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# MEASURING FISCAL SUSTAINABILITY IN THE EU: A SYNTHETIC AND COMPARATIVE ASSESSMENT (2014, 2017, 2020, 2023)[1]

PAWEŁ KONOPKA
corresponding author
Department of Economy and Finance, Department of Quantitative Methods, University of Bialystok
p.konopka@uwb.edu.pl
ORCID: 0000-0003-3822-5267

PATRYCJA ŁAPIŃSKA
Department of Economy and Finance, Department of Political Economy, University of Bialystok
p.lapisnka@uwb.edu.pl
ORCID: 0000-0002-8539-8403

## Abstract

**Motivation:** Fiscal sustainability constitutes a fundamental prerequisite for the long-term stability of public finances and the resilience of economies to external disturbances. Successive global and regional crises, including the global financial crisis, the sovereign debt crisis, the COVID-19 pandemic, as well as the energy and security shocks related to geopolitical developments, have exposed the vulnerability of fiscal systems within the European Union (EU). States characterized by a higher degree of fiscal sustainability were able to mitigate the adverse macroeconomic and social effects of such crises more effectively, whereas fiscally

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weaker economies experienced prolonged instability and higher adjustment costs. Consequently, the assessment of fiscal sustainability acquires not only theoretical but also practical significance for shaping fiscal governance. While the subject has been widely discussed in the literature, existing studies frequently focus on single indicators or limited periods, which underscores the need for multidimensional and comparative analyses conducted within a longer time horizon.
**Aim:** The principal objective of this article is to identify the key determinants of fiscal sustainability and to evaluate its level across EU Member States in 2014, 2017, 2020, and 2023. By applying an integrated, synthetic measure, the study addresses the identified research gap, offering a comprehensive and temporally consistent framework for the comparative assessment of fiscal sustainability among EU economies.
**Results:** The Synthetic Measure of Fiscal Sustainability (SMFS) was constructed by employing the modified Hellwig method with Mahalanobis distance. The analysis incorporated five diagnostic variables: the public debt-to-GDP ratio, the budget balance-to-GDP ratio, the GDP growth rate, the current account balance, and EMU bond yields. Empirical data were derived from Eurostat. Hierarchical cluster analysis was subsequently applied to classify Member States into homogeneous groups according to their fiscal sustainability levels. The results indicate that Germany maintained the highest level of fiscal sustainability throughout the examined period, followed by the Netherlands and Malta. In contrast, Greece recorded the lowest SMFS values in 2014 and 2017, France in 2020, and Ireland in 2023. Overall, five distinct clusters of countries were identified, ranging from low to high sustainability. The findings demonstrate significant heterogeneity within the EU and underscore the necessity of designing fiscal frameworks that are both country-specific and consistent with the requirements of supranational fiscal governance.

**Keywords:** fiscal sustainability, multidimensionality, Hellwig method, Mahalanobis distance, hierarchical cluster analysis
**JEL:** E62, H50

## 1. Introduction

Successive economic downturns have directed economists' attention to the issue of fiscal sustainability. Countries characterized by high fiscal sustainability were more resilient to shocks and neutralized their adverse effects on the functioning of the economy more efficiently. In an era of overlapping economic and non-economic crises and the need to deal with their compounded effects, achieving and maintaining fiscal sustainability poses a major challenge. Therefore, it is crucial that the determinants of fiscal sustainability are identified.

In order to adopt the right fiscal policy strategy, it is also necessary to analyze the historical data and determine the current level of fiscal sustainability. Such considerations should serve as a prelude to assessing the legitimacy of the fiscal rules in place, the effectiveness of the policies implemented so far and the introduction of potential modifications.

## 2. Literature review

The sustained fiscal unsustainability of the state is associated with numerous negative consequences. Therefore, it is important to monitor the situation and, if necessary, adjust the fiscal (budget) policy pursued. The policy in question entails decisions made by the government on public spending and taxes [Begg et al., 2011, p. 77]. It is essential that these decisions meet the needs of the economy and follow the so-called '3T' principles for effective fiscal stimulus. The standard theory for fiscal stimulus specifies that fiscal policy is effective only if the instruments used are [Steel, Harris, 2020, p. 10]:

1. Timely,
2. Targeted,
3. Temporary.

Timeliness comes down to the quick implementation of fiscal policy instruments and the proper timing of their application, i.e. lasting no longer than necessary. Targeting means defining social groups in need of assistance and supporting only these specific groups. The last feature, temporariness, indicates the legitimacy of using fiscal policy instruments only until the economy improves (in the short term). Variable conditions may create the need to adapt these aspects to the current economic situation [Steel, Harris, 2020, p. 10].

Fiscal policy plays several key functions in the economy. One of them is the stabilization function. It primarily involves countering economic fluctuations, preventing crises, eliminating state dysfunctions and alleviating socio-economic tensions. Another function of fiscal policy is the optimal distribution of financial resources in the economy, which is called the allocative function. The redistributive function, in turn, involves the government making decisions on how and to what extent to reduce social, economic and spatial inequalities [Wójcicki, 2021, p. 27–28].

Fiscal sustainability is a multidimensional concept. The literature on the subject identifies a range of its determinants. Recognizing an economy as fiscally sustainable can, for example, come down to assessing the ratio of public sector net worth to GDP [Buiter, 1985]. It can also be analyzed in terms of the government's ability to finance its liabilities [Blanchard et al., 1990]. Another definition indicates that fiscal sustainability is achieved when the current and projected levels of budget deficit and public debt make the need for abrupt adjustments in fiscal policy possible to avoid [Alesina, Perotti, 1995]. Fiscal sustainability is also the authorities' efficiency in managing public spending and revenues in response to economic shocks, without unnecessarily causing social anxiety or economic crisis [Kopits, Symansky, 1998]. The literature on the subject also presents an approach in which fiscal sustainability is defined by the absence of the need to finance government expenditure through debt and ensuring long-term budget balance [Schick, 2005].

To measure fiscal sustainability, among other things, the following are used: quantitative and qualitative measures or assessment of institutional behavior [Filipiak, Wyszkowska, 2022, p. 25–26], (see Table 1).

Fiscal sustainability has been the subject of many significant empirical studies over the years. For example, the fiscal sustainability of selected European Union countries was studied by Vanhorebeek and Van Rompuy (1995), Afonso (2005), Brady and Magazzino (2018), and Afonso and Coelho (2024). A comprehensive study on fiscal sustainability covering 173 countries was conducted by Afonso and Jalles (2019).

In addition to the classical approaches defining fiscal sustainability and its determinants, more recent studies have offered new insights and frameworks for assessing this multidimensional concept in the European Union. Afonso and Rault (2010) applied a panel data diagnostic to evaluate fiscal sustainability across EU Member States, confirming significant heterogeneity in fiscal performance and institutional constraints. Stoian, Obreja Brașoveanu and Brașoveanu (2018) proposed a framework to assess fiscal vulnerability based on market indicators such as sovereign credit risk, highlighting the importance of investors' perceptions in shaping debt sustainability. Collignon (2012) emphasized the role of fiscal policy rules in ensuring the long-term sustainability of public debt, arguing that compliance with well-designed rules is essential for convergence within the EU. Another perspective was provided by Bénassy-Quéré and Roussellet (2014), who extended the analysis to include the fiscal implications of systemic banking risks, thereby integrating financial stability concerns into the sustainability debate. Göndör (2019) examined comparative trends in EU countries with a focus on Romania, presenting long-term projections but stressing country-specific challenges. Earlier works such as Papadopoulos and Sidiropoulos (1999) concentrated on the Maastricht fiscal criteria as benchmarks of sustainability, yet these proved insufficient to capture broader fiscal resilience. Institutional aspects were also addressed by Kopits and Symansky (1998), who conceptualized fiscal rules as mechanisms disciplining government actions, and by Larch and Martins (2009), who analyzed fiscal policymaking in the EU and highlighted persistent enforcement challenges. Taken together, these studies confirm the complexity of fiscal sustainability but also reveal important gaps, as most focus on single indicators, specific countries, or institutional dimensions. The present study contributes to this body of literature by integrating multiple fiscal and macroeconomic variables into a synthetic measure and by applying a multidimensional comparative approach that allows for both temporal and cross-country assessment of fiscal sustainability in the European Union.

Fiscal rules in the form of indicators, benchmarks or procedures are helpful in maintaining fiscal sustainability. These rules impose a kind of framework, limiting the fiscal policies implemented by the government. The literature identifies four main types of fiscal rules [Marchewka-Bartkowiak, 2010, p. 4–6]:

- debt rules (government debt to GDP),
- budget balance rules (e.g. 'golden budget rule'),
- spending rules (limits on public spending),
- revenue rules (limits on public revenues).

However, the effectiveness of fiscal rules depends on their right construction. The implementation of improperly structured fiscal regulations can result in a number of problems, such as the transfer of debt, creative accounting or fiscal illusions [Marchewka-Bartkowiak, 2010, p. 3].

The essential question in the discussion on fiscal rules and fiscal sustainability in the EU is whether fiscal rules in their current form are adequate. Researchers analyze data and assess the effectiveness of current EU fiscal law and consider replacing the existing fiscal rules with a more effective method of fiscal management [Gwóźdź, Kołodziej, 2024, p. 129].Some economists warn that the current fiscal framework could lead to pro-cyclical and thus destabilizing fiscal policies. Furthermore, they signal that the different economic and fiscal situations of individual EU member states should be taken into account [Postuła, Kawarska, Chmielewski, 2025, p. 9].

In each of the European Union's Member States there are fiscal rules, implemented both at the national and community-wide level. The latter act as a kind of instrument for disciplining and unifying national policies. In 2021, there were between 3 and 7 fiscal rules in the individual EU member states. [IMF, *Fiscal Rules…*, 2022]. Adherence to these principles certainly supports the long-term maintenance of fiscal sustainability, but nevertheless some of the restrictions in place are not respected. Additionally, it should be noted that, should serious economic shocks occur, the European Union allows a temporary waiver of certain preventive or corrective rules, as specified in the Stability and Growth Pact in the General Escape Clause [*The 'general…*, 2020].

Undoubtedly, long-term fiscal unsustainability leads to many negative consequences. Therefore, it is important to determine the state that the economy is in and, in the case of sustained instability, implement corrective mechanisms. The right fiscal policy decisions support the resilience of individual countries to economic slumps and limit the adverse effects of the crises that occur.

## 3. Methods

The Synthetic Measure of Fiscal Sustainability (SMFS) was constructed using the Hellwig method [Hellwig, 1968]. This method is one of the linear ordering techniques used in multidimensional comparative analysis. It involves determining a synthetic index that allows for the assessment and ranking of objects (e.g., countries, regions, enterprises) according to their level of development relative to an established benchmark.

The foundation of the method is calculating the distance of each examined object from the benchmark, which serves as a reference point determined by the best values of individual diagnostic variables. The resulting index measures the proximity of the analyzed object to the pattern – the higher its value, the higher the overall evaluation of the analyzed object.

Hellwig method has found numerous applications, including in measuring sustainable development [Roszkowska et al., 2021], assessing municipal competitiveness [Adamowicz et al., 2012], analyzing sustainable development [Iwacewicz-Orłowska et al., 2016], measuring technical infrastructure development [Krakowiak-Bal, 2005], evaluating investment fund performance [Kopiński, 2014], identifying economic types of agriculture and rural areas [Wysocki, 2010] and studying corporate financing risk [Konopka, 2021].

According to the Hellwig method, the process of creating a synthetic measure consists of the following steps:

**Step 1.** Determination of variables and a finite set of assessed objects. Let:

$$X_i = [x_{i1}, x_{i2}, ..., x_{in}] - i\text{- object representation,} \quad (1)$$

where is a value of *i*– the object, with respect to *j* – the variable ($i$=1,2,…,$m$; $j$ = 1,2,…,$n$);

where $X_i$ is an object (in our case – a country).

**Step 2.** Definition of a set of weights for the variables ($j$ = 1,2,…,$n$) whose sum equals one:

$$w_1 + w_2 + ... + w_n = 1 \quad (2)$$

**Step 3.** Building the ideal solution (pattern of development):

$$I = [x_1^+, x_2^+, ..., x_n^+] \quad (3)$$

where:

$$x_j^+ = \begin{cases} \max\limits_i x_{ij} \text{ for benefit variables} \\ \min\limits_i x_{ij} \text{ for cost variables} \end{cases} \quad (4)$$

**Step 4**. Normalization of variables. This step is critical and ensures that the variable values can be compared.

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \tag{5}$$

where:

$$\bar{x}_j = \frac{1}{m}\sum_{i=1}^{m} x_{ij} \tag{6}$$

and:

$$s_j = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(x_{ij} - \bar{x}_j)^2} \tag{7}$$

**Step 5.** Calculation of normalized weighted variable values. A normalized *i*- object with vector weights is expressed as:

$$\tilde{X}_i = [\tilde{x}_{i1,}\tilde{x}_{i2}, \dots, \tilde{x}_{in}] \tag{8}$$

where:

$$\tilde{x}_{ij} = z_{ij} w_j \tag{9}$$

**Step 6.** Determination of the distance of normalized weighted objects from the ideal *I* by using classical Euclidean distance measure:

$$d_{i0}(X_i, I) = E(\tilde{X}_i, \tilde{I}) = \sqrt{\sum_{j=1}^{n}(\tilde{x}_{ij} - \tilde{x}_j^{+})^2} \tag{10}$$

**Step 7.** Calculating Hellwig's measure for the *i* - th object as follows:

$$H_i = 1 - \frac{d_{i0}}{d_0} \tag{11}$$

where:

$$d_0 = \bar{d} + 2S \text{ and } \bar{d} = \frac{1}{m}\sum_{i=1}^{m} d_{i0} \tag{12}$$

and:

$$S = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(d_{i0} - \bar{d})^2} \tag{13}$$

**Step 8.** Ranking of objects according to descending $H_i$.

As a rule, the values of the indicator $H_i$ fall within the range [0,1]. However, in extreme cases, the value of the synthetic measure may exceed this range. This particularly occurs when a given object drastically differs from the others [Młodak, 2006, p. 126]. Hellwig method has served as a theoretical basis for other methods based on the concept of a pattern, such as the TOPSIS method [Hwang, Yoon, 1981], [Bąk, 2016]. Hellwig method has numerous modifications that have emerged from research on various practical issues [Roszkowska et al., 2024]. The results of ordering (in addition to the values of the variables themselves) may be influenced by the method of variable normalization and the metric adopted to determine the distance between objects.

In this study, due to significant linear dependencies between variables, the Mahalanobis metric was used [Roszkowska et al., 2024], which allows for include the relationships between variables. The distance between objects measured using the Mahalanobis metric is as follows:

$$d_{i0}(X_i, I) = M(X_i, \bar{I}) = \sqrt{(Z_i - \bar{I})WC^{-1}W^T(Z_i - \bar{I})^T}$$

where C the covariance matrix, $Z = [z_{ij}]$, $W = diad(\sqrt{w_1}, \sqrt{w_2}, ..., \sqrt{w_n})$ is a diagonal matrix, where $w_1, w_2, ..., w_n = 1$ represents the weights assigned to the variables, $\bar{I}$ is the normalized pattern.

The evaluation scale, constructed on the basis of the modified Hellwig method with the application of the Mahalanobis distance, was selected owing to its capacity to aggregate multidimensional indicators into a single synthetic measure while simultaneously mitigating the issue of collinearity.

When the covariance matrix is an identity matrix, the Mahalanobis distance simplifies to the Euclidean distance. It should be emphasized that, in the approach applied in this study, unlike the classical Hellwig method, the weights of the selected variables are considered during the calculation of distances between objects measured using the Mahalanobis metric [Roszkowska et al., 2024]. Moreover, an equal weight level was adopted for all variables used in constructing the SMFS indicator. As an additional stage of the analysis, a hierarchical cluster analysis was conducted on the synthetic variables obtained through the application of the modified Hellwig method for the years under consideration. This procedure made it possible to classify Member States into five categories of fiscal sustainability, ranging from low to high. Unlike approaches based on arbitrarily imposed thresholds, the clustering was derived directly from the structure of the data, ensuring that the resulting typology reflects the empirical heterogeneity of fiscal sustainability across EU countries.

## 4. Results

The constructed Synthetic Measure of Fiscal Sustainability (SMFS, Table 3) includes determinants of fiscal stability such as the level of public debt relative to GDP, the budget deficit or surplus as a percentage of GDP, the GDP growth rate, the current account balance, and EMU bond yields. The selection of years (2014, 2017, 2020, and 2023) was deliberate and aimed at capturing different phases in the fiscal position of EU Member States. The year 2014 reflects the post–sovereign debt crisis adjustment period, 2017 represents a phase of relative fiscal stability, 2020 corresponds to the pandemic crisis with the activation of the General Escape Clause of the Stability and Growth Pact, while 2023 offers the most recent data, reflecting the fiscal situation during the recovery process and in the context of new challenges such as rising energy and defense expenditures. This temporal perspective makes it possible to evaluate fiscal sustainability under both stable and extraordinary conditions, thereby providing a more comprehensive assessment of resilience.

The variables incorporated in the construction of the SMFS reflect the multidimensional character of fiscal sustainability and are widely recognized in the literature as essential indicators of long-term fiscal stability. The debt-to-GDP ratio serves as a fundamental measure of debt sustainability, while the budget balance expressed as a share of GDP captures the government's current fiscal position. The GDP growth rate indicates the economy's capacity to generate revenues and gradually reduce the relative debt burden, and the current account balance reflects the degree of external equilibrium and the extent to which countries rely on foreign financing. The inclusion of EMU bond yields is intended to capture sovereign financing costs and the market's perception of fiscal risk in the euro area. Although German government bonds are frequently employed as a proxy for the risk-free benchmark, the use of EMU bond yields provides a broader representation of financing conditions across the monetary union. By reflecting systemic market dynamics rather than the conditions of a single country, this measure ensures a higher degree of comparability of fiscal sustainability among EU Member States.

For variables V1 (current account balance), V3 (real GDP growth), and V4 (budget deficit/surplus), the higher the value of the variable, the higher the level of a country's fiscal stability. Conversely, the preference direction is reversed for variables V2 (EMU bond yield) and V5 (public debt level), meaning that the lower the value of the variable, the higher the level of fiscal stability of a given economy. The matrix of linear correlation coefficients among the variables was computed and is presented in Table 2.

In 2014, the yield on EMU bonds (V2) exhibited a significant negative correlation with the budget deficit/surplus (V4) at a level of -0.554, indicating that higher bond yields were associated with a larger deficit. Public debt (V5) showed a positive correlation with bond yields (V2) at a level of 0.490, suggesting that an increase in government debt could lead to higher bond yields. At the same time, public debt (V5) was negatively correlated with the budget deficit/surplus (V4) at a level of -0.510, indicating that a larger budget deficit contributed to an increase in government debt.

In 2017, public debt (V5) continued to show a positive correlation with bond yields (V2) at a level of 0.539, confirming previous relationships. The correlation between the budget deficit/surplus (V4) and public debt (V5) weakened, reaching -0.391, meaning that while a larger deficit still contributed to an increase in debt, its impact was smaller than in 2014.

In 2020, bond yields (V2) continued to exhibit a negative correlation with the budget deficit/surplus (V4) at a level of -0.471, which could be attributed to monetary policy measures such as quantitative easing. GDP growth (V3) was positively correlated with the budget deficit/surplus (V4) at a level of 0.539, suggesting that a stronger economy supported an improved fiscal position. At the same time, public debt (V5) showed a strong negative correlation with GDP (V3) at a level of -0.646, indicating that economic growth could contribute to reducing government debt.

In 2023, bond yields (V2) remained negatively correlated with the budget deficit/surplus (V4) at a level of -0.520, meaning that a larger deficit was associated with lower bond yields. The budget deficit/surplus (V4) displayed a strong negative correlation with public debt (V5) at a level of -0.633, confirming that a larger deficit led to an increase in government debt.

The analysis of these results fully justifies the application of the Mahalanobis metric. The research findings were used to assess the level of fiscal stability among individual European Union member states. The analysis was conducted for the years 2014, 2017, 2020, and 2023. The year 2023 was chosen for analysis as the last period for which all data were available, the year 2020 was chosen because it was the first year of the COVID-19 pandemic, and the years 2014 and 2017 were chosen for comparison purposes. The analysis was based on data available in the Eurostat database. Estonia was excluded from the study due to incomplete data.

The applied method enabled the ranking of countries from the most to the least fiscally stable, as well as the identification of factors contributing to an improvement or deterioration in ranking position. This comparison allows for the identification of problematic areas and the implementation of measures to improve the components responsible for adverse changes.

The study of fiscal stability among European Union member states in each of the analyzed years illustrated significant changes in the classification. A substantial decline in the SMFS index value, and consequently a notable drop in ranking, was observed for Ireland in 2023. This was primarily due to a decrease in real GDP of -5.5% year-over-year. In 2023, Hungary also experienced a weakening position in terms of fiscal stability. This was partly linked to an increase in EMU bond yields (in 2023, Hungary's EMU bond yield stood at 7.51%, while the average among EU member states was 3.72%).

Conversely, Denmark recorded a significant increase in the SMFS index value in 2023. The country's advancement in the 2023 ranking was associated with a relatively high surplus in the current account balance, a budget surplus, and a relatively low public debt-to-GDP ratio of 33.6%. Croatia also improved its position in the ranking in 2023, recording real GDP growth of 3.3% year-over-year. Rankings are visualized in the charts 1 and 2.

In all the analyzed years, Germany exhibited the highest level of fiscal stability. The Netherlands and Malta also ranked highly. In 2014 and 2017, Greece had the lowest value of the Synthetic Measure of Fiscal Sustainability (SMFS), in 2020, it was France, and in 2023, Ireland. Table 3 presents the values of the SMFS determined for the years 2014, 2017, 2020, and 2023.

In the next step, an attempt was made to group EU member states based on their ranking positions derived from the $SMFS_{2014}$, $SMFS_{2017}$, $SMFS_{2020}$ and $SMFS_{2023}$ index values (see Chart 3), considering their level of fiscal stability in 2014, 2017, 2020, and 2023. For this purpose, hierarchical cluster analysis was used, employing Ward's method to determine the distance between groups and the Euclidean distance to calculate distances between objects.

Group 1 consists of Greece and France. These countries exhibited the lowest level of fiscal stability among the analyzed EU member states across all assessed periods. Group 2 includes seven countries: Finland, Italy, Austria, Belgium, Luxembourg, Hungary, and Ireland. The SMFS index values for 2014, 2017, 2020, and 2023 in Group 2 were slightly higher than in Group 1, yet fiscal stability remained relatively low.

Group 3 comprises 13 EU member states: Portugal, Croatia, Spain, the Czech Republic, Romania, Cyprus, Denmark, Latvia, Bulgaria, Slovakia, Slovenia, Poland, and Lithuania. This group demonstrated a moderate level of fiscal stability throughout the analyzed years.

Group 4 consists of Malta and the Netherlands, whose fiscal stability level, based on the calculations, can be described as relatively high throughout the studied period. Group 5 is a single-member group, containing only Germany. Compared to the other analyzed countries, Germany proved to be the most fiscally stable economy in the European Union.

The conducted analysis of fiscal stability levels among EU member states allowed for the identification of groups of countries with similar fiscal stability levels. Moreover, incorporating variables such as the level of public debt relative to GDP, the budget deficit/surplus as a percentage of GDP, GDP growth rate, current account balance, and EMU bond yields enabled the identification of factors contributing to a country's ranking position and the assessment of the overall impact of these components on ensuring fiscal stability in individual economies.

## 5. Conclusion

The persistence of state fiscal unsustainability is associated with many negative consequences. Therefore, it is important to monitor the situation and pursue policies that support fiscal sustainability. Fiscal rules, which impose a kind of framework that limits the policies implemented by the government, are helpful in maintaining fiscal sustainability. These regulations can be established at two levels – the national and the EU one. The effectiveness of the fiscal rules used depends on their right construction and consistent compliance.

The right fiscal policy decisions support the resilience of individual countries to economic slumps and limit the adverse effects of the crises that occur. Nowadays, it is particularly important due to the multiplicity of simultaneously occurring economic and non-economic crises (polycrisis), the compounded consequences of which pose a major threat. Therefore, it is important to identify the determinants of fiscal sustainability and take actions aimed at achieving and maintaining it.

The fiscal sustainability of a country is determined, among other factors, by the level of public debt, budget deficit/surplus, GDP growth rate, current account balance or bond yields EMU. The above factors were taken into account when constructing the Synthetic Measure of Fiscal Sustainability (SMFS). The Hellwig method and the Mahalanobis metric were used to build the SMFS. The method used made it possible to determine the level of fiscal sustainability of individual European Union Member States in 2014, 2017, 2020 and 2023. The results of the survey indicate that by far the most fiscally stable country was Germany. The Netherlands and Malta also ranked high. Greece had the lowest value of SMFS in 2014 and 2017, France in 2020, and Ireland in 2023.

Furthermore, the analysis of individual components of the SMFS enabled the identification of the factors responsible for the position in the presented ranking moving upwards or downwards. This type of comparison makes it possible to identify problem areas and improve elements that cause adverse changes.

Additionally, based on the conducted research, 5 groups of European Union Member States were identified, ordered by the level of their fiscal sustainability. The least fiscally sustainable group 1. included Greece and France. Group 2., characterized by lower average sustainability, included 7 countries. Group 3., with an average level of fiscal sustainability, included 13 countries, whereas group 4., with a higher average level of fiscal sustainability, included 2 of them. In the case of one country, namely Germany, fiscal sustainability was defined as high.

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# Appendix

Table 1. Measures used to assess fiscal sustainability

| Quantitative measures | Qualitative measures | Assessment of institutional behavior |
|---|---|---|
| Budget deficit and government debt to GDP, annual budget revenues, credit default swap (CDS), current account balance | Subjective opinions on market trends, assessment of social preferences and habits, and surveys of public behavior and public sentiment | Evaluation of the adopted action strategies and decisions of the central and/or local authorities and the adopted direction of local and regional development |

Source: own compilation based on: Filipiak, Wyszkowska, 2022, p. 25-26.

Table 2. Matrix of Linear Correlation Coefficients Between Variables

| *year* | 2014 | | | | |
|---|---|---|---|---|---|
| *variable* | V1 | V2 | V3 | V4 | V5 |
| V1 | 1,000 | -0,300 | -0,037 | 0,372 | 0,004 |
| V2 | -0,300 | 1,000 | -0,125 | -0,554 | 0,490 |
| V3 | -0,037 | -0,125 | 1,000 | 0,334 | -0,257 |
| V4 | 0,372 | -0,554* | 0,334 | 1,000 | -0,510 |
| V5 | 0,004 | 0,490* | -0,257 | -0,510* | 1,000 |
| *year* | 2017 | | | | |
| *variable* | V1 | V2 | V3 | V4 | V5 |
| V1 | 1,000 | -0,243 | -0,156 | 0,169 | -0,004 |
| V2 | -0,243 | 1,000 | 0,067 | -0,251 | 0,539 |
| V3 | -0,156 | 0,067 | 1,000 | 0,234 | -0,288 |
| V4 | 0,169 | -0,251 | 0,234 | 1,000 | -0,391 |
| V5 | -0,004 | 0,539* | -0,288 | -0,391* | 1,000 |
| *year* | 2020 | | | | |
| *variable* | V1 | V2 | V3 | V4 | V5 |
| V1 | 1,000 | -0,221 | -0,071 | 0,224 | -0,057 |
| V2 | -0,221 | 1,000 | -0,190 | -0,471 | 0,140 |
| V3 | -0,071 | -0,190 | 1,000 | 0,539 | -0,646 |
| V4 | 0,224 | -0,471* | 0,539* | 1,000 | -0,603 |
| V5 | -0,057 | 0,140 | -0,646* | -0,603* | 1,000 |
| *year* | 2023 | | | | |
| *variable* | V1 | V2 | V3 | V4 | V5 |
| V1 | 1,000 | -0,346 | -0,229 | 0,380 | -0,175 |
| V2 | -0,346 | 1,000 | 0,094 | -0,520 | 0,062 |
| V3 | -0,229 | 0,094 | 1,000 | -0,185 | 0,154 |

| *year* | 2023 | | | | |
|---|---|---|---|---|---|
| *variable* | V1 | V2 | V3 | V4 | V5 |
| V4 | 0,380 | -0,520* | -0,185 | 1,000 | -0,633 |
| V5 | -0,175 | 0,062 | 0,154 | -0,633* | 1,000 |

*p<0,05
Source: Own elaboration.

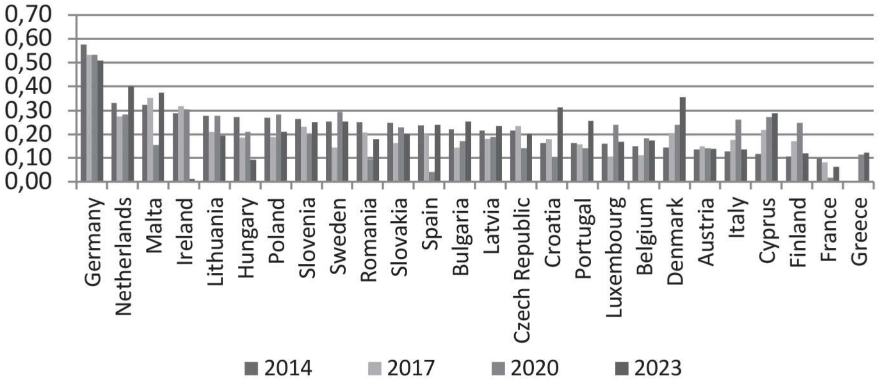
Table 3. Value of the SMFS index obtained using Hellwig's method with the Mahalanobis metric for the years 2014, 2017, 2020 and 2023

| | Country | SMFS2014 | Country | SMFS2017 |
|---|---|---|---|---|
| 1. | Germany | 0,575 | Germany | 0,533 |
| 2. | Netherlands | 0,331 | Netherlands | 0,352 |
| 3. | Malta | 0,323 | Malta | 0,318 |
| 4. | Ireland | 0,289 | Ireland | 0,275 |
| 5. | Lithuania | 0,278 | Lithuania | 0,234 |
| 6. | Hungary | 0,273 | Hungary | 0,232 |
| 7. | Poland | 0,269 | Poland | 0,218 |
| 8. | Slovenia | 0,263 | Slovenia | 0,210 |
| 9. | Sweden | 0,252 | Sweden | 0,209 |
| 10. | Romania | 0,251 | Romania | 0,205 |
| 11. | Slovakia | 0,249 | Slovakia | 0,200 |
| 12. | Spain | 0,238 | Spain | 0,190 |
| 13. | Bulgaria | 0,222 | Bulgaria | 0,186 |
| 14. | Latvia | 0,216 | Latvia | 0,180 |
| 15. | Czech Republic | 0,215 | Czech Republic | 0,179 |
| 16. | Croatia | 0,162 | Croatia | 0,175 |
| 17. | Portugal | 0,161 | Portugal | 0,169 |
| 18. | Luxembourg | 0,160 | Luxembourg | 0,161 |
| 19. | Belgium | 0,147 | Belgium | 0,157 |
| 20. | Denmark | 0,143 | Denmark | 0,149 |
| 21. | Austria | 0,135 | Austria | 0,143 |
| 22. | Italy | 0,128 | Italy | 0,143 |
| 23. | Cyprus | 0,116 | Cyprus | 0,111 |
| 24. | Finland | 0,107 | Finland | 0,104 |
| 25. | France | 0,096 | France | 0,082 |
| 26. | Greece | 0,003 | Greece | 0,001 |

| | Country | SMFS2020 | Country | SMFS2023 |
|---|---|---|---|---|
| 1. | Germany | 0,533 | Germany | 0,510 |
| 2. | Netherlands | 0,305 | Netherlands | 0,401 |
| 3. | Malta | 0,295 | Malta | 0,374 |
| 4. | Ireland | 0,282 | Ireland | 0,356 |
| 5. | Lithuania | 0,282 | Lithuania | 0,312 |
| 6. | Hungary | 0,277 | Hungary | 0,289 |
| 7. | Poland | 0,272 | Poland | 0,257 |
| 8. | Slovenia | 0,260 | Slovenia | 0,254 |
| 9. | Sweden | 0,248 | Sweden | 0,254 |
| 10. | Romania | 0,240 | Romania | 0,251 |
| 11. | Slovakia | 0,239 | Slovakia | 0,239 |
| 12. | Spain | 0,228 | Spain | 0,233 |
| 13. | Bulgaria | 0,211 | Bulgaria | 0,211 |
| 14. | Latvia | 0,200 | Latvia | 0,203 |
| 15. | Czech Republic | 0,189 | Czech Republic | 0,202 |
| 16. | Croatia | 0,184 | Croatia | 0,194 |
| 17. | Portugal | 0,171 | Portugal | 0,179 |
| 18. | Luxembourg | 0,154 | Luxembourg | 0,173 |
| 19. | Belgium | 0,141 | Belgium | 0,167 |
| 20. | Denmark | 0,140 | Denmark | 0,137 |
| 21. | Austria | 0,139 | Austria | 0,135 |
| 22. | Italy | 0,113 | Italy | 0,120 |
| 23. | Cyprus | 0,103 | Cyprus | 0,119 |
| 24. | Finland | 0,094 | Finland | 0,093 |
| 25. | France | 0,042 | France | 0,062 |
| 26. | Greece | 0,016 | Greece | 0,012 |

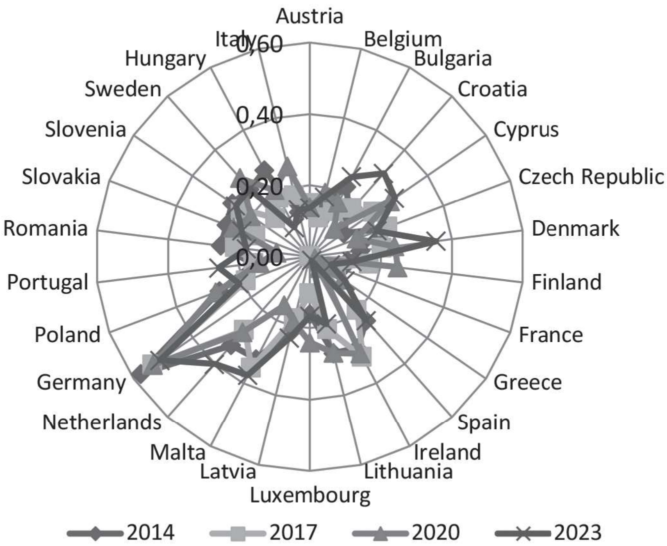
Source: Own elaboration.

Chart 1. Value of the SMFS index obtained using Hellwig's method with the Mahalanobis metric for the years 2014, 2017, 2020 and 2023



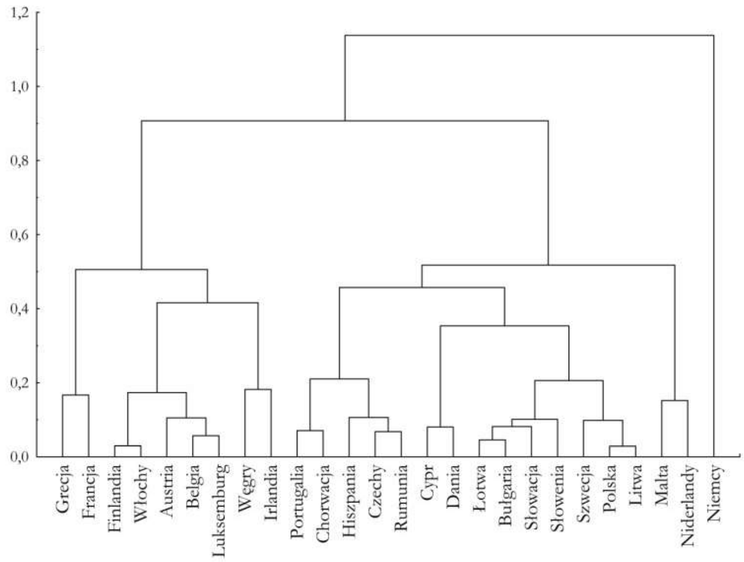

Source: Own elaboration.

Chart 2. Value of the SMFS index obtained using Hellwig's method with the Mahalanobis metric for the years2014, 2017, 2020 and 2023




Source: Own elaboration.

Chart 3. Hierarchical Cluster Analysis, Variables $SMFS_{2014}$, $SMFS_{2017}$, $SMFS_{2020}$, $SMFS_{2023}$




Source: Own calculations, cluster distances determined using Ward's method, observation distances calculated using the Euclidean metric.