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ROY BAHL'S IMPLEMENTATION RULES FOR FISCAL DECENTRALIZATION: THEORETICAL INSIGHTS AND EMPIRICAL EVIDENCE FROM OECD COUNTRIES

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Abstract. The paper refers to the twelve principles of fiscal decentralization, proposed by Roy Bahl (Bahl's Rules for Fiscal Decentralization – BRfd), with special emphasis on the first Bahl's rule (regarding the comprehensiveness of the fiscal decentralization, CSfd). The purpose of the research was to estimate the level of CSfd in OECD countries. Thus, the objective was to construct a synthetic measure of the first Bahl's rule (CSfd) which constitutes the value added of this research. The goal was also to rank countries as the main idea was to advance empirical assessment in the field of fiscal federalism and to provide practical guidance for shaping public finance policy including policies on the collection of public revenues and the allocation of public expenditure. This directly corresponds to the research problem of the very limited number of tools available for measuring fiscal decentralization. Based on Hellwig's method of linear ordering two rankings were developed using the Euclidean metric and the Mahalanobis metric. The results indicate that the most comprehensive fiscal decentralisation systems in 2022 were found in the Slovak Republic, Switzerland and Canada (ranking based on the Mahalanobis metric). When the Euclidean metric is used, Switzerland emerges as the leader, followed by Spain and Austria.

Keywords: fiscal decentralization, Bahl's rules for fiscal decentralization, OECD countries.

JEL Classification: H71, H72, H77, O57.

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1. Introduction

Fiscal decentralization is a multifaceted and complex process regarded as a key pillar of fiscal federalism. It is one of the modern economic concepts developed since the mid-20th century and holds significant importance for multi-level governance and multi-level public finance systems (Poniatowicz, 2023).

Fiscal federalism offers valuable theoretical tools for analysing and designing such systems (Bird & Vaillancourt, 1998; Oates, 1972). The model of fiscal federalism assumes, among other things: (1) the allocation of fiscal functions (allocative, redistributive, and stabilisation) across different levels of government (Musgrave, 1959; Oates, 1972); (2) adherence to the principles of efficiency and equity in the distribution of public financial resources (Ebel & Yilmaz, 2002; Musgrave, 1959; Oates, 1972; Meloche et al., 2004); and (3) coordination among various levels of government in macroeconomic policy (Musgrave, 1959; Oates, 1972).

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Roy Bahl, a distinguished American economist specializing in public finance, fiscal federalism, and tax policy, published a seminal paper titled *Implementation Rules for Fiscal Decentralization* (Bahl, 1999), in which he outlined twelve principles as his recommendations for a model framework for implementing fiscal decentralization in a country. Bahl's Rules for Fiscal Decentralization (BRfd) provide detailed guidelines for allocating financial functions and achieving fiscal policy objectives within the framework of fiscal federalism.

Bahl (1999) introduced rules for implementing fiscal decentralization within a specific historical context, addressing the growing interest in administrative and fiscal reforms in countries with varying levels of socio-economic development. During the 1980s and 1990s, decentralization was seen to enhance the efficiency of public administration, increase the accountability of subnational authorities, and strengthen democracy at the subnational level. However, many reforms faced significant challenges, largely due to the absence of cohesive and comprehensive frameworks.

Drawing on global experiences, Bahl (1999) proposed a set of universal rules designed to guide the process of fiscal decentralization. These principles were intended to serve as a framework for policymakers tasked with reforming public finance systems in diverse national contexts. The rules, presented in Table 1, not only outline best practices but also highlight essential principles for the effective design and implementation of decentralization. These principles are adaptable to a variety of economic and institutional conditions, ensuring their relevance across different contexts.

Each principle presented is logically interconnected, emphasizing the need for a holistic approach to fiscal decentralization. Our analysis of the scope and specifics of Roy Bahl's Rules for Fiscal Decentralization (BRfd) allows us to categorize them into three main groups.

Table 1. Rules for implementing fiscal decentralization according to Roy Bahl and their implications for public finance systems (source: Bahl, 1999; own elaboration, 2024)

Decentralization principle according to Roy Bahl	Core concept and implications for public finance system
Rule #1: *Fiscal decentralisation should be a comprehensive system*	The fiscal relationship between central and subnational governments should be cohesive and comprehensive. Successful implementation requires a carefully designed plan that addresses all aspects of decentralization, including the allocation of responsibilities, revenue sources, and transfer mechanisms. Without a holistic approach, reforms may face inconsistencies, reduced effectiveness, and difficulties in managing public finances.
Rule #2: *Finance follows function*	The responsibilities and duties of subnational units should be clearly defined first, followed by the allocation of appropriate funding sources. This approach ensures better alignment between revenues and responsibilities, avoiding discrepancies between expenditures and income, which is crucial for fiscal efficiency.
Rule #3: *Strong central ability to monitor and evaluate decentralisation*	The central government should establish a system for analysing local finances and monitoring tools to ensure transparency, accountability, and the effectiveness of decentralization. Without proper oversight mechanisms, there is a risk of abuse, inequality, and difficulties in implementing public policies at the subnational level.

End of Table 1

Decentralization principle according to Roy Bahl	Core concept and implications for public finance system
Rule #4: *One intergovernmental system does not fit the urban and the rural sector*	Subnational governments in urban and rural areas have varying fiscal capacities and investment needs. Adopting a tailored approach allows for better policy adaptation and ensures the efficient allocation of resources. For example, wealthier urban municipalities may rely more on local taxation, while poorer rural areas might depend on transfers from the central government.
Rule #5: *Fiscal decentralisation requires significant local government taxing powers*	Subnational governments should have the authority to levy transparent taxes, which serve as a crucial source of revenue. This approach strengthens the accountability of local leaders to their communities and improves the efficiency of public resource allocation. The absence of such powers restricts the financial autonomy of subnational governments and their ability to effectively carry out their responsibilities.
Rule #6: *Central governments must keep the fiscal decentralisation rules that they make*	The stability of fiscal rules, such as transfer mechanisms and tax authority regulations, is essential for fostering trust among subnational governments and ensuring the effective functioning of the system. Sudden changes or failure to uphold established rules can result in financial instability and diminish the effectiveness of decentralization.
Rule #7: *Keep it simple*	Complex transfer systems or overly complicated tax mechanisms can be difficult to manage at both the subnational and central levels. A simpler structure reduces administrative costs while improving transparency and the efficiency of public finance management.
Rule #8: *The design of the intergovernmental transfer system should match the objectives of the decentralisation reform*	Financial transfer mechanisms should be designed to align with the objectives of decentralization, such as promoting regional equity and enhancing local autonomy. A poorly designed transfer system can result in wasted resources and inefficiencies in the implementation of public policies.
Rule #9: *Fiscal decentralisation should consider all levels of government*	In countries with multi-tiered administrative systems, decentralization should account for all levels of government to prevent inequalities and ensure coherence in public policies. Neglecting any level may lead to inequities and difficulties in coordinating actions.
Rule #10: *Impose a hard budget constraint*	Subnational governments should be obligated to balance their budgets without dependence on central assistance. Strict budgetary constraints promote accountability in subnational finances and encourage efficient resource management.
Rule #11: *Recognize that intergovernmental systems are always in transition and plan for it*	Fiscal systems must be flexible and capable of adapting to changing conditions, such as economic development or demographic shifts. Failure to adapt can lead to inefficiencies and diminish the effectiveness of public policies.
Rule #12: *There must be a champion for fiscal decentralisation*	The success of decentralization depends on the presence of political leaders and institutions that actively support the process. A lack of strong support can result in limited implementation of reforms and weaken their impact on the efficiency of public administration.

The first group, framework principles, addresses the overarching design of the fiscal decentralization system. These principles highlight the necessity of creating a coherent and comprehensive system of fiscal relationships between different levels of government (e.g., Principle 1: *Fiscal decentralization should be a comprehensive system*). They also emphasize the need to account for the distinct requirements of urban and rural areas within a unified system (e.g., Principle 4: *One intergovernmental system does not fit the urban and the rural sector*).

The second group, functional principles, focuses on assigning appropriate functions and funding sources. These principles stress the importance of aligning responsibilities with financing, as exemplified by Principle 2: *Finance follows function*. Furthermore, they underscore the necessity of granting subnational governments significant taxation authority to ensure a key source of independent revenue (e.g., Principle 5: *Fiscal decentralization requires significant local government taxing powers*).

The third group, operational principles, addresses the practical aspects of implementing and monitoring the decentralization process. For example, Principle 3: *Strong central ability to monitor and evaluate decentralization* underscores the importance of oversight and evaluation mechanisms. Similarly, Principle 7: *Keep it simple* stresses the need to streamline transfer mechanisms and tax systems to enhance the efficiency and transparency of public finance.

Categorizing these principles into three groups allows for a more systematic approach to analysing Bahl's framework and exploring its potential applications across diverse economic and institutional contexts.

Despite the importance of fiscal decentralization and the framework outlined in Roy Bahl's 12 principles for an effective decentralization process, no tools to monitor and assess the degree of compliance with the specified principles were proposed. Thus, the main objective of our research was to construct a novel, synthetic measure of the first Bahl's rule.

This study focuses on Bahl's Rules for Fiscal Decentralization, with empirical attention to the first rule – are the focus of analysis in this study. The importance and relevance of the research on fiscal decentralization are supported by several key arguments.

First, fiscal decentralization plays a particularly critical role in crisis situations. The COVID-19 pandemic serves as a prime example (Hu, 2025; Poniatowicz, 2022). Such crises demand the rapid adaptation of public policies to address local needs and specific circumstances. On the one hand, decentralization can enhance the flexibility and resilience of public systems, enabling faster and more precise responses to crisis challenges (Organization for Economic Cooperation and Development [OECD], 2020). On the other hand, it presents challenges, such as widening regional inequalities and difficulties in coordinating actions among different levels of public authority (Boadway & Shah, 2009; Rodden, 2004).

Second, fiscal decentralization assumes particular importance in the context of the global democracy crisis (Diamond, 2020; Levitsky & Ziblatt, 2018). This crisis is characterized by declining public trust in institutions, increasing political polarization, and the erosion of the rule of law. In such circumstances, decentralization and the associated multi-level division of public power are regarded in theory as effective tools for safeguarding freedom in democracies (Hayek, 1960). Decentralization can play a pivotal role in enhancing citizen participation in decision-making processes, increasing administrative transparency, and rebuilding social trust. By giving local communities greater influence over public policymaking, decentralization becomes a vital tool for countering citizen alienation and strengthening the foundations of democracy.

Third, there is a notable research gap in the literature: while the theory of fiscal federalism and decentralization has been extensively developed, comprehensive quantitative studies analysing the implementation of Roy Bahl's fiscal decentralization rules in a broader comparative context, such as OECD countries, remain scarce. Existing studies tend to rely on qualitative analyses, leaving room for quantitative research.

In this context, this paper aims to address this research gap. The purpose of the research is to conduct a quantitative analysis (based on Hellwig's method) of the implementation of the first Bahl's fiscal decentralization rule in OECD countries. The main objective is to advance knowledge in the field of fiscal federalism and to construct a tool for empirical assessment, thereby providing practical guidance for shaping public policies. We proposed two hypotheses. The first hypothesis assumed that the comprehensiveness of fiscal decentralization (CSfD) across OECD member countries exhibits significant heterogeneity. A further methodological hypothesis is that the use of the Mahalanobis distance metric within the Hellwig method does not lead to statistically significant differences in the ranking of OECD countries compared to those generated using the classical Euclidean distance metric.

2. Related work

The measurement of decentralization remains a complex and underexplored area in academic research, with few comprehensive studies addressing the issue at the country level. Notable contributions to the field include works by Ebel and Yilmaz (2002), Rodden (2004), Stegarescu (2005), Schneider (2003), OECD (2013), Treisman (2002), Poniatowicz (2018), Guziejewska (2018). Reingewertz (2014) offers a comprehensive review of empirical research on fiscal decentralization, pointing to such trends as the costs and benefits of fiscal decentralization, its consequences, e.g., in terms of inequalities, and its relation to various aspects of fiscal decentralization such as allocation, distribution, or stabilization. Numerous studies have formulated indicators of fiscal decentralization that encompass various dimensions of autonomy. Ivanyna and Shah (2014) created a decentralization index, based on the data set (mostly from 2005) that covers 182 countries, which captures institutional dimensions of political, fiscal and administrative autonomy enjoyed by subnational governments. However, the dataset pertains exclusively to the mid-2000s and has not been revised since. Multidimensional decentralization indices have also been explored by Gu (2012), who proposed a Vertical Fiscal Imbalance-Weighted Decentralization Indicator. A study by Trusova et al. (2019) focuses on the implementation of fiscal decentralization reforms in Ukraine and the countries of the European Union (and presents quantitative indicators of the decentralization reform). Poniatowicz et al. (2024) introduced a novel methodology for analysing decentralization across three dimensions: political, administrative, and fiscal. They have constructed synthetic measures for assessing political (MPD), administrative (MAD), and fiscal (MFD) decentralization. While overall analyses of the fiscal decentralisation process are valuable and unquestionable, analyses of selected aspects of fiscal decentralisation are also necessary, e.g., in terms of specific principles that should guide this process. Although Roy Bahl's fundamental work has been cited over 550 times to date, literature review suggests that the studies do not refer in a quantitative way to the Bahl's rules of fiscal decentralization. As Wright (2017, p. 76) points out, since Roy Bahl's 12 principles of fiscal decentralization were developed, they have not been fully tested in real-world fiscal decentralization implementation. There have been no tests, research, or evaluation of these principles or their application in actual fiscal decentralization efforts.

Empirical studies that allow researchers to evaluate how fiscal decentralization is implemented are usually descriptive in nature. For example, referring to Bahl's principles of decentralization, Rao (2003, p. 26) in a comparative analysis of fiscal decentralization in China and India indicates that effective fiscal decentralization requires granting significant powers to subnational governments, which is related to decisions on revenues and expenditures. Tunio and Nabi (2021, p. 8) analysed fiscal (de)centralization in Pakistan and used two measuring indicators: the share of federal and local expenditures in total expenditures, and the share of federal and local revenues in total revenues, respectively). No new measure was proposed. Among the latest research referring to Bahl's rules, there is only one from 2025. Namely, Yimenu (2025) examined the political economy of fiscal transfers in Ethiopia. The data sources are worth emphasizing: a statistical dataset covering 1995–2020, supplemented by interviews and document analysis, and a variety of quantitative and qualitative methods. In the quantitative analysis, correlation analysis and cross-tabulation were employed).

Despite these valuable contributions, significant methodological and practical challenges persist, highlighting the need for a nuanced and multifaceted approach to measuring Bahl's Rules for Fiscal Decentralization.

The limited number of empirical studies in this area is due, among other factors, to the fact that the measurement of decentralization encounters several overarching difficulties:

- Diverse definitions and models – decentralization can take multiple forms (political, administrative, and fiscal) each with unique characteristics; the lack of a standardised definition complicates comparative analyses of decentralization levels across countries;
- Limited data availability – in many countries, consistent and up-to-date data on subnational government finances are unavailable, hindering reliable comparative analyses;
- Dynamic nature of decentralization processes – decentralization is an evolving process, influenced by changes in policies and legislation. This requires continuous monitoring and regular updates to datasets. For example, the COVID-19 pandemic prompted significant and rapid adjustments in public finance systems worldwide.

The challenges outlined above are illustrative rather than exhaustive, underscoring the complexity of measuring decentralization. Further research is needed to develop standardized measurement methodologies that better account for the unique features of financial systems worldwide. Existing studies serve as a valuable foundation for advancing the field and offer inspiration for creating research tools capable of more precise measurement of fiscal decentralization and its effects across diverse administrative and political systems.

To sum up, there are quantitative studies on fiscal decentralization, that address all its dimensions or focus on selected elements. Regarding Roy Bahl's principles of fiscal decentralization, a thorough literature review reveals that the analyses are qualitative in nature. Quantitative tools for assessing, comparing results across countries, and comparing the degree of implementation of Roy Bahl's principles of fiscal decentralization over time have not yet been developed. Our study fills this identified research gap: the synthetic measure of the first rule of fiscal decentralization we propose is a novel tool, constituting the added value of the analysis.

3. Data

Theoretical research was conducted in the context of fiscal decentralization as a pillar of fiscal federalism, and the twelve Bahl's Rules (BRfd), treated as specific standards for this process. The empirical analysis focuses on the first rule of the twelve BRfd. While all Bahl's rules are crucial for a comprehensive understanding of the fiscal decentralization process, not all can be readily translated into measurable quantitative indicators available in databases such as the OECD Data Explorer or the Fiscal Decentralization Database. Including the entire set of principles would necessitate more complex and time-intensive qualitative analyses, which go beyond the scope of a single study.

For the analysis of the implementation of the first BRfd in OECD countries regarding comprehensiveness of fiscal decentralization, five quantitative indicators were proposed with reference to two years: 2022, i.e., the most recent year for which data were available at the commencement of the study, and 2016, i.e., data available from the period preceding the COVID-19 pandemic in order to enable a comparative perspective and to explore the dynamics of the decentralisation process. Data were selected to capture the comprehensiveness of the fiscal decentralization system. A detailed list of these indicators is presented in Table 2.

These five indicators are well-suited to assess whether fiscal decentralisation is comprehensive. The number of subnational government entities per 100 000 people provides insight into the territorial and administrative scope of decentralisation, indicating how governance is

Table 2. Proposed indicators for assessing the first rule of BRfd in public financial systems of OECD Countries (source: own elaboration, 2025)

Indicator name and symbol	Indicator interpretation
Number of subnational government entities per 100 000 people (SNG_NO_ENT)	The indicator evaluates whether Subnational Governments (SNGs) have adequate administrative resources to effectively fulfil their responsibilities (administrative decentralization). A high number of subnational government units indicates a broad presence of SNGs within a country, which can facilitate administrative decentralization and enhance their capacity for independently managing public services.
Subnational government revenue as a percentage of GDP (SNG_REV_GDP)	A higher indicator value reflects a greater degree of decentralization as a comprehensive process within a country. For example, a higher share of SNG revenue in GDP may indicate a broader scope of fiscal autonomy for subnational governments in the economy.
Subnational government revenue as a percentage of general government revenue (SNG_REV_GGR)	A higher indicator value signifies a broader extent of fiscal decentralization and greater fiscal autonomy of SNGs within the public finance system.
Subnational government expenditure as a percentage of GDP (SNG_EXP_GDP)	The higher the indicator value, the greater the overall degree of decentralization in a country. For instance, a higher share of SNG expenditures in GDP may suggest a broader scope of expenditure autonomy for subnational governments in the economy.
Subnational government expenditure as a percentage of general government expenditure (SNG_EXP_GGE)	The higher the indicator value, the broader the scope of decentralization as a comprehensive process in a country. A higher indicator level reflects an expanded range of fiscal decentralization and greater expenditure autonomy for subnational governments (SNGs) within the public finance system.

distributed across the population. Subnational government revenue as a percentage of GDP measures the economic significance of local governments' fiscal capacity, while subnational government revenue as a percentage of general government revenue reveals the balance of revenue-raising power between central and subnational levels. In his earlier work Bahl and Linn (1992) based on research in selected transition countries, Bahl pointed out that it is crucial for local governments to have an adequate revenue base, no matter whether it comes from their own/shared taxes or central transfers. On the spending side, subnational government expenditure as a percentage of GDP reflects the extent to which local governments contribute to overall economic activity through public spending. Finally, subnational government expenditure as a percentage of general government expenditure captures the share of total public service delivery handled at the subnational level. Together, these indicators cover both revenue and expenditure dimensions, enabling an assessment of the overall coherence, balance, and completeness of the fiscal relationship between central and subnational governments.

Despite limited research on the comprehensiveness of fiscal decentralization, there are country-level analyses available. For example, Kimchoeun (2011, p. 5), in his analysis of fiscal decentralization in Cambodia, considers, among others, financial authority and bureaucratic capacity. As explained in Table 2, this directly corresponds to the adopted indicators – in the former: SNG_REV_GDP, SNG_REV_GGR, SNG_EXP_GDP, SNG_EXP_GGE, and in the latter: SNG_NO_ENT. Darby et al. (2002, p. 32), analysing fiscal decentralization in the United Kingdom, referring to the issue of comprehensiveness of fiscal decentralization (in the context of asymmetric devolution between regional governments which is justified for historical reasons), also point to fiscal autonomy. Further, Liu (2011, p. 366) takes the view that fiscal decentralization should be regarded as a system and indicates that one of its components is expenditure assignment. The variable adopted by the author is SNG expenditure as a share of total government expenditure, hence we also used this variable in our study.

Data presented in Table 2 were gathered from OECD Data Explorer (n.d.). The unavailability of data on subnational government revenue as a percentage of GDP and as a percentage of general government revenue for the Czech Republic and Turkey prevented their inclusion in the analysis. Still, the coverage should be considered high – the analysis covered 36 out of 38 OECD member states. However, some of the gaps can be filled with data from the IMF Government Finance Statistics. This procedure was carried out, among others, in the study Subnational Governments Structure and Finance (OECD, 2024).

4. Methodology

The goal of this study – to measure the first Bahl's rule in a complex and multidimensional way, required the use of appropriate quantitative methods. The authors decided to use the linear ordering Hellwig's method (Hellwig, 1968). This method uses the concept of a so-called synthetic variable. Assessments of the objects in terms of the variables considered are aggregated into a single value/utility function with values in the form of real numbers. This approach has several advantages, for example, it excludes the situation of incomparability of objects, which enables their complete ordering. The Hellwig method is a compensatory

method, which means that a low score on one variable can be compensated for by a high score on another variable. Linear ordering methods determine the order of objects based on a synthetic measure that is representative of several variables that describe the objects (Bąk, 2016). Different objects (such as countries) with varying degrees of decentralisation may be subject to linear ordering. Variables such as decentralisation, level of economic development, and financial position are not directly measurable. They are aggregated quantities whose values are derived from observations of diagnostic variables that are directly measurable. The results obtained for the synthetic variable allow multidimensional objects to be ordered in the context of the research problem.

Hellwig's method has found numerous of applications, including in studying demographic development (Kurkiewicz et al., 1991), measuring sustainable development (Roszkowska & Filipowicz-Chomko, 2021) determining the competitive position of municipalities (Adamowicz & Janulewicz, 2012), studying the sustainable development of regions (Iwacewicz-Orłowska & Sokołowska, 2016), measuring the development of technical infrastructure (Krakowiak-Bal, 2005), assessing the effectiveness of investment funds (Kopiński, 2014), identifying economic types of agriculture and rural areas (Wysocki, 2010), and studying corporate financing risks (Konopka, 2021).

In accordance with the Hellwig's method the process of creating a synthetic measure consists of the following steps (Hellwig, 1968):

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

$$X_i = \left[x_{i1}, x_{i2}, \ldots, x_{in}\right] - i - \text{object representation}, \tag{1}$$

where x_{ij} 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 w_j for the variables (j = 1, 2, ..., n) whose sum equals one:

$$w_1 + w_2 + \ldots + w_n = 1. \tag{2}$$

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

$$I = \left[x_1^+, x_2^+, \ldots, x_n^+\right], \tag{3}$$

where:

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

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

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

where:

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

and:

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

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

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

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:

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

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

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

where:

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

and:

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

Step 8. Ranking of objects according to descending H_i.

As a rule, the values of H_i belong to the range [0,1], while in extreme cases the value of the synthetic measure falls outside this range. This is especially the case when a particular object drastically deviates from the others (Młodak, 2006). Hellwig's method provided the theoretical basis for other methods based on the concept of pattern, such as the TOPSIS method (Hwang & Yoon, 1981).

Hellwig's method has several modifications that have emerged because of research into various practical issues (Roszkowska et al., 2024). The results of ordering (in addition to the values of the variables themselves) may be affected by the way in which the variables are normalised and the metric adopted for determining the distances between the objects. An analysis of six normalisation techniques (Roszkowska et al., 2024; Vafaei et al., 2016) showed that vector normalisation is the most suitable method in the context of the TOPSIS (Zavadskas et al., 2016) approach. As Hellwig's method belongs to the same group of multi-criteria methods based on similar aggregation formulas, authors of this study used vector normalisation to construct presented synthetic measure:

$$z_{ij} = \begin{cases} \dfrac{x_{ij}}{\sqrt{\sum_{i=1}^{m}\left(x_{ij}\right)^2}} & \text{for benefit variables,} \\ \dfrac{1/x_{ij}}{\sqrt{\sum_{i=1}^{m}1/\left(x_{ij}\right)^2}} & \text{for cost variables.} \end{cases} \tag{14}$$

In addition, the Mahalanobis metric (Roszkowska et al., 2024) was used to determine the distance between objects (in addition to the Euclidean metric), which allows the dependencies between variables to be considered. The distance between objects as measured by the Mahalanobis metric is as follows:

$$d_{i0}\left(X_i, I\right) = M\left(\mathrm{Z}_i, \overline{\mathrm{I}}\right) = \sqrt{\left(\mathrm{Z}_i - \overline{\mathrm{I}}\right)\mathrm{WC}^{-1}\mathrm{W}^T\left(\mathrm{Z}_i - \overline{\mathrm{I}}\right)^T}, \tag{15}$$

where: C is the variance – covariance matrix of the data matrix $\overline{\mathrm{Z}} = \left[z_{ij}\right]$, $\overline{\mathrm{I}}$ is normalized ideal solution, $W = diag\left(\sqrt{w_1}, \sqrt{w_2}, \ldots, \sqrt{w_n}\right)$ is the diagonal matrix where $w_1 + w_2 + \ldots + w_n = 1$ are the weights assigned to the variables.

When the covariance matrix is equal to the identity matrix, the Mahalanobis distance simplifies to the Euclidean distance.

Calculations regarding covariance matrix C (for 2016 and 2022), data matrix Z and diagonal matrix are presented in Tables 3–6 respectively.

Table 3. Covariance matrix C of the data matrix Z for 2016 (source: own calculations based on OECD, 2024)

variable	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE
SNG_NO_ENT	0.01693	–0.00018	–0.00072	–0.00023	–0.00045
SNG_REV_GDP	–0.00018	0.00728	0.00630	0.00739	0.00654
SNG_REV_GGR	–0.00072	0.00630	0.00652	0.00641	0.00647
SNG_EXP_GDP	–0.00023	0.00739	0.00641	0.00751	0.00667
SNG_EXP_GGE	–0.00045	0.00654	0.00647	0.00667	0.00664

Table 4. Covariance matrix C of the data matrix Z for 2022 (source: own calculations based on OECD, 2024)

variables	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE
SNG_NO_ENT	0.01736	0.00004	–0.00059	0.00007	–0.00064
SNG_REV_GDP	0.00004	0.00711	0.00636	0.00703	0.00648
SNG_REV_GGR	–0.00059	0.00636	0.00663	0.00627	0.00645
SNG_EXP_GDP	0.00007	0.00703	0.00627	0.00700	0.00644
SNG_EXP_GGE	–0.00064	0.00648	0.00645	0.00644	0.00659

Table 5. Matrix Z for 2016 and 2022 (source: own calculations based on OECD, 2024)

Year	2016					2022				
variables / country	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE
Australia	0.023	0.174	0.224	0.175	0.214	0.022	0.162	0.209	0.184	0.223
Austria	0.237	0.188	0.162	0.192	0.214	0.237	0.201	0.169	0.193	0.158
Belgium	0.053	0.286	0.237	0.283	0.230	0.052	0.277	0.233	0.285	0.233
Canada	0.107	0.324	0.339	0.337	0.352	0.103	0.330	0.328	0.331	0.344
Germany	0.137	0.231	0.216	0.226	0.223	0.136	0.258	0.229	0.251	0.221
Mexico	0.020	0.133	0.242	0.129	0.197	0.019	0.129	0.245	0.125	0.200

End of Table 5

Year	2016					2022				
variables / country	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE
Spain	0.174	0.220	0.246	0.222	0.227	0.176	0.250	0.244	0.261	0.240
Switzerland	0.263	0.227	0.275	0.225	0.284	0.251	0.227	0.277	0.218	0.287
United States	0.118	0.185	0.237	0.195	0.224	0.118	0.209	0.250	0.204	0.226
Chile	0.019	0.040	0.074	0.039	0.067	0.018	0.042	0.063	0.039	0.064
Colombia	0.023	0.137	0.136	0.137	0.126	0.022	0.123	0.169	0.119	0.146
Costa Rica	0.016	0.014	0.024	0.014	0.022	0.016	0.018	0.019	0.018	0.020
Denmark	0.018	0.377	0.298	0.371	0.300	0.017	0.323	0.279	0.320	0.309
Estonia	0.059	0.102	0.107	0.100	0.107	0.060	0.100	0.108	0.103	0.113
Finland	0.056	0.238	0.185	0.241	0.187	0.061	0.236	0.186	0.236	0.192
France	0.525	0.121	0.096	0.119	0.091	0.527	0.121	0.094	0.119	0.089
Greece	0.031	0.041	0.034	0.037	0.033	0.034	0.040	0.033	0.042	0.034
Hungary	0.323	0.067	0.064	0.064	0.060	0.336	0.061	0.060	0.063	0.056
Iceland	0.213	0.135	0.098	0.133	0.127	0.172	0.136	0.131	0.151	0.138
Ireland	0.006	0.024	0.037	0.023	0.037	0.006	0.021	0.038	0.022	0.045
Israel	0.029	0.060	0.068	0.059	0.065	0.028	0.061	0.067	0.058	0.067
Italy	0.130	0.155	0.139	0.152	0.134	0.137	0.154	0.134	0.153	0.118
Japan	0.014	0.166	0.196	0.165	0.183	0.014	0.196	0.208	0.184	0.187
Korea	0.005	0.153	0.187	0.147	0.195	0.005	0.195	0.208	0.190	0.202
Latvia	0.061	0.104	0.118	0.101	0.118	0.023	0.108	0.126	0.107	0.115
Lithuania	0.021	0.089	0.109	0.083	0.106	0.021	0.097	0.114	0.095	0.113
Luxembourg	0.169	0.056	0.054	0.052	0.054	0.156	0.052	0.049	0.054	0.053
Netherlands	0.023	0.149	0.143	0.147	0.146	0.020	0.140	0.135	0.137	0.137
New Zealand	0.016	0.046	0.049	0.047	0.053	0.015	0.041	0.046	0.048	0.050
Norway	0.082	0.177	0.135	0.180	0.153	0.069	0.126	0.082	0.135	0.152
Poland	0.074	0.140	0.153	0.137	0.145	0.078	0.144	0.149	0.147	0.146
Portugal	0.030	0.065	0.064	0.060	0.058	0.031	0.069	0.066	0.069	0.068
Slovak Republic	0.535	0.076	0.082	0.070	0.073	0.551	0.082	0.084	0.085	0.087
Slovenia	0.102	0.090	0.087	0.087	0.084	0.103	0.095	0.090	0.096	0.089
Sweden	0.031	0.262	0.218	0.266	0.234	0.031	0.255	0.218	0.249	0.228
United Kingdom	0.006	0.104	0.114	0.107	0.112	0.006	0.096	0.096	0.098	0.092

Table 6. Matrix W for 2016 and 2022 (source: own calculations based on OECD, 2024)

Variables	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE
SNG_NO_ENT	0.4472	0.0000	0.0000	0.0000	0.0000
SNG_REV_GDP	0.0000	0.4472	0.0000	0.0000	0.0000
SNG_REV_GGR	0.0000	0.0000	0.4472	0.0000	0.0000
SNG_EXP_GDP	0.0000	0.0000	0.0000	0.4472	0.0000
SNG_EXP_GGE	0.0000	0.0000	0.0000	0.0000	0.4472

In this paper, two country rankings were determined:

- using the vector normalization of the variables and the Euclidean metric to calculate the distance between the objects (denoted by H_VE) and,
- susing the normalisation of the vector of variables and the Mahalanobis metric to calculate the distance between objects (denoted by H_VM).

The focus was on the year 2022, but for comparative purposes, the results for 2016 were also presented. To build the models data from the OECD database for 36 countries was used. The statistical description of variables used to build the rankings is presented in Table 7.

The first variable: SNG_NO_ENT shows a strongly positively skewed distribution (skewness = 2.2) with heavy tails (kurtosis = 5.0), as most values are concentrated at the lower end with some significantly higher outliers. In contrast, SNG_REV_GDP, SNG_EXP_GDP, SNG_REV_GGR, and SNG_EXP_GGE exhibit relatively symmetric distributions (skewness close to 0) with low or moderate kurtosis, indicating balanced spreads.

The analysis of the data presented in Figure 1 allows one to draw several conclusions. First, OECD countries exhibit significant variation in the number of subnational government entities per 100 000 people (to avoid the influence of country size, this indicator was calculated relative to population). The SNG_NO_ENT indicator in 2016 and 2022 was the highest in Slovakia, followed by France and Hungary, and the lowest in Korea, as well as the United Kingdom and Ireland. In 2016, This indicates that the territorial governance system is not correlated with SNG_NO_ENT, as both unitary states appear among the countries with the highest and lowest indicators. The same conclusion can be drawn from the comparison of federal countries shown on the Figure 1, such as Austria and Australia, as well as Belgium and Switzerland.

OECD countries also remain diverse in terms of subnational government revenue as a percentage of GDP (Figure 2). Notwithstanding, this differentiation is not as strong as in the case of the number of subnational government entities. Costa Rica is an OECD country in which subnational government revenue constituted only 1.7% of GDP in 2022 (1.3% in 2016). The leaders in this respect were Canada and Denmark (for both 2016 and 2022) – in these countries subnational government revenue constitutes over 30% of GDP.

In terms of subnational government revenue as a percentage of general government revenue (Figure 3), one can observe similar patterns like in case of SNG_REV_GDP. Costa Rica both in 2016 and 2022 was an OECD country in which subnational government revenue constitutes the lowest share of GDP, while Denmark, Canada and Switzerland (in 2016 and 2022) were the leaders with the subnational government revenue at above 60% of general government revenue.

Table 7. Basic descriptive statistics of variables for 2022 (source: own elaboration, 2024)

Variables	mean	median	min	max	StDev	skewness	kurtosis
SNG_NO_ENT	10.0	4.2	0.5	54.0	13.1	2.2	5.0
SNG_REV_GDP	13.4	11.9	1.7	30.7	8.0	0.5	–0.6
SNG_REV_GGR	32.5	29.6	4.3	73.2	18.4	0.4	–1.0
SNG_EXP_GDP	13.5	12.1	1.6	31.0	7.9	0.5	–0.5
SNG_EXP_GGE	31.4	29.7	4.3	74.1	17.8	0.5	–0.4

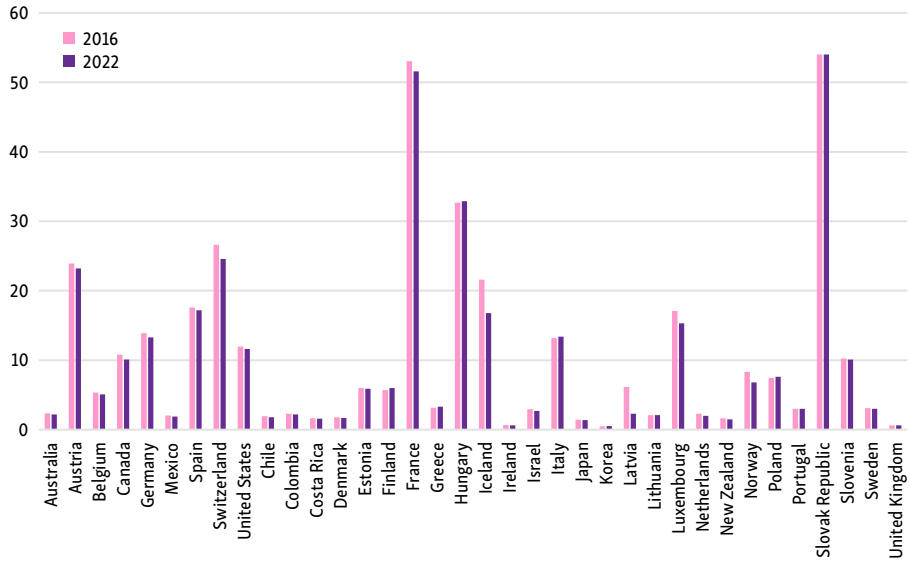


Figure 1. Number of subnational government entities per 100 000 people (SNG_NO_ENT) in 2016 and 2022 (source: authors' calculations based on OECD, 2024)

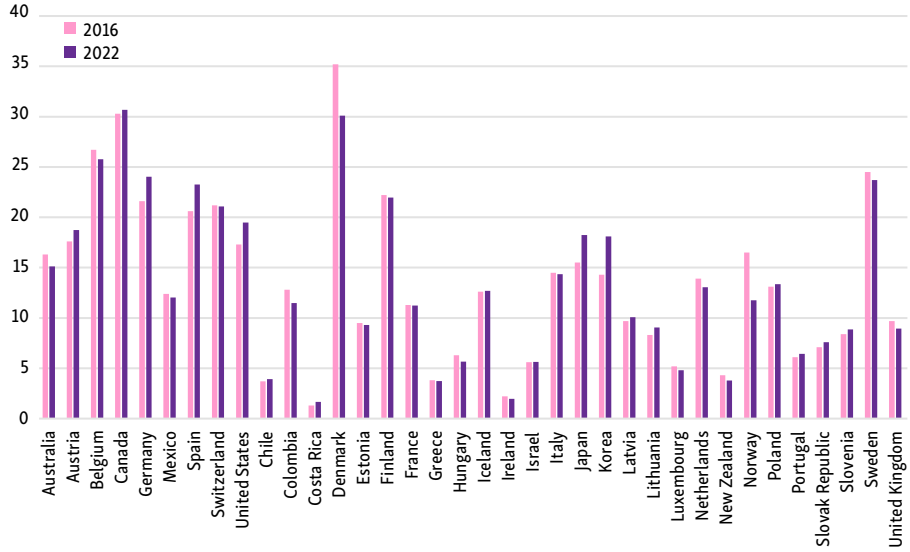


Figure 2. Subnational government revenue as a percentage of GDP (SNG_REV_GDP) in 2016 and 2022 (source: OECD, 2024)

As far as subnational government expenditure is concern, there is no astonishment when it comes to its relationship with revenues. One can notice some common patterns in Figures 2 and 4. This was considered in the research methods used, which will be developed later in the paper. Nonetheless, as was already mentioned, a higher share of SNG expenditures in GDP may relate to a broader scope of expenditure autonomy of subnational governments in the economy. That would be a case of Denmark, Canada and Belgium (Figure 4).

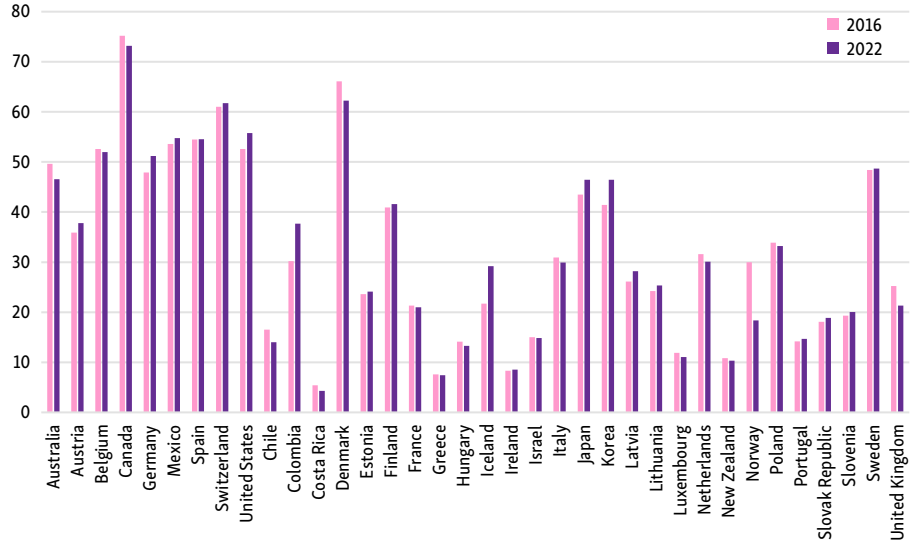


Figure 3. Subnational government revenue as a percentage of general government revenue (SNG_REV_GGR) in 2016 and 2022 (source: OECD, 2024)

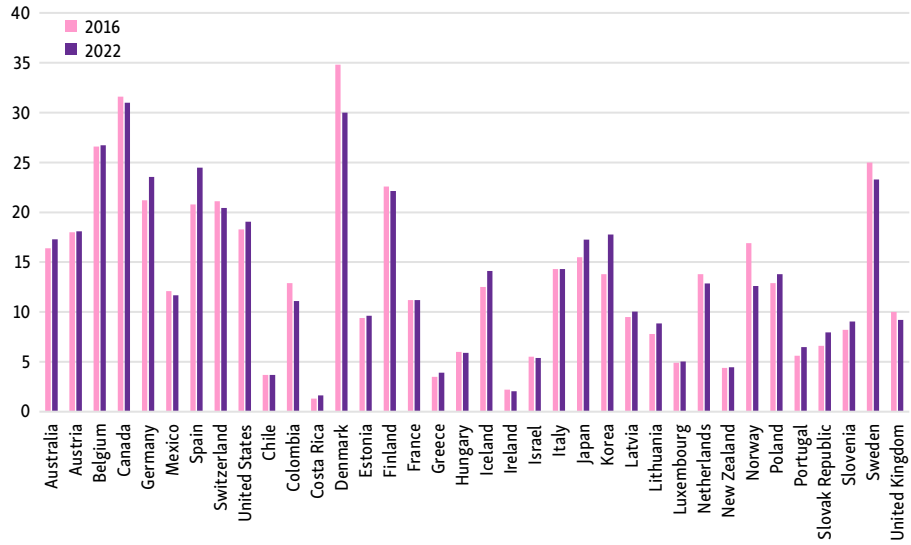


Figure 4. Subnational government expenditure as a percentage of GDP (SNG_EXP_GDP) in 2016 and 2022 (source: OECD, 2024)

Finally, subnational government expenditure as a percentage of general government expenditure was explored (Figure 5). Within this context, the analysis leads to at least two conclusions: First, OECD countries are very diverse in terms of SNG_EXP_GGE, with subnational government expenditure as a percentage of general government expenditure ranging from 4.3 in Costa Rica to 74.1 in Canada in 2022 (4.8 and 76.2 in 2016 respectively). Second, among the countries with the highest level of the indicator, there are both unitary and federal

states, such as Canada, Denmark, Switzerland, Sweden. However, among the countries with the lowest levels of SNG_EXP_GGE there are only unitary states, such as Ireland, Costa Rica, Greece.

Some of the variables, as already mentioned, showed a correlation between each other, therefore, we used the modified Hellwig method as a structured tool for multivariate comparative analysis, which allows for a synthetic assessment of entities (e.g., countries) based on multiple variables, which may additionally be linearly correlated. The modification involved using the Mahalanobis measure instead of the classical Euclidean distance from the development pattern. This allowed for the interdependencies between variables (which is crucial in multivariate analysis, where variables are often correlated). The analysis of the linear dependencies of the variables and relevant commentary are included in Table 8.

The results in correlation matrix reveals that subnational government revenue as a percentage of GDP (SNG_REV_GDP) and subnational government expenditure as a percentage of GDP (SNG_EXP_GDP) are highly positively correlated (0.997), indicating a strong relationship between these variables, which is strongly justified in terms of subnational government

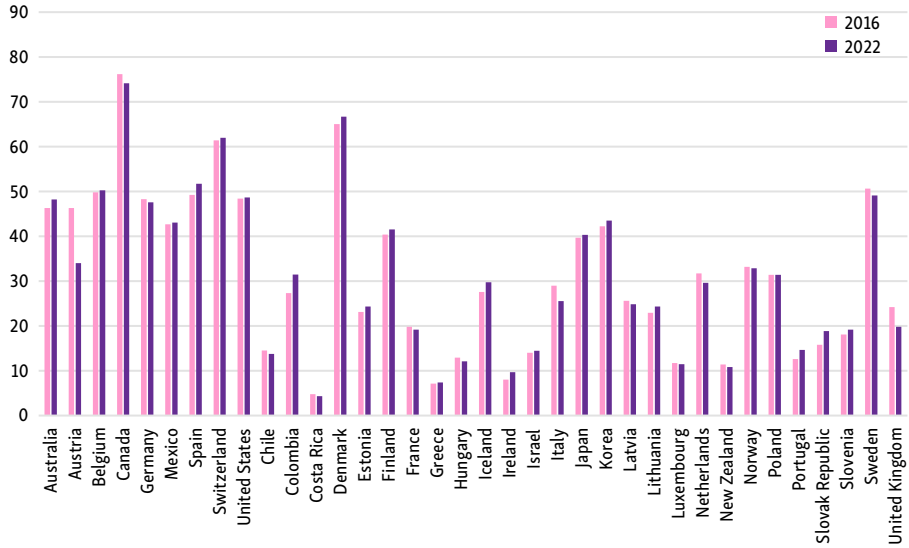


Figure 5. Subnational government expenditure as a percentage of general government expenditure (SNG_EXP_GGE) in 2016 and 2022 (source: OECD, 2024)

Table 8. Correlation table for variables (source: own calculations based on OECD, 2024)

variables	SNG_NO_ENT	SNG_REV_GDP	SNG_REV_GGR	SNG_EXP_GDP	SNG_EXP_GGE
SNG_NO_ENT	1.000	0.004	–0.055	0.006	–0.060
SNG_REV_GDP	0.004	1.000	0.927	0.997	0.947
SNG_REV_GGR	–0.055	0.927*	1.000	0.920	0.977
SNG_EXP_GDP	0.006	0.997*	0.920*	1.000	0.948
SNG_EXP_GGE	–0.060	0.947*	0.977*	0.948*	1.000

Note: **p-value: $p < 0.005$.

finances. Similarly, subnational government revenue as a percentage of general government revenue (SNG_REV_GGR) and subnational government expenditure as a percentage of general government expenditure (SNG_EXP_GGE) also demonstrate a very high positive correlation (0.977), suggesting that these metrics tend to increase together. In contrast, number of subnational government entities per 100 000 people (SNG_NO_ENT) has very weak or negligible correlations with all other variables, highlighting its independence from the financial indicators. Analysis of the above results makes the use of the Mahalanobis metric fully justified.

Inclusion the high correlation between the variables used in the construction of the synthetic variable increased the credibility and statistical reliability of the results, increased the method's resistance to information redundancy and variable redundancy, and enabled a more realistic modelling of the distance of objects from the pattern based on the actual data distribution. We have included the justification for the choice of this method in this section, also citing the latest applications of the Hellwig method in regional and financial analyses, where the Mahalanobis measure is considered a modern approach to creating multidimensional comparative analyses, including those using panel data.

5. Results

Based on methodology presented in part 3 two country rankings were determined:

- using the vector normalization of the variables and the Euclidean metric to calculate the distance between the objects (denoted as H_VE) and,
- using the normalisation of the vector of variables and the Mahalanobis metric to calculate the distance between objects (denoted as H_VM).

The results obtained – the values of synthetic measure of CSfd and rank-ordering of OECD countries for 2016 and 2022 – with the assumption that the weights of each variable will be equal – are presented in Table 9.

The conclusion that emerges from the analysis of the results is that OECD countries are diverse in terms of CSfd. The results thus allowed for a positive verification of the first research hypothesis. The fiscal decentralization system in 2022 was the most comprehensive in the Slovak Republic, Switzerland and Canada (considering the normalization of the vector of variables and the Mahalanobis metric used to calculate the distance between objects, H_VM), and the least comprehensive in Costa Rica, Mexico and Greece. The difference between the leader and the country that took last place in the ranking is over sevenfold. In 2016 Germany was the leader, followed by Switzerland and the Slovak Republic, while Costa Rica, as in 2022, also ranked last among OECD countries.

When analysing the countries with the lowest and highest scores in terms of comprehensiveness of fiscal decentralization (CSfd), it should be noted that Costa Rica has long been characterized by a highly centralized fiscal structure. Although formally established, local governments rely heavily on transfers from the central budget, and their fiscal and budgetary autonomy is limited (Ebel & Yilmaz, 2002). Furthermore, administrative costs and insufficient human and technical resources of local governments limit their ability to effectively manage local finances (Rodden, 2004; Treisman, 2002). Our results are not surprising considering the recent literature indicating a low level of fiscal decentralization in Costa Rica (Pinilla-Rodríguez & Hernández-Medina, 2024). As Nickson (2023) points out in his analysis

Table 9. The values of CSfd and rank-ordering of OECD countries for 2016 and 2022 obtained by the variants of Hellwig's measures (source: own calculations based on OECD, 2024)

CSfd 2016				CSfd 2022			
Country	H_VE	Country	H_VM	Country	H_VE	Country	H_VM
Switzerland	0.599	Germany	0.470	Switzerland	0.597	Slovak Republic	0.499
Canada	0.513	Switzerland	0.457	Spain	0.518	Switzerland	0.488
Spain	0.494	Slovak Republic	0.413	Austria	0.485	Canada	0.459
Austria	0.487	France	0.369	Canada	0.476	France	0.430
Germany	0.457	Spain	0.339	France	0.467	Hungary	0.348
France	0.429	Hungary	0.329	Germany	0.466	United States	0.329
United States	0.416	Denmark	0.322	United States	0.430	Spain	0.309
Denmark	0.412	Italy	0.321	Slovak Republic	0.420	Austria	0.299
Belgium	0.410	Iceland	0.316	Belgium	0.387	Germany	0.290
Sweden	0.375	Belgium	0.310	Denmark	0.372	Denmark	0.281
Finland	0.365	Poland	0.285	Iceland	0.365	Iceland	0.260
Slovak Republic	0.357	Luxembourg	0.243	Finland	0.359	Poland	0.257
Iceland	0.355	Netherlands	0.242	Sweden	0.351	Korea	0.244
Italy	0.335	Korea	0.239	Italy	0.337	Sweden	0.238
Norway	0.321	Latvia	0.238	Hungary	0.314	Estonia	0.236
Australia	0.311	Australia	0.233	Australia	0.301	Luxembourg	0.234
Hungary	0.290	Japan	0.232	Poland	0.295	Slovenia	0.219
Poland	0.287	Slovenia	0.229	Japan	0.293	Netherlands	0.204
Japan	0.281	Sweden	0.229	Korea	0.288	Finland	0.198
Mexico	0.272	Lithuania	0.215	Mexico	0.268	Lithuania	0.196
Korea	0.261	Estonia	0.214	Norway	0.253	Italy	0.190
Netherlands	0.247	Austria	0.210	Slovenia	0.232	Colombia	0.182
Colombia	0.230	Norway	0.193	Colombia	0.232	Latvia	0.175
Latvia	0.222	Finland	0.187	Netherlands	0.230	Japan	0.167
Slovenia	0.214	Portugal	0.175	Estonia	0.218	Belgium	0.145
Estonia	0.211	Colombia	0.166	Latvia	0.199	Israel	0.140
Luxembourg	0.196	Canada	0.143	Luxembourg	0.197	Portugal	0.140
United Kingdom	0.177	Israel	0.128	Lithuania	0.182	Chile	0.137
Lithuania	0.169	Greece	0.117	United Kingdom	0.155	Norway	0.135
Israel	0.119	United Kingdom	0.100	Portugal	0.132	Australia	0.127
Portugal	0.118	Mexico	0.097	Israel	0.121	United Kingdom	0.126
Chile	0.097	Chile	0.086	Chile	0.095	Ireland	0.110
New Zealand	0.085	New Zealand	0.066	New Zealand	0.083	New Zealand	0.099
Greece	0.075	United States	0.065	Greece	0.082	Greece	0.091
Ireland	0.046	Ireland	0.049	Ireland	0.050	Mexico	0.088
Costa Rica	0.032	Costa Rica	0.035	Costa Rica	0.036	Costa Rica	0.068

of fiscal decentralization processes in Latin America, Costa Rica (and El Salvador) are the only countries in the region that have not seen an increase in the number of municipalities. Furthermore, Costa Rica (and Paraguay) are exceptions in the region in terms of the share of local government expenditures in total government expenditures – only in these two countries this share has stagnated. In assessing the decentralization process, the author therefore describes Costa Rica as a "late comer".

Switzerland is a classic example of high levels of fiscal decentralization thanks to the high autonomy of cantons and local communities. Despite its comparatively small territory, Switzerland has an extensive federal structure. Its subnational jurisdictions, the cantons, enjoy wide-ranging political and fiscal freedom. The fiscal autonomy of lower-tier governments is particularly extensive on the revenue side of the budget (Schaltegger & Schmid, 2023, p. 383).

Historically a relatively centralized country, Slovakia has undergone very significant administrative and fiscal reforms in recent decades, increasing the number and powers of local governments. Fiscal decentralization that is dated back to 2005 (Ministry of Finance of the Slovak Republic, n.d.) was preceded by transfers of powers between 2002–2004 and a new tax system in 2004. In 2009 the program budgeting in the territorial self-administrations was introduced (on the basis of an amendment of the act of budgetary rules of the territorial self-administrations dated September 2007). Reforms have introduced greater decentralization of expenditures and revenues. For instance, according to the Constitution of the Slovak Republic, certain legal obligation and thus also a tax or fee obligation may be imposed also by municipal authorities. This means in practice, that in terms of determining taxes and fee rates, the rate is, in principle, constituted by the municipality (Felis et al., 2025, p. 69). In a study of local government systems in Eastern Europe, on the basis of such characteristics like high scope of functions provided by local governments, the direct election of mayors, and high level of financial autonomy Slovakia was named one of the champions of decentralisation (Swianiewicz, 2014, p. 304). It's worth explaining that, as recently as the 1990s, governance structures in Slovakia remained centralized. This had a negative impact on prosperity, leading to weaker regional economic and labor market performance. Slovakia lost the opportunity to use EU transfers more productively. This provided a strong incentive to implement a series of changes from the unsatisfactory public governance model to significantly greater decision-making and financial autonomy for the regions (Marcinčin, 2024). Thus, the small number of inhabitants per local government unit and increased budgetary autonomy translate into a very high level of comprehensiveness of fiscal decentralization.

6. Discussion

As already explained, quantitative empirical research on the comprehensiveness of fiscal decentralization has not been undertaken to date – no indicator has been proposed in this regard. This means that our innovative study is difficult to compare to similar studies. Nevertheless, from a broader perspective, i.e., comparing our results to other fiscal decentralization rankings, the presented results are not surprising.

In a study by Wichowska (2021, p. 203), Denmark, Finland, and Sweden were categorized as countries with the highest degree of decentralization. In our study, these countries also achieved a high degree of comprehensive fiscal decentralization, but were overtaken by,

for example, Switzerland, which was not included in the author's analysis (focused on EU countries). Moreover, the author based her typology on only one measure: the local revenue-to-GDP ratio in the EU Member States. As the author explained, other variables were not considered, as "their inclusion would extend beyond the conceptual framework of this research".

Similar results are found in the analysis by Onofrei et al. (2022), which compiled two comparisons: expenditure decentralization and revenue decentralization in EU member states. The first was based on a single measure – total local expenditures as a percentage of total central expenditures, while the second was based on data on total local revenues as a percentage of total central revenues (for the period 2001–2019, every three years). Denmark, Finland, and Sweden (with levels of fiscal decentralization between 80% and 90%) were the countries with the highest levels of fiscal decentralization, while the lowest levels of fiscal decentralization were reported by Greece and Ireland (similar to our study).

Although the studies mentioned did not propose new measures of fiscal decentralization, they indicate their potential applications. Onoferi et al. (2022) used fiscal decentralization indicators to analyze the impact of local fiscal consolidation efforts on regional development (by employing the Generalized Linear Model, GLM). There are a number of analyses of the impact of fiscal decentralization on, for example, the supply of basic public services (Wang et al., 2024), economic growth (Bahasoan et al., 2025), or fiscal discipline (Olaide et al., 2025).

Additionally, it is worth pointing out studies in which fiscal decentralization is an explanatory variable when searching for the sources and causes of its development or limitations in this regard. For example, W. Li and D. Li (2024) undertook interesting research on the impact of technological innovation on the fiscal decentralization of local governments in China.

Our analysis – creating a synthetic measure of Roy Bahl's first rule regarding the comprehensiveness of fiscal decentralization – carries similar implications. Our results allow for further research to analyze the causes and consequences of high/low levels of system comprehensiveness. By analyzing, for example, its impact on the efficiency of public service delivery or GDP growth, it will be possible – for the first time – to determine how important this factor in public management may be.

Our research also has methodological implications. In constructing the synthetic measure, we used not one but five variables, demonstrating the potential application of the Mahalanobis metric in the case of dependencies between variables.

What is important to note is that the ordering changes when it is created using the vector normalization of the variables and the Euclidean metric used to calculate the distance between the objects (H_VE). The leader is now Switzerland, followed by Spain and Austria, while Costa Rica closes the order, where the value of the synthetic measure CSfd is just 0.068. Greece remains among the three countries with the lowest CSfd value, although Mexico's place in this group has been taken by Ireland (Figure 6, Figure 8).

The order, depending on the metric used, also changes regarding data for 2016. In the ranking based on the Euclidean metric used to calculate distances between objects (H_VE), Switzerland led the way, followed by Canada, Spain, and Austria. In the ranking based on the Mahalanobis metric, Germany took first place, with Switzerland dropping to second, followed by the Slovak Republic. Nevertheless, Costa Rica finished last in both the H_VE and H_VM rankings (Figure 7, Figure 9).

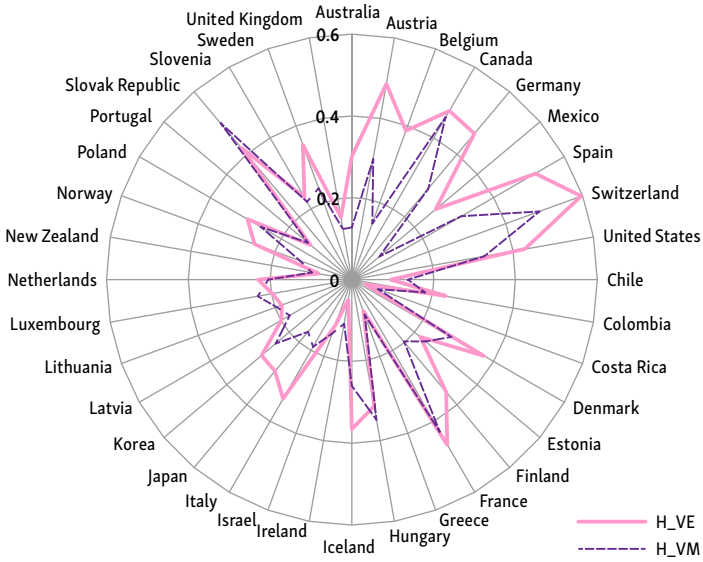


Figure 6. The values of CSfd in OECD countries in 2022 obtained by the variants of Hellwig's measures (source: own calculations based on OECD, 2024)

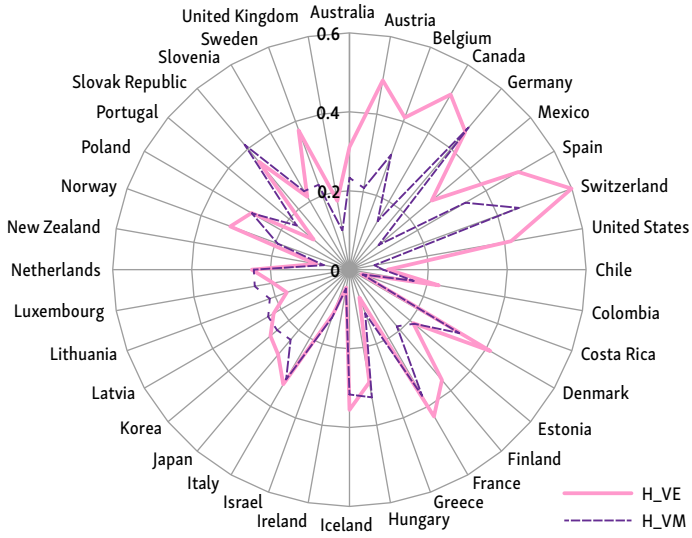


Figure 7. The values of CSfd in OECD countries in 2016 obtained by the variants of Hellwig's measures (source: own calculations based on OECD, 2024)

The differences in rankings for all countries under evaluation for 2022 are visualised in Figure 7. The differences in rankings are due to the use of a different metric to measure the distance between objects, as variables from SNG_REV_GDP to SNG_EXP_GGE showed a high linear dependency, hence these variables were less significant when constructing the synthetic indicator H_VM.

The differences between the rankings obtained from the two variants of the modified Hellwig method – H_VE (using the Euclidean metric) and H_VM (using the Mahalanobis metric) – result from the presence of strong collinearity (linear correlation) between some of the variables used in the study – particularly variables related to local government revenues and expenditures (e.g., SNG_REV_GDP, SNG_REV_GGR, SNG_EXP_GDP, SNG_EXP_GGE). These indicators are linearly correlated, as confirmed by correlation analyses conducted during the preliminary data exploration stage. In the case of the H_VE measure, which is based on the Euclidean metric, each variable is treated as equivalent and independent, regardless of whether there is a strong correlation between them. This design leads to an overrepresentation

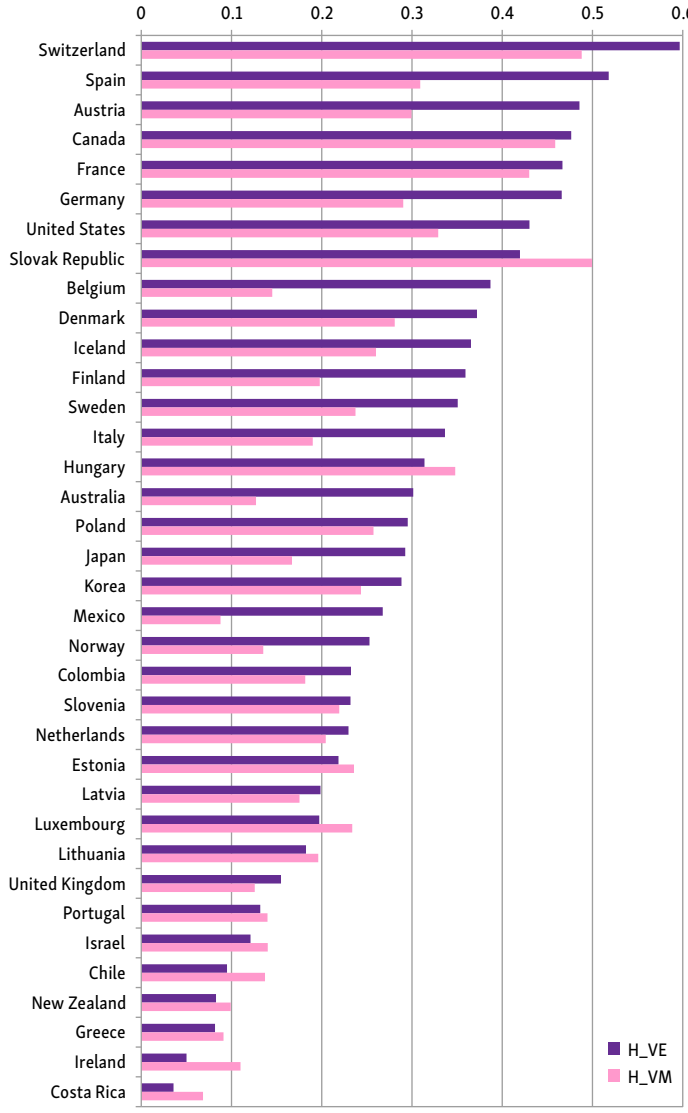


Figure 8. The differences in values of CSfd in OECD countries in 2022 obtained by the variants of Hellwig's measures (source: own calculations based on OECD, 2024)

of the influence of groups of highly correlated variables in the synthetic CSfd index, which can lead to overestimation or underestimation of the final values for individual countries. The H_VM measure, on the other hand, based on the Mahalanobis metric, considers the full covariance structure of the variable set. This means that the influence of correlated variables is statistically compensated for – the greater the linear relationship between variables, the smaller the contribution of such variables to the distance from the benchmark. As a result, the H_VM ranking better reflects the actual, independent differences between countries in terms of fiscal decentralization, reducing the effect of multiple counting. For example, in the case of Belgium and Mexico, the difference in ranking position measured using the synthetic CSfd variable between H_VE and H_VM reaches 16 and 15 ranking positions, respectively.

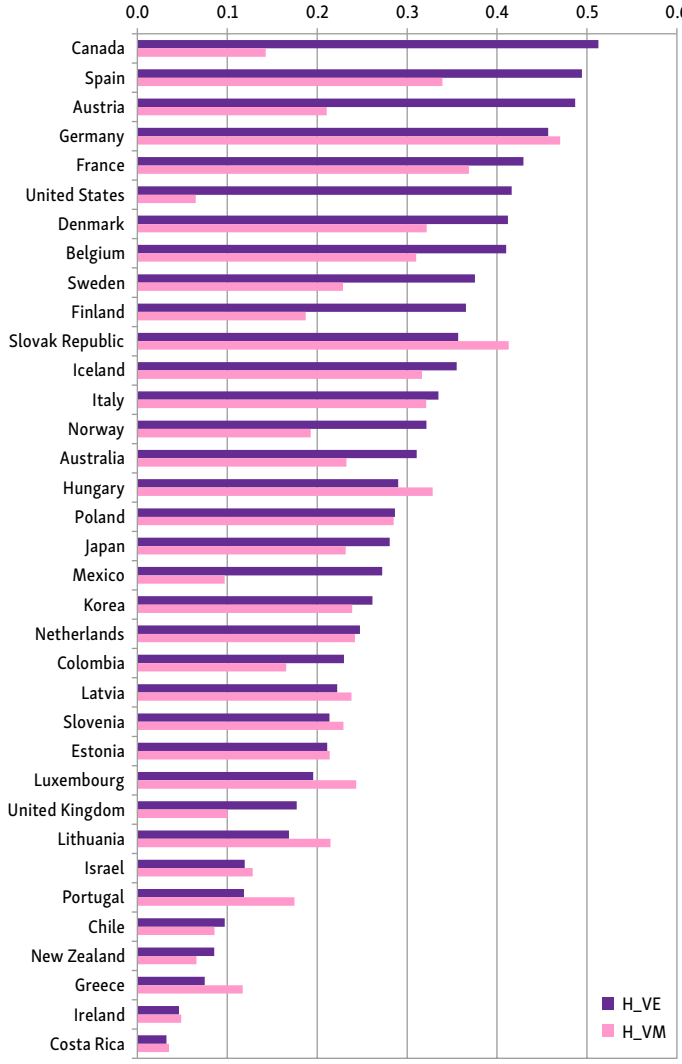


Figure 9. The differences in values of CSfd in OECD countries in 2016 obtained by the variants of Hellwig's measures (source: own calculations based on OECD, 2024)

This is because, when we correct the distance between objects for the high collinearity of variables, the SNG_NO_ENT variable makes a significant contribution to shaping the ranking position. This means that in H_VE, their result was strongly dependent on correlated variables (SNG_REV_GDP, SNG_EXP_GGE, SNG_EXP_GGE), which was corrected in H_VM.

Analysis of the data allows one to notice that, in the case of some countries the differences in CSfd values are significant. In 2022 this is especially the case of Ireland and Costa Rica, where H_VM is approximately twice as large as H_VE (in 2016 the is especially true for United States and Canada). Out of the 36 countries under scrutiny, for 12 the value of CSfd calculated on Mahalanobis metric basis (H_VM) is higher than value of CSfd calculated on Euclidean metric basis (denoted by H_VE), whereas for 24 countries the situation is the opposite. Nevertheless, for 18 of 36 countries analysed, the changes in CSfd values do not exceed 20%.

Taking this into account, the consistency of the rankings obtained using the two approaches (H_VE, H_VM) was verified. For this purpose, Pearson and Spearman coefficients were calculated. The results are presented in Table 10.

Finally, to confirm the statistical consistency of both rankings (H_VE and H_VM) for 2022, Pearson's (r = 0.798) and Spearman's (rs = 0.797) correlation coefficients were calculated, both significant at $p < 0.005$. Despite using two different metrics, both rankings converge in their overall pattern, which already suggests robustness. To provide a stronger justification for the credibility and reliability of the findings, additional consistency checks were performed for 2022 and 2016. For rankings based on the Euclidean metric (H_VE), the correlations between the two years were very high (Pearson's r = 0.987; Spearman's rs = 0.986), while for Hellwig's method with the Mahalanobis metric (H_VM), the correlation coefficients were moderate (Pearson's r = 0.650; Spearman's rs = 0.665). These differences stem from the fact that the Mahalanobis metric explicitly incorporates correlations among variables, which inevitably affects the relative positioning of units. Nevertheless, the high degree of convergence, especially for the Euclidean metric, demonstrates that the rankings derived using Hellwig's method of linear ordering are not only consistent but also methodologically reliable. This indicates that the observed differences arise from the assumptions underlying the applied metrics rather than from computational errors or random variation. The results thus allowed for a positive verification of the second research hypothesis.

Table 10. Pearson and Spearman Coefficients of rankings for 2016 and 2022 (source: own calculations based on OECD, 2024)

2016					
Pearson coefficient	H_VE	H_VM	Spearman coefficient	H_VE	H_VM
H_VE	1.000	0.668*	H_VE	1.000	0.599*
H_VM	0.668*	1.000	H_VM	0.599*	1.000
2022					
Pearson coefficient	H_VE	H_VM	Spearman coefficient	H_VE	H_VM
H_VE	1.000	0.798*	H_VE	1.000	0.797*
H_VM	0.798*	1.000	H_VM	0.797*	1.000

Note: **p-value*: $p < 0.005$.

7. Conclusions

The empirical verification of Roy Bahl's first rule reveals not only heterogeneity in the comprehensiveness of fiscal decentralization across OECD countries but also limitations in its measurement. By operationalizing the concept of "comprehensiveness" using a synthetic index based on five fiscal and administrative indicators, this study leads to several conclusions – policy recommendations and practical implications.

From a policy perspective, the results suggest that strengthening fiscal decentralization requires more than adjustments to revenue and expenditure allocation. The countries that ranked highest in the final rankings illustrate that a high level of fiscal decentralization coherence is not solely a function of revenues and expenditures, but rather of coherence between the institutional structure and administrative capacity, the liabilities underlying expenditures and the revenues required to achieve them. This has several implications.

Firstly, policymakers should go beyond single indicators (e.g., the share of subnational expenditures) and focus on the internal coherence of the decentralization framework, ensuring coherence of powers, capacity, and autonomy.

Secondly, as there is no single, universal model for fiscal decentralization, thus decentralization policies need to be tailored. Policymakers should recognize that there is no one-size-fits-all model for fiscal decentralization. Country-specific approaches should be adopted based on economic, political, and administrative contexts. It follows that countries with low system comprehensiveness may require phased reforms that build administrative and fiscal capacity in tandem.

Thirdly, there is a need to systematically track the effectiveness of decentralization over time, which would enable assessment of the impact of reforms and appropriate adjustments to strategies. Our analysis leads to the conclusion that fiscal decentralization should be viewed strategically, as an important element of public governance, rather than a static system.

Well-designed and implemented decentralization can increase trust in public institutions, enable more flexible management, and improve allocative efficiency – but only if systemic comprehensiveness is treated as a deliberate design goal, not a byproduct of piecemeal reforms.

In terms of decentralization analysis methodology, two rankings were established using Hellwig's method: one based on Euclidean distance (H_VE) and the other using the Mahalanobis metric (H_VM). The results indicate that the most comprehensive fiscal decentralisation systems are found in the Slovak Republic, Switzerland and Canada (H_VM ranking), while Costa Rica, Mexico and Greece rank lowest. The rankings differ when the Euclidean metric is used, with Switzerland emerging as the leader, followed by Spain and Austria.

Regarding consistency between rankings, despite differences in ranking methodologies, a strong positive correlation exists between the rankings derived from H_VE and H_VM. Pearson's correlation coefficient ($r = 0.798$) and Spearman's rank correlation coefficient ($r_s = 0.797$) confirm the overall consistency of the results. The study also finds that in the case of half of the countries, differences between the two CSfd measures do not exceed 20%, reinforcing the reliability of the findings.

Our study, still, is subject to several limitations. First, the analysis focuses on the first of Bahl's twelve rules, which limits the scope of inference to the comprehensiveness of fiscal

decentralization and does not yet capture its full, multidimensional nature. Second, the availability of OECD data limits the set of indicators, potentially omitting qualitative aspects such as political commitment, management culture, or informal practices. Third, the analysis focuses on creating a synthetic measure, assessing the level and comparison of OECD countries in terms of the comprehensiveness of fiscal decentralization. Due to the framework of the study, the analysis did not include causal relationships or capturing the dynamics of decentralization processes over time, although the results of our research allow for this in the future.

Future research plans to expand the set of rules for assessing decentralization, including principles related to the relationship between fiscal autonomy and accountability, the stability of local government revenue sources, the creditworthiness and debt capacity of local governments, and transparency and accountability in the allocation of central transfers. At the same time, consideration is being given to the use of alternative methods for constructing synthetic variables, such as Principal Component Analysis (PCA), factor analysis, the TOPSIS method with weights determined, for example, by the entropy method, the classic MCDM (Multi-Criteria Decision Making) approach, as well as further variants of the Hellwig method based on various metrics and data normalization methods. Additionally, a significant direction for research development will be a dynamic approach, utilizing panel data and enabling the analysis of changes in the level of decentralization over time, considering factors such as fiscal reforms, budget crises, and public service decentralization processes. A comparative approach, including benchmarking groups of countries with different political systems (e.g., federal vs. unitary states, European Union countries vs. non-EU OECD countries), will additionally allow for the assessment of compliance with individual rules and the identification of the effects of their application in diverse institutional and economic contexts. Our results allow also to extend this work by using a synthetic measure and demonstrating the impact of fiscal decentralization comprehensiveness on socioeconomic outcomes. Such evidence would allow policymakers to treat fiscal decentralization not as an abstract principle, but as a measurable and manageable dimension of public sector reform.

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Author contributions

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References

Adamowicz, M., & Janulewicz, P. (2012). Wykorzystanie metod wielowymiarowych w określeniu pozycji konkurencyjnej gminy na przykładzie województwa lubelskiego [The use of multidimensional methods in determining the competitive position of a commune on the example of the Lublin Voivodeship]. *Metody Ilościowe w Badaniach Ekonomicznych – Quantitative Methods in Economic Research*, *13*(1), 17–28.

Bahasoan, A. N., Rahmatia, Tajibu, M. J., & Yunus, A. K. F. A. (2025). The impact of fiscal decentralization on economic growth: A theoretical and empirical review. *International Journal of Environmental Sciences*, *11*(3), 1076–1087. https://doi.org/10.64252/7jtxts62

Bahl, R. (1999). *Implementation rules for fiscal decentralization* (Working Paper No. 99-1). Georgia State University.

Bahl, R. W., & Linn, J. F. (1992). *Urban public finance in developing countries*. Oxford University Press.

Bąk, A. (2016). Porządkowanie liniowe obiektów metodą Hellwiga i TOPSIS – analiza porównawcza [Linear ordering of subjects using Hellwig and TOPSIS methods – a comparative analysis. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu = Research Papers of Wroclaw University of Economics*, (426), 22–31. http://doi.org/10.15611/pn.2016.426.02

Bird, R. M., & Vaillancourt, F. (1999). *Fiscal decentralization in developing countries*. Cambridge University Press. https://doi.org/10.1017/CBO9780511559815

Boadway, R., & Shah, A. (2009). *Fiscal federalism*: *Principles and practice of multiorder governance*. Cambridge University Press. https://doi.org/10.1017/CBO9780511626883

Diamond, L. (2020). Breaking out of the democratic slump. *Journal of Democracy*, *31*(1), 36–50.

Darby, J., Muscatelli, A., & Roy, G. (2002). Fiscal federalism and fiscal autonomy: Lessons for the UK from other industrialised countries. *Scottish Affairs*, *41*(1), 26–55. https://doi.org/10.3366/scot.2002.0052

Ebel, R. D., & Yilmaz, S. (2002). *On the measurement and impact of fiscal decentralization* (World Bank Policy Research Working Paper No. 2809). The World Bank. https://doi.org/10.1596/1813-9450-2809

Felis, P., Patrzałek, L., Bem, A., Bernardelli, M., Malinowska-Misiąg, E., Olejniczak, J., & Kowalska, M. (2025). *Local tax policy in Central and Eastern Europe*: *Property taxation and municipal finance*. Routledge. https://doi.org/10.4324/9781003530503

Gu, G. C. (2012). *Developing composite indicators for fiscal decentralization*: *Which is the best measure for whom?* (Munich Personal RePEc Archive Paper No. 43032). University Library of Munich.

Guziejewska, B. (2018). Normatywne versus pozytywne ujęcie decentralizacji fiskalnej a mierniki jej oceny [Normative versus positive aproach to fiscal decentralisation and the measures of decentralisation. An analysis based on the example of selected countries of Central and Eastern Europe]. *Comparative Economic Research*, *21*(1), 101–117. https://doi.org/10.2478/cer-2018-0006

Hayek, F. A. (1960). *The constitution of liberty*. R. Hamowy (Ed.). The University of Chicago Press.

Hellwig, Z. (1968). Zastosowanie metody taksonomicznej do typologicznego podziału kraju ze względu na poziom rozwoju oraz zasoby i strukturę wykwalifikowanych kadr [Application of the taxonomic method to the typological division of countries according to the level of development and the resources and structure of qualified personnel]. *Przegląd Statystyczny – Statistical Review*, *15*(4), 307–326.

Hu, J. (2025). Fiscal decentralization and COVID-19 response: An evaluation of OECD countries. *International Tax and Public Finance*. https://doi.org/10.1007/s10797-025-09939-z

Hwang, C.-L., & Yoon, K. (1981). *Lecture notes in economics and mathematical systems: Vol. 186. Multiple attribute decision making: Methods and applications a state-ofthe-art survey.* Springer. https://doi.org/10.1007/978-3-642-48318-9

Ivanyna, M., & Shah, A. (2014). How close is your government to its people? Worldwide indicators on localization and decentralization. *Economics*: *The Open-Access*, *Open-Assessment E-Journal*, *8*. http://doi.org/10.5018/economics-ejournal.ja.2014-3

Iwacewicz-Orłowska, A., & Sokołowska, D. (2016). Ocena realizacji koncepcji zrównoważonego rozwoju w podregionach województw Polski Wschodniej z wykorzystaniem metody wzorca rozwoju Hellwiga [Assesment of the implementation of the concept of sustainable development in the subregions of the Eastern Polish Voivodeships using the Hellwig development pattern method]. *Optimum*. *Studia Ekonomiczne – Optimum*. *Economic Studies*, *1*(79), 182–197. https://doi.org/10.15290/ose.2016.01.79.12

Kimchoeun, P. (2011). *Fiscal decentralisation in Cambodia*: *A review of progress and challenges*. (CDRI Working Paper Series No. 50).

Konopka, P. (2021). *Metody wielokryterialnego podejmowania decyzji w badaniu ryzyka finansowania przedsiębiorstw* [Multi-criteria decision-making methods in the study or corporate financing risk]. Wydawnictwo Uniwersytetu w Białymstoku.

Kopiński, A. (2014). Taksonomia i zastosowanie metody Hellwiga w ocenie efektywności funduszu inwestycyjnych [Taxonomy and aplication of Hellwig's method for assessing the effectiveness of investment funds]. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu = Research Papers of Wroclaw University of Economics*, *330*, 192–204. https://doi.org/10.15611/pn.2014.330.20

Krakowiak-Bal, A. (2005). Wykorzystanie wybranych miar syntetycznych do budowy miary rozwoju infrastruktury technicznej [The implementation of chosen synthetic measures for construction of development's measure of technical infrastructure]. *Infrastruktura i Ekologia Terenów Wiejskich*, *3*, 71–82.

Kurkiewicz, J., Pociecha, J., & Zając, K. (1991). *Metody wielowymiarowej analizy porównawczej w badaniach rozwoju demograficznego: Vol. 336. Monografie i Opracowania. Szkoła Główna Handlowa* [Methods of multivariate comparative analysis in demographic development research: Vol. 336. Monographs and Studies]. Warsaw School of Economics, Institute of Statistics and Demography.

Levitsky, S., & Ziblatt, D. (2018). *How democracies die*. Crown.

Li, W., & Li, D. (2024). How does technological innovation affect the fiscal decentralization of local governments? Evidence from China. *Heliyon*, *10*(9), Article e30132. https://doi.org/10.1016/j.heliyon.2024.e30132

Liu, L. C.-h. (2011). The typology of fiscal decentralization system: A cluster analysis approach. *Public Administration and Development*, *31*(5), 363–376. https://doi.org/10.1002/pad.605

Marcinčin, A. (2024). Divergence of Slovak regions: Bumpy road to decentralization. In M. Augustín, P. Jančovič, & B. S. Sergi (Eds.). *Modeling economic growth in contemporary Slovakia*. Emerald. https://doi.org/10.1108/978-1-83549-454-720241011

Meloche, J.-P., Vaillancourt, F., & Yilmaz, S. (2004). *Decentralization or fiscal autonomy? What does really matter? Effects on growth and public sector size in European transition countries* (World Bank Policy Research Working Paper No. 3254). The World Bank. https://doi.org/10.1596/1813-9450-3254

Młodak, A. (2006). *Analiza taksonomiczna w statystyce regionalnej* [Taxonomic analysis in regional statistics]. Difin.

Ministry of Finance of the Slovak Republic (n.d.). *The process of fiscal decentralization*. Retrieved 8 August, 2025, from https://www.mfsr.sk/en/finance/public-finance/fiscal-decentralization/the-process-fiscal-decentralization/

Musgrave, R. A. (1959). *The theory of public finance*: *A study in public economy*. McGraw-Hill.

Nickson, A. (2023). Decentralization in Latin America after 40 years: Work in progress; A commentary essay. *Public Organization Review*, *23*, 1017–1034. https://doi.org/10.1007/s11115-023-00739-9

Oates, W. E. (1972). *Fiscal federalism*. Harcourt Brace Jovanovich.

Olaide, K., Uwilingiye, J., & Simo-Kengne, B. D. (2025). The relationship between fiscal federalism and fiscal discipline: Panel quantile regression approach. *Humanities and Social Sciences Communications*, *12*, Article 161. https://doi.org/10.1057/s41599-025-04489-5

Onofrei, M., Oprea, F., Iaţu, C., Cojocariu, L., & Anton, S. G. (2022). Fiscal decentralization, good governance and regional development – Empirical evidence in the European context. *Sustainability*, *14*(12), Article 7093. https://doi.org/10.3390/su14127093

Organization for Economic Cooperation and Development. (2013). *Measuring fiscal decentralisation*: *Concepts and policies*. *OECD Fiscal Federalism Studies*. OECD Publishing. http://doi.org/10.1787/9789264174849-en

Organization for Economic Cooperation and Development. (2020). *The territorial impact of COVID-19*: *Managing the crisis across levels of government*. OECD Publishing. https://doi.org/10.1787/d3e314e1-en

Organization for Economic Cooperation and Development (2024). *Subnational governments structure and finance*. https://www.oecd.org/content/dam/oecd/en/topics/policy-issues/subnational-finance-and-investment/subnational-governments-infrastructure-finance-2024.pdf

OECD Data Explorer (n.d.). https://data-explorer.oecd.org

Pinilla-Rodríguez, D. E., & Hernández-Medina, P. (2024). Governance and fiscal decentralisation in Latin America: An empirical approach. *Economies*, *12*(8), Article 207. https://doi.org/10.3390/economies12080207

Poniatowicz, M. (2018). *Koncepcja federalizmu fiskalnego w systemie finansów samorządu terytorialnego* [The concept of fiscal federalism in the local government financial system]. CeDeWu.

Poniatowicz, M. (2022). Fiscal federalism and the COVID-19 Crisis: Theoretical aspects and Poland's experience. *Studies in Logic*, *Grammar and Rhetoric*, *67*(1), 517–546. https://doi.org/10.2478/slgr-2022-0026

Poniatowicz, M. (2023). Decentralizacja oraz autonomia finansowa i podatkowa samorządu terytorialnego jako fundamenty federalizmu fiskalnego [Decentralization and financial and fiscal autonomy of local government as foundations of fiscal federalism]. In J. Szołno-Koguc (Ed.), *Finanse samorządowe* (pp. 27–52). Polska Akademia Nauk. https://doi.org/10.24425/146953

Poniatowicz, M., Konopka, P., & Piekutowska, A. (2024). Towards a comprehensive evaluation of decentralization: A multidimensional insight of OECD countries. *Technological and Economic Development of Economy*, *30*(6), 1652–1681. https://doi.org/10.3846/tede.2024.21518

Rao, M. G. (2003). Fiscal decentralization in China and India: A comparative perspective. *Asia Pacific Development Journal*, *10*(1), 25–46. https://doi.org/10.18356/0d190afc-en

Reingewertz, Y. (2014). *Fiscal decentralization – a survey of the empirical literature*. SSRN. http://doi.org/10.2139/ssrn.2523335

Rodden, J. (2004). Comparative federalism and decentralization: On meaning and measurement. *Comparative Politics*, *36*(4), 481–500. https://doi.org/10.2307/4150172

Roszkowska, E., & Filipowicz-Chomko, M. (2021). Measuring sustainable development using an extended Hellwig method: A case study of education. *Social Indicators Research*, *153*, 299–322. https://doi.org/10.1007/s11205-020-02491-9

Roszkowska, E., Filipowicz-Chomko, M., Łyczkowska-Hanćkowiak, A., & Majewska, E. (2024). Extended Hellwig's method utilizing entropy-based weights and Mahalanobis distance: Applications in evaluating sustainable development in the education area. *Entropy*, *26*(3), Article 197. https://doi.org/10.3390/e26030197

Stegarescu, D. (2005). Public sector decentralization: Measurement concepts and recent international trends. *Fiscal Studies*, *26*(3), 301–333. https://doi.org/10.1111/j.1475-5890.2005.00014.x

Schaltegger, C. A., & Schmid, L. A. (2023). Switzerland. In J. F. Tremblay (Ed.). *The forum of federations handbook of fiscal federalism* (pp. 383–419). Palgrave. https://doi.org/10.1007/978-3-030-97258-5_10

Schneider, A. (2003). Decentralization: Conceptualization and measurement. *Studies in Comparative International Development*, *38*, 32–56. https://doi.org/10.1007/BF02686198

Swianiewicz, P. (2014). An empirical typology of local government systems in Eastern Europe. *Local Government Studies*, *40*(2), 292–311. https://doi.org/10.1080/03003930.2013.807807

Treisman, D. (2002). *Defining and measuring decentralization*: *A global perspective* (Unpublished manuscript).

Trusova, N. V., Kohut, I. A., Osypenko, S. A., Radchenko, N. G., & Rubtsova, N. N. (2019). Implementation of the results of fiscal decentralization of Ukraine and the countries of the European Union. *Journal of Advanced Research in Law and Economics*, *10*(6), 1649–1663.

Tunio, F. H., & Nabi, A. A. (2021). Political decentralization, fiscal centralization, and its consequences in case of Pakistan. *Cogent Social Sciences*, *7*(1), Article 1924949. https://doi.org/10.1080/23311886.2021.1924949

Vafaei, N., Ribeiro, R. A., & Camarinha-Matos, L. M. (2016). Normalization techniques for multi-criteria decision making: Analytical hierarchy process case study. In L. M. Camarinha-Matos, A. J. Falcão, N. Vafaei, & S. Najdi (Eds.), *IFIP advances in information and communication technology*: *Vol. 470. Technological innovation for cyber-physical systems*. *DoCEIS 2016*. (pp. 261–269). Springer. https://doi.org/10.1007/978-3-319-31165-4_26

Wang, Y., Huang, X., Zhang, T., Jiang, B., & Wang, X. (2024). Impact of fiscal decentralization and local government competition on the supply of basic public services: Based on the empirical evidence of prefecture-level cities in China. *Heliyon*, *10*(4), Article e26511. https://doi.org/10.1016/j.heliyon.2024.e26511

Wichowska, A. (2021). The degree of fiscal decentralization in European Union countries in different stages of the economic cycle. *Entrepreneurship and Sustainability Issues*, *9*(2), 198–208. http://doi.org/10.9770/jesi.2021.9.2(13)

Wright, G. (2017). New rules for implementation of fiscal decentralization. *Developments in Administration*, *2*(1), 75–104. https://doi.org/10.46996/dina.v2i1.5113

Wysocki, F. (2010). *Metody taksonomiczne w rozpoznawaniu typów ekonomicznych rolnictwa i obszarów wiejskich* [Taxonomic methods in recognizing types of agriculture and rural areas]. Wydawnictwo Uniwersytetu Przyrodniczego.

Yimenu, B. (2024). The political economy of fiscal transfers: The case of Ethiopia. *Public Administration and Development*, *44*(3), 212–229. https://doi.org/10.1002/pad.2053

Zavadskas, E. K., Mardani, A., Turskis, Z., Jusoh, A., & Nor, K. M. (2016). Development of TOPSIS method to solve complicated decision-making problems – an overview on developments from 2000 to 2015. *International Journal of Information Technology & Decision Making*, *15*(3), 645–682. https://doi.org/10.1142/S0219622016300019