Lucia Mihokova
PhD (Economics), Assistant Professor,
Faculty of Economics, Department of Finance,
Technical University of Kosice
32 Nemcovej Str., Kosice,
04001, Slovak Republic
lucia.mihokova@tuke.sk

Alena Andrejovska
PhD (Economics), Assistant Professor,
Faculty of Economics, Department of Finance,
Technical University of Kosice
32 Nemcovej Str., Kosice,
04001, Slovak Republic
alena.andrejovska@tuke.sk

Slavomira Martinkova
PhD Student, Faculty of Economics,
Department of Finance,
Technical University of Kosice
32 Nemcovej Str., Kosice,
04001, Slovak Republic
slavomira.martinkova@tuke.sk

Categorization of corporate taxation in the European Union countries using cluster analysis: a comparative study

Abstract. The corporate tax burden is in the spotlight of entrepreneurs, investors, politicians, lawyers, economists, research scholars and analysts, because corporate tax encompasses variety of economic, political and social aspects. The presented research focuses on identification, analysis and assessment of current state of corporate taxation in countries across Europe. Its main purpose is to elaborate an economically meaningful categorization of the EU countries based on the level of corporate taxes, tax competition and tax policy convergence. Authors used two clustering methods to differentiate the groups of countries within the European Union.

We decided to organize the EU countries states into five clusters. Although the number of clusters was selected solely based on our decision and the results of testing in R-program, identical results by both Ward's hierarchical method and non-hierarchical k-means method grounded our choice of the EU member states grouping into five clusters. According to categorization results for 2013, both non-hierarchical k-means method and hierarchical Ward's method grouped the EU countries in identical clusters. However, results for 2015 for Malta and the United Kingdom came differently by Ward's method and k-means method. We assume these shift may be caused by significant changes in segmentation criteria between analysed years or by some processes in the methodology of the methods used.

The countries remaining in the first cluster either in 2013 and 2015 (namely, Italy, Belgium and France) have large macroeconomic issues and instability in public finances. A low fiscal discipline was reflected in the indicator deficit, as well as in the average value of public debt. All countries in the first cluster have a similar corporate taxation system and with their high level of corporate taxation can be considered as the least competitive in both years researched.

Results confirmed tax competition between countries within the European Union. Cluster analysis proved that the level of convergence in the European Union countries' tax systems is not sufficient. A certain level of convergence of corporate tax system is shown, but we conclude that it rather exists in two separate groups of the member states (the old and the new EU member countries) separately. Therefore, there is still much space for tax harmonization measures implementation.
Keywords: European Union; Tax System; Tax Harmonization; Tax Convergence; Corporate Tax; Categorization; Cluster Analysis
JEL Classification: H25

Міхокова Люция
кандидат економічних наук, асистент, економічний факультет, кафедра фінансів,
Технічний університет в Кошице, Словацька республіка
Андрейовска Алена
кандидат економічних наук, асистент, економічний факультет, кафедра фінансів,
Технічний університет в Кошице, Словацька республіка
Мартінкова Славоміра
аспірант, економічний факультет, кафедра фінансів,
Технічний університет в Кошице, Словацька республіка
Категоризація оподаткування підприємств у країнах Європейського Союзу на основі кластерного аналізу: порівняльне дослідження
Анотація. Питання оподаткування підприємств традиційно знаходиться в центрі уваги підприємців, інвесторів, політиків, правників, науковців й аналітиків ринку, адже рівень податкового тягаря безпосередньо впливає на різні аспекти економічного, політичного та суспільного життя держави. Дослідження має на меті визначити, проаналізувати й оцінити поточний стан оподаткування підприємств у країнах ЄС. Головна ціль дослідження полягає у створенні економічно обґрунтованої категоризації країн ЄС відповідно до розбіжностей у рівні податкових ставок, стану податкової конкуренції та взаємної узгодженості податкової політики. Розділення країн ЄС на окремі групи за цими показниками було здійснено із застосуванням кластерних методів. Кластерний аналіз дозволив авторам визначити, що узгодженість податкових політик у Європейському Союзу продовжує залишатися на недостатньому рівні, відтак, існує потреба в подальшій гармонізації дій окремих держав у податковій сфері.
Ключові слова: корпоративний податок; категоризація країн; кластерний аналіз; узгодження податкової політики.

Михокова Люция
кандидат экономических наук, ассистент, экономический факультет, кафедра финансов,
Технический университет в Кошице, Словацкая республика
Андрейовска Алена
кандидат экономических наук, экономический факультет, кафедра финансов,
Технический университет в Кошице, Словацкая республика
Мартинкова Славомира
аспирант, экономический факультет, кафедра финансов, Технический университет в Кошице, Словацкая республика

Категоризация налогообложения предприятий стран Европейского Союза на основе кластерного анализа: сравнительное исследование

Аннотация. Вопросы налогообложения предприятий традиционно остаются в центре внимания предпринимателей, инвесторов, политиков, юристов, ученых и аналитиков рынка, поскольку уровень налогового бремени в стране непосредственно влияет на различные аспекты экономической, политической и общественной жизни. Задачей исследования является определение, анализ и оценка текущего состояния налогообложения предприятий в странах Европы. Цель исследования состоит в разработке экономически обоснованной категоризации стран ЕС в соответствии с различиями уровней налоговых ставок, состояния налоговой конкуренции и взаимной согласованности налоговых политик. Разделение стран ЕС на отдельные группы в соответствии с указанными показателями производилось с использованием кластерных методов. Применение кластерного анализа позволило авторам исследования установить, что страны Европейского Союза продолжают демонстрировать недостаточный уровень согласованности налоговых политик, в силу чего сохраняется потребность в дальнейшей гармонизации действий отдельных стран в налоговой сфере.

Ключевые слова: корпоративный налог; категоризация стран; кластерный анализ; согласование налоговой политики.

1. Introduction

The tax burden on legal entities is defined by numerous quantitative and qualitative determinants. The level of tax burden is an aggregate result of measurable determinants both in short and long-term period (Karagoz, 2013 [1]; Vasiliauskaite & Stankevicius, 2009 [2]). Among these factors one should name tax rate, tax base, tax evasion from direct taxes, grey economy, the extent of government support through the tax expenses, GDP and economic cycles, the effect of GDP growth rate, fiscal imbalance, and debt service of the country (Castro & Camarillo, 2014 [3]; Velaj & Prendi, 2014 [4]; Vasiliauskaite & Stankevicius, 2009 [2]; Kubatova & Rihova, 2009 [5]).

Except for abovementioned quantitative indicators, the tax corporate burden is influenced by some qualitative factors which cannot be measured properly. This group of determinants consists of historical and societal factors, as well as political ones, like political atmosphere, political cycle, and priorities of government and legislature (David & Formanova, 2016 [6]; Foremmy & Riedel, 2014 [7]); business environment and business strategies; and the state of nation's economic development (Banociova & Raisova, 2012 [8]; Bobakova & Cepelova, 2014 [9]; Kisela, Virdzek & Vajda, 2015 [10]; Soltes & Gavurova, 2013 [11]; Mura & Buleca, 2012 [12]); geographical location and regional competitiveness (Hrabovska, 2015 [13]). These factors are instrumental for construction of tax policies and legal systems behind the corporate tax construction (to name one example, we may remind of coexistence of continental civil law and British common law within the EU, which directly impact tax competitiveness of different countries within the European Union). All the determinants represented are dynamic and constantly evolving and influencing each other (Mihokova, Andrejovska, Glova & Drab, 2015 [14]).

Thus, combination of all quantitative and qualitative factors is decisive for development of tax system in every individual country. Differences between national tax systems within economic community may lead to some negative outcomes (Baskaran & Fonseca, 2014 [15]; Stiglitz & Rosengard, 2015 [16]). That is why tax coordination and tax harmonization were at the table of multilateral discussions on tax burden convergence since the beginning of the European integration process. However, the argument for more harmonization in fiscal issues still divides the EU (Psarrakis, 2015 [17]; Elkins, 2015 [18]). Tax competition between national tax systems amid globalization and internationalization is ongoing, nations are keen to profit from revenues coming from taxes on income from financial capital, VAT and excise taxes, personal income of individuals and, not least, profits of companies (European Commission, 2015 [19]; Remeur, 2015 [20]; Klazar, 2011 [21]).

Our research concentrates on identification, analysis, comparison and assessment of the EU countries groups in order to illustrate the common features in the corporate taxation in the context of tax system's convergence. The article is divided into two main parts. The first part (paragraph 2) describes main objective of the research and the use of clustering methods. The second part of the article (paragraphs 3 and 4) presents results of the research, mainly an application of clustering methods in two separate timeframes (2013 and 2015), a comparison of their results and discussion about meaning of defined clusters for understandings of the tax competition level and tax convergence.

2. Objective and description of segmentation criteria and methods

The objective of our research is to create an economically meaningful categorization of the European countries in 2013 and 2015, and to analyse the level of corporate tax competition within the corporate tax convergence, taking into consideration selected segmentation criteria to represent corporate taxation system of individual countries, economic performance of the countries and their fiscal position: *(1) total tax burden, expressed as tax quota II in % (TQ), (2) nominal corporate income tax rate (NTR), expressed in %, (3) effective corporate income tax rate (EATR), expressed in %, (4) economic performance, in the form of indicator nominal GDP per capita in EUR (GDPpc), (5) public debt, expressed as a ratio to GDP in % (PD), (6) state budget balance, expressed as a ratio to GDP in % (SBB).*

The selection of segmentation criteria was based primarily on works of Devereux & Griffith (2003) [22] and Krogstrup (2002) [23], and other researches focused on impact of these factors on specific corporate tax treatment, amount of tax revenues from this type of taxes, and eventually on the retroactive influence of tax on these factors in the future periods. These variables are also often used as decisive criteria for objects clustering when classifying the EU member countries (Vasiliauskaite & Stankevicius, 2009 [2]).

2. 1. Description of selected segmentation criteria

The group of variables representing corporate tax burden includes three factors: effective corporate tax, nominal corporate tax rate, and tax quota II. Nominal and effective tax rates are important indicators used not only by investors, but also by political and economic analysts. The dependency between tax rate and tax income was examined by many scholars: Cederwall (2015) [24], Kawano and Slemrod (2012) [25], Clausing (2007) [26]. The results of research show that higher tax rate lead to tax income increase.

The selection of other three variables was defined by the very nature of corporate income tax, which aggregates different economic aspects. The variable GDP or GDP per capita represents the economic performance of the country, and is the aim of research by Castro & Camarillo (2014) [3], and Iriqat & Anabtawi (2016) [27]. The impact of GDP on corporate income tax revenue is studied by Kubatova & Rihova (2009) [5], Bayer (2011) [28], and Banociova & Pavlikova (2013) [29], who use panel regression analysis to point out a positive impact of GDP on this tax. Interdependence of GDP fluctuation and structured tax burden

was studied by Vasiliauskaite & Stankevicius (2009) [2]. Their results show interconnection between the level of a country's GDP per capita and decrease of the corporate income tax. The ability of government to effectively manage the finances of state budget has a direct impact on its tax policy. When the government is facing need to cover budget deficit, it often chooses to raise taxes for that purpose. An existing fiscal imbalance can be tracked based on two indicators: state budget balance and public debt (Drab & Mihokova, 2013 [30]; Mirdala, 2013 [31]). Impact of tax debt service on taxes, tax systems, primary expenditures, and tax competitiveness was studied by Krogstrup (2002) [23] with specific focus on the causal dependency between fiscal imbalance and tax burden. He used regression analysis to confirm that one percent increase in the debt service to GDP ratio results on an average of 0.2% increase in the tax burden in the next budget period.

2. 2. Specification of selected clustering methods

The categorization was performed by authors through various clustering methods based on Euclidean distance measure. We used both traditional hierarchical methods and non-hierarchical methods. The hierarchical methods were represented by Ward linkage. The hierarchical methods of clustering show high level of versatility and can produce multiple nested partitions organized as a tree (called a dendrogram), which allows user to choose different partitions based on the desired level of similarity (Suzuki & Shimodaira, 2006 [32]). We applied non-hierarchical method as a supplementary one, and it was represented by k-means clustering. Non-hierarchical techniques are based on various optimization criteria. The instances are relocated by moving from one cluster to another, starting with the initial partitioning, resulting in a set of non-overlapping clusters having no hierarchical relationships between them.

The cluster analysis was performed in the statistical program R for the EU countries in 2013 and 2015. The quantitative data were taken from the Eurostat database. The results of individual applied clustering methods were further compared. We took into consideration possible output deviations caused by algorithms of clustering processes while assessing similarities in the EU countries' corporate tax systems.

3. Cluster analysis of corporate taxation

The EU countries were assembled in two sets of groups (both for 2013 and 2015) according to reported similar characteristics based on selected segmentation criteria. We took in consideration the level of mutual influence between the EU countries, assuming that it is natural to group in the same cluster those countries with high level of mutual impact on fiscal policy.

3. 1. Ward's method of hierarchical clustering

The hierarchical clustering encompasses a number of methods, which are different in determining which clusters should merge at each stage. The Ward's method produced near equal distribution of countries in clusters for both years

Tab. 1: **Cluster classification of the EU member countries using the Ward's method**

Cluster	2013	2015
1.	Italy, Spain, Portugal, France, Belgium, Malta	Italy, France, Belgium
2.	Bulgaria, Romania, Czech Republic, Poland, Estonia, Lithuania, Latvia	Bulgaria, Romania, Czech Republic, Estonia, Lithuania, Latvia
3.	Luxembourg, Netherlands, Germany, Austria, Sweden, Finland, Denmark	Luxembourg, Netherlands, Germany, Austria, Sweden, Finland, Denmark, Malta
4.	United Kingdom, Ireland, Cyprus, Hungary, Slovakia, Croatia	Ireland, Cyprus, Hungary, Slovakia, Croatia, Poland, Slovenia
5.	Greece, Slovenia	Greece, United Kingdom, Spain, Portugal

Source: Elaborated by the authors

(see Tab. 1). Two exceptions occurred: in the fifth cluster for 2013 (Greece and Slovenia) and the first cluster for 2015 (France, Belgium and Italy). However, both cases share same characteristics different from all other clusters. We used the function *NbClust* to define that optimal number of clusters was five.

The similarity rate of objects within one cluster and the degree of dissimilarity of objects from different clusters for both years (2013 and 2015) are shown in Fig. 1 and Fig. 2. The results of the cluster analysis were satisfactory, as there were no between clusters. The figures also illustrate significant difference of the objects in fifth cluster (Greece and Slovenia) in 2013 and first cluster (France, Belgium and Italy) in 2015 from the rest of the objects.
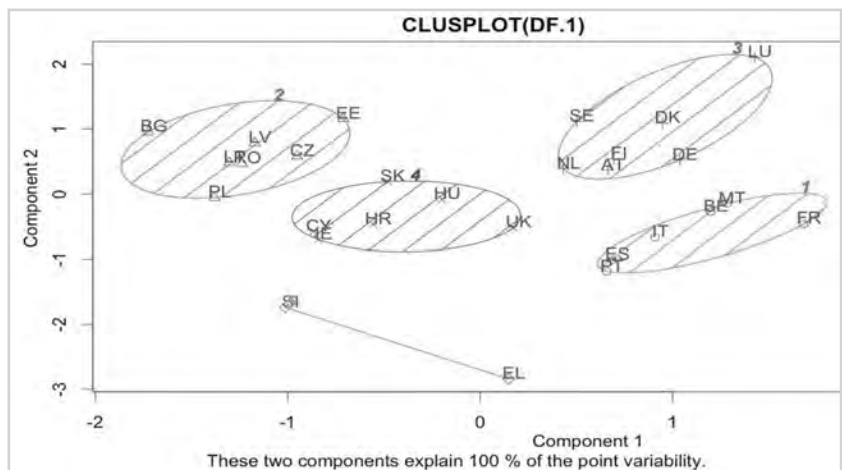

Fig. 1: **Graphical presentation of Ward's method classification 2013 (Graphical output from R-program)**
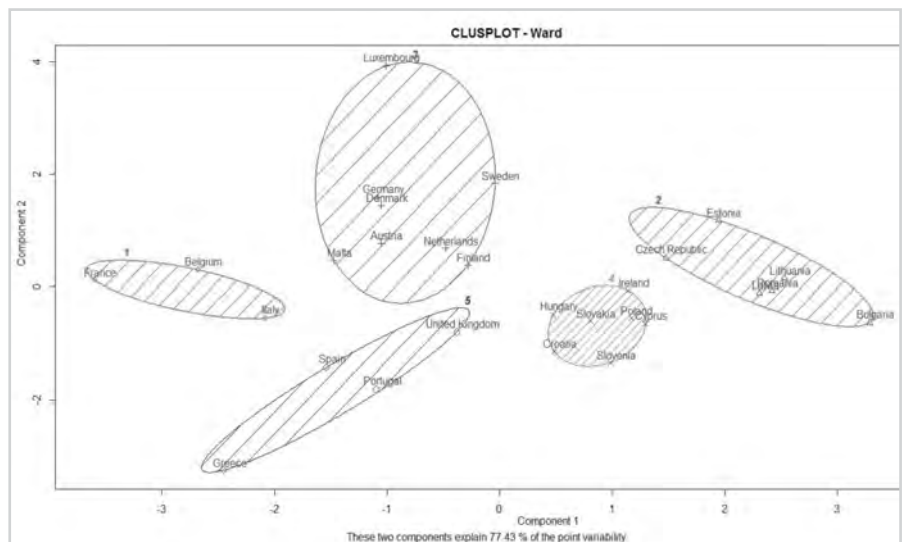Source: Elaborated by the authors

Fig. 2: **Graphical presentation of Ward's method classification 2015 (Graphical output from R-program)**
Source: Elaborated by the authors

3. 2. k-means method of non-hierarchical clustering

For comparison with the hierarchical methods a non-hierarchical clustering method approach was used. An optimal number of clusters was determined visually from the slope of the information gain curve graphical presentation in Fig. 3, based on which we decided on optimal number of clusters being five, both in 2013 and 2015. The testing shows the optimal number of clusters between one to 10.

The curve sharply increased to the value of five, which indicated that this value represents the optimum, both in 2013 and 2015. Although the curve had the steepest increase at the value of two clusters, it would not have sufficient informative nor analytical value to perform the cluster analysis for classification of the EU member countries only into two clusters. Therefore, we prefer using the results of grouping the objects (28 EU member states) into five clusters also in case of non-hierarchical clustering through k-means method, as it was in the analysis done through the hierarchical clustering. The result of analysis is performed through the k-means method in five clusters for 2013 and 2015 as it is shown in Tab. 2.

4. Discussion about clustering results

Comparing the results in 2013 and 2015, obtained from the hierarchical Ward's method (Tab. 1) and the results from the k-means method (Tab. 2), we found that both methods produced similar results. In general, the results of clustering method proved that the clustering fitted the requirements of clear categorization, the clusters were not overlapping and the distance between them is sufficient. Considering similarities between both clustering methods, quantitative characteristics of final multidimensional objects were considered valid for both clustering methods. As Tab. 3 and Tab. 4 show, the characteristics of individual clusters are expressed as the average values of selected segmentation criteria.

According to clustering results in 2013, *the first cluster* consists of six EU countries: Italy, Spain, Portugal, France, Belgium and Malta. This cluster reports high total tax burden (46.37% GDP) and the highest corporate tax rates (NTR at 33% and EATR at 29.8%). In 2015, the first cluster includes only three of initial countries (Italy, Belgium and France). The difference between years of observation could be defined by many reasons, such as decrease of corporate tax burden in Spain and Portugal, shifts in macroeconomic situation, change of fiscal position of the three excluded countries. However, the situation in the context of tax convergence is similar. These countries report the highest total tax burden (46.5% GDP) and the highest corporate tax rates (NTR at 32.91% and EATR at 30.0%). In the context of corporate taxation convergence assessment, we conclude that countries from the first group, both in 2013 and 2015, are characterized by a high degree of similarity. None of the countries grouped in the first cluster had enacted a nominal corporate income tax rate lower than 30% of tax base.

Estonia, Lithuania, Latvia, Bulgaria, Romania, and Czech Republic constitute *the second cluster* for both 2013 and 2015. Poland joins this cluster for 2013 yet moves to the forth one for 2015. The second cluster is characterized by the lowest average corporate tax burden both in 2013 and 2015. Their EATR and NTR in 2013 and 2015 belong to the lowest values compared to other EU countries (Tab. 3 and Tab. 4). The lowest tax rates for taxation of corporations were applied in both years mainly in Bulgaria (10%), Lithuania (15%), Latvia (15%) and Romania (16%). Considering the economic performance, fiscal discipline of these countries and based on tax quantitative characteristics mentioned above, the second group of countries represents the most tax competitive countries. It consists mostly of the newly acceding EU member countries, in which the convergence of economic policies and convergence of tax systems at the same time do not reach the level comparable to the old EU member countries (countries included into the first and third cluster).

The third cluster consists of seven countries: Luxemburg, Netherlands, Denmark, Sweden, Finland, Germany and Austria. Malta is added tj the cluster for 2015. Countries in the third cluster represent old member states (except Malta), with high tax burden (the highest average burden of 48.2% in 2013 and the second
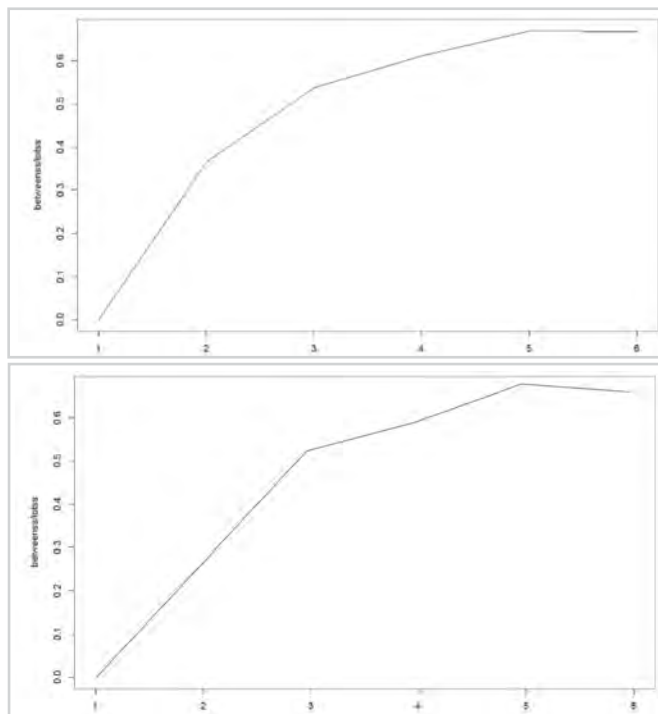

Fig. 3: **Determination of optimal number of clusters by k-means method in 2013 and 2015 (Graphical output from R-program)**
Source: Elaborated by the authors

Tab. 2: **Cluster classification of the EU member countries using the k-means method**

Cluster	2013	2015
1.	Italy, Spain, Portugal, France, Belgium, Malta	Italy, France, Belgium, Malta
2.	Bulgaria, Romania, Czech Republic, Poland, Estonia, Lithuania, Latvia	Bulgaria, Romania, Czech Republic, Estonia, Lithuania, Latvia
3.	Greece, Slovenia	Greece, Spain, Portugal
4.	United Kingdom, Ireland, Cyprus, Hungary, Slovakia, Croatia	United Kingdom, Ireland, Cyprus, Hungary, Slovakia, Croatia, Poland, Slovenia
5.	Luxembourg, Netherlands, Germany, Austria, Sweden, Finland, Denmark	Luxembourg, Netherlands, Germany, Austria, Sweden, Finland, Denmark

Source: Elaborated by the authors

highest average burden of 41.8% in 2015). These geographically similar countries (except Malta) with the highest total tax burden within the EU can be considered as the less tax competitive countries. In the corporate tax system convergence process, the third cluster countries' convergence has similar level as those in the first cluster. From the fiscal point of view, high economic performance (highly exceeding the EU average) and the high level of tax burden (which can improve budget revenues collecting) are contributing to low and sustainable values of short-term as well as long-term fiscal imbalance.

The fourth cluster consisted of six countries for 2013: Slovakia, Hungary, United Kingdom, Ireland, Cyprus and Croatia. It shrinked to only two countries for 2015: Slovenia and Poland. This categorization can be considered appropriate because of the corporate tax burden's value in these countries. The corporate tax rates in the countries from this cluster were among the lowest ones within the EU. Ireland and Cyprus had enacted the corporate tax rates only at 12.5%. This cluster represents the second most tax competitive cluster. Countries in the fourth cluster are new EU members and show significant similarity with the second cluster in both 2013 and 2015. Judging on the convergence of the corporate tax system, these countries are in the «catching up» process with the EU average. The fourth cluster can be defined by the instability of public finances and low fiscal discipline, because the state budget balance and public debt variables usually exceed the level set for the member countries.

Based on 2013 clustering results, *the fifth cluster* includes only two countries: Greece and Slovenia. According to the results in 2015, the last cluster consists of four countries: Greece,

Tab. 3: **Quantitative characteristics of clusters for 2013**

Cluster	Countries	EATR (%)	NTR (%)	TQ (% GDP)	GDP pc (EUR)	SBB (% GDP)	PD (% GDP)
1	IT, ES, PT, FR, BE, MT	29.8	33.0	46.37	24,450	-4.03	102.42
2	BG, RO, CZ, PL, EE, LV, LT	14.3	16.4	30.76	10,586	-1.81	34.99
3	LU, NL, DE, AT, SE, FI, DK	23.2	25.8	48.20	44,771	-1.07	55.70
4	UK, IE, CY, HU, SK, HR	18.4	18.6	40.17	19,583	-4.43	86.72
5	EL, SI	19.8	21.5	42.75	17,300	-13.40	122.65

Source: Elaborated by the authors based on the results of clustering

Tab. 4: **Quantitative characteristics of clusters for 2015**

Cluster	Countries	EATR (%)	NTR (%)	TQ (% GDP)	GDP pc (EUR)	SBB (% GDP)	PD (% GDP)
1	IT, FR, BE	30.0	32.91	46.5	32,066.7	-2.9	111.5
2	BG, RO, CZ, EE, LV, LT	14.2	15.83	29.9	11,783.4	-2.1	41.10
3	LU, NL, DE, AT, SE, FI, DK, MT	23.9	25.99	41.8	44,862.5	-0.93	56.81
4	IE, CY, HU, SK, HR, SI, PL	16.8	17.4	34.7	17,531.2	-2.42	75.3
5	EL, UK, ES, PT	26.6	23.75	36.2	24,100	-5.27	123.6

Source: Elaborated by the authors based on the results of clustering

the United Kingdom, Spain and Portugal. Countries of the fifth cluster are characterized by fiscal imbalance in short-term as well as in long-term prospective (with the highest value of budget imbalance and public debt). These negative values are especially sound in Greece and Portugal. Despite that fact, all the countries (except Greece) decreased their nominal tax rates during 2013-2015. The nominal corporate income tax rate is at the average of 23% and the effective corporate income tax rate at 26.6% (in 2015). Together with the third highest value of the total tax burden, these countries show the lowest level of competitiveness in EU. The level of corporate taxation convergence within this cluster is the same as that by the first and third clusters.

5. Conclusion

Categorization of the EU countries on the terms of the corporate taxation convergence process was performed using hierarchical method (Ward's method) and non-hierarchical method (*k*-means method). Both methods applied showed same results, which is very favourable and testify the appropriate classification of the member states into individual clusters. Based on the comparison of two methods, it can be stated that the economically transparent categorization is the classification into five clusters.

The results of cluster analysis discover differences in corporate taxation within the European countries in both 2013 and 2015. Thus, despite ongoing integration within the EU, differences between its member countries persist, and are visible in the nominal and effective tax rates, especially between old and new EU members. It means that the second and fourth clusters, which consist mostly of the new EU member countries, did not reach the level of tax systems convergence comparable to the old EU member countries (countries included into the first, third and fifth clusters). Results confirmed tax competition between countries within the European Union. It means that the overall level of convergence of the EU member states' tax systems is not sufficient and there is still place for further harmonization.

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