAT gap and the number of VAT rates in force. Only in a regression analysis of the VAT gap as a percentage of GDP is a positive relationship observed between the number of VAT rates and the VAT gap. Indeed, for each additional VAT rate introduced, the VAT gap increases by 0.11 p.p. In contrast, the estimates for the VAT gap relative to potential VAT revenue were statistically insignificant. Moreover, no significant relationship has been observed in previous studies either (Szczypińska, 2019). Drawing clear conclusions is therefore not possible and future research in this area is required.

The paper also confirms that the standard VAT rate has no significant effect on the VAT gap, consistent with Majerova (2016). Regression estimates of the VAT

gap as a percentage of GDP and potential VAT revenue did not reveal a significant relationship between the two.

7. Conclusion

The VAT gap poses a threat to budget revenues in many EU countries. Implementing solutions to reduce this gap is essential to prevent it occurring. A study using the DiD with multiple periods found that the VAT gap narrowed in countries with mandatory SAF-T reporting. The analysis also focused on verifying whether the measurement of the VAT gap affects the final results. Our outcomes suggest a negative correlation between the VAT gap and the implementation of the SAF-T reporting system in a given country. The primary difference lies in the overall impact of the SAF-T reporting regulation in Portugal. The estimates indicate an increase in the VAT gap during the period when taxpayers were required to report data to the tax authorities. Explaining this state of affairs requires further research.

To date, the primary objective of authors studying the VAT gap has been to estimate it. Therefore, few works attempt to identify the drivers of the VAT gap. However, this issue is crucial as it enables appropriate steps to be taken to reduce the VAT gap, which places a significant burden on the state budget's tax revenues. A study verifying the relationship between the VAT gap and macroeconomic, demographic, institutional, and legal factors can guide public authorities in identifying areas that warrant closer examination for their impact on the VAT gap and in identifying key risk areas for the revenue administration's audit activities.

The results of the panel survey indicate that the VAT gap arises primarily from a higher proportion of imports relative to global imports. On the other hand, the VAT gap declines when there is a SAF-T system within the tax system, specifically by a higher percentage of domestic turnover relative to intra-community supply of goods. Public authorities seeking to reduce the VAT gap should focus on the above factors to the extent that they can be influenced.

In addition to identifying the determinants of the VAT gap, future studies may focus on decomposing it to enable a detailed examination of its structure. Identifying a factor that accounts for a significant portion of the VAT gap can help public authorities select an appropriate tool to mitigate its impact. Also, the cost of such a measure does not exceed the VAT revenue lost due to the existence of this component.

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