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Evaluation of the factors affecting tax audits effectiveness. Evidence from EU tax administrations

Athanasios Anastasiou[*], Charalampos Kalligosfyris[†], Eleni Kalamara[‡], Zacharias Dermatis[§]

Abstract

The purpose of this paper is to assess the factors that influence the effectiveness of tax audits carried out by the tax administrations of the European Union economies and to draw useful conclusions on the development of an effective European tax audit strategy. More specifically, using panel data from 21 member states of the European Union, for the period 2016-2019, we analyze the causal relationships between the effectiveness of tax audits and various economic, institutional and political factors. To analyze the long-run and short-run interdependence and causality relationships between these factors, we use panel cointegration theory and estimate error correction models (ECM). The results of the research revealed the existence of significant causal relationships between the effectiveness of tax audits and factors related to per capita income, gross domestic product, tax rates, tax capacity, time to comply, the level of corruption, adherence to the rule of law and the quality of institutions in an economy. It was also found that increased efficiency of tax audits significantly affects the per capita income of the economy, the quality of institutions, the political stability of a country and the tax buoyancy.

JEL classification: C3, H2, H7, H8

Keywords: Taxation, tax audits, efficiency, causality, European Union

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1. Introduction

Taxes are the main source of government budget revenue (Gbadago & Awunyo-Vitor, 2015). For this reason, state governments make efforts to increase public revenues in order to eliminate fiscal deficits, balance their budgets (Leahy, 2006) and enhance the level of tax compliance. Based on the above, tax audits are at the center of interest of economic policy makers, playing a critical role for the implementation of an efficient and fair tax system (Karagiorgos et al., 2006).

Tax audit is defined as the activity carried out by the tax authorities in order to ascertain the degree of accuracy of the tax returns submitted by the taxpayer in accordance with tax legislation (Das-Gupta & Gang, 1996; Pantelidis, 2009). In this sense, tax audits are a powerful tool through which taxpayers' compliance with tax legislation is achieved. Conducting targeted tax audits allows the identification of cases of tax evasion and income concealment, which significantly affect the level of tax revenues (Doe & Smith, 2018). Admittedly, tax audits exert a general deterrent effect on taxpayers who have not been audited (Isa & Pope, 2011) thus enhancing the level of voluntary tax compliance. In fact, notable studies find that tax audits increase reported income in subsequent tax years after the tax audit (Kleven et al., 2011; Advani et al., 2018; DeBacker et al., 2018; Anastasiou et al., 2022a; 2023). The results of tax audits are influenced by many factors such as the level of income, compliance history, the sector of activity and the competence of tax auditors. In addition, the conduct of tax audits entails significant consequences for taxpayers, including increased legal costs, financial penalties and damage to the company's image. On the other hand, it has been observed that conducting tax audits contributes to improving the efficiency of companies by providing clarification from tax auditors on the correct application of tax legislation and compliance with accounting standards and procedures and by identifying improvements needed in the company's financial monitoring system (Dittenhofer, 2001; OECD, 2006). For these reasons, the procedures and results of tax audits have attracted the interest and attention of researchers in recent years. (Yusof, et. al, 2014; Chalu & Mzee, 2017; Anastasiou et al., 2021a; 2022b).

2. Literature review

The effectiveness of tax audits is a multi-dimensional issue that has been studied on a limited scale in the accounting and auditing literature. Previous research on tax audits does not take into account the important macroeconomic, institutional and political factors in the success of tax audits. These studies usually focus on organizational and administrative constraints and perceptions to explain the results of audit procedures. According to the findings documented in a consultative forum on improving audits, Gansberghe (2005) argued that taxpayers' perceptions of the quality of tax audits, the structure of tax audit procedures, the level of governance, legislation, professionalism and integrity of auditors are important factors affecting the effectiveness of tax audits.

Mihret & Yismaw (2007) and Cohen & Sayag, (2010), find that audit quality, which relates to the ability of auditors to uncover non-compliant behavior and provide useful audit recommendations, is considered a determinant of the effectiveness of tax audits. Moreover, the degree of independence of tax auditors in the performance of their duties, in terms of objectivity and absence of any administrative influence, is considered fundamental to the reliability and results of audits. In particular, the studies of Drogalas et. al, (2015) and Ayalew (2014), support the existence of a positive and significant relationship between auditor independence and audit effectiveness. In addition, Bou-Raad (2000) argued that the skills and qualifications of auditors, contribute to the effectiveness of tax audits and have a positive effect on tax administration's audit work evaluations. Also, Ahmad & Taylor (2009) analyzing the system of tax audits in Malaysia concluded that the inadequacy of tax auditors and the lack of training, knowledge and experience adversely affect audit results. Moreover, the behavior of tax auditors is considered a critical factor in the success of tax audits since the way of interaction with taxpayers during the tax audit influences compliance behavior by creating a strong incentive for voluntary compliance (Isa & Pope, 2011), as opposed to arbitrary audit procedures and judgements that reduce the intrinsic motivation to comply (OECD, 2010). More recently, Adane (2020) showed that factors related to the independence and abilities of tax auditors, the degree of taxpayer awareness and their attitudes towards tax auditing are key determinants of audit effectiveness.

In addition, the complexity of tax legislation can negatively affect the level of tax compliance and thus the effectiveness of tax audits (Richardson, 2006; Cox & Eger, 2006; Pantelidis, 2009). Baralexis (2004) argues that the complexity of tax audit procedures and the prevailing perception of high tax burden have significantly increased tax evasion in Greece. In many cases auditors are required to interpret complex tax provisions and process a huge volume of accounting records (OECD, 2006). Therefore, it is suggested that tax legislation should be simplified and a stable and simple tax system should be implemented which will help to create an attractive tax environment (James et al, 2015; Drogalas et. al., 2015; Anastasiou et al., 2021a). In fact, Artavanis et al. (2012), showed that the lack of political will to implement clear and effective tax legislation and the inadequacy of tax procedures, combined with the prevalence of semi-formal economy conditions, are serious reasons for encouraging tax evasion in Greece.

At the same time, notable studies support the importance of the use of modern technologies and the upgrading of tax administration information systems as factors to improve the process of collecting, analyzing and processing accounting information, providing valuable data and information to support the process of conducting effective tax audits (Ho & Lau, 1999; Sen & Bala, 2002; Chatzipanagiotou, 2010; Drogalas et. al, 2015; Anastasiou et al., 2020). Nevertheless, in the studies found in the international literature regarding tax audits, the possible ineffectiveness of tax audits is not taken into account, i.e. the inability to identify cases of tax evasion that actually exist or the incorrect finding of tax evasion when it does not exist. In fact, according to Feinstein (1991), the average level of

detection of cases of tax evasion through tax audits is 50%. This weakness of tax audits appears to have an effect on compliance behavior. Thus, Gemmell & Ratto (2012) and Beer et al. (2020), argue that the specific deterrent effect of audits depends on the outcome of the tax audits. Specifically, they find that tax audits increase the post-audit tax compliance of taxpayers who are found to be non-compliant, while on the contrary, they decrease the tax compliance level of those who are judged to be compliant.

These results raise additional questions regarding the effectiveness of tax audits in the degree of compliance after the audit. In particular, it is not clear whether the effectiveness of tax audits affects their deterrent effect or whether the effects of audits depend on prior compliance behavior. Regarding the above question of the effect of tax audits on the level of tax compliance, it is found that some studies support the existence of a positive effect, in contrast to laboratory experiments that report such a negative relationship. Particularly interesting is the study of Kasper & Rablen (2023) whose results showed that after the tax audit, the perceived audit risk decreases in the case of the exogenous audit option. However, in the case of endogenous audit whereby the tax entity learns to reduce audit risk by reporting higher incomes, the effect of learning outcomes outweighs the misperception of audit probability, resulting in an increased level of post-audit tax compliance. Furthermore, Kasper & Alm (2022) showed that the effectiveness of tax audits differentially affects the level of tax compliance after the audit. In particular, the researchers argue that effective tax audits tend to increase the degree of compliance after the audit, in contrast to ineffective audits that show the opposite effect. In addition, taxpayers with greater prior tax compliance exhibit stronger compliance behavior. Therefore, the results indicate that the deterrent effect of tax audits depends on their effectiveness and the previous reporting behavior of the taxpayer.

With these data, it is found that the above studies suggest different factors that shape the effectiveness of tax audits, focusing on organizational, administrative issues and behavioral explanations, but failing to interpret the actual mechanisms that shape the success rates of tax audits. The contribution of this study focuses on the investigation and assessment for the first time of important macroeconomic, institutional and political factors that affect the efficiency of tax audits, and in fact in the form of causal relationships making use of the cointegration method which is applied for the first time. It mainly focuses on the study of the factors that shape the success of tax audits, without, however, extending to issues of investigating the relationship that links the effectiveness of audits to post-audit compliance behavior. Indeed, the review of the literature reveals the absence of a comprehensive study of this kind at the European level, which would aim to highlight issues relating to the effectiveness of audits and the implementation of a common European policy of tax cooperation and audit methods and procedures, with a view to tackling fraud and tax evasion in a unified way. The present study attempts to fill this gap in the literature.

3. Data and variables

To assess the factors affecting the effectiveness of tax audits (HRA), 12 economic, institutional and political factors were selected and are presented in Table 1 below:

Table 1: Evaluation factors

AA	Factors	Symbol
	Economic	
1	GDP growth (annual %)	GDP
2	GDP per capita	GDPCA
3	Total tax and contribution rate (% of profit)	TR
4	Tax effort (ratio)	TE
5	Tax capacity (as percentage of GDP)	TC
6	Tax buoyancy	TB
7	Time to prepare and pay taxes (hours)	CT
	Institutional	
8	Corruption	COR
9	Rule of Law	RL
10	Regulatory Quality	RQ
	Political	
11	Government Effectiveness	GE
12	Political Stability	PS

The effectiveness of tax audits is measured by the hit rate of tax audits (HRA), which represents the ratio between the number of audits from which hidden taxable material was found to the total number of audits carried out. (No of audits where a tax adjustment was made / No of audits completed * 100). The above index is widely used by tax administrations in order to evaluate the results of the tax audit activity of tax administrations and is proposed by the Intra-European Organization of Tax Administrations (IOTA). And while the effectiveness of tax audits is affected by endogenous and exogenous factors, and there are additional inherent limitations as cases of tax evasion may go undetected or tax evasion may be falsely detected when it does not exist, there is no official data on the percentage of additional taxes that challenged before the administrative or judicial authorities and those that were finally upheld. This limitation should be taken into account in relevant research that reports on the effectiveness of tax audits.

Regarding the proposed factors, it is chosen to include variables related to the growth rate, GDP per capita, the level of tax rates, tax compliance time, tax effort of the economy, tax capacity and tax buoyancy, which represent the economic dimension of the success of tax audits that concerns the level

of economic activity and the size of the tax burden, taking into account the results of previous studies that support such an interaction relationship (Baralexis, 2004; Drogalas et. al., 2015). In addition, the research is strengthened by incorporating variables related to the quality of the economy's institutions, the level of corruption and adherence to the rule of law, in order to take into account parameters related to the integrity of auditors, the quality of tax procedures and perceptions of taxpayers, according to the literature (Adane, 2020; Elias, 2014; Van Gansberghe, 2005). Regarding the indicators referring to the effectiveness of the government and political stability, they were chosen with the aim of taking into account elements related to the political will to implement a clear and effective tax legislation and the adequacy of tax administrations, as the factors these have emerged through the literature as critical parameters for the effectiveness of tax audits (Artavanis et al., 2012; Van Gansberghe, 2005).

The relationship between the effectiveness of tax audits (HRA) and these factors is defined as follows:

$$HRA_{it} = f\,(GDP_{it,}\, GDPCA_{it},\, TR_{it},\, TE_{it},\, TC_{it,}\, TB_{it},\, CT_{it},\, COR_{it},\, RL_{it},\, RQ_{it},\, GE_{it},\, PS_{it})$$

$$HRA_{it} = \beta_{1i}\, GDP_{it,} + \beta_{2i}\, GDPCA_{it,} + \beta_{3i}\, TR_{it} + \beta_{4i}\, TE_{it} + \beta_{5i}\, TC_{it} + \beta_{6i}\, TB_{it} + \beta_{7i}\, CT_{it} + \beta_{8i}\, COR_{it} + \beta_{9i}\, RL_{it} + \beta_{10i}\, RQ_{it} + \beta_{11i}\, GE_{it} + \beta_{12i}\, PS_{it} + u_{it}$$

where i=1, 2,…..N the cross-sections, t the time period and u the stochastic term. Data from 21 EU countries were used to estimate the above econometric relationship, based on data availability. In particular, used panel data from Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Germany, Greece, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Portugal, Romania, the Slovak Republic, the Slovak Republic, the Republic of Slovenia, Sweden and the Netherlands. The 21 countries were selected on the basis of their accession to the European Union and the development of a common fiscal policy and strategy to combat tax evasion. The rest of the European Union countries are not included in the survey due to lack of data. The survey data were collected from official public sources (United States Agency for International Development (USAID) [https://data.usaid.gov] and Intra-European Organization of Tax Administrations (IOTA)) [https://data.rafit.org] and cover the period 2016-2019.

4. Methodology and results

As already mentioned, the aim of this paper is to examine the causal relationships between the effectiveness of tax audits and a set of economic, institutional and political factors in the economies of the European Union, with the help of the cointegration theory. For the needs of the research, panel data for the period 2016-2019 are used. The panel data method, also known as the panel method, is a statistical method used to analyze data derived from a group of objects (such as companies, people, countries) observed at various points in time. In this method, data are collected from the same objects (or units) at successive time intervals, combining cross-stratified and time-series data. Panel data

analysis can provide advantages over traditional time series data analysis methods as it takes into account potential heteroscedasticity and internal structure of the data.

The basic model of panel data analysis is formulated as the follow:

$$Y_{it} = a_i + \beta_1 X_{1it} + \beta_2 X_{2it} + .. + \beta_k X_{kit} + u_{it}$$

where the dependent variable, the explanatory variables, with i = 1,...,N and t = 1,...,T (Hsiao, 2003).

The advantages of the method are related to the treatment of heteroscedasticity problems through the incorporation of fixed or random effects, the estimation of the dynamic effects of variables over time in order to understand the effect of one variable on another over time and the incorporating additional information. Overall, panel analysis offers a powerful tool for drawing research conclusions and making decisions based on comparative data, where tracking items through time is important for understanding the processes and factors influencing phenomena.

Further, the application of the cointegration method requires the testing of the stationarity properties of the variables, through the unit root test of the panel data, in order to ascertain whether the observed time series of the variables under consideration show a stochastic trend. A test of cointegration is then carried out to investigate any long-run equilibrium relationships between them and Error Correction Models are estimated to test for short-run causal relationships.

To examine the order of integration and the stationarity properties of the variables under consideration, a series of panel unit root tests are required. Such stationarity tests were proposed by Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), ADF-Fisher (Dickey & Fuller, 1979, 1981), PP-Fisher (Phillips & Perron, 1988). The ADF panel data test developed by Levin, Lin and Chu (2002) assumes that there is homogeneity of the autoregressive coefficients for all panel units. Also, the control proposed by Maddala and Wu (1999) allows unit root testing on panel data through non-parametric methods by making use of the Fisher-ADF and Fisher-PP tests, which allow for greater unit heterogeneity. In these tests the null hypothesis is that there is a unit root versus the alternative of no unit root. Table 2 below presents the results of the unit root test, as proposed by Levin, Lin and Chu (LLC test), at the initial levels and first differences of the variables. The data reveal that the variables are first-order integrated I(1).

Table 2: Unit root tests (LLC test)

Variables	**At level**		**At first difference**	
	Statistic	**p-value**	**Statistic**	**p-value**
HRA	-0.81	0.2089	-28.67	0.000*
GDP	-0.7937	0.2137	-10.73	0.000*
GDPCA	10.4026	1.0000	- 12.22	0.000*
COR	11.8438	1.0000	-20.69	0.000*

GE	-1.2701	0.1020	-7.853	0.000*
PS	0.66609	0.7473	-54.61	0.000*
RL	0.2656	0.6047	-20.42	0.000*
RQ	7.4989	1.0000	-4.10	0.000*
TE	0.1607	1.0000	-3.109	0.0009*
TR	4.45795	1.0000	-5.024	0.000*
TB	0.627	0.7347	-14.548	0.000*
TC	1.81	0.9649	-7.221	0.000*
CT	0.184	0.5731	-9.615	0.000*

Subsequently, a cointegration test of the variables is carried out to examine the equilibrium relationships between them. The application of cointegration theory is based on the study of Granger (1988) which argues that when among a set of d-order integrated variables, there is a linear combination of them which is stationary, then the time series are cointegrated. To test for cointegration, the classical methods of Kao (1999), Pedroni (1999, 2004) and Johansen-Fisher (Johansen, 1988, 1991; Johansen & Juselius, 1990) and the Westerlund (2007) test have been proposed, which is applied in case of cross-section dependence of the panel units. In this study, the Pedroni heterogeneous panel cointegration test that allows cross-sectional interdependence, was applied in order to investigate the existence of a long-run equilibrium relationship between the effectiveness of tax audits (HRA) and each variable (X), as follows:

$$HRA_{it} = \alpha_{it} + \delta_i t + \beta_i X_{it} + \varepsilon_{it}$$

where i= 1,...,N is each European economy and t= 1,...,T is the time period. The coefficients α_{it} and δ_i incorporate the possibility of country-specific fixed effects and deterministic trends. The estimated residuals ε_{it} represent any deviations from the long-run equilibrium relationship. The test of the hypothesis of non-cointegration of the variables H_0: $\rho_i = 1$, is carried out through the unit root test on the residuals $\varepsilon_{it} = \rho_i \varepsilon_{it} - 1 + w_{it}$. Table 3 presents the panel and group mean panel cointegration test statistics. The results of the Pedroni (1999, 2004) cointegration tests reject the null hypothesis of no cointegration of the variables and thus a long-run equilibrium relationship exists at the bivariate level that allows the estimation of Error Correction Models in order to identify long and short-run causal relationships.

Table 3: Pedroni residuals Cointegration Test

Pedroni residuals Cointegration Test (Dependent Variable: Hit rate of tax audits (HRA))							
Independent Variable	**Panel v-Statistic**	**Panel ρ-Statistic**	**Panel PP-Statistic**	**Panel ADF-Statistic**	**Group ρ-Statistic**	**Group PP-Statistic**	**Group ADF Statistic**

GDP	-3.474858 (0.9997)	1.79188 (0.9634)	-1.637110 (0.0508)*	-1.383211 (0.0833)**	2.51017 (0.9940)	-9.43654 (0.000)*	-8.27548 (0.000)*
GDPCA	-2.845029 (0.9978)	-0.177258 (0.4297)	-1.759751 (0.0392)*	-1.757900 (0.0394)*	3.167256 (0.9992)	-1.423822 (0.0772)**	-1.734019 (0.0415)*
COR	-3.470133 (0.9997)	-0.604160 (0.2729)	-3.849652 (0.0001)*	-3.946648 (0.000)*	2.545605 (0.9945)	-4.690803 (0.000)*	-4.335264 (0.000)*
GE	-3.458985 (0.9997)	0.160307 (0.5637)	-1.725366 (0.0422)*	-1.760387 (0.0392)*	3.177112 (0.9993)	-1.323494 (0.0928)**	-1.88175 (0.0299)*
PS	-3.475405 (0.9997)	-0.069998 (0.4721)	-3.106293 (0.0009)*	-3.075351 (0.0011)*	3.090731 (0.9990)	-2.924249 (0.0017)*	-2.603728 (0.0046)*
RL	-3.472027 (0.9997)	-0.251556 (0.4007)	-5.354996 (0.000)*	-5.434488 (0.000)*	2.728091 (0.9968)	-3.268272 (0.0005)*	-3.836358 (0.0001)*
RQ	-3.472665 (0.9997)	0.002052 (0.5008)	-6.166716 (0.000)*	-7.637838 (0.000)*	3.137037 (0.9991)	-6.644757 (0.000)*	-6.710283 (0.000)*
TE	-3.375556 (0.9996)	1.577453 (0.9427)	-1.347821 (0.0889)**	-1.715547 (0.0431)*	2.517377 (0.9941)	-4.158095 (0.000)*	-4.362488 (0.000)*
TR	-1.412395 (0.9211)	-0.257596 (0.3984)	-1.346020 (0.0891)**	-1.430725 (0.0763)**	2.837713 (0.9977)	-1.654283 (0.0490)*	-2.048303 (0.0203)*
TB	-3.474481 (0.997)	0.659930 (0.7454)	-1.812844 (0.0349)*	-1.800434 (0.0359)*	3.348940 (0.9996)	-2.280899 (0.0113)*	-1.285371 (0.0993)**
TC	-0.952900 (0.8297)	0.224374 (0.4112)	-1.587709 (0.0562)*	-1.589587 (0.0560)*	3.080266 (0.9990)	-1.864266 (0.0311)*	-2.022546 (0.0216)*
CT	1.433482 (0.0759)**	-0.066483 (0.4735)	-7.488278 (0.000)*	-7.792619 (0.000)*	1.912906 (0.9721)	-3.396337 (0.0003)*	-3.929884 (0.000)*

** , ** Indicates rejection of the null hypothesis at the 5% and 10% significance level respectively.*

Since there are cointegration relationships between the variables, it is possible to estimate the long-run relationship between them using the fully modified OLS (FMOLS) technique for heterogeneous cointegrated panels (Pedroni, 2000). Table 4 presents the estimates of the parameters of the long-run function by case when the HRA variable is used as the dependent variable, according to the FMOLS method. The results of the FMOLS estimates show that an increase in GDP, GDP per capita, tax effort, tax rates, tax buoyancy, tax capacity and time for tax compliance by one point, will result in a small increase in the effectiveness of tax audits in the long run. Further, an improvement in the Government Effectiveness Index, Political Stability, Adherence to the Rule of Law and Quality of Institutions Index by one point will significantly enhance the efficiency of tax audits as it will increase (%) of 113.50 points, 12.43 points, 21.9 points and 242.7 points, respectively. On the contrary, a one

point increase in the corruption index will result a decrease in the effectiveness of tax audits in the long run, by 0.43 points.

Table 4: Results of the FMOLS method

FMOLS panel results (Dependent Variable: Hit rate of tax audits (HRA))			
Independent Variables	**Coefficient**	**t-statistic**	**p-value**
GDP	0.000575*	234.95	0.0000
GDPCA	0.430033*	146.56	0.0000
COR	-0.436290*	233.24	0.0000
GE	113.4957*	21.56	0.0000
PS	12.42648*	3.15	0.0023
RL	21.90272*	43.13	0.0000
RQ	242.7552*	32.99	0.0000
TE	0.989528*	42.35	0.0000
TR	0.660492*	57.74	0.0000
TB	0.371424*	9.72	0.0012
TC	0.384583*	22.30	0.0000
CT	0.388954*	41.51	0.0000

** indicates significance at the 1% level.*

The estimation of the long-run equilibrium relationship between variables (bivariate level) allows the development of Error Correction Models (ECM) to estimate the short-run imbalance relationship, the long-run equilibrium relationship, the short-run imbalance error (ECT) and the short-run imbalance correction speed. Following Pesaran et al. (1999), Error Correction Models of the following form are estimated:

$$\Delta HRA_{i,t} = a_j^{HRA} + \beta_i^{HRA} ECT_{i,t-1}^{HRA} + \sum_{k=1}^{m} \delta_{i,k}^{HRA} \Delta HRA_{i,t-k} + \sum_{s=1}^{q} \gamma_{i,s}^{HRA} \Delta X_{i,t-s} + u_{i,t}$$

$$\Delta X_{i,t} = a_j^{x} + \beta_i^{x} ECT_{i,t-1}^{x} + \sum_{k=1}^{m} \delta_{i,k}^{x} \Delta HRA_{i,t-k} + \sum_{s=1}^{q} \gamma_{i,s}^{x} \Delta X_{i,t-s} + v_{i,t}$$

where HRA is the dependent variable representing the effectiveness of tax audits and X is the independent variable of the model from the determinants under investigation, D is the first difference operator, $ECT_{i,t-1}$ are the estimated time lagged residuals derived from the estimation of the above long-run equilibrium function as an error correction term, γ_i and δ_i are the short-run adjustment

coefficients (i = 1, 2) and u_{it} , v_{it} are the white noise residuals. The short-run causality as represented by the time lags of the differences of the variables is determined by the joint statistical significance of coefficients γ_i and δ_i respectively through the X^2 distribution (Wald - test). The long-run causality, which is derived from the deviations observed in the long-run equilibrium relationship and the speed of correction of the imbalance error, is determined by the statistical significance of the error correction term $ECT_{i,t-1}$ using the t distribution (t-test).

Table 5: Estimation results of Error Correction Models

Error Correction Models (ECM) and Causality Relationship					
ECM Variables	**Dependent Variable**	**Short- run causality**	**Long - run causality**		**Causality**
		Wald Chi-sq statistic	**ECT coefficient**	**t-statistic**	
HRA, GDP	HRA	5.15259 (0.0761)**	-0.060463	-1.775218 (0.086)**	**GDP Granger cause HRA short-run and long-run**
	GDP	0.963602 (0.6177)	-0.042451	-0.442531 (0.6613)	HRA does not Granger cause GDP
HRA,GDPCA	HRA	6.947546 (0.0310)*	-0.047566	-3.088473 (0.0043)*	**GDPCA Granger cause HRA short-run and long-run**
	GDPCA	0.641071 (0.7258)	-0.003583	-3.874471 (0.0005)*	**HRA Granger cause GDPCA long-run**
HRA, COR	HRA	0.658744 (0.7194)	-0.095499	-2.004853 (0.0541)*	**COR Granger cause HRA long-run**
	COR	0.094293 (0.9539)	-0.068832	-0.543108 (0.5911)	HRA does not Granger cause COR
HRA, GE	HRA	2.820053 (0.2441)	0.0000544	0.181585 (0.8571)	GE does not Granger cause HRA
	GE	0.996242 (0.6077)	0.000755	3.564297 (0.0012)	HRA does not Granger cause GE
HRA, PS	HRA	0.951640 (0.6214)	0.002357	0.803243 (0.4278)	PS does not Granger cause HRA
	PS	1.057194 (0.5894)	-0.038012	-6.391903 (0.000)*	**HRA Granger cause PS long-run**
HRA, RL	HRA	1.808469 (0.4049)	-0.057387	-1.790417 (0.0835)**	**RL Granger cause HRA long-run**

	RL	0.377454 (0.8280)	0.190237	1.805782 (0.0810)	HRA does not Granger cause RL
HRA, RQ	HRA	0.082349 (0.9597)	-0.063549	-1.728030 (0.0943)**	**RQ Granger cause HRA long-run**
	RQ	0.847155 (0.6547)	-0.080460	-1.847061 (0.0746)**	**HRA Granger cause RQ long-run**
HRA, TE	HRA	1.726409 (0.4218)	-0.037263	-1.453512 (0.1565)	TE does not Granger cause HRA
	TE	0.815478 (0.6652)	0.0021748	0.412621 (0.6828)	HRA does not Granger cause TE
HRA, TB	HRA	0.602938 (0.7397)	-0.013435	-1.253112 (0.2192)	TB does not Granger cause HRA
	TB	4.8034 (0.0906)**	-0.193422	-3.123849 (0.0038)*	**HRA Granger cause TB short-run and long-run**
HRA, TC	HRA	4.47136 (0.106)**	-0.072784	-1.889008 (0.068)**	**TC Granger cause HRA short-run and long-run**
	TC	1.9888 (0.3699)	0.0000105	0.003460 (0.9973)	TC does not Granger cause HRA
HRA, TR	HRA	3.4341 (0.1796)	-0.052412	-1.943162 (0.0608)**	**TR Granger cause HRA long-run**
	TR	0.52454 (0.7693)	0.002885	0.069297 (0.9452)	HRA does not Granger cause TR
HRA, CT	HRA	1.05279 (0.5907)	-0.098022	-2.529598 (0.0165)*	**CT Granger cause HRA long-run**
	CT	1.04439 (0.5732)	0.002068	0.843836 (0.4050)	HRA does not Granger cause CT

*and** indicates causality at 5% and 10% significance level respectively.

Table 5 presents the estimation results of the panel Error Correction Models using the Generalized Method of Moments. The results reveal that GDP, per capita income and tax capacity have a positive and statistically significant effect on the effectiveness of tax audits in the short run. Regarding the long-run dynamics reflected in the statistical significance of error correction terms (ECT), the results show that GDP, per capita income, level of corruption, adherence to the rule of law, quality of institutions, tax capacity, level of tax rates and compliance time, respond to deviations from the long-run equilibrium. Given the magnitude of the coefficients of the error correction terms, we could consider the speed of adjustment towards the long-run equilibrium to be rather slow. Furthermore, the

results of the survey support the existence of a significant effect of the audits' effectiveness on per capita income, political stability and institutional quality in the long run and on tax buoyancy in the short and long run.

Table 6: Causal relationships

Variables (X_i)		Sort-run causality			Long – run causality		
		γ_i^{HRA}		δ_i^x	β_i^{HRA}		β_i^x
	Economic						
HRA	GDP	(5.15259)	←		-0.060463	←	
HRA	GDPCA	(6.94754)	←		-0.047566	↔	-0.003583
HRA	TE		-			-	
HRA	TB		→	(4.8034)		→	-0.193422
HRA	TR		-		-0.052412	←	
HRA	TC	(4.47136)	←		-0.072784	←	
HRA	CT		-		-0.098022	←	
	Institutional						
HRA	COR		-		-0.095499	←	
HRA	RL				-0.057387	←	
HRA	RQ				-0.063549	↔	-0.080460
	Political						
HRA	GE		-			-	
HRA	PS		-			→	-0.038012

In fact, the conclusion of the existence of a strong long-run effect of GDP per capita and compliance time on the effectiveness of tax audits can be supported even at a 1% significance level, while the short-run effect of GDP per capita and the long-run effect of the level of corruption are supported at 5% significance level. Similarly, the results of the research on the existence of a significant effect of the effectiveness of tax audits on GDP per capita and long-run political stability can be supported even at a significance level of 0.1%, while the effect of audits on tax buoyancy in the long-run, in significance level of 1%, which strengthens the robustness of the results. Thus, the causality panel results, as presented in Table 6, show a bi-directional causality relationship between the effectiveness of tax audits and per capita income and the effectiveness of tax audits and the quality of institutions in the long run. In the remaining cases of causality, the existence of a one-way causal relationship is found.

Further, the variance decomposition of the forecast error provides an possibility to investigate the effect of the change in the values of one variable on the variance of the forecast error of the change in

another variable of the system. Table 7 presents the results of the Choleski variance decomposition of the forecast error of the variables under investigation for a period of 10 years.

Table 7: Variance Decomposition (VD) as percentage of forecast error variance

Year	GDP shock	HRA shock	GDPCA shock	HRA shock	COR shock	HRA shock
	VD of HRA	VD of GDP	VD of HRA	VD of GDPCA	VD of HRA	VD of COR
1	0.0000	1.4367	0.0000	1.7768	0.0000	3.9465
5	0.6028	2.9629	0.1354	2.4317	2.9590	1.1853
10	0.8278	4.0967	0.3106	4.1829	12.4869	0.5678

Year	GE shock	HRA shock	PS shock	HRA shock	RL shock	HRA shock
	VD of HRA	VD of GE	VD of HRA	VD of PS	VD of HRA	VD of RL
1	0.0000	0.1533	0.000	2.0844	0.0000	1.7025
5	7.0811	0.8805	2.3260	1.0390	3.8494	2.4817
10	8.7670	1.0425	2.7702	1.0469	19.7426	3.1416

Year	RQ shock	HRA shock	TE shock	HRA shock	TB shock	HRA shock
	VD of HRA	VD of RQ	VD of HRA	VD of TE	VD of HRA	VD of TB
1	0.0000	4.7019	0.000	0.3772	0.0000	1.2396
5	4.1344	14.2484	8.7822	3.3583	13.5928	2.9852
10	4.4114	18.0395	9.4223	2.9016	20.2133	3.1887

Year	TC shock	HRA shock	TR shock	HRA shock	CT shock	HRA shock
	VD of HRA	VD of TC	VD of HRA	VD of TR	VD of HRA	VD of CT
1	0.0000	5.9568	0.000	0.1940	0.0000	3.8274
5	29.0521	13.8195	3.2828	3.4914	0.1129	3.2672
10	34.3803	16.5851	3.2836	3.3159	0.1149	2.3553

As can be seen from the data in Table 7, a shock in the level of corruption, the level of adherence to the rule of law, tax buoyancy and tax capacity explains a significant percentage of the variation in the forecast error of the change in the effectiveness of tax audits in the EU economies, which is formed at 12.48%, 19.77%, 20.21% and 34.38% respectively, over a 10-year period. In the other cases of the factors, the variation rate is at low levels. Moreover, a shock in the effectiveness of tax audits in the EU economies explains a significant percentage of the variance of the forecast error of the change in the level of institutional quality and tax capacity, which is 18.03% and 16.58%, respectively, over a 10-year period.

5. Conclusions

This paper aims to investigate the causal relationships and the degree of interdependence between the effectiveness of tax audits and a set of macroeconomic, institutional and political factors in the EU economies, by applying panel cointegration theory, using annual panel data for the period 2016-2019. The main objective is to investigate important factors that contribute to increasing the efficiency of tax audits in the EU. From the analysis of the results, the following useful conclusions emerge:

The estimation results of the Error Correction Models indicate the existence of a short-run causal relationship between the effectiveness of tax audits (HRA) and GDP, per capita income and tax capacity, so that changes in the price level of these factors in the short-run have an impact on the effectiveness of tax audits in the EU economies. The results also show that there is a long-run causal relationship between the effectiveness of tax audits and the GDP, per capita income, level of corruption, adherence to rules law, the quality of the institutions, the tax capacity, the level of tax rates and the time of tax compliance, so that changes in their level affect the effectiveness of tax audits in the long term as long-term causal relationships develop between them. At the same time, the degree of correction of the imbalance error is found to be very low. In addition, the development and estimation of the Error Correction Models showed that there are long-run causal relationships in the direction from the level of effectiveness of tax audits to per capita income, political stability, quality of institutions and tax buoyancy and short-run causal relationships in the direction from the effectiveness of audits to tax buoyancy. Therefore, changes in the effectiveness of tax audits have a significant impact on the level of per capita income, political stability, the quality of institutions and the tax buoyancy of an economy.

The results of the FMOLS estimates show that a one point increase in GDP, GDP per capita, tax effort, tax rates, tax buoyancy, tax capacity and time for tax compliance will result in a small increase in the effectiveness of tax audits in the long run. Furthermore, an one-unit improvement in the Government Efficiency Index, political stability, adherence to the rule of law and quality of institutions will significantly enhance the effectiveness of tax audits, while an one-unit increase in the corruption index will reduce the effectiveness of audits in the long run. Subsequently, by applying the variance decomposition method of the forecast error of the variables under consideration, it is found that a shock of the level of corruption, the level of adherence to the rule of law, tax buoyancy and tax capacity explains a significant percentage of the forecast error variance of the change in the effectiveness of tax audits in the EU economies. Similarly, a shock in the effectiveness of tax audits in the EU economies explains a significant percentage of the variance of the forecast error of the change in the level of institutional quality and tax capacity.

With these data, it can be argued that an improvement of the macroeconomic position of the EU countries in terms of the level of GDP, per capita income and tax capacity of the economy, combined with a reduction in the level of tax rates and time for tax compliance, will contribute to the

effectiveness of tax audits. This conclusion is in agreement with the results of the study by Baralexis (2004) who argued that the complexity of the tax audit procedures and the prevailing perception of a high tax burden, significantly increased tax evasion in Greece. Consequently, increasing the time required to comply with a complex tax legislation and increasing the tax burden through increasing tax rates, will reduce the effectiveness of audits. The above relationship of tax rates with the effectiveness of tax audits can also be supported through the more general concluding position formulated in the literature, that the reduction of tax rates leads to an increase in tax revenues (Sergi, 2005). Also, the positive relationship found between the level of GDP and the effectiveness of tax audits can be linked to the higher level of economic development of a country, the greater taxable material and consequently the greater ability to collect tax revenues (Brun et al., 2006), part of which comes from tax audits. Besides, according to the international literature, the level of per capita income, which is considered as an approximation of the degree of economic development of a country, is positively correlated with tax revenues (Drummond et al., 2012; Fenochietto & Pessino, 2013; Anastasiou et al., 2022).

Furthermore, from the preceding analysis it appears that the worsening of the country's position in the fight against corruption creates difficulties and additional obstacles for tax auditors in the exercise of their duties. This conclusion agrees with the results of the analysis of Van Gansberghe (2005) who argued that taxpayers' perceptions of the quality of tax audits, the structure of tax audit procedures and the integrity of auditors, are important factors that influence the effectiveness of tax audits. Also, it could be linked to the results of the analysis of Adane (2020) who showed that factors related to the independence and abilities of tax auditors affect the effectiveness of audits.

Additionally, the conclusion that adherence to the rules of law and the high quality of an economy's institutions, enhances the ability to conduct efficient tax audits could be linked to the results of the study by Artavanis et al. (2012), that the lack of political will to implement a clear and effective tax legislation and the inadequacy of tax procedures, combined with the prevailing operating conditions of a underground economy, are serious reasons for encouraging tax evasion. Therefore, the effectiveness of tax audits is reduced. In addition, the above conclusion could be considered to agree, even partially, with the results of Van Gansberghe's (2005) analysis regarding the relationship between the country's level of governance and the quality of tax legislation, with the effectiveness of tax audits.

Based on these results, policy makers should introduce appropriate mechanisms to reduce corruption, improve the quality of institutions in the economy, public administration and the justice and enhance legitimacy in the political, economic and business sectors. At the same time, it is necessary to implement appropriate policies to boost national income, reduce the tax burden and increase the tax capacity of the economy.

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