Tax Competitiveness and Diversity in Tax Incentives for Innovation: Categorization of EU Countries

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Abstract: Tax competitiveness is one of the factors shaping a country's business climate to support innovation. The aim of this research is to evaluate tax competitiveness across EU countries, with a focus on tax support for innovation. Based on the identified measurable indicators from the International Tax Competitiveness Index, we classify countries into relatively homogeneous groups. The results were obtained using PCA and clustering. We identified six main clusters of countries with similar levels of tax burden, system complexity, and the intensity of use of tax incentives for research and development (R&D). Slovakia was included in the second cluster, which comprises countries with below-average tax burdens and, at the same time, relatively high tax breaks for research and development. The Czech Republic was included in a cluster together with Estonia and Latvia. These are countries with the lowest tax burdens. However, these countries do not use patent boxes. The results indicate a relatively significant diversity among EU countries.

Keywords: tax competitiveness, tax incentives, innovation support, research and development incentives, tax policy.

JEL Classification codes: H25, O38, O31

INTRODUCTION

Society is undergoing dynamic development in innovative areas, reflected in the intensification of international globalisation and the expansion of opportunities to connect global markets. This trend is subsequently reflected in increased competition between countries seeking to gain and sustain a competitive advantage, mainly through tax policy instruments (Slemrod & Razin, 1990). The dynamics of tax competitiveness have been altered by the arrival of new member states, which have had both positive and negative effects (Podviezko et al., 2019). Investors in individual countries are sensitive to tax differences across countries, which is reflected in investment and capital allocation decisions.

Existing studies often focus only on individual determinants or use aggregate indices that may obscure differences between countries' tax systems. One group of authors spotlights the essence of the tax system, another stresses the importance of the tax burden, while a third stresses the role of tax incentives in supporting innovative activities. The competitiveness of countries results from the interaction and complementarity among a set of these determinants. However, innovation is a key channel of tax policy in this context. Innovation performance is important for countries' economic improvement. Innovation contributes to greater efficiency, quality, and competitiveness, which creates conditions for successful participation in the global

economy (World Bank, 2025). Based on this, it is important to take an extensive approach to assessing tax competitiveness to capture the structure of tax systems and identify differences across European Union countries. The identified research gap creates space for a comprehensive assessment of the tax competitiveness of EU countries, with a focus on tax support for innovation, which is also the focus of this paper.

The aim of this research is to evaluate tax competitiveness in EU countries, with a focus on tax support for innovation, using the identified, measurable indicators of the International Tax Competitiveness Index. Section 1, Literature review, focuses on defining tax competitiveness and the role of tax policy factors in promoting it in the context of globalisation. Section 2 summarises the methodological framework for research evaluating the tax competitiveness of EU countries, with an emphasis on supporting innovation. In Section 3, we present and interpret the results of the cluster analysis of EU countries.

1 LITERATURE REVIEW

Economic competitiveness is the ability to succeed in a competitive environment. This is done through the effective use of available resources, adaptation to change, and the maintenance of economic growth and development relative to other economic entities (Porter, 1990; Fagerberg, 1996). It is a complex concept that can take various forms depending on the objectives set by economic entities, and it is accompanied by a range of tools to achieve them (Mazurenko & Tiutiunyk, 2021). Tax competitiveness is determined by a set of factors whose interactions shape countries' competitive positions, their attractiveness to foreign investors, and economic growth. Among the most analysed determinants examined in this paper are the institutional aspects of taxation, tax burden, and tax incentives. An effective tax system is one of the main factors driving higher tax competitiveness and fostering a business environment that promotes capital mobility and foreign investment inflows (Štofková, 2021; Summers, 1998; Talpoș & Crâșneac, 2010). Countries' attractiveness to foreign investors is often determined by the tax collection, transparent tax rules, and the quality of institutions and regulations (Helcmanovská & Andrejovská, 2021; Levchenko et al., 2015; Markusen, 2007). In the context of globalisation, these factors are closely linked to tax competition between countries, which puts pressure on tax systems (Genschel & Schwarz, 2011). This is where the need for coordination of tax policies at the EU level comes in, as a tool to mitigate the negative effects of tax competition and ensure the long-term stability of tax systems (Redoano, 2014; Avi-Yonah & Sartori, 2012).

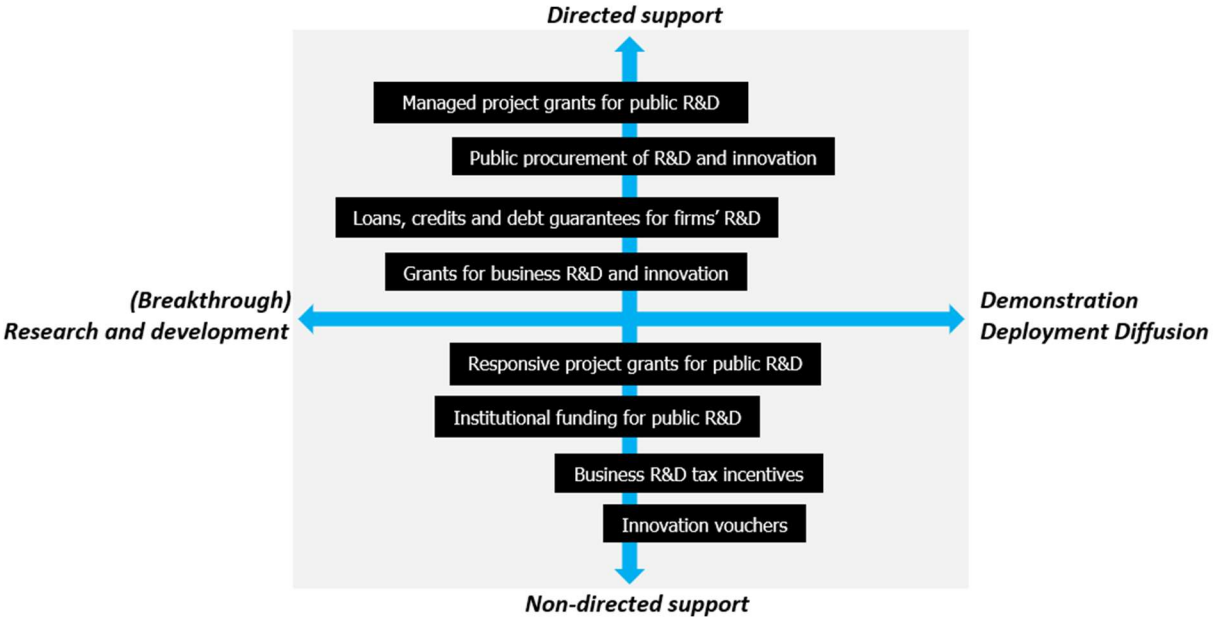
Regarding international tax competitiveness, the level of taxation itself is also important. In particular, corporate income tax rates tend to directly affect investment decisions and productivity. With rising capital mobility, the tax burden is under increasing competitive pressure (OECD, 2025; Heimberger, 2021). In general, lower tax rates are mostly associated with higher investment and productivity. However, potential excessive reductions in tax rates can lead to fiscal problems due to a drop in public revenues (Vartia, 2008; Keen, 2008). As a result, countries' tax competitiveness is increasingly shifting from across-the-board tax rate cuts to targeted tax incentives that support investment and innovation.

Tax incentives are a selective tax policy tool that countries use to reduce investment costs and influence investors' decisions on where to allocate capital and investments (Celani et al., 2022). Their common goal is to reduce the effective tax burden on innovative activities without a blanket rate reduction. Current scientific studies analysing factors of countries' tax competitiveness are based on the concept of national competitiveness developed by the leading representative, M. E. Porter (1990), who included among the factors of competitiveness the ability of countries to absorb and create innovation, as well as to drive technological progress. Several studies confirm that tax incentives to support R&D have a

positive impact on innovation performance, productivity, and sustainable economic growth, thereby strengthening the global position of EU countries (Priede & Pereira, 2013; Bugnar et al., 2016; Kiseláková et al., 2017). On the other hand, insufficient investment in R&D weakens countries' competitiveness and deepens regional disparities within Europe (Bukowski & Siek, 2013). However, the effectiveness of tax incentives depends on the overall economic environment in a given country (Linhartová & Owusu, 2018; Morisset & Pirnia, 2000).

Governments tend to encourage companies to invest more in R&D to promote innovation. One approach is to provide direct government funding for activities, with many jurisdictions also offering indirect support through tax incentives. Such incentives typically have two distinct forms: patent boxes (taxing intellectual property income at a rate lower than the statutory corporate income tax rate) and tax incentives for R&D expenditures (Tax Foundation, 2025).

Fig. 1 Combination of tax policy instruments for public financing of R&D and innovation



Source: OECD, 2025, p. 27.

Tax policymakers should focus on achieving a balance between direct and indirect measures, using them in synergy. On the one hand, direct measures mostly support novel R&D that leads to technological breakthroughs. On the other hand, measures often support research activities closer to the market and can accelerate transformative economic change (OECD, 2025). Effective and targeted tax support thus contributes to creating an overall competitive advantage for countries.

Existing studies confirm the importance of tax incentives for promoting R&D and innovation, but less attention has been paid to a systematic comparison of EU countries using a comprehensive index that reflects tax systems and their impact on the innovation environment. Based on this research gap, we will use the International Tax Competitiveness Index (ITCI) to assess the competitiveness of EU countries and subsequently cluster countries to identify groups with similar tax conditions and innovation support.

2 METHODOLOGY

The main objective of this paper is to evaluate tax competitiveness in EU countries with a focus on tax support for innovation based on the measurable indicators identified by the International Tax Competitiveness Index.

The main objective of the paper is to examine tax competitiveness among EU countries, with particular focus on tax support for innovation. Based on the literature review, we identify key determinants of international tax competitiveness, including institutional aspects of taxation, tax burdens, and tax incentives to support innovation. The analysis further used measurable indicators from the International Tax Competitiveness Index to quantitatively assess the mentioned determinants. The Tax Competitiveness Index (ITCI) represents a rather comprehensive framework for evaluating national tax systems and their competitiveness. All selected indicators are derived from specific ITCI segments that reflect diverse critical aspects of tax policy. Table 1 summarises the individual indicators required for the analysis, along with their characteristics and measurement units.

Tab. 1 Factors of tax competitiveness

Group	ITCI Indicator	Indicator	Description	Measurement
Tax rates and effective capital taxation	corporate_rate	CIT	Statutory corporate income tax rate.	Percentage
	top_income_rate	PIT	Top statutory personal income tax rate (one-year lag).	Percentage
	dividends_rate	DIV	Top statutory tax rate on dividends after accounting for any imputation system or reliefs.	Percentage
	asset_tax	AT	Application of a net corporate asset tax.	Binary variable (1 = yes)
	financial_transaction_tax	FTT	Taxation of financial transactions.	Binary variable (1 = yes)
Tax incentives for businesses and innovation	allowance_corporate_equity	ACE	Provision of an allowance for corporate equity.	Binary variable (1 = yes)
	patent_box	PB	Use of patent box regimes.	Binary variable (1 = yes)
	r_and_d_credit	R&D	Scope of R&D tax incentives (one-year lag).	Percentage
Tax system complexity	corporate_surtax	CIT_S	Existence of a surtax applied to corporate income tax.	Binary variable (1 = yes)
	personal_surtax	PIT_S	Existence of a surtax applied to personal income tax.	Binary variable (1 = yes)
	corporate_alt_minimum	AMT	Number of corporate income tax rates applied to company profits.	Number

Source: Own processing

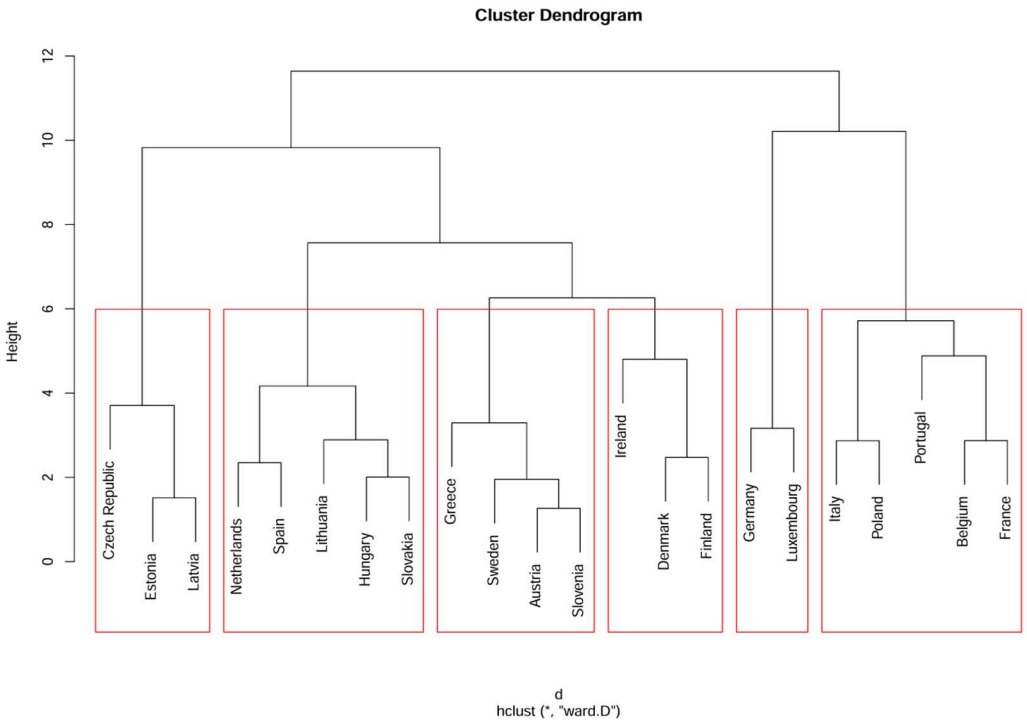
The analysis is based on panel data for the period 2014 to 2025 and 11 measurable indicators based on determinants of tax competitiveness. The selection of countries included in the analysis is determined by the data availability. Due to the limited data availability, we analysed only twenty-two OECD member states. Hence, our analysis excluded European Union member states that are not OECD members (such as Bulgaria, Romania, Croatia, Cyprus, and Malta). Alternative tax competitiveness indices do not provide an equivalent methodology and time frame that would allow their inclusion without disrupting the analysis's consistency.

In preparing the quantitative analysis, we used several methods in view of the set objective. Prior to analysis, we standardised the collected panel for the years 2014–2025 using z-scores. This step enabled us to eliminate the issue of different units of measurement. We classified countries based on their similarity using hierarchical cluster analysis (Ward's method and Euclidean distance) and selected the optimal number of clusters using the Calinski-Harabasz index. To reduce dimensions and simplify the data, we used principal component (PC) loadings, identifying the indicators with the greatest contribution to data variability and ranking them by their loadings in each dimension.

3 RESULTS AND DISCUSSION

We classified countries based on selected determinants of tax competitiveness using Ward's hierarchical cluster analysis method with Euclidean distance. The optimal number of clusters was determined using the Calinski-Harabasz index, with 6 selected for interpretability and the highest possible value. A graphical representation of the cluster analysis output is shown in Figure 2.

Fig. 2 Dendogram of the results of hierarchical cluster analysis of EU countries



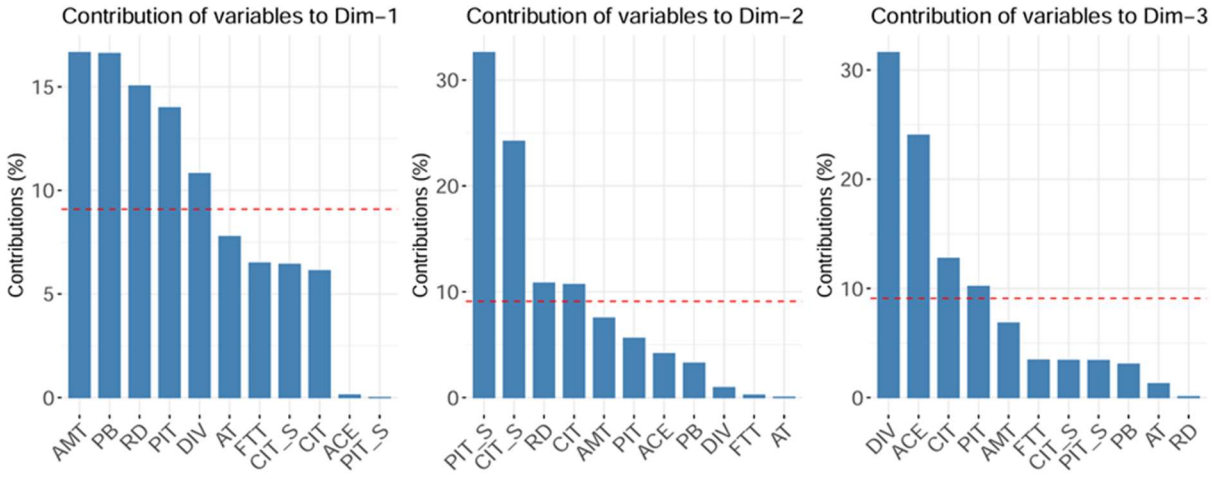
Source: Own processing.

The second and sixth clusters comprise the largest number of countries. The third cluster is medium-sized, with four countries, while the first and fourth clusters are smaller, each

consisting of three countries. The smallest cluster is the fifth cluster with two countries. To reduce dimensionality and improve the interpretability of the cluster analysis results, we proceeded with a principal component analysis (PCA). We determined the number of principal components using a scree plot, identifying three components that explain 62.80% of the variability, which we consider sufficient to capture the main trends.

As part of the principal component analysis (PCA), we identified the indicators with the largest contributions to data variability and ranked them by their loadings in each dimension. The component load and its percentage contribution within the dimension are shown in Figure 3.

Fig. 3 Load on variable components



Source: Own processing.

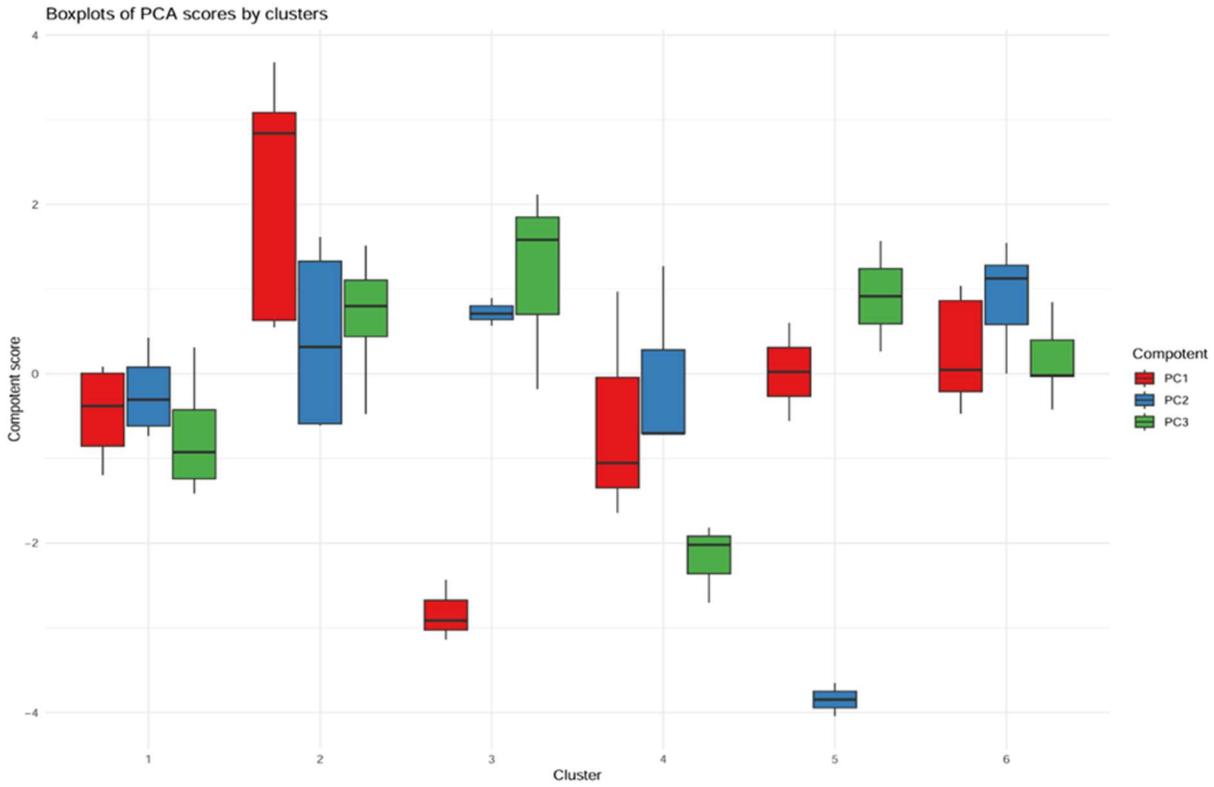
Within dimension 1, the dominant variables identified were the number of corporate taxes applied to company profits (AMT), the use of patent boxes (PB), and the extent of tax relief for R&D (RD). Basic personal income tax rates (PIT) and dividend taxation (DIV) also make a significant contribution to this dimension. Dim-1 thus captures the main trend of variability related to the active use of tax incentives for businesses and innovation, as well as the complexity of the tax system in the area of capital and profit taxation. Countries with a high PC1 score can thus be characterised as having more developed tax instruments to support business and innovation activities and a more complex tax system.

Dimension 2 is primarily formed by the existence of additional taxes on the income of legal entities and individuals (PIT_S, CIT_S). This dimension thus captures the total tax burden that arises from a combination of basic rates and additional tax instruments. A high PC2 score indicates that countries use additional tax rates to raise the tax burden, suggesting greater tax system complexity.

Dimension 3 is mainly characterised by variables capturing specific forms of capital taxation, in particular dividend taxation (DIV) and basic top rates of corporate and personal income tax (CIT, PIT). This dimension also includes the ACE variable, which represents the deduction for equity capital. Dimension 3 thus reflects differences in how EU countries combine capital taxation with selected mitigation mechanisms. A high PC3 score indicates countries that combine higher tax rates on capital income with the simultaneous use of selective instruments to mitigate their negative effects, such as equity capital deductions.

We then used the three main components to describe the characteristics of the identified clusters. Figure 4 shows the distributions of the scores for the three main components (PC1, PC2, PC3) for each country cluster.

Fig. 4 Boxplots of the three main components



Source: Own processing.

Boxplots and their differences allow us to assess in more detail the characteristics of tax competitiveness in which the identified clusters of countries differ most significantly. These differences point to factors in tax systems that can significantly influence a country's economic environment and investor attractiveness.

Countries with high scores in PC1 are characterised by a well-developed system of tax incentives, including patent boxes and R&D tax relief, that positively impact their competitiveness. It follows that a high PC1 is characteristic mainly of countries that are specifically focused on supporting innovation potential and attracting technological investment. A high PC2 score indicates that a country uses additional taxes on the profits of individuals and legal entities, which is reflected in the complexity and administrative burden of the tax system. This is one of the key factors for investors. A high administrative tax burden is a barrier to the inflow of foreign capital. Clusters of countries with high PC3 scores are characterised by a higher tax burden on capital and the simultaneous presence of mitigating mechanisms. A higher tax burden may reduce a country's attractiveness to both domestic and foreign investors. The actual effect would also depend on the scope and effectiveness of the compensatory instruments.

Based on the literature review, we identified a research gap, which we used to define the paper's main objective and partial objectives. The results of studies conducted to date have identified three significant groups of determinants of countries' tax competitiveness. However, there are few studies that assess tax competitiveness comprehensively, with a focus on supporting innovation, which is the main objective of this study. The results are provided by a cluster analysis based on PCA analysis over an 11-year time horizon.

The cluster analysis showed that EU countries use different tax strategies to support innovation. Their tax policies regarding innovation are determined by their institutional and economic environments, and do not converge on a single model. This is in line with previous

findings achieved by Porter (1990), Fagerberg (1996), and the OECD (2025). Hence, countries' tax competitiveness is not determined solely by the tax burden, but primarily by the structure of their tax systems and their links to innovation promotion. The identified clusters of countries reflect different tax policy strategies, within which countries optimise their competitive position through different approaches to capital taxation, institutional settings, and tax incentives for research and development. Table 2 below summarises the individual country clusters and provides a clear overview of the characteristics of tax competitiveness clusters in the EU.

Tab. 2 Characteristics of EU country clusters

Cluster	Countries	Tax burden	Additional tax burden	R&D incentives	Patent box	Competitiveness model
1	Czech Republic, Estonia, Latvia	Lowest	No	Below average	No	Non-innovative model
2	Netherlands, Spain, Lithuania, Hungary, Slovakia	Below average	No	Above average	Yes	Innovative model
3	Greece, Sweden, Austria, Slovenia	Above average	No	Below average	No	Weakly innovative model
4	Ireland, Denmark, Finland	Highest	No	Below average	No	Moderately innovative model
5	Luxembourg, Germany	Above average	Yes	Lowest	No	Innovative model
6	Poland, Italy, Portugal, Belgium, France	Above average	No	Highest	Yes	Strongly innovative model

Source: Own processing.

Countries in cluster 1 are characterised by systematically lower values across all monitored tax indicators than the average of the monitored EU countries. The tax burden on individuals and legal entities, as well as on dividends, is significantly below average in this cluster, indicating these countries' orientation towards a low-tax model of tax competitiveness. At the same time, they use innovation support instruments sparingly. Support for R&D is only visible in the application of tax credits in the Czech Republic and Latvia. The tax policies of these countries are based on simplicity and a low tax burden, although it should be emphasised that low taxes alone are not sufficient to strengthen innovation competitiveness in the long term (Bukowski & Siek, 2013). In international competition, the countries in the first cluster are particularly competitive in attracting tax-sensitive, less innovation-oriented companies.

The second cluster reflects a shift away from the "race to the bottom" towards selective tax competition (Genschel & Schwarz, 2011). It includes countries with below-average tax burdens combined with intensive use of tax instruments to support innovation. Compared to the average of the countries surveyed, these countries show a significantly higher intensity of use of patent box regimes, as well as above-average tax relief for R&D. The countries in the second cluster are strong competitors in attracting R&D-performing companies, due to a combination of low tax burden and strong innovation incentives.

The countries in the third cluster are characterised by an above-average overall tax burden and do not use selective tax instruments, such as patent box regimes. They support innovation to a limited extent through R&D tax credits, which are slightly below average. These are countries with low tax competitiveness compared to pro-innovation countries.

The countries in cluster 4 have the highest overall tax burden, with low corporate taxation combined with higher taxation of personal income and dividends. These countries ranked lower in the ITCI ranking (Tax Foundation, 2025), supporting Talpoș and Crâșneac's (2010) argument that complex tax systems can reduce overall competitiveness.

Both countries in cluster 5 are dominated by an above-average overall tax burden, which is, however, offset by selective tax instruments, primarily patent box regimes. At the same time, they provide above-average tax relief for R&D, suggesting a strategy focused on comprehensive support for innovation through tax policy, with a higher tax burden. The identified cluster aligns with the theory of Celani et al. (2022), which argues that incentives are a selective tax policy tool through which countries reduce investment costs and influence investors' decisions on capital location and investment. Countries within the cluster are thus particularly competitive in attracting multinational companies.

Countries in Cluster 6 are characterized by an above-average overall tax burden, with no additional taxes imposed. At the same time, however, they provide above-average tax incentives for R&D in combination with patent box regimes, which points to a strategy aimed at comprehensively supporting innovative activities through tax policy, despite a higher tax burden.

CONCLUSION

The main objective of this paper was to evaluate tax competitiveness in EU countries with a focus on tax support for innovation. The measurable indicators included the International Tax Competitiveness Index, derived from the identified determinants of countries' tax competitiveness. Based on the results of the cluster analysis, we demonstrated that the tax competitiveness of EU countries is shaped by distinct tax-innovation strategies that reflect their economic and institutional environments. Countries that focus on targeted support for innovation through tax incentives are more attractive for investment in research and development, which is subsequently reflected in their international competitiveness. The results of the cluster analysis show that a low tax burden alone, without support for innovation, is not sufficient to strengthen competitiveness in the long term. On the contrary, a balanced tax burden combined with innovative tax incentives creates favourable conditions for productivity growth and technological progress. Innovation thus represents the link between tax policy and the sustainable competitiveness of EU countries.

The results obtained reflect an analysis of 22 EU countries; due to the unavailability of data, we excluded countries that may apply different tax regimes. The results regarding the tax competitiveness of countries may thus appear partially distorted. At the same time, the selected factors of tax support for innovation do not reflect their actual use in practice but only the design of tax policy. In future research, it would therefore be important to examine causal relationships, such as the link between tax competitiveness and investment flows, to verify whether the observed tax competitiveness corresponds to reality.

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