

Taxation and Financial Stability: Cluster-Based Insights from EU States

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Abstract

This study investigates the relationship between taxation and financial stability in the European Union (EU) from 2005 to 2019, a period that encompasses a full economic cycle, including the 2008-2009 financial crisis. The EU's diverse economic landscape, with varying tax systems, provides an opportunity to analyse the interaction between tax burden and national economic development. Using a quantile regression approach and hierarchical clustering (Ward method), the study examines the effects of different taxation levels across 28 EU member states. The research highlights the role of tax structures in promoting economic growth while maintaining financial stability, addressing how tax reforms—particularly lowering taxation rates while broadening the tax base—can impact financial systems. The findings demonstrate that while tax burdens play a critical role in shaping financial stability, this relationship varies across countries and time periods. Data from international organisations such as the World Bank and Eurostat were utilised to support the empirical analysis. This paper contributes to the ongoing discussion on optimising tax policies to foster stable and competitive financial environments in the EU, especially in the wake of the global financial crisis.

Keywords

Financial Stability, Tax Burden, Impact Assessment, Quantile Regression, Cluster Analysis

1. Introduction

The economic and social development objectives of the European Union (EU) are closely linked to the process of reforming the tax system. The EU comprises countries with different levels of economic development, which calculate taxes based on different principles. This provides a real opportunity for researchers to study

the interrelationships between the parameters of the tax burden and the development trends of national economies. In open economies, the structure of the national tax system is often designed to address the tax systems of other countries, as countries increasingly use their tax systems to improve their ability to compete in global markets. Globalisation can also increase the scope for tax avoidance and evasion, especially in the case of mobile capital income tax bases (OECD, 2024). An optimal tax burden is seen as an essential condition for social development, the quality of public welfare and business growth, and the tax system's efficiency is one of the most critical factors in determining the potential of a national economy. A key challenge in tax policy-making is to assess how the tax structure's design and the taxation level can stimulate economic growth without causing or minimising adverse effects on financial stability. In this context, countries have undertaken structural reforms of their tax systems in recent decades to promote competition and economic activity (Dotsenko et al., 2024; Ajeigbe et al., 2024; Mazurenko et al., 2023). All of these reforms can be characterised as lowering the level of taxation but broadening the taxpayer base, thus maintaining the level of tax revenue.

Scientific attempts to assess the interaction between tax burden and financial stability, using various indices and other methods, have been confronted with several problems and scientific impasses presented in this paper. New definitions, index construction, hypothesis formulation and methodologies in this area have intensified since the recent global financial crisis of 2007 and 2008. The global crisis demonstrated the close correlation between the financial system and macroeconomic factors, with a financial shock in one institution spilling over to a whole range of other institutions and markets, thereby threatening the system (Liao et al., 2020). The economic and social fallout from the financial crisis has led to interest from financial sector stakeholders, including central banks, in new tools and methodologies to monitor financial stability in real economies and to identify potential threats to the financial system and the economy as a whole (Ilesanmi & Tewari, 2020). Arachi and Assisi (2021) argue that the financial sector has been quite profitable recently. It is expected to contribute significantly to the stability of public finances, so it is worth discussing how additional or higher taxes could help consolidate and stabilise financial markets. This study investigates the relationship between taxation and financial stability in European Union member states from 2005 to 2019, employing a quantile regression approach to identify patterns across different country groupings. A hierarchical clustering analysis of EU countries, based on taxation levels, was conducted using the Ward method. The primary contribution of this paper is developing a comprehensive model that elucidates the complex relationship between tax burden and financial stability, which was tested across 28 EU countries. The model allowed for the identification and examination of hypotheses about the impact of the tax burden on a state's financial stability from a cluster-based perspective. For the theoretical analysis of the study, databases of scientific articles (EBSCO, Scopus, Web of Science), legal

acts, documents, and reviews of the EU, ECB, OECD, and other international organisations were used. At different stages of the empirical research, publicly available data from the World Bank and Eurostat were used to present the financial data for the European Union Member States in the period from 2005 to 2019. The period 2005-2019 was chosen for the study, covering the entire economic cycle: the pre-crisis years (boom and peak), the 2008-2009 financial crisis (recession and crisis) and the post-crisis recovery (recovery or boom). The choice of the period is based on theoretical insights and scientific results, which suggest that the interaction between tax burden and the State's financial stability is a complex phenomenon that varies over time. Therefore, choosing a period that covers the entire economic cycle is appropriate. The post-2019 period is excluded from the study period to avoid the impact of a one-off shock, the Covid-19 pandemic.

The remaining study is structured as follows: the second part of the article analyses the theoretical aspects of the relationship between tax burden and State financial stability, performing an analysis and summary of scientific publications. The third section of the article describes formed research hypotheses and selected assessment methods in order to comprehensively assess the impact of the tax burden on the State's financial stability. In the fourth section of the article, EU countries were clustered into groups according to tax burden level, which was used to evaluate tax burden impact on the State's financial stability in the sixth section by applying quantile regression analysis. In the last section of the article, conclusions about the results of the research are formed and research hypotheses are checked.

2. The Relationship between Tax Burden and Financial Stability

The analysis of tax burden studies showed that while tax burden comparisons are possible internationally, the question of the impact of tax burden on a state's financial stability remains problematic, primarily due to the heterogeneous nature of the measurement of tax burden and the complexity of the channels of influence and feedback loops. While most authors unanimously agree that an impact exists, quantifying the impact is problematic. Tax burden studies tend to focus on the impact of the tax structure on the individual components of financial stability—the stability of public finances and the financial system, as well as on economic growth (Chen et al., 2022; Tvaronaviciene & Burinskas, 2022). The different methods of assessing this interaction used by researchers and the studies from different countries and periods are valuable for the research and justify the need for a more in-depth analysis of this phenomenon. While some researchers analyse the factors that influence the tax burden, others assess the impact of changes in the tax burden on macroeconomic indicators or assess the causal links between factors and the tax burden (Paul & Pedtke, 2020; Honda et al., 2020). Factors such as the rise of divergent social needs, the pursuit of social welfare, and other needs of the modern State have increased the cost of public finances and led to a diversification of taxes. Thus, the increase in the tax burden can be seen as a result of such policies

rather than a cause. At the same time, another global neoliberal initiative to reduce taxes and the influence of government management in the functioning of the State is emerging (Kurt & Celikay, 2024). Nevertheless, government intervention in tax policy remains unavoidable when countries are caught in regional or global crises, pursuing the welfare state, or dealing with other global problems. The largest body of empirical research has focused on the impact of the tax burden on economic growth (Hope & Limberg, 2020; Das & Ordal, 2022). Research results on this topic are contradictory, but there is some consensus on the negative impact of certain taxes. Myles and Yousefi (2020) argued that endogenous growth theory (EGT) has led to a broader exploration of the relationship between taxes and economic growth. This theory is based on the view that growth results from rational economic decisions, including tax policy (Hashimzade et al., 2021). From the perspective of endogenous growth theory, the interaction between taxes and economic growth seems obvious. Simulations of economic growth models assume that taxes impact economic growth, but empirical evidence has only confirmed a weak relationship between the variables. Myles and Yousefi (2020) argue that based on an empirical study, he would question the relationship between taxes and economic growth and consider them mutually exclusive, even though such a claim would be theoretically illogical. The study concludes that the impact of taxation may not be immediate but may take place over time and should, therefore, be monitored over a more extended period. Another assumption is that the impact may occur through the “hidden economy”, which is why this data is not part of the study’s scope of analysis. The “hidden economy” (Schneider & Enste, 2000) involves significant economic activity, often outside the scope of everyday process observation. Thus, theoretical and empirical estimates of the impact of tax burdens can differ markedly, leading to debates on the choice of methods and their limitations. An analysis of the literature allows us to distinguish between two main channels of tax burden that influence the State’s financial stability. The first channel involves the influence of the tax structure on the economic behaviour of individuals and companies, which directly affects global living standards (Valenduc, 2019; Bunn & Asen, 2020). The second channel of impact on a country’s financial stability is through the level of taxation. There is a consensus among scholars that globalisation promotes tax competition and reduces the tax burden (Ozili & Ioremberg, 2023; Malik et al., 2023). Pečiulis and Vasiliauskaitė (2024) emphasise the influence of the level of tax burden in line with a country’s economic development level. According to these authors, a high tax burden is justified when the country’s technological and labour efficiency levels are high, and it has a well-established tax culture. In countries with a higher level of economic development, a gradual increase in taxes positively affects GDP growth, while a decrease in the tax burden leads to a decrease in GDP. As a literature review shows, the impact of tax burdens and the methods of impact assessment need to be defined in the holistic way. The analysis of the relevant research papers shows that publications are dominated by a narrow and isolated assessment of the impact of tax burdens,

focusing only on specific channels (financial system soundness, economic indicators, stock market data, etc.). While the interaction between tax burden and a state's financial stability is undoubted at the theoretical level, an appropriate cross-cutting methodology must be used to measure this interaction correctly.

3. Theoretical Model and Hypothesis

3.1. Valuation Methods of Tax Burden and State Financial Stability

The assessment of state financial stability, as a complex social phenomenon, is a constant subject of discussion among scientists and practitioners. Based on the theoretical analysis of scientific sources described in the second section—public finance stability, financial system stability, and balanced economic growth are considered the main components affecting the financial stability of the Economic and Monetary Union. Due to the complexity of the phenomenon, the financial stability was evaluated by constructing the composite index, which includes all three mentioned components (i.e., sub-indexes) that have equal weight in the final value of the composite index.

Table 1. Structure of the composite index. (Source: compiled by author)

Sub-index	Indicator	Impact	Weight in sub-index
Public Finance Stability (Fedec, 2009)	Government bond yield	Negative	20%
	Central government debt/GDP	Negative	30%
	Central government interest expenditure/Central government revenue	Negative	30%
	Growth rate of GDP per capita	Positive	10%
	Reserves/Import	Positive	10%
Financial System Stability (Albulescu, 2012)	Stock market capitalisation/GDP	Positive	22%
	Loans to all sectors/GDP	Negative	
	Net interest margin	Negative	
	Bank concentration indicator (C5)	Positive	39%
	Annual inflation rate	Negative	
	Budget surplus or deficit/GDP	Positive	
	Current account surplus or deficit/GDP	Positive	
	Real effective exchange rate	Negative	22%
	Loans to private sector/Loans to all sectors	Positive	
	Loans to all sectors/Deposits	Negative	
Deposits/M2	Positive	17%	
Non-performing loans/Loans to all sectors	Negative		
Bank capital/Bank asset	Positive		

Continued

	Z-score	Positive	
	The difference between the inflation rate and the target value	Negative	30%
Economic Stability (Riley, 2014)	GDP growth rate difference from the target value	Negative	30%
	Unemployment	Negative	
	Current account surplus or deficit/GDP	Positive	20%
	State budget surplus or deficit	Positive	
	Fluctuation of government bonds interest rates	Negative	20%

The composite index structure was created by using theoretical insights of Fedec (2009) for Public Finance Stability sub-index, Albulescu (2012) for Financial System Stability sub-index and Riley (2014) for Economic Stability sub-index. In total, 25 indicators were assessed to evaluate the state financial stability of European Union member states comprehensively from 2005 to 2019.

Meanwhile, due to problematic nature of assessing the tax burden, as there is no one generally accepted way to evaluate it, two different methodologies of calculating the tax burden were selected—the ratio of tax revenue to GDP (Celikay, 2022; Vasileva, 2020; Paientko & Oparin, 2020) based on OECD (2019) tax type classification and a composite Tax burden index (Skaržauskas, 2021) based on corporate, labor and consumption tax groups.

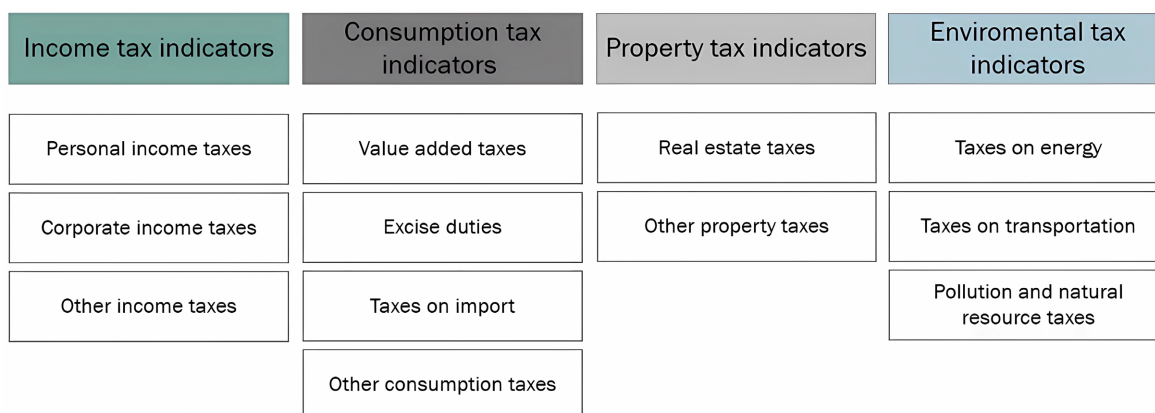


Figure 1. Tax burden evaluation using the ratio tax revenue to GDP. (Source: compiled by the author)

To evaluate the tax burden based on tax revenue to GDP ratio, four types of tax indicators were used: 1) income taxes, 2) consumption taxes, 3) property taxes, and 4) environmental taxes (see Figure 1). Each of these indicators has components calculated as the ratio of tax revenue collected to GDP. It should be noted that this method of calculation takes into account tax exemptions, standard and reduced tax rates, tax system progressivity, and other factors. The chosen evaluation methodology is multi-criteria and reflects the burden of different tax groups.

As a second method for calculating the tax burden, the construction of a

composite Tax Burden Index was chosen. Based on the previously discussed concept of the tax burden, the composite index was built from three main tax groups: business, employee, and consumption taxes (see **Figure 2**). Methods for calculating the sub-indices were selected after a comprehensive analysis of various composite indices, identifying their strengths and weaknesses. Business taxes were calculated using a combination of indicators proposed by **Keller and Schanz (2017)**, including tax rates (6 indicators), tax system structure (3 indicators), legal regulation (5 indicators), and tax administration (1 indicator). Employee taxes were calculated using the indicator set suggested by **Kotlan and Machova (2012)**, which includes the average net personal income and social security rates, a tax administration indicator, and the ratio of the highest tax rate to the average wage. Consumption taxes cover indicators such as the consumption tax rate, consumption tax base, and a tax administration indicator. This combination of indicators was chosen based on the consumption tax methodology proposed by **Bunn and Asen (2020)**.

Corporate taxes	Taxes on labor	Taxes on consumption
Tax rates (6)	Net personal average tax rate	Consumption tax rate
Tax system indicators (3)	Top personal tax rate threshold / average wage	Consumption tax base
Regulatory indicators (5)	Average rate of social security contribution	Tax administration
Tax administration	Tax administration	

Figure 2. Structure of composite tax burden index. (Source: compiled by the author, based on **Skaržauskas, 2021**)

3.2. Theoretical Model of Tax Burden Impact on Financial Stability

The interrelationship between the tax burden and the State's financial stability is a complex multidimensional phenomenon that can be assessed and analysed from different angles, manifest itself at different levels and create different economic effects. **Figure 3** introduces a theoretical model for assessing the impact of the tax burden on state financial stability from a holistic perspective.

The impact assessment was conducted using quantile regression models, as the EU countries differ significantly in terms of economic development, public finance stability, and financial system stability levels. Analysis based on quantile regression enables the identification of differences and comparison of impact strength according to tax burden level. The chosen methodology allows for the analysis of phenomena by considering different characteristics and their variations, rather than relying on linear, mean-based relationships between data points.

The decision to use the quantile regression analysis method in the empirical study is also based on methodological recommendations from **Čekanavičius and**

Murauskas (2014), as well as insights and experiences from other researchers who have applied quantile regression to measure interactions among the components of tax burden, fiscal policy, and financial stability in various national and European contexts (Staffa et al., 2019; Delgado et al., 2014; Casalone & Sonedda, 2013; Baer & Galvao, 2008; Blanco & Delgado, 2019).

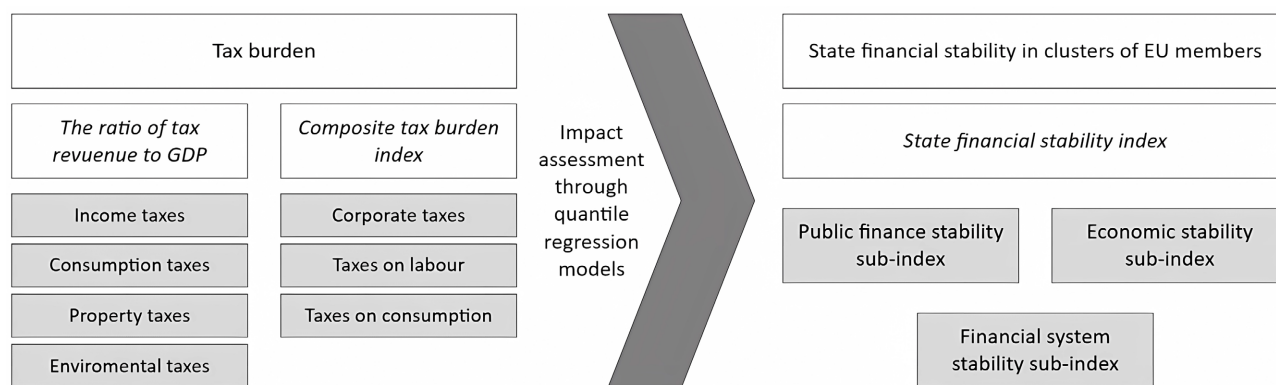


Figure 3. The model for assessing the impact of the tax burden on state financial stability. (Source: compiled by the author)

The empirical study's sample (28 countries over a 15-year period) does not provide sufficient cases to analyse the study object using time series or cross-section data-based models. Meanwhile, Hsiao (2014) suggested that panel data provide a larger dataset, increasing degrees of freedom and minimising collinearity among independent variables. Therefore, quantile regression analysis was conducted using panel data, ensuring a sufficient number of cases for analysis (420 cases) to meet the study's objectives.

To identify the interaction between tax burden level and state financial stability, it is necessary to group the analysed countries according to their tax burden level. For this purpose, a hierarchical clustering methodology was chosen, allowing countries to be grouped into clusters based on relative tax burden indicators and composite index values, which could then be categorised into high, medium, or low tax burden groups. Hierarchical cluster analysis enables data grouping and allows for the step-by-step merging (or separation) of the closest (or farthest) data points, followed by those that are increasingly distant (or closer). Applying this method makes the observations within a cluster, in a certain sense, interrelated (Eszergár-Kiss & Caesar, 2017). For this study, the widely used Ward's linkage method in scientific and practical research was applied:

$$d(X_i, X_j) = \frac{\|\bar{X}_i - \bar{X}_j\|^2}{\frac{1}{N_{X_i}} + \frac{1}{N_{X_j}}}$$

where:

\bar{X}_i and \bar{X}_j are the means of the vectors of the objects forming the clusters;
 N_{X_i} and N_{X_j} are the number of observations in the clusters.

Since the impact of the tax burden in this study is evaluated through indicators

of the three State financial stability components (see **Table 1**), the scientific literature review identified nine indicators for these indices (dependent variables) that may be statistically significantly influenced by the tax burden (see **Table 2**).

Table 2. Regression models for the indicators of State financial stability index. (Source: compiled by author)

Dependent variables	Regression equation	Source
Budget surplus or deficit/GDP	$BSD_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 POP_{it} + \beta_3 UR_{it} + \beta_4 GBY_{it} + \beta_5 GDP_{it} + \beta_6 PD_{it} + \varepsilon_{it}$	Tevdovski, Jolakoski, & Stojkoski (2021)
GDP growth rate difference from the target value	$GDPTR_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 CF_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 INF_{it} + \varepsilon_{it}$	Enu, Attah-Obeng, & Opoku (2020)
Current account surplus or deficit/GDP	$CASD_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 CF_{it} + \beta_3 IEG_{it} + \beta_4 FDI_{it} + \beta_5 RES_{it} + \beta_6 GDP_{it} + \varepsilon_{it}$	Benhima & Havrylychuk (2006)
Fluctuation of government bonds interest rates	$FGB_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 BSD_{it} + \beta_3 GE_{it} + \beta_4 PD_{it} + \beta_5 INF_{it} + \beta_6 GDPT_{it} + \varepsilon_{it}$	Ribeiro, Cermeno, & Curto (2017)
Growth rate of GDP per capita	$GDP_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 CF_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 INF_{it} + \varepsilon_{it}$	Enu, Attah-Obeng, & Opoku (2020)
Government bond yield	$GBY_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 GE_{it} + \beta_3 PD_{it} + \beta_4 INF_{it} + \beta_5 GDPT_{it} + \beta_6 OP_{it} + \beta_7 PDE_{it} + \varepsilon_{it}$	Gale & Orszag (2004)
Central government debt/GDP	$PD_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 PV_{it} + \beta_3 GDPT_{it} + \beta_4 INF_{it} + \beta_5 FDI_{it} + \beta_6 IEG_{it} + \beta_7 CF_{it} + \beta_8 GBY_{it} + \beta_9 POP_{it} + \beta_{10} UR_{it} + \varepsilon_{it}$	Swamy (2015)
Non-performing loans/Loans to all sectors	$NP_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 PD_{it} + \beta_3 GDP_{it} + \beta_4 INF_{it} + \beta_5 UR_{it} + \beta_6 CAR_{it} + \beta_7 LD_{it} + \beta_8 ROE_{it} + \beta_9 ROA_{it} + \varepsilon_{it}$	Makri, Tsagkanos, & Bellas (2014)
Loans to private sector/GDP	$LPG_{it} = \beta_0 + \beta_1 TB_{it} + \beta_2 GDP_{it} + \beta_3 BIC_{it} + \beta_4 INF_{it} + \varepsilon_{it}$	Branch, Cooper, & Moxey (2016)

where:

TB_{it} —tax burden indicator (ratio or index)

POP_{it} —annual population change,

UR_{it} —unemployment rate,

INF_{it} —inflation rate (consumer price index),

CF_{it} —capital formation value to GDP,

FDI_{it} —change of foreign direct investment,

CAR_{it} —capital adequacy ratio,

ROA_{it} —banking sector return on assets,

ROE_{it} —banking sector return on equity,

BIC_{it} —base interest rate of the central bank,

RES_{it} —state reserves to GDP,

GE_{it} —budget expenditures to GDP,

$GDPT_{it}$ —GDP growth rate,

OP_{it} —Brent oil price,

PDE_{it} —public defense expenditure to GDP,

PV_{it} —private consumption to GDP,

LD_{it} —loan to deposit ratio,

IEG_{it} —imports and exports to GDP.

Quantile regression models, assessing the tax burden using tax revenue to GDP

ratio and composite index values, are constructed for three quantiles: the lowest 25% of values (0.25), the median of the sample (0.5), and the top 25% of values (0.75). Since the values of both dependent and independent variables in the quantile regression models will be normalised, the coefficients (Beta (β) coefficient) associated with the tax burden independent variables are used as measures of the impact of tax burden changes on the analysed indicators. This method of analysis makes it possible to assess the influence of the tax burden evaluation method, as well as the direction and strength of the tax burden's impact on state financial stability within the tax burden country groups formed during cluster analysis.

Data for tax burden indicators were calculated using tax revenues and GDP ratio, composite tax burden index, and quantile regression models, which were obtained from publicly available databases of the World Bank and Eurostat. Descriptive statistics of the variables used in regression models are provided in Annex 6.

3.3. Research Hypotheses

Based on the theoretical insights compiled in the second section of the article, five research hypotheses were formed in order to comprehensively assess the impact of the tax burden on the financial stability of the State:

- **H1:** The tax burden statistically significantly impacts the State's financial stability.
- **H2:** The direction of the impact of the tax burden on the State's financial stability is dependent on the level of the tax burden.
- **H3:** The direction of the impact of the tax burden on the State's financial stability does not depend on the level of tax burden.
- **H4:** The strength of the impact of the tax burden on the State's financial stability is dependent on the level of the tax burden.
- **H5:** The strength of the impact of the tax burden on a State's financial stability does not depend on the level of tax burden.

For each hypothesis formulated, the following verification procedures are established. Quantile regression models of panel data will be used to confirm or reject the H1 hypothesis to compile indicators of the State's financial stability indices based on an analysis of the scientific literature. Hypothesis H1 will be confirmed if statistically significant quantile regression models are developed to include the Tax burden as an independent variable. To confirm or reject the hypotheses of H2, H3, H4 and H5, an analysis of quantile regression will be carried out, with the help of which the effect of the Tax burden on the components of the State's financial stability in the three quantiles will be determined. Assigning the Beta coefficients of quantile regression models to the analysed will assess the impact of the Tax burden on the financial stability of each analysed country. Hypothesis H2 is considered to be confirmed, and hypothesis H3 will be rejected if the direction of the impact of the Tax burden on the State's financial stability differentiates between the different clusters by assessing the tax burden using two different assessment methods. Accordingly, hypothesis H2 will be rejected, and

hypothesis H3 will be confirmed if it is found that the direction of the impact of the Tax burden on the State's financial stability will not differentiate between different clusters or contradictory results are obtained in assessing the tax burden using different methods. Hypothesis H4 is considered to be confirmed, and hypothesis H5 will be rejected if the strength of the impact of the Tax burden on the State's financial stability differentiates between the different clusters of the Tax burden by assessing the tax burden using different assessment methods. Accordingly, hypothesis H4 will be rejected, and hypothesis H5 will be confirmed if it is found that the strength of the impact of the Tax burden on the State's financial stability is not differentiated.

4. Clustering the EU Countries by Tax Burden Level

One of the EU's objectives is to develop a tax policy that ensures economic prosperity and financial stability for all the community's inhabitants. This circumstance leads to the fact that to monitor the impact of the tax burden on the State's financial stability, it is appropriate to choose 28 countries that were EU members during the analysis period. Such a sample of the study allows the use of economic and financial indicators, the calculation methodologies of which are standardised at the EU level, which makes it possible to ensure the objectivity and comparability of the research data. When analysing the dynamics of the tax burden in the EU, it is concluded that the tax systems of all the countries concerned changed during the analysis period 2005-2019. In some, the tax system reforms fundamentally changed the tax environment. As mentioned in the previous sections, the tax burden calculations are often based on the ratio of tax revenues to GDP. In this work, the translation of the tax burden is carried out not only by the ratio mentioned above but also by a composite index, so it makes sense to review the dynamics of the meanings of different methods of assessing the tax burden in the analysed period. The tax burden, measured tax revenue and GDP ratio, is divided into four types of EU tax classification at work according to the EU tax classification: income taxes, consumption taxes, property taxes and environmental taxes. The dynamics of the values of which are presented in **Figure 4**, together with the dynamics of the values of the composite Tax burden index.

The tax burden level developed moderately in all countries during the analysis period. It remained at a similar level when comparing values at the beginning of the period (28.7%) and at the end (29.1%). The growth of the tax burden on income (growth of 2.2%), consumption (0.6%) and wealth (10.9%) was mitigated by a decrease in the tax burden arising from environmental taxes (-4%). Meanwhile, the tax burden, measured by the values of the Tax burden index, grew stronger during the analysed period (from 0.55 in 2005 to 0.59 in 2019) than the tax burden measured by the indicator of tax revenue to GDP (see **Figure 4**).

The clusters were divided into three groups (high tax burden level, medium tax burden level and low tax burden level) according to the level of tax burden (see **Table 3**).

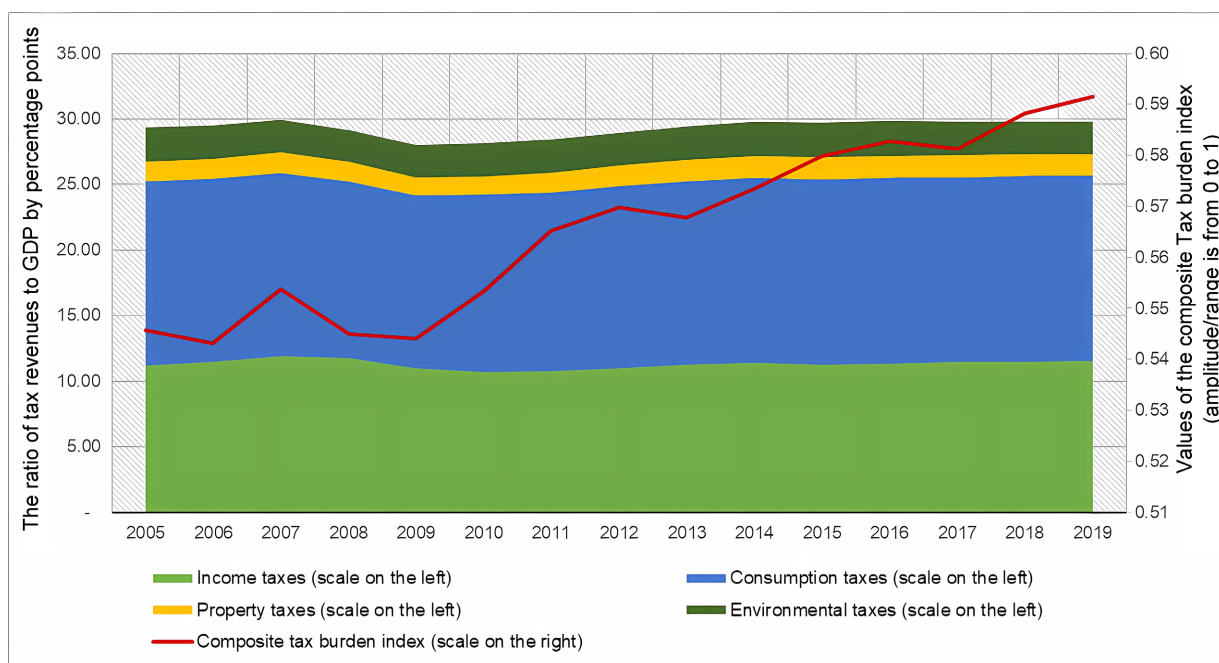


Figure 4. Dynamics of the components of the ratio of tax revenues to GDP of the tax burden and the values of the composite Tax burden index in EU countries. (Source: compiled by the author based on data from Eurostat)

Table 3. Groups of countries according to tax burden level. (Source: compiled by author)

Groups according to tax level	Clusters
High	High values of indicator of tax revenue to GDP and high values of Tax burden index (HTB-HTI)
Medium	Low values of indicator of tax revenue to GDP and high values of Tax burden index (LTB-HTI)
Medium	High values of indicator of tax revenue to GDP and low values of Tax burden index (HTB-LTI)
Low	Low values of indicator of tax revenue to GDP and low values of Tax burden index (LTB-LTI)

The two clusters (LTB-HTI and HTB-LTI) are the average tax burden group, while HTB-HTI and LTB-LTI are classified as high and low, respectively. **Figure 5** shows the graphical result of the clustering process, which illustrates that clusters based contain respectively: HTB-HTI—5 states, LTB-LTI—11 states, HTB-LTI—9 states and LTB-HTI—3 states (see Annex 1). It should be noted that the HTB-HTI cluster includes the old Member States (which joined the EU before 2004), while the cluster of LTB-LTI mainly includes the new Member States (having joined the EU since 2004), so it could be argued that the old Member States have a higher tax burden than the new Member States.

5. Assessing the Impact of Tax Burden on Financial Stability: Cluster-Based Insights from EU Member States (2005-2019)

In order to empirically assess the impact of the tax burden on financial stability, a study consisted of several stages. To assess states' financial stability, the Financial Stability Index was used, the construction of which is based on the author's

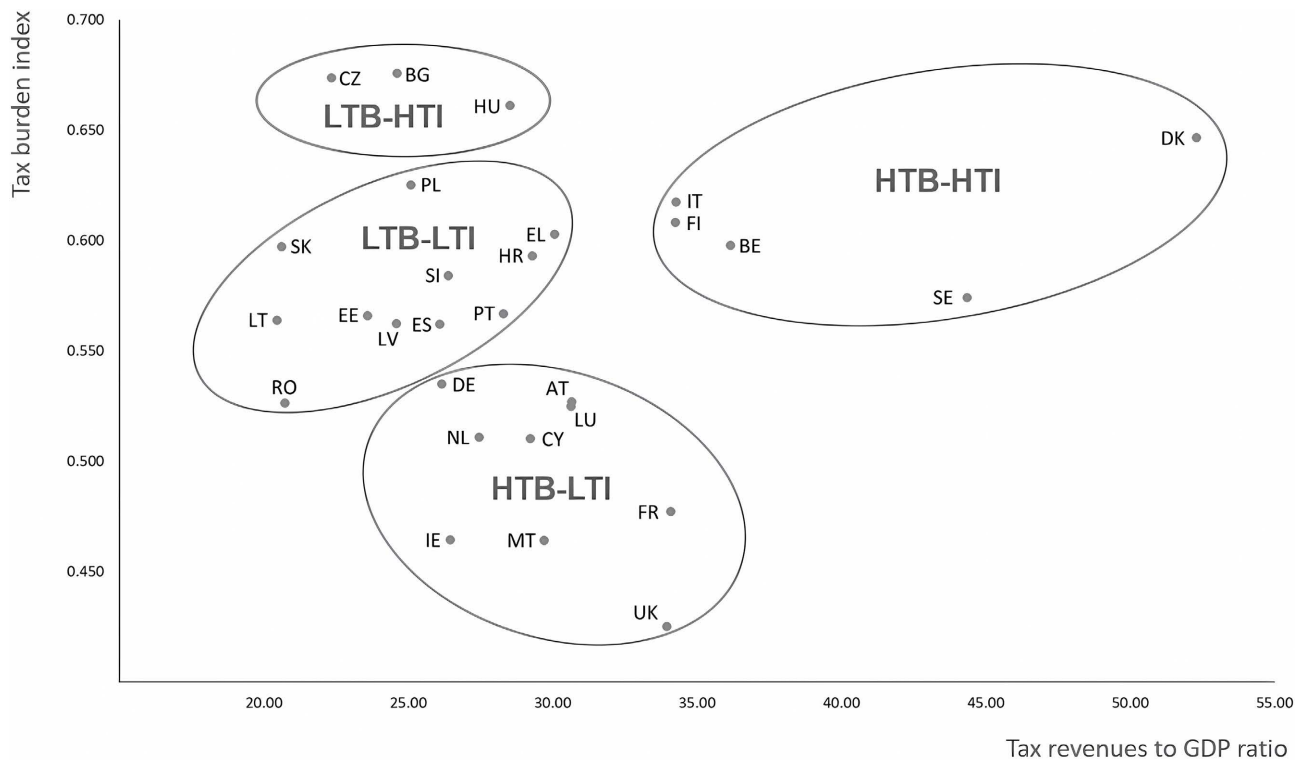


Figure 5. Visualisation of clusters according to tax burden level. (Source: compiled by the author based on data from Eurostat and World Bank)

previous works (Skaržauskas, 2021). The Financial Stability Index consists of three sub-indices: the Public Finance Stability, Financial Systems and Economic Stability Indices. As mentioned before, the tax burden in this work was calculated in two ways. First, the traditional tax burden assessment method was used, i.e., the ratio of tax revenues to GDP. The second method of calculating the tax burden, constructing a composite Tax burden index based on sub-indices, was chosen. Based on EU countries clustering results, a comparative analysis of the tax burden and the dynamics of financial stability was carried out in the distinguished groups of states. The theoretical model of the impact of the tax burden on financial stability was tested using the method of quantile regression analysis. The study also uses descriptive statistical methods (average, standard deviation, dispersion). Quantile regression is an alternative to linear regression, which is used when simple assumptions of linear regression are not satisfied: data has exceptions, the assumption of normality is violated, or variables have non-linear dependencies. The quantile regression method provides an opportunity to study not only the average variation in characteristics but also to analyse extreme cases (e.g. the consequences of the strongest and weakest effects) (Zhang et al., 2024). The advantage of the quantile regression methodology is that it allows for understanding relationships between variables outside of the conditional mean of the response; it helps understand an outcome at its various quantiles and compares groups or levels of exposure on those quantiles (Park et al., 2023). Regression models were constructed for assessment using three quantiles (0.25, 0.5, 0.75). Since in quantile

regression models, the values of both dependent and independent variables are normalised, the coefficients (Beta (β) coefficient) of the independent variables are used to measure the impact of the tax burden on analysed indicators. This analysis method made it possible to assess the influence direction and strength of the impact of the tax burden on financial stability. The regression equations for the Public finance, Financial system and Economic stability indices allowed us to estimate the overall impact of changes in the Tax burden on the State's financial stability. For this purpose, countries were divided into three quartiles according to the average value of each indicator over the period analysed. Depending on which quartile a country belongs to, the Beta coefficient (the value of the tax burden effect) of the same quartile is assigned. The Beta coefficient is then weighted by the indicator's weight in the Public finance, Financial system and Economic stability indices and by the weight of these indices in the State's Financial Stability index (the results obtained for each country analysed are presented in Annex 2). The impact of the tax burden in each group is determined by calculating the average of the weighted Beta coefficients in the tax burden group. **Table 4** shows the changes in the subindices of the State's financial stability index (Public finance, Financial system and Economic stability indices) in the tax burden groups

Table 4. The impact of Tax burden change on State's financial stability subindices. (Source: compiled by author)

Subindices	EU countries groups	Clusters	Indicator of tax revenue to GDP			Tax burden index		
			Number of countries		Average impact indicator (Beta)	Number of countries		Average impact indicator (Beta)
			Positive impact	Negative impact		Positive impact	Negative impact	
Public Finance Stability Index	High tax burden level	HTB-HTI	3	2	-0.002	5	0	0.032
	Medium tax burden level	LTB-HTI	10	2	0.008	12	0	0.030
		HTB-LTI						
	Low tax burden level	LTB-LTI	8	3	-0.001	11	0	0.021
		Total:	21	7	0.0025	28	0	0.0275
Financial system stability index	High tax burden level	HTB-HTI	0	5	-0.010	5	0	0.027
	Medium tax burden level	LTB-HTI	0	12	-0.010	12	0	0.025
		HTB-LTI						
	Low tax burden level	LTB-LTI	0	11	-0.010	11	0	0.024
		Total:	0	28	-0.010	28	0	0.025
Economic stability index	High tax burden level	HTB-HTI	5	0	0.017	5	0	0.010
	Medium tax burden level	LTB-HTI	3	0	0.017	3	0	0.011
		HTB-LTI						
	Low tax burden level	LTB-LTI	11	0	0.014	11	0	0.010
		Total:	19	0	0.016	19	0	0.011

for the Indicator of tax revenue to GDP and the Tax burden index after an increase in the tax burden index by 0.01 normalised (or 0.374% of the ratio of tax revenue to GDP throughout analysis). Descriptive data on regression models of indicators of Public Finance Stability Index, Financial system stability index and Economic stability index are provided in Annex 3, Annex 4 and Annex 5 respectively.

The average impact indicator shows that an increase in the tax burden, measured as tax revenue to GDP indicator, would have a negative impact on Public finance stability (PFS) index in two tax burden groups, except for the group of medium tax burden countries, which has the weakest impact among the tax burden groups analysed. In contrast, the tax burden as measured by the Tax burden index values in all tax burden groups recorded negative impact indicator values.

The negative impact was due to a strong inverse relationship between the values of the central government debt indicator, which has the highest weight in the PFS index, and the values of the tax burden ratio indicator and the index, as the other components of the PFS index recorded a positive correlation. The most substantial effect of the tax burden was found in the high tax burden group for the tax revenue to GDP indicator and in the low tax burden group for the Tax burden index.

Meanwhile, the impact of the tax burden on the Financial system stability index (FSS) has been measured in different ways. For example, a negative impact is captured by tax revenue to GDP indicator, while the Tax burden index value captures a positive impact (see **Table 4**). The negative impact of the tax burden measured as the tax revenue to GDP indicator was most pronounced for non-performing loans and loans to the private sector as a percentage of GDP, with negative beta coefficients in all quantiles. The positive impact on the tax burden measured by the index values is because the Beta coefficients were positive in all quantiles and for all indicators for which statistically significant regression models were constructed. The effect of the tax burden was similar in all tax burden groups measured in terms of the tax revenue to GDP indicator but slightly higher in the high tax burden group measured in terms of the index values. The study's results (see **Table 4**) also show that the Economic stability index indicators would be positively affected by an increase in the tax burden in all tax burden groups, both in terms of the tax revenue to GDP indicator and the index values. It can be noted that the Beta coefficients for all indicators for which statistically significant regression models were constructed were positive (implying a positive effect on the indicator when the tax burden increases). The results also suggest that the tax burden has the weakest impact on economic stability in the low-tax burden countries, as this group had the lowest average impact on the index.

According to the generalised empirical results, an increase in the tax burden increased the State's financial stability in all tax burden groups, measured in terms of the Tax burden index and the medium burden group regarding the tax revenue to GDP indicator (see **Table 5**).

It can also be noted that the most substantial effect of the tax revenue to GDP indicator was found in the group of medium tax burden countries (0.008 effect as

the average of the Beta coefficients in the tax burden group). In contrast, weaker but similar effects were found in the high- and low-tax burden countries (-0.002 and -0.001, respectively). When the tax burden is measured in terms of Tax burden index values, similar impact indicators are found in the high and medium tax burden groups (0.032 and 0.03, respectively). However, a lower value of the impact indicator is recorded in the low tax burden group. The study's results, taken together, allowed us to confirm and reject the paper's hypotheses. The empirical test's results led to the confirmation of 2 and the rejection of 3 hypotheses of the study, based on the reasoning presented in **Table 6**.

Table 5. Generalisation of quantile regression results. (Source: compiled by author)

EU countries groups	Clusters	Indicator of tax revenue to GDP			Tax burden index		
		Number of countries		Average impact indicator (Beta)	Number of countries		Average impact indicator (Beta)
		Positive impact	Negative impact		Positive impact	Negative impact	
High tax burden level	HTB-HTI	3	2	-0.002	5	0	0.032
Medium tax burden level	LTB-HTI	10	2	0.008	12	0	0.030
	HTB-LTI						
Low tax burden level	LTB-LTI	8	3	-0.001	11	0	0.021
	Total:	21	7	0.0025	28	0	0.0275

Table 6. Hypothesis testing. (Source: compiled by author)

Tested hypothesis	Result	Argumentation
H1 The tax burden statistically significantly impacts the State's financial stability.	Accepted	Measuring the tax burden in terms of the tax revenue to GDP indicator and the Tax burden index values, statistically significant regression models were constructed between the State's financial stability variables and the tax burden values, thus confirming the hypothesis.
H2 The direction of the impact of the tax burden on the State's financial stability is dependent on the level of the tax burden.	Rejected	When measuring tax burdens regarding the tax revenue to GDP indicator, the direction of the tax burden effect (negative/positive) varied across tax burden groups. In contrast, the direction of the tax burden effect, as measured by the index values, was positive in all tax burden groups.
H3 The direction of the impact of the tax burden on the State's financial stability does not	Rejected	Due to the contradictory results obtained using different methods of calculating the tax burden, H2 and H3 were rejected.
H4 The strength of the impact of the tax burden on the State's financial stability is dependent on the level of the tax burden.	Rejected	Measuring tax burden in terms of the tax revenue to GDP indicator, the strength of the tax burden effect varied between the different tax burden groups, with a stronger relationship in the medium tax burden group and a weaker one in the high and low tax burden groups. In terms of the Tax burden index, the high and medium tax burden groups recorded a higher strength of effect than the low tax burden group.
H5 The strength of the impact of the tax burden on a State's financial stability does not	Accepted	As the strength of the effect of the different methods of measuring tax burden differed between tax burden groups, hypothesis H4 was confirmed, and hypothesis H5 was rejected.

6. Conclusion

Testing the theoretical model in 28 European countries has led to mixed conclusions regarding tax burden measurement's specificities. Taken together, the results of the empirical study suggest that different methods of measuring the tax burden yielded different results on the impact of the tax burden on the State's financial stability for different clusters of EU countries with different tax burdens. Thus, the study's results confirmed the theoretical assumptions about the complex links between tax burden and financial stability. The impact of tax burden growth on a state's financial stability was calculated by assessing the impact of the tax burden on the separate subindices of the State's financial stability index. According to the empirical results, an increase in the tax burden increased the financial stability in all tax burden groups, as measured by the Tax burden index. Similar impact indicators were found in the high and medium tax burden groups (0.032 and 0.03, respectively), but a lower impact indicator value was recorded in the low tax burden group (0.021). Regarding tax revenue to GDP indicator, only the medium tax burden group positively impacted the State's financial stability. In contrast, the high and low tax burden groups recorded a negative impact. It can also be noted that the most substantial impact of tax burden measured as tax revenue to GDP indicator was found in the medium tax burden group (0.008). In contrast, weaker but similar impacts were found in the high and low tax burden groups (-0.002 and -0.001 , respectively).

The analysis of the academic literature and the examples of different countries show that the tax burden is closely linked to both the stability of the real economy and the stability of public finances and that this link is complex, heterogeneous and needs to be assessed on a case-by-case basis. It must be acknowledged that these areas interact and are inextricably linked, even if there is no consensus on the reasons for these links. The results of this study complement other studies by confirming the existence of an interaction phenomenon between tax burden and State's financial stability in a large sample of countries in a global environment. The study's results contribute to the academic literature by shedding light on the circumstances and indicators under which this interaction is more pronounced.

The study's results, which cover a large sample of countries over a long period, show that an increase in the tax burden has an impact of varying magnitude on a country's public financial stability across different tax-burden countries. Although the direction of the tax burden effect was statistically significant, the results obtained using different tax burden estimation methods were mixed. Therefore, a deeper investigation of the impact pathway across countries with different levels of tax burden could be the subject of further research. The tax burden should be modelled according to a country's specific tax and financial situation. The model's properties suggest that differences in the level of the tax burden associated with the characteristics of countries' fiscal systems can significantly impact a country's financial stability.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Annexes

Annex 1. Country clusters according to the values of tax revenue to GDP indicator and tax burden index. (Source: compiled by author based on data from Eurostat and World Bank)

EU countries	Financial stability index <i>(average value for the period 2005-2019)</i>	Tax revenue to GDP indicator <i>(average value for the period 2005-2019)</i>	Tax burden index <i>(average value for the period 2005-2019)</i>	GDP per capita <i>(average value for the period 2005-2019)</i>	Clusters
Belgium	0.659	36.18	0.598		
Denmark	0.726	52.32	0.647		
Italy	0.612	34.29	0.617	36,565	HTB-HTI
Finland	0.702	34.27	0.608		
Sweden	0.718	44.36	0.574		
Bulgaria	0.686	24.64	0.676		
Czech Republic	0.707	22.36	0.673	10,787	LTB-HTI
Hungary	0.627	28.54	0.661		
Germany	0.702	26.18	0.535		
Ireland	0.640	26.47	0.464		
France	0.678	34.11	0.477		
Cyprus	0.631	29.25	0.510		
Luxemburg	0.770	30.64	0.525	37,824	HTB-LTI
Malta	0.665	29.72	0.464		
Netherlands	0.722	27.47	0.511		
Austria	0.687	30.68	0.527		
United Kingdom	0.679	33.98	0.425		
Estonia	0.699	23.60	0.566		
Greece	0.516	30.09	0.603		
Spain	0.655	26.11	0.562		
Croatia	0.661	29.32	0.593		
Latvia	0.654	24.61	0.562		
Lithuania	0.669	20.46	0.564	13,899	LTB-LTI
Poland	0.668	25.10	0.625		
Portugal	0.610	28.32	0.567		
Romania	0.661	20.75	0.526		
Slovenia	0.670	26.40	0.584		
Slovakia	0.669	20.62	0.597		

Annex 2. The impact of tax burden on State's financial stability. Results of quantile regression. (Source: compiled by author)

EU countries	Tax burden impact (Tax revenue to GDP indicator)	Tax burden impact (Tax burden index)	Clusters	Groups according to tax burden level
Belgium	-0.035	0.030		
Denmark	0.012	0.032		
Italy	-0.023	0.020	HTB-HTI	High
Finland	0.020	0.035		
Sweden	0.017	0.043		
Bulgaria	0.026	0.054		
Czech Republic	0.018	0.033	LTB-HTI	
Hungary	0.025	0.011		
Germany	0.016	0.021		
Ireland	0.023	0.029		
France	-0.034	0.037		Medium
Cyprus	-0.040	0.024		
Luxemburg	0.020	0.042	HTB-LTI	
Malta	0.017	0.026		
Netherlands	0.005	0.021		
Austria	0.007	0.019		
United Kingdom	0.011	0.039		
Estonia	0.032	0.045		
Greece	-0.030	0.021		
Spain	-0.035	0.030		
Croatia	0.004	0.006		
Latvia	0.009	0.028		
Lithuania	0.012	0.019	LTB-LTI	Low
Poland	0.012	0.019		
Portugal	-0.043	0.016		
Romania	0.029	0.040		
Slovenia	0.000	0.008		
Slovakia	0.004	0.022		

Annex 3. Data of regression models of indicators of Public Finance Stability Index.

Assessment method of tax burden	Dependent variable	The quantile of the dependent variable	Beta (β) coefficient of the tax burden	Standard error	T-ratio	P-value
Tax revenue to GDP indicator	Growth rate of GDP per capita	0.25	0.3307000	0.0415140	5.172	0.000000
		0.5	0.3609860	0.0267436	13.500	0.000000
		0.75	0.3733350	0.0615493	6.066	0.000000
	Government bond yield	0.25	0.1405860	0.0244981	5.739	0.000000
		0.5	0.1143910	0.0252731	4.526	0.000007
		0.75	0.0677902	0.0327821	2.068	0.039300
	Central government debt/GDP	0.25	-0.5990530	0.0495415	-12.092	0.000000
		0.5	-0.1478340	0.0451562	-3.274	0.001100
		0.75	-	-	-	-
Tax burden index	Growth rate of GDP per capita	0.25	-0.4372010	0.0719460	-6.077	0.000000
		0.5	-0.4971100	0.0928708	-14.010	0.000000
		0.75	-0.8102620	0.0940974	-8.611	0.000000
	Government bond yield	0.25	-	-	-	-
		0.5	0.1519610	0.0749288	2.028	0.043200
		0.75	-	-	-	-
	Central government debt/GDP	0.25	-	-	-	-
		0.5	-	-	-	-
		0.75	0.2208990	0.0858356	2.574	0.010400

Annex 4. Data of regression models of indicators of Financial system stability index.

Assessment method of tax burden	Dependent variable	The quantile of the dependent variable	Beta (β) coefficient of the tax burden	Standard error	T-ratio	P-value
Tax revenue to GDP indicator	Budget surplus or deficit/GDP	0.25	0.0880047	0.0201567	4.366	0.000016
		0.5	0.0838195	0.0139896	5.992	0.000000
		0.75	0.1436070	0.0189152	7.592	0.000000
	Non-performing loans/Loans to all sectors	0.25	-0.0705481	0.0202435	-3.485	0.005000
		0.5	-0.0677010	0.0231363	-2.926	0.003600
		0.75	-0.1443620	0.0357825	-4.034	0.000065
	Loans to private sector/GDP	0.25	-0.5843310	0.0630363	-9.270	0.000000
		0.5	-0.5497210	0.0210065	-26.170	0.000000
		0.75	-0.4952620	0.0292844	-16.910	0.000000

Continued

		0.25	0.2024640	0.0389982	5.192	0.000000
	Budget surplus or deficit/GDP	0.5	0.1670750	0.0401458	4.162	0.000038
		0.75	0.1994910	0.0688349	2.898	0.004000
	Non-performing	0.25	0.0925504	0.0238015	3.888	0.000100
Tax burden index	loans/Loans to all sectors	0.5	–	–	–	–
		0.75	0.2162460	0.0685694	3.154	0.010100
	Loans to private sector/GDP	0.25	1.2854100	0.1614340	7.962	0.000000
		0.5	1.1063000	0.0803537	13.768	0.000000
		0.75	0.8314610	0.0919525	9.042	0.000000

Annex 5. Data of regression models of indicators of Economic stability index.

Assessment method of tax burden	Dependent variable	The quantile of the dependent variable	Beta (β) coefficient of the tax burden	Standard error	T-ratio	P-value
		0.25	0.0880047	0.0201567	4.366	0.000016
	Budget surplus or deficit/GDP	0.5	0.0838195	0.0139896	5.992	0.000000
		0.75	0.1436070	0.0189152	7.592	0.000000
	GDP growth rate difference from the target value	0.25	0.1964170	0.0363217	5.408	0.000001
		0.5	0.0788603	0.0301303	2.617	0.009200
Tax revenue to GDP indicator		0.75	–	–	–	–
	Current account surplus or deficit/GDP	0.25	0.2069630	0.0667848	3.099	0.002100
		0.5	0.1490740	0.0315256	4.729	0.000003
		0.75	–	–	–	–
	Fluctuation of government bonds interest rates	0.25	0.0475595	0.0188135	2.528	0.011800
		0.5	0.0274033	0.0135208	2.027	0.043300
		0.75	0.0180160	0.0052468	3.434	0.000700
		0.25	0.2024640	0.0389982	5.192	0.000000
	Budget surplus or deficit/GDP	0.5	0.1670750	0.0401458	4.162	0.000038
		0.75	0.1994910	0.0688349	2.898	0.004000
	Current account surplus or deficit/GDP	0.25	0.7121850	0.1104180	6.450	0.000000
Tax burden index		0.5	0.5753030	0.1050470	5.477	0.000000
		0.75	0.3428400	0.1190630	2.880	0.004200
	Fluctuation of government bonds interest rates	0.25	–0.1641030	0.0542934	6.790	0.000000
		0.5	–0.0694629	0.0302960	–2.293	0.000048
		0.75	–0.0353704	0.0142248	–2.487	0.013300

Annex 6. Descriptive statistics of the variables used in regression models.

Variable	Mean	Median	Standard deviation	Min	Max
Tax burden (tax revenue to GDP ratio)	29.30	28.30	7.06	18.00	55.20
Tax burden (tax burden index)	0.57	0.57	0.07	0.37	0.74
Budget surplus or deficit/GDP	-2.48	-2.20	3.68	-32.10	5.30
GDP growth rate difference from the target value	2.45	1.66	2.60	0.01	17.80
Current account surplus or deficit/GDP	-0.63	-0.21	5.64	-25.80	10.80
Fluctuation of government bonds interest rates	0.39	0.28	0.39	0.06	4.93
Growth rate of GDP per capita	1.92	1.90	3.81	-14.60	23.50
Government bond yield	3.43	3.42	2.52	-0.36	22.50
Central government debt/GDP	61.30	54.70	35.60	3.80	186.00
Non-performing loans/Loans to all sectors	6.39	3.80	7.48	0.08	47.70
Loans to private sector/GDP	90.40	84.30	45.00	20.10	255.00
Annual population change	0.26	0.27	0.84	-2.26	3.93
Unemployment rate	8.68	7.65	4.36	2.00	27.70
Inflation rate	2.04	1.80	1.97	-2.60	14.00
Capital formation value to GDP	22.60	22.30	4.76	11.90	46.00
Foreign direct investment to GDP	13.50	3.15	43.50	-58.30	449.00
Capital adequacy ratio	16.20	15.90	4.19	7.34	35.70
Imports and exports to GDP	123.00	105.00	67.90	45.40	408.00
Banking sector return on assets	0.47	0.63	1.30	-10.50	4.24
Banking sector return on equity	5.99	8.69	15.40	-118.00	38.50
Base interest rate of the central bank	1.28	0.50	2.16	-0.50	12.50
State reserves to GDP	2.26	1.55	2.14	0.01	9.88
Budget expenditures to GDP	19.80	19.50	2.92	11.90	27.90
GDP growth rate	2.10	2.31	3.50	-14.80	12.00
Brent oil price	73.30	66.20	23.60	37.30	111.00
Public defense expenditure to GDP	1.37	1.33	0.53	0.28	3.22
Private consumption to GDP	75.00	76.20	8.54	41.10	92.50
Loan to deposit ratio	122.00	114.00	55.90	17.80	367.00