

# CATEGORISATION OF EUROPEAN UNION MEMBER COUNTRIES: THE RELATION BETWEEN TAX EVASION AND SHORT-TERM FISCAL IMBALANCE

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***Abstract:** The fiscal imbalance can be determined by many factors of economic, monetary or fiscal environment. The main goal of the paper is to create, choose and assess a meaningful categorisation of the European Union member countries that show homogeneity in the fiscal balance and the level of tax evasion. The purpose of the research by using hierarchical methods is to study relations between tax evasion (expressed as shadow economy) and short-term fiscal imbalance (expressed as primary balance) and to verify an assumption that the European Union countries with high values of the tax evasion report negative values of primary balance and vice versa. The research results point to significant differences between four identified clusters of multidimensional objects. The provided cluster analysis does not prove the preliminary assumption about the negative relation between tax evasion and primary balance. The analysis represents a background for further analysis of the effect of tax evasion on fiscal imbalance.*

***Keywords:** Primary balance, Tax evasion, Hierarchical cluster analysis, Short-term fiscal homogeneity, The European Union.*

***JEL Classification:** H26, H62.*

## **Introduction**

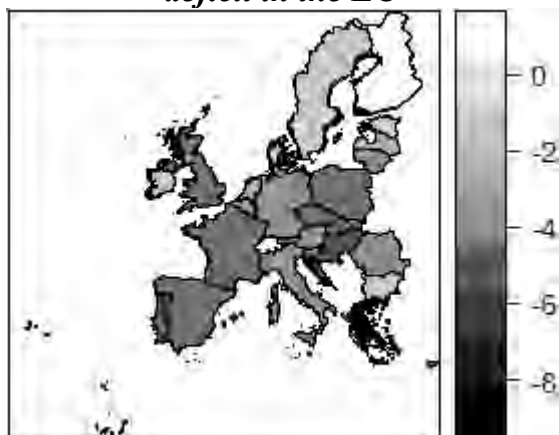
The existing and deepening fiscal imbalance during the period of the latest crises has led to the significant changes in values of short term imbalance and to an increasing number of problems concerning the long term sustainability of public finances. The growing government deficit and public debt are affected by exogenous factors such as the latest global crisis. Among these determinants which have the significant impact shadow economy and tax evasion itself are (e.g. [12], [13], etc.).

In general, both tax evasion and tax avoidance as a part of shadow economy have negative implications on the economy (e.g. [17], [2] and [18], etc.) in the form of destabilisation of economic and social balance and damage of macroeconomic, monetary and fiscal development. Cobham [3] points to the importance of tracking and controlling the tax evasion and tax avoidance as they affect both volume and nature of government finances. One of the most important facts is that they negatively influence budget revenues and budget expenses and at the end they negatively impact the country's fiscal balance, both in a short-term as well as in a long-term horizon (e.g. [17], [15], etc.).

All the considerable values of a shadow economy and high levels of general government deficit in the European Union member countries are proven by the maps which illustrate the twenty-eight European Union countries ranked by the level of median values over the period from 1995 to 2015 as illustrated in the Fig. 1 and the Fig. 2. As shown in the Fig. 1, most of the European Union countries report a median value of the government deficit in the interval from -3.93 up to -1.15 % of gross domestic product. The shadow economy is more or less spread evenly with the lowest value at 9.68 % of gross domestic product

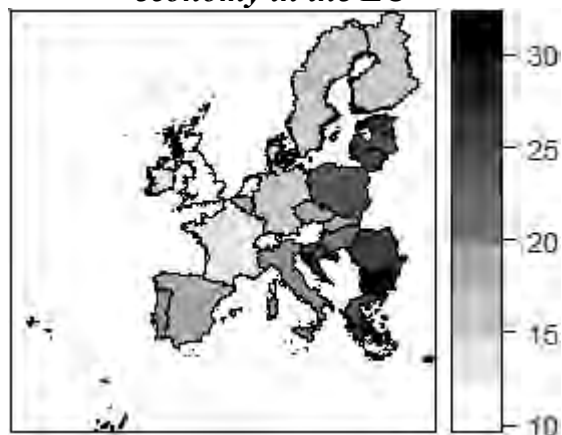
and with the highest value at 32.3 % of gross domestic product, as shown in Fig. 2. The homogeneity of the selected countries in the level of short-term fiscal imbalance as well as in amount of shadow economy is stimulus for creation a meaningful categorisation.

**Fig. 1: Map projection of government deficit in the EU**



Source: Authors' own elaboration according to [1]

**Fig. 2: Map projection of shadow economy in the EU**



Source: Authors' own elaboration according to [18], [19], [20], [21]

## 1 Objectives and methodology of research

The categorisation of countries provides a base to verify the assumption that *based on the countries' homogeneity in the primary balance and the level of tax evasion are the European Union member countries categorised into two main different groups: clusters with a high value of the tax evasion that would report negative values of primary balances and clusters with a low value of the tax evasion that would report positive values of primary balances*. The analysis allows to study the relation between existing shadow economy and a level of deficit as well as to identify the differences between the individual groups of the countries. In addition, this analysis represents a starting point for a further analysis to be conducted as a panel regression analysis with a purpose to search the impact and the extent of tax evasion on fiscal imbalance in short-term as well as in long-term time period.

The purpose of the research in the context of theoretical implication is to verify and prove the applicability of the clustering methods in gaining knowledge about fiscal development of the country. In the context of practical implication is the main purpose of the research the formation of the European Union member countries' categorisation based on their similarity in fiscal imbalance taking into account the existence of tax evasion as its important determinant.

### 1.1 Objective of the research

The main goal of this paper is to create and choose an economically transparent and meaningful categorisation of the European Union member countries using cluster analysis, based on the selected segmentation criteria and to assess the countries' homogeneity in the fiscal balance and the level of tax evasion in order to verify the formulated assumption.

Due to the large extent of tax evasion and tax avoidance, empirical research is carried out in the area of tax evasion and studied the size of the tax evasion and its relation to primary balance separately from the tax avoidance. Because of incompleteness and inconsistency of the tax evasion data as well as differences in estimates on the size

of the tax evasion, it is measured through the estimated size of the shadow economy published in the research papers by Friedrich Schneider [18], [19], [20] and [21].

The classification is based on five segmentation criteria: tax evasion (TE), net lending and net borrowing excluding interest of the general government adjusted for the cyclical component (PrimaryB), general government consolidated gross debt (GDEBT), fiscal rule index (FRI) and gross domestic product at current prices (GDP growth). Segmentation criteria were supported by empirical analysis and theoretical findings ([17], [4] and [18]). The selection of the variables is adequate to assess relations between tax evasion and short-term fiscal imbalance and to verify the stated assumption based on the following arguments.

The first variable is tax evasion expressed through the shadow economy indicator. This variable is chosen in accordance with the main purpose of the article as well as because of its significant and undeniable consequences within fiscal development of the country. As the research [14] states, the loss of the tax revenues due to the tax evasion and its gradual decline leads to the fiscal imbalance, which creates or deepens an already existing government deficit as well as the debt of the country. It also decreases the reported gross domestic product and last but not least, it is also reflected in the level of services provided by the state, since as a result of the reduction in government revenues, government expenditures will also need to be reduced [14]. All the fiscal variables provide a sufficient base to conduct cluster analysis because they represent basic fiscal indicators which can be used to reflect the fiscal situation in individual countries. The first fiscal variable is primary balance. In order to eliminate the impact of net interest payments, which are according to [5] characterised by their own dynamics and have an exogenous character, is for the assessment of countries' fiscal policy primary balance applied. Fiscal development cannot be assessed without another, more complex, phenomenon expressing total fiscal sustainability of country's public finance. Therefore, debt ratio is taken into consideration. The change in debt ratio captures the dynamics of the debt ratio to gross domestic product which can have a positive as well as a negative impact on short-term fiscal imbalance. A high level of debt may lead to a positive change that can improve the short-term fiscal imbalance, but a change in the debt ratio may also be reflected negatively and that would be due to the exposure on growth of the interest payments [12]. In the fiscal sustainability context, several fiscal rules within budgetary surveillance in European countries are implemented. The fiscal rules represent a permanent constraint on fiscal policy, expressed in terms of a summary indicator of fiscal outcomes, such as the government budget balance, debt, expenditure, or revenue developments [7]. Hence, for the third clustering fiscal variable index of fiscal rules is taken into account. The decline in relative weight of public debt in the individual countries does not necessarily mean that total debt should be declined. A positive phenomenon for the economy is a situation where the growth rate of public debt is lower than real gross domestic product growth, because it creates conditions and possible solutions to the debt issue. The empirical literature significantly varies in explaining the fiscal effects of gross domestic product growth variable. The overall economic situation of the country has a tendency to contribute to the reduction of the fiscal imbalance in the times of its boom. In addition, the low economic growth is one of the major causes of the excessive deficits within the European Union (e.g. [14], [13], etc.).

Secondary data of the each individual segmentation criteria for all the twenty-eight European Union countries for a period of twenty-one years from 1995 to 2015 are obtained from the Ameco database of the European Commission. The secondary sources of estimates on the size of the tax evasion measured through the estimated size of the shadow economy

are taken from the publications of Friedrich Schneider [18], [19], [20], [21]. The calculation of the size and development of the shadow economy is done with the MIMIC (Multiple Indicators and Multiple Courses) estimation procedure.

## 1.2 Methodology of the research

The cluster analysis is in the context of methodological approach carried out in five basic phases: (1) *the definition of segmentation criteria and database creation*, (2) *data normalisation*, (3) *data factorability verification*, (4) *implementation of cluster analysis*, and (5) *evaluation of the cluster analysis results*.

*The first phase (1)* is represented by the selection and definition of segmentation criteria. According to theoretical knowledge and empirical research as well as in line with the main goal of the research, the five segmentation criteria are considered as characterised in the subchapter 1.1. For the purpose of clustering, mean of all the data series for each of the observed countries and for each segmentation criterion is calculated. The obtained data are transformed in the next step to weighted averages with the accent on the basic fiscal indicators deficit and debt that represents the most important segmentation criteria. The indicators have been assigned with the estimated weights – deficit (primaryB) with 50 %, debt (GDEBT) with 30 %, tax evasion (TE) with 10 %, gross domestic product growth (GDP growth) with 5 % and fiscal rule index (FRI) with 5 %. The transformed weighted indicators represent the final segmentation criteria for clustering. Such individual weights are determined according to the particular expert methods [10], [24]. The mentioned criteria represent the secondary data obtained from the Ameco and from the empirical research of Schneider. These sources provide for the comparability of time series between the European Union member countries, as the used European System of Accounts 2010 methodology is fully in line with the European System of National Accounts. The definitions of individual variables are in line with the used methodology [1]. The values for each criterion are obtained for all the European Union countries for the time span from 1995 to 2015.

*The second phase (2)* is concentrated on normalisation of the segmentation criteria. It is necessary to set up comparable units of all the applied variables – in this case of two kinds that is in form of percentage and index. Scientific literature, such as [23], offers the various normalisation techniques. Therefore, there is no best approach to standardise data, taking into consideration the dataset of the segmentation criteria and the definitions of the individual normalisation methods.

*The third phase (3)* represents the factorability verification of segmentation criteria. The variables are tested on a degree of collinearity and thus prove or disprove an extreme degree of singularity among the variables [8]. The most commonly used tests of the data factorability are the Bartlett's test of sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy. Therefore, within the research these two mentioned tests are applied. Based on the Bartlett's test of sphericity result, whose p-value stands at  $6.5311 \cdot 10^{-6}$ , can be stated that there are the correlations in the dataset that are appropriate for the cluster analysis. Interpretation of the Kaiser-Meyer-Olkin measure of sampling adequacy considers six intervals with the assigned degree of common variance, starting with the "don't factor" degree up to the "marvelous" degree. The common variance among our five variables is 0.62, which corresponds to the definition of "mediocre". The both test results show that the investigated variables correlate with each other at a required level and therefore represent a solid base of variables used for the further cluster analysis.

After selecting, normalising and testing the segmentation data, *the fourth phase (4)* of clustering is performed. This phase is divided into the two stages – *selection of clustering method* and *determining the number of clusters*.

Selection of clustering method represents a critical step in the clustering process and the literature offers a large number of clustering methods [6], [11], [22]. As authors [9] state, the choice of a clustering algorithm depends both on the type of data available and on the particular purpose. In accordance to formulated purpose and relative small database, the traditional hierarchical cluster methods are applied – conducted by the four methods where single linkage method, average linkage method, complete linkage method and the Ward's method belong. Within the cluster analysis, the Euclidean distance, as the most common distance measure, is chosen.

Determining the number of clusters is the second step of the cluster analysis. One of the advantages of the hierarchical methods of clustering is the ability to determine the number of clusters at this stage of the analysis and not to have to do it in advance. The R statistical software offers the NbClust function, which provides a list of validity indices to estimate the relevant number of clusters in the dataset. For the purpose of this research two indices were applied, namely the Hubert statistic index and the Dindex, which are graphical methods of determining the number of clusters.

*The last phase (5)* represent the evaluation of cluster analysis. The analysis is evaluated in the two steps. In the first step, the individual clusters from the processes performed in the subchapter 2.1 using each of the hierarchical methods are evaluated. The final groups of these multidimensional objects with characteristics are mutually compared. In the second step – using the processes in the subchapter 2.2 – is the final chosen categorisation discussed and assessed in order to verify the formulated assumption.

## **2 Cluster analysis results**

The cluster analysis, which is performed in the R statistical software, allows to transform the values of the five segmentation criteria into characterising groups of the countries called clusters with a certain level of similarity, but also a considerable level of dissimilarity. A visual presentation of the results of the hierarchical clustering is a dendrogram. However, these dendrograms do not cluster the countries in the limited groups. They only show how homogenous the nests of cases are formed.

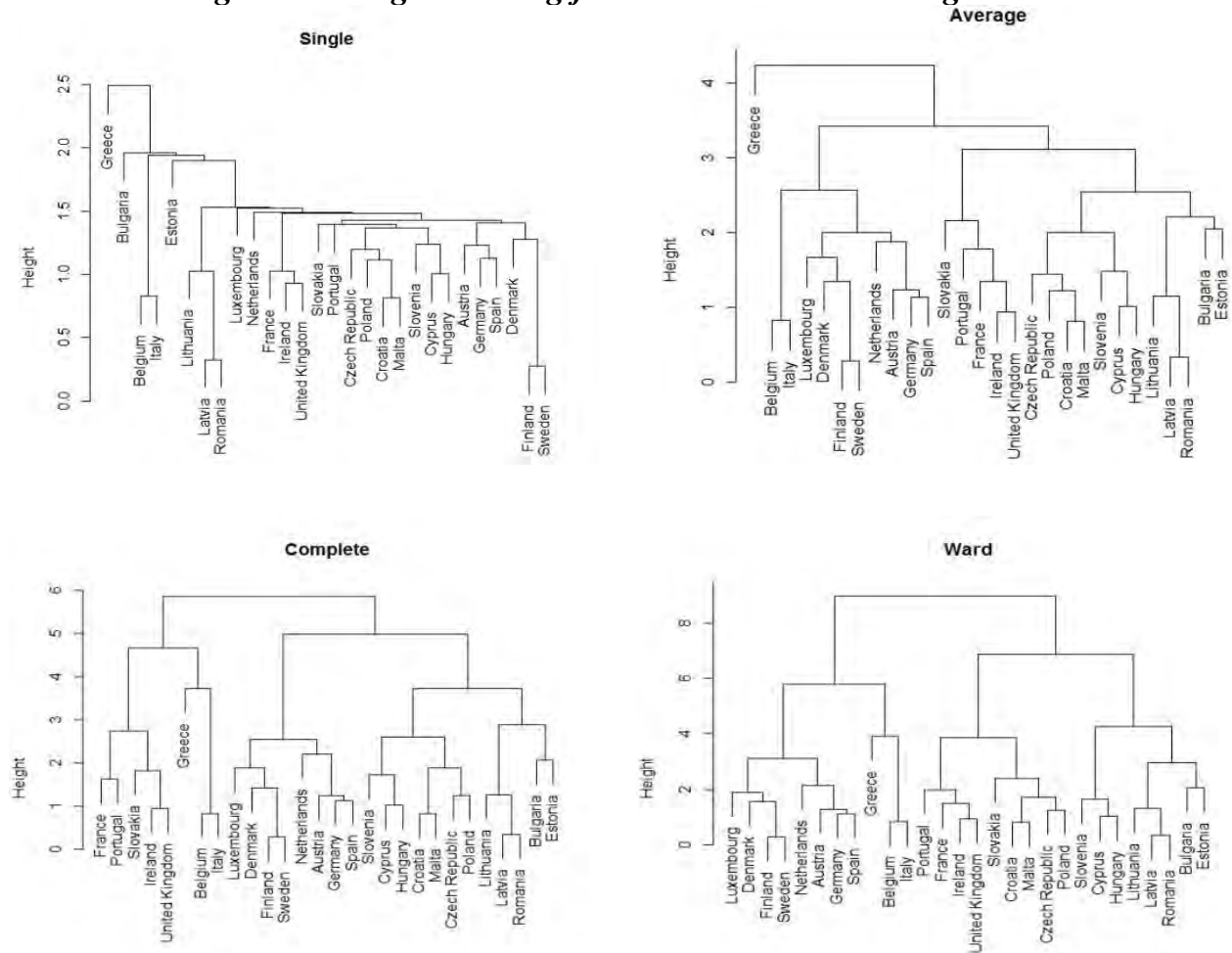
### **2.1 Cluster analysis results within hierarchical clustering methods**

The Fig. 3 shows the outcome of individual hierarchical methods. As illustrated, various methods lead to the different results, where individual countries are displayed next to each other in different order and at different distances.

By comparing outputs of individual methods may be concluded the following findings. According to the single method, the recommended number of clusters equal to three is lower than according to the other methods. The single method reports one cluster containing almost every country except the five countries. The other methods group the European Union countries mainly into the four clusters in the case of the complete method and the Ward's method or the five clusters in a case of the average method. The countries such as Greece, Belgium and Italy represent the outliers almost in every method. The reason why these countries are separated could be the fact that they have had fiscal imbalance problem for a long-term period. The reason can be also the methodology of the method used – only the Ward's method creates the clusters of the approximately same size. Based

on comparison of the clustering results, it can be concluded that clusters point out that the classification of the European Union countries is exactly the same.

**Fig. 3: Dendrograms using four hierarchical clustering methods**



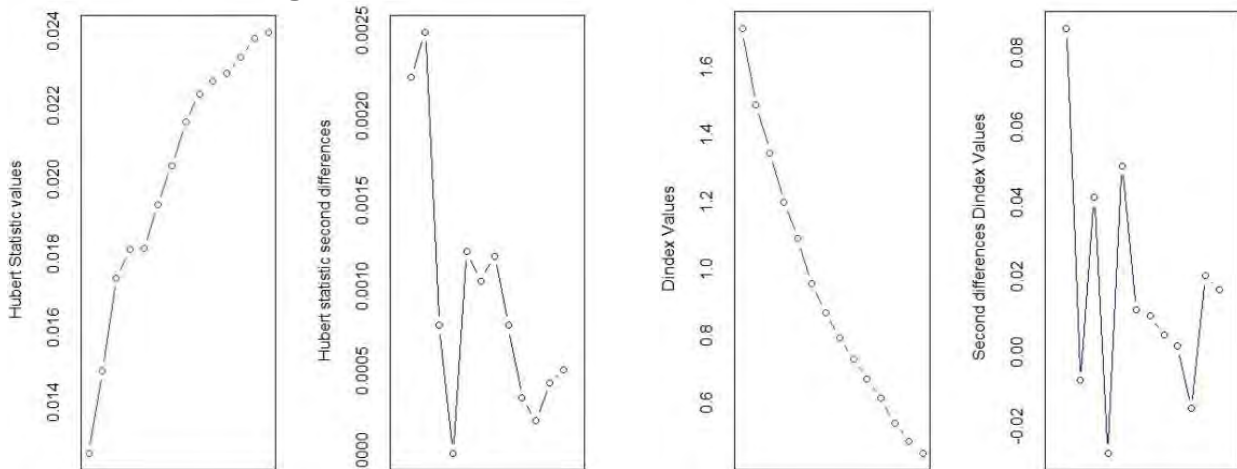
*Source: Authors' own elaboration as output from R statistical software*

The number of clusters within the individual methods is different, but grouping of the countries is almost identical. Based on the above mentioned, it can be stated that the clustering of member states is performed mainly by using their similarities and differences and the selection of the certain method of the hierarchical clustering influence the results only in small extent.

Based on the clustering results, it can be concluded that while the single linkage method tends to create clusters that are quite heterogeneous internally and is also known for creating a chaining problem – long and straggy clusters, the average linkage method is considered to be fairly robust. The complete linkage method, similarly to the single linkage method, does not take into consideration the structure of the clusters and is very sensitive to the outliers. The Ward's method, even if showing some disadvantages where for instance sensitivity to the outliers belongs, seems to be the best choice. As it is not goal of the research to show and explain the differences between the results of individual clustering methods, it is required to decide on one clustering method that would be the most suitable for the particular case and that will be used for further analysis. According to the scientific literature, as well as empirical knowledge, the most appropriate method in this research is the Ward's method. The next step is determining a number of clusters.

The Hubert index proposes three as the best number of the clusters and the Dindex proposes two as the best number of the clusters which only proves above stated that there is no unanimous choice in regards to the optimal number of the clusters. R statistical software also provides all the validation measures. To summarise proposed results, the most frequently recommended optimal number of clusters is 4 times of each: 2 clusters (which was also the solution in the form of results based on majority rule), 3 clusters, 4 clusters and 15 clusters. Taking into consideration all 4 best options, we had to clearly exclude the choice of 15 clusters being the optimal result, as 15 clusters out of 28 countries do not provide us with the sufficient level of similarity between all the countries. Within the process of deciding between 2, 3 or 4 clusters being an optimal number of clusters, clusplots (2-dimensional clustering plots) were used.

**Fig. 4: The Hubert statistics and the Dindex statistics**



*Source: Authors' own elaboration as output from the R statistical software*

By comparing the bivariate cluster plots for each of the three stated options, the final clusters are easily visible and readable. From the cluster plots of the two and the three clusters, the individual clusters overlap mutually. Therefore, it can be concluded that the degree of dissimilarities between the clusters is not acceptable. The cluster plot does not show any joint intersections of the clusters or overlapping areas and thus is considered to be the best option for our further analysis.

## 2.2 Cluster analysis results using Ward's method

The final dendrogram and the cluster plot prove that the Ward's method of clustering creates clusters of the approximately same size as displayed in the Tab. 1. The first cluster is clearly smaller than the other three clusters. However, the countries within, for instance Belgium, Greece and Italy, report the common characteristics of the investigated segmentation criteria, which they differ from countries in the other three clusters by.

The cluster 1 consists of the three countries with the highest gross debt among all the European Union members – they are above 100 % of gross domestic product. The cluster 2 groups the eight countries with the individual tax evasion above the European Union average, but with the highest gross domestic product growth. The countries involved the cluster 3 are characteristic by their average level of gross debt, but report high deficits and relatively high gross domestic product growth. The cluster 4 consists of the eight countries, which report on individual basis relatively low gross debt and tax evasion and at the same time their primary balance is in the form of surplus or very small deficit.

**Tab. 1: Categorisation of the European Union countries according to the Ward's method**

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

Source: Authors' own elaboration

There are summarised quantitative characteristics of the segmentation criteria, calculated as median within each cluster, in the Tab. 2. The primary balance with positive values represents a surplus, while negative primary balance reflects a deficit. By improving primary balance, values move towards positive numbers or in the case of positive primary balance towards higher positive values.

**Tab. 2: Quantitative characteristics of the clusters**

| cluster | GDP growth<br>(in % GDP) | Primary B<br>(in % GDP) | GDEBT<br>(in % GDP) | FRI<br>(index) | TE<br>(in % GDP) |
|---------|--------------------------|-------------------------|---------------------|----------------|------------------|
| 1       | 2.913                    | 2.705                   | 111.781             | -0.342         | 20.067           |
| 2       | 8.948                    | -0.958                  | 30.092              | -0.200         | 27.120           |
| 3       | 6.463                    | -1.325                  | 55.616              | -0.353         | 22.020           |
| 4       | 4.017                    | 1.744                   | 53.577              | 1.013          | 17.853           |

Source: Authors' own elaboration

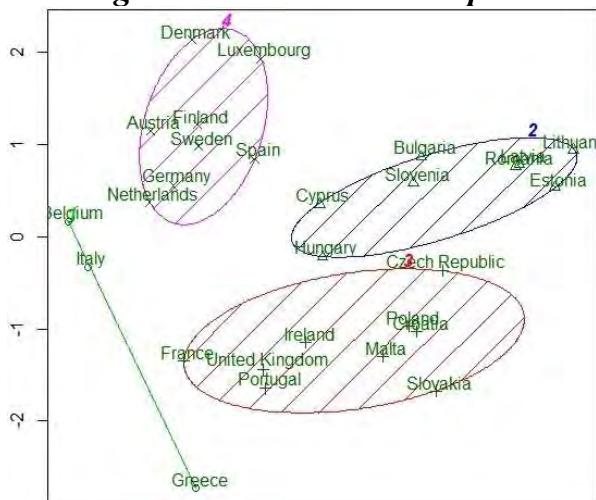
The first cluster consists of the three countries – Belgium, Greece and Italy. In the context of fiscal imbalance assessment, it can be stated that this cluster has a special position in comparison with other clusters. Despite the fact, that two of these countries (Belgium and Italy) have a positive primary balance, these countries are characterised by problems in long-term fiscal imbalance. Government debt of this cluster is over 100 %. Among the determinants of high debt, value can conclude interest payments from previous debt. The level of tax evasion stands at 20.06 %. Based on the second lowest level of tax evasion and high positive value of primary balance, from the short-term period point of view can be stated that in these countries the low level of tax evasion can contribute to a high positive value of primary balance.

The second cluster consists of the eight countries – Bulgaria, Estonia, Cyprus, Latvia, Lithuania, Hungary, Romania, and Slovenia. This group comprises most of the newly acceding European Union member countries and in the terms of fiscal discipline they are among disciplined countries, especially in the long-term fiscal discipline except for Cyprus and Hungary, particularly in the recent five years. All the countries in this cluster reach value of government debt below 40 % of gross domestic product except for Hungary and Cyprus whose average value of debt is at level of about 65 % of gross domestic product. The country deserving most attention is Estonia with the lowest average value of debt and deficit. Because of Estonia's attitude to macroeconomic and fiscal problems and their solutions the country became an extraordinary member of the European Union and the euro area and could inspire other states in keeping their public finances [14]. Despite their fiscal

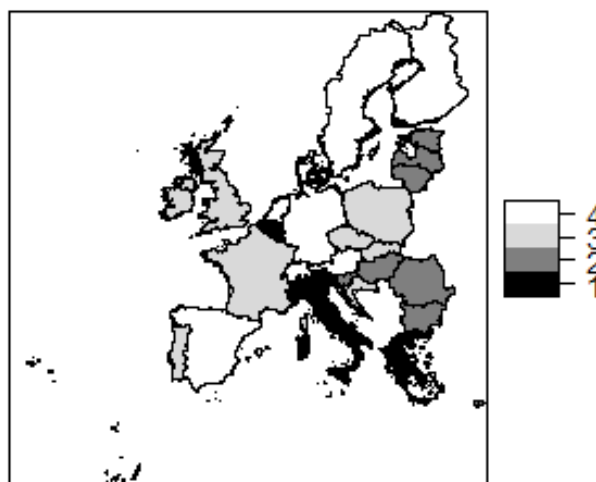


position, the level of shadow economy represents the highest value in comparison with the other clusters. Based on these results, high value of tax evasion can contribute to negative value of primary balance.

**Fig. 5: The Ward's cluster plot**



**Fig. 6: The clustering map projection**



*Source: Authors' own elaboration as output from R statistical software*

The third cluster contains the nine countries comprising the Czech Republic, Ireland, France, Croatia, Malta, Poland, Portugal, Slovakia, and the United Kingdom. In the fiscal context, these countries are characterised by instability of short-term fiscal imbalance and lower fiscal discipline than the cluster 3. The indicator of public debt exceeds the level set for the member states almost in a half of these countries. The worst position in the fiscal area clearly Portugal and Ireland have, where their public debt overran level of 120 % of gross domestic product during the last five years. The value of shadow economy within this cluster represents the second highest value which can contribute to highest negative value of primary balance.

The last cluster, which groups the eight countries, where Denmark, Germany, Spain, Luxembourg, Netherlands, Austria, Finland, and Sweden belong, represents the old European Union members and the most developed countries in the European Union with very good values of economic performance and fiscal imbalance. In the fiscal context, short-term budget management is very positive and the countries like Denmark, Germany, and Luxemburg have had a budget surplus. The public debt values were within this group in accordance to long-term sustainability requirement. These geographically clustered and connected countries – except for Spain – have a positive economic growth with a positive fiscal situation and a low value of shadow economy at level of 18% of gross domestic product. Based on these values, it can be supposed a negative relation between tax evasion and primary balance that means the low level of tax evasion can contribute to positive value of primary balance.

### 3 Discussion

The assumption assumed that the cluster with the high value of the tax evasion, which is measured through the estimated size of the shadow economy, would report negative values of the government deficit that is measured by the indicator primary balance. Also assumed that clusters with a low value of the tax evasion would report positive values of primary balances.

According to the results, the differences between the clusters are identifiable. The countries assigned to the cluster 1 and the cluster 4 represent the countries with a positive value of primary balance and a low level of tax evasion. On the other hand, the countries categorised in the cluster 2 and the cluster 3 have a problem with primary balance and high level of tax evasion. Based on the found outcome, it can be supposed that the assumption could be accepted. However, at a detailed view it can be seen that there is no linear relationship or negative relation between the value of tax evasion and the primary balance, so the assumption may be the result of the other factors too. The reason is that the highest median value of tax evasion at level of 27.12 % of gross domestic product, which was reached in the countries within the cluster 2, does not contribute to the second highest median negative value of primary balance standing at -0.96 % of gross domestic product. On the other side, the second highest level of tax evasion reaching 22.02 % of gross domestic product contributes to the highest negative value primary balance peaking at -1.33 % gross domestic product. Because of the mentioned differences, it cannot be unambiguously stated that the relation between tax evasion and primary balance is negative. The cluster analysis results show the differences in the two separate blocks of the countries, between the old members and the new member of the European Union. The analysis confirmed that the old member countries are characterised by lower short-term fiscal imbalance and a lower level of tax evasion than the newly joint countries.

## **Conclusion**

The purpose of the research in the context of theoretical, as well as practical implication can be considered as satisfied. The research results verified the applicability of clustering method within assessing similarities and differences of fiscal imbalances and the level of the tax evasion of countries. Categorization of EU member countries based on their homogeneity in fiscal imbalance taking into account the existence of tax evasion as its important determinant was created using hierarchical clustering methods.

The analysis shows that a negative relation between tax evasion and primary balance cannot be proven. According to results, there are differences between countries in the level of short-term fiscal imbalances (expressed as primary balance) and tax evasion, especially between old and new EU member countries. In addition, it needs to be noted that the results of the cluster analysis might be affected by several process-related factors, such as disadvantages of hierarchical methods, the use of estimated values (measuring the tax evasion through shadow economy indicator), the selection of segmentation criteria, etc. Therefore, the issue of the tax evasion and relation with the short-term fiscal imbalance could be developed and analysed in more detail and by using other non-hierarchical methods with modified conditions.

## **Acknowledgement**

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