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European Union "unanimously" entering the post-pandemic recovery period: An empirical evidence on heterogeneity of EU members

Abstract

In the wake of Recovery and Resilience Facility, and unprecedent monetary policy conducted by ECB, the study examines with statistical modelling whether the European union is homogenous enough so that cohesive plan leads to equal bounce back effect across all countries. This paper measures the degree of dissimilarity among European union members by hierarchical clustering and visualizes the results in form of a dendrogram. The analysis considers fundamental macroeconomic indicators and the variability of these indicators in analysed periods as a basis for calculation of dissimilarity matrix. Three distinct clusters are detected before the launch of a single currency – the euro, with Luxemburg being an outlier. It was assumed that the introduction of the European Monetary Union (EMU) and strengthening the position of European institutions would straighten out the differences among member states, yet the paper releases compelling evidence to the contrary. The results exhibit rising dissimilarities not only among initial clusters but also within the groups themselves. Having experienced the economic shock of coronavirus, it is inevitable for policy makers to understand those discrepancies in order to propose the plan, which would fight the plausible asynchronous business cycle inside the Union.

Key Words

heterogeneity, European union, recovery, optimal currency area, cluster analysis

JEL Classification: E52, E63, F53, C38

Introduction

The optimal currency area (OCA) can be defined as a monetary union formed by a group of countries within which there is a single currency. The primary goal of the optimal monetary area is to maximize the economic efficiency of the member states. Initially, this theory was formed by Mundell (1961), who defined the factors needed to create OCA, considering labour mobility to be the most important. This theory was supplemented by McKinnon (1963), who distinguished between geographical and sectoral labour mobility. At the same time, he argues that the openness of the economy is the most crucial factor for OCA. Kennen (1969) proved that workers in the OCA countries must be homogeneous. Otherwise, perfect labour mobility is not possible and therefore it is not feasible to create an OCA. Kennen also believes that it is important for OCA countries to have a diversified product, thus reducing the risk of crises.

The OCA theory developed more markedly in the 1970s. Corden (1972) argued that the creation of a monetary union causes a loss of direct control over monetary policy and the level of the exchange rate. As a result, the asymmetric shock would cause rising unemployment, changes in prices, or significant fiscal measures. For this reason, Corden considered the price and the wage flexibility to be an important prerequisite for an OCA. If countries have different inflation preferences, then monetary union alone will be costly. Ishiyama (1975) was the first to claim that there was no single criterion for the formation of OCA. The author discussed various economic and social factors that need to be considered when creating a monetary union.

The lack of real-life examples of monetary unions in the world has slowed down the research on the topic. A significant shift occurred in the 1990s when the possibility of creating the European Monetary Union began to emerge. A significant milestone was the work "One Market, One Currency" by the European Community (1990), which focused on the benefits of creating a monetary union in Europe. Alesina, Barro and Tenreyero (2002) claimed that the costs of monetary union are lower the higher the potential of economic shock arising among countries if each uses its own currency. However, Mélitz (1991) argued that despite symmetric shocks, it is possible that each country should adopt different monetary policy response, because their economies are different. Calvo and Reinhart (2002) defined the so-called "fear of floating". For some smaller countries, it is more advantageous to be in a monetary union for fear of failing to conduct their own monetary policy. In European Union we can find some smaller and open economies, hence we consider this as a valid point to be added to the strand of others. Obstfeld and Roggoff (1996) summarized the benefits of OCA, including reduced transaction costs, reduced accounting costs, better price predictability, and reduced risk of speculative bubbles.

The authors generally agree that the creation of OCA requires individual countries to be to some extent economically and socially homogeneous. At the same time, they must be adequately integrated and to have a mobile labour market and developed financial markets. At the same time, the individual countries of the monetary union should gradually converge economically, as the conduct of monetary policy is transferred to a supranational central bank. Yet asymmetric shocks can make monetary union unable to pursue a monetary policy that helps one country and does not harm another.

Most authors do not consider the current version of the euro area to be the OCA. Eichengreen (1991) argues that Europe is significantly more heterogeneous than the United States or Canada. Thus, a monetary union may not work in the long run. The economic, political, and social integration of EU countries will be particularly important. Krugman (1993) opposed the creation of EMU. On the contrary, Frankel and Rose (1998) contend that EMU can significantly increase trade, which will be reflected in a higher correlated economic cycle between member countries. The countries were expected to converge economically after the creation of the monetary union. It should be added, however, that these assumptions have not been met to a large extent. Handler (2013) says that economic disparities between euro area members are now more pronounced than before. At the same time, financial markets are not integrated, and the labour market is not mobile enough.

Over time, two contradictory concepts have developed (De Grauwe, 2009) that describe changes after economic integration of several countries. Those concepts can be also applied to judge the monetary union:

I. **Endogeneity hypothesis**: After economic integration, countries gradually converge towards each other. Economic cycles are unifying. In principle, the joint implementation of monetary policy does not harm any country.
II. **Specialization hypothesis**: Greater economic integration of countries leads to significant specialization. In case of demand shocks within selected sectors, asymmetric effects may arise. This prevents the functioning of the monetary union.

At present, the European Monetary Union is relatively stable. However, based on empirical research, EMU cannot yet be considered as the OCA. The countries forming the EMU are heterogeneous (Coudert, 2020). However, this would not be such a significant issue if the individual countries converged over time, which would confirm the endogeneity hypothesis. This would presume that the member states may form the OCA in the future.

In our research, we are answering the question whether the current EU countries converge over time and whether there is a precondition for confirming the endogeneity hypothesis. Through analysis, we monitor whether individual member states are ironing out the dissimilarities. We also analyse EU countries that are not members of the eurozone. The reason is the assumption that over time, these states are obliged to become members of the euro area.

The member states are divided into two groups – early members (joined the EU before 2004) and late joiners (coming after 2004). Eventually, we analyse the original countries and newcomers EU countries together. We examine the level of heterogeneity in several periods to inspect if individual countries converge or diverge towards each other. At the same time, we try to find possible clusters of countries that are moving in the same direction over time. We determined the individual periods examined based on noteworthy events that affected the development in the EU. These include the creation of the euro area (1998), the accession of CEE countries to the EU (2004), the outbreak of the global financial crisis (2009), or the launch of the quantitative easing program APP as a response to the debt crisis (2014). Based on the data obtained, we are assessing whether there is an economic convergence of countries within the EU, or rather divergence prevails over time.

1. Methods of Research

Clustering is a popular technique, which is commonly used in the field of statistical data analysis to group similar objects into a single cluster and separate them from dissimilar ones, which are assigned to different cluster(s). The first attempts were presented in the 1930s (Zubin, 1938). Clustering has gained a significant popularity in the aftermath of high-speed computers (not earlier than in the 1960s) as the computational expensiveness can by polynomial or even more complex depending on the problem to cluster (Mahajan, 2009) and can be expected to hit up to $O(n^2 \log(n))$ as presented by Murtagh (1983).

In the paper, we rely on the principles of Hierarchical algorithms (HA) which are built to find successive clusters in relation to already formed ones. HA can be of two types (i) the agglomerative or (ii) the divisive (Madhulatha, 2012). The former represents the bottom-up approach and is also employed in our analysis, the latter is of top-down style. Agglomerative approach starts with every observation in dataset forming cluster of its own and, in every iteration, these clusters are enlarged by the most similar instance(s) until all observations are in only one cluster. The history of grouping suggests which instances are more similar than the others. To make decision-making more intuitive, we visualize the results in form of a dendrogram. Dendrograms visually represent hierarchy in a tree-like structure (Phipps, 1971).

For calculating the distances between countries in n-dimensional space, we use the standard metric – Euclidean distance. We are aware that other metrics exist (Kumar, 2014; Cha, 2007), Euclidean distance is seen as the most suitable for our analysis, inasmuch as the data are continuous and properly scaled in all dimensions. The Euclidean distance, D_e, between two observations x_i and x_j, is defined as following (Kumar, 2014):

$$D_e(x_i, x_j) = \left(\sum_{l=1}^{n} |x_{il} - x_{jl}|^2 \right)^{\frac{1}{2}} \tag{1}$$

where the letter l in subscript of variables x_{il} and x_{jl} represent l^{th} dimension in n-dimensional space of x_i and x_j observation, respectively.

Having defined distance measure (which in our case also meats 4 conditions of the real metric), we must decide on cluster analysis procedure. A number of agglomerative clustering methods (single linkage, complete linkage, weighted and unweighted pair-group average, weighted and unweighted pair-group centroid, Ward´s method, etc.) are available (Saracli, 2013).

Single linkage method was introduced in 1950's by Florek (1951) and is still commonly used (Jarman, 2020). This method is sometimes referred to as Nearest Point Algorithm because it depends on the smallest distance between points of two distinct clusters. The distance, $D(u, v)$, between cluster u and v is calculated:

$$D(u, v) = min\left(dist(u_i, v_j) \right) \tag{2}$$

where u_i, v_j are individual observations inside the respective cluster, either u or v.

In the contrary, the farthest distance between two points from two clusters is of interest in the so-called Complete linkage method (Murtagh, 1983).

$$D(u, v) = max\left(dist(u_i, v_j)\right) \tag{3}$$

Average linkage is an interesting method which does not focus on a distance between two points, as it was the case before, but rather scrutinizes distances among all points in both clusters and calculates the average distance for those instances (Blashfield, 1988).

$$D(u, v) = \sum_{ij} \frac{dist(u_i, v_j)}{(|u| * |v|)} \tag{4}$$

The last method we introduce in the paper is the Ward´s method. By its nature, it is a very general method, which decides on merging the cluster during clustering procedure based on the optimal value of optimization function (Szekely, 2005). It was originally designed to optimize the minimum variance within the clusters (Ward, 1963).

$$D(u, v) = \sqrt{\frac{|v| + |s|}{T} * d(v, s)^2 + \frac{|v| + |t|}{T} * d(v, t)^2 - \frac{|v|}{T} * d(s, t)^2} \tag{5}$$

where s and t denote clusters from original forest, which are combined into a new (single) cluster u, and the cluster v is then unused cluster in that iteration, $T = |v| + |s| + |t|$.

As presented later, in Fig. 1, all four methods release comparable information. For the sake of saving space, the rest of the paper relies merely on Ward´s method. There is also a foundation for that in literature. It was demonstrated that Ward´s method performs better than the others (e. g. Blashfield, 1976; Hands 1987) based on assumption there are no clear outliers in the sample (Milligan, 1980).

Our analysis is centred on the list of EU member states right after 2004 intake. We aim to analyze countries of EU which are members for long enough to have sufficient history in the union to uncover the impact of being a member state. Hence, we leave Bulgaria, Romania (2007) and Croatia (2013) as current members of EU out from the sample. We refer to the countries via their abbreviations presented in the European Commission glossary. For the abovementioned countries we collect fundamental macroeconomic data, such as inflation, unemployment, GDP growth, public debt, private debt, and the balance of current account. The data are gathered from two main sources, IMF, and Eurostat on an annual basis. We break down the analysis on three samples of countries, i. e. early members, late joiners and all countries together. We start our analysis with the subset of countries that joined the union prior the 2004 enlargement. This is followed by the analysis of 10 countries which accomplished accession to EU in 2004. Finally, we conclude with the joint analysis of all countries.

The countries are analysed and clustered in different time windows. We start with the period 1980–1998, which preceded the launch of the monetary union. Afterwards, we try to apprehend how countries evolved over time. Therefore, we repeat the same procedure in clustering over several other time periods (i) prior to the global financial crisis 1999-2008 (ii) in the wake of debt crisis 2009-2014, and (iii) up to now – period 2015-2019. With the already mentioned pre-euro period, we review in the article 4 timeframes. Each country is in every period characterized by the mean values of indicators and their standard deviations to capture the dynamics inside the time interval. The panel is then properly scaled in all dimensions to prevent clustering algorithm to behave erratically.

2. Results of the Research

In this chapter, we analyse the dissimilarities among EU members by performing cluster analysis. As a method chosen out of clustering universe, we employ hierarchical ascendant clustering (HAC) and its visualization in form of a dendrogram. We aim to answer two important questions (i) whether the European Union is divided into groups inside which cluster peers are notably more similar than members of other clusters, and (ii) whether there is any sign of convergence or divergence in time.

Fig. 1: HAC analysis with different linkage methods
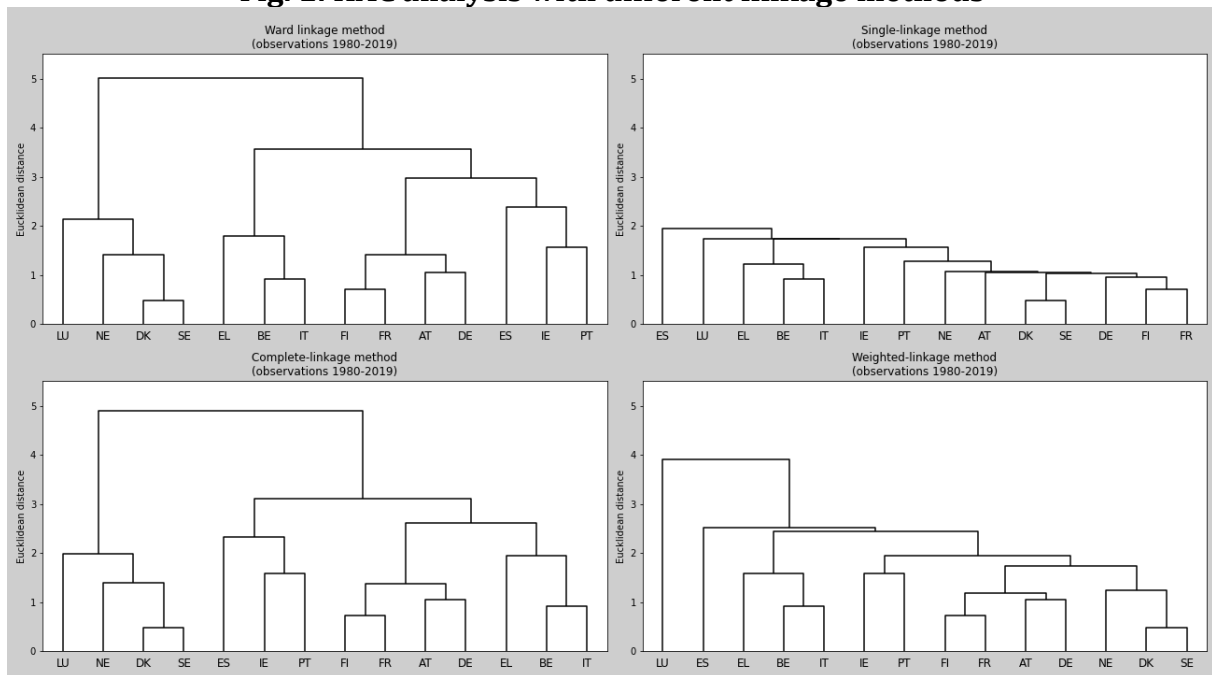
Source: own calculation in python 3.8, data from (EUROSTAT, IMF, 2021)

As Fig. 1 depicts, all four methods described in methodology section release comparable conclusion. The countries form in every subplot four clusters of similar representation. The first cluster shaped by Germany, France, Finland, and Austria might be seen as the core one. Secondly, we can see Sweden and Denmark (EU members which do not have euro currency in circulation) being linked one to another. Moreover, the block of Spain, Portugal, and Greece seems to be stable across all charts as well.

Fig. 2: HAC analysis in different timeframes of EU members prior 2004 enlargement
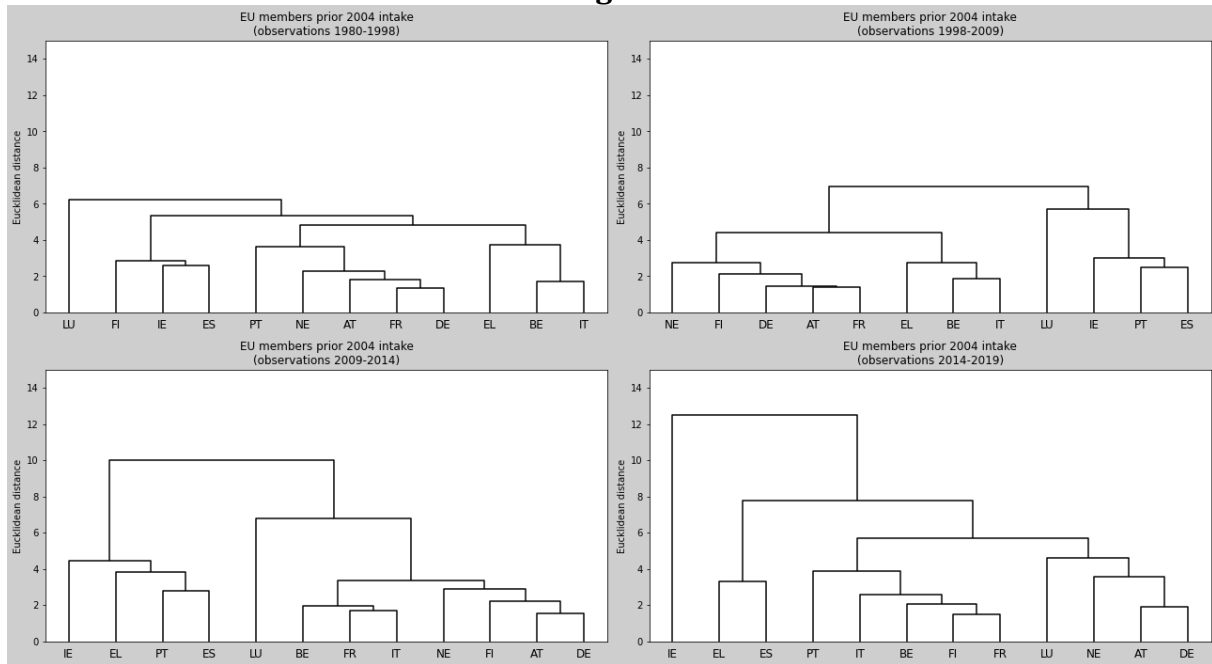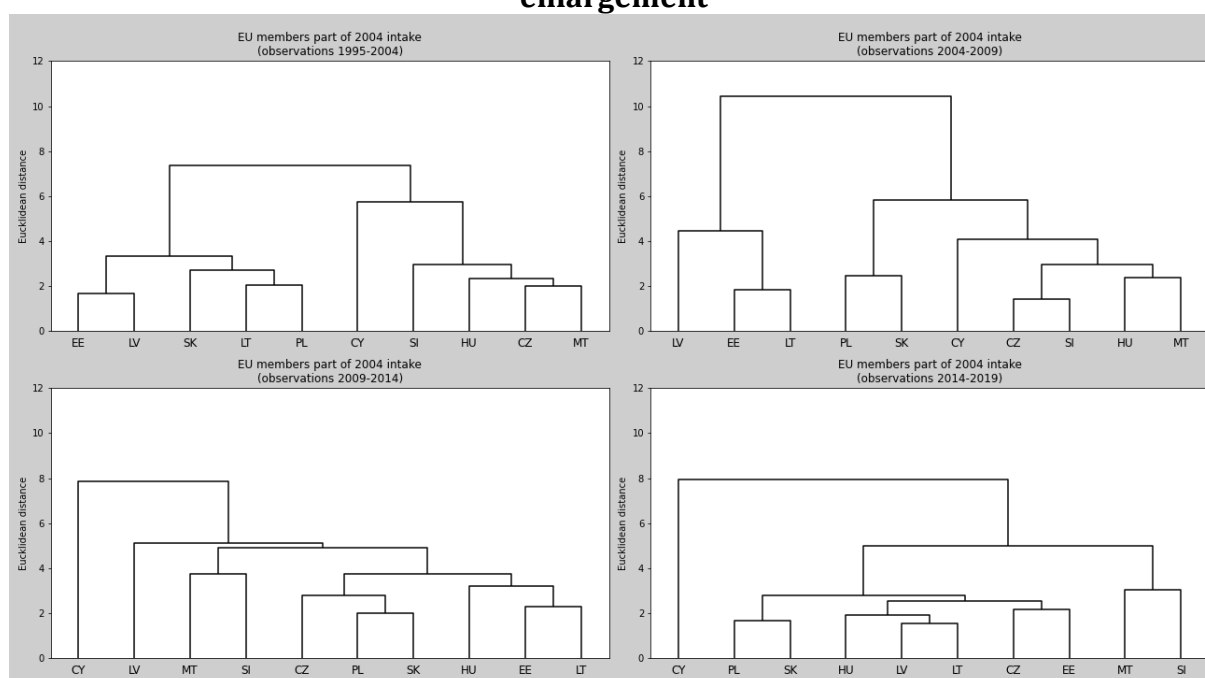

Source: own calculation in python 3.8, data from (EUROSTAT, IMF, 2021)

If we look at EU members prior 2004 intake through the time, we can clearly see three distinct clusters to be formed, with Luxemburg being the most idiosyncratic country. Germany, Austria, and Netherlands form a stable group throughout all periods, with various countries joining and leaving them. Observations between 2009 and 2014 show the impact of the debt crisis in the European Union, thus countries known as PIIGS formed temporary their own cluster. We assume this happened due to the rising government debt and related difficulties in financing through financial markets. After the years marked by high volatility following the financial crisis, Ireland has recovered quickly and is currently achieving an exceptional growth rates accompanied by a significant decline in private debt. Hence, stepping out as a positive outlier.

The dissimilarity measures are visually captured by the heights of the links. The longer the "branch" of the dendrogram, the higher the level of dissimilarity. The Fig. 2 provides the time perspective, where we see the rising height of the links. This pattern suggests a stronger divergence across countries, which originally created the eurozone. The findings put into the question the widespread believe that European countries would form a viable monetary union once they had adopted single currency.

Fig. 3: HAC analysis in different timeframes EU members involved in 2004 enlargement

Source: own calculation in python 3.8, data from (EUROSTAT, IMF, 2021)

HAC analysis of EU members involved in 2004 intake shows long-lasting resemblance between Slovakia and Poland. Other countries from the Visegrad Group - Hungary and the Czech Republic do not share these similarities, yet in the period after the global financial crisis Czech Republic joined the cluster. As the results show, Cyprus has been a clear outlier since the enlargement of the EU in 2004, which it was part of. Cyprus differs from the other countries mainly because of the elevated level of government and private debt, not typical for the rest of the group.

Fig. 4: HAC analysis in different timeframes EU members after 2004 enlargement
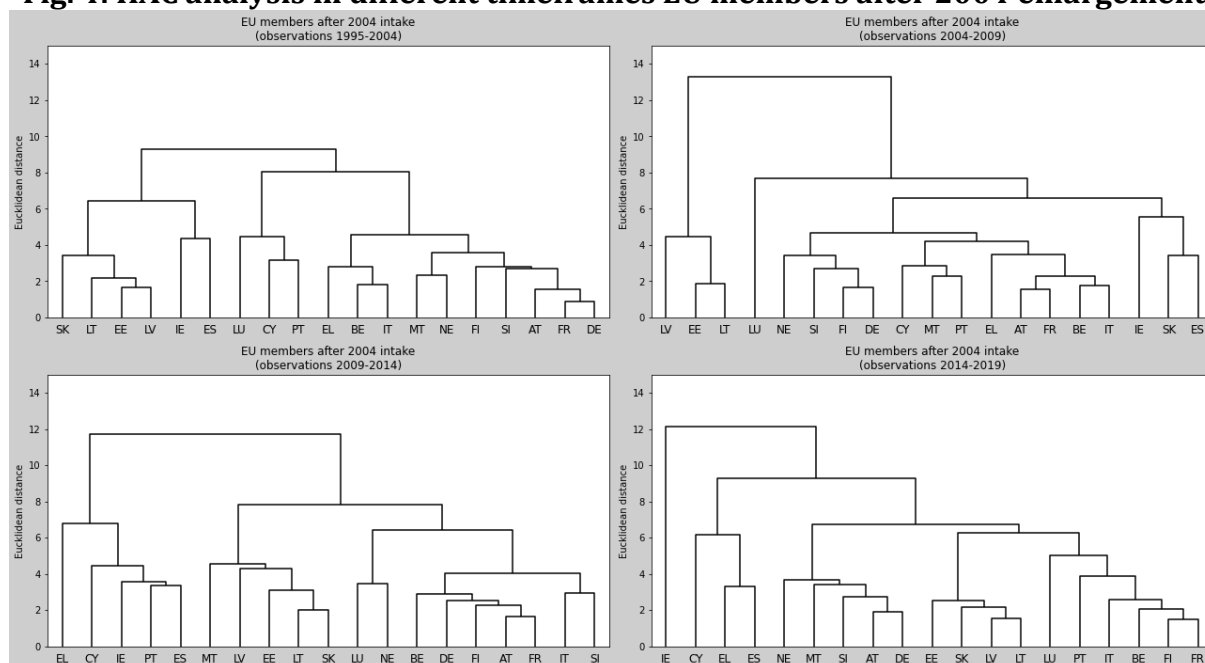
Source: own calculation in python 3.8, data from (EUROSTAT, IMF, 2021)

A single joint analysis of all countries manifests the division of European Union members into the core countries and periphery. In the period of 2014-2019 four clusters of countries are visible, thereof the group of Cyprus, Spain, and Greece is a strong outlier, assuming this is the result of high public and private debt distinctive for all of them. Ireland, which shares some similarities with those countries, has experienced remarkable growth positioning itself as a positive outlier. The countries, which took part in 2004 enlargement of EU, demonstrate an above-average level of homogeneity. As the most stable connection emerges the one among Slovakia, Lithuania, Latvia, and Estonia.

The recent tendency of Portugal advancing back towards the core countries might be the positive signal out of the analysis. The data suggests that the government debt still poses major risks to the future of country that lies on Iberian Peninsula. Slovenia and Malta in this period reached the core of Europe, sharing similarities with Germany, Austria, and the Netherlands. These countries exhibit non-negative current account balances over the course of the last 5 years.

An interesting story to follow might be the development of Italy, which, thanks to its increasing government debt and the third highest unemployment in the EU, is diverging gradually from the core.

3. Discussion

According to the results of empirical study, we conclude that the euro area should not be considered a perfect OCA. The results visible in Fig. 2 and Fig. 4 exhibit diverging tendencies not only among initial clusters but also within the groups themselves. The rising hight of the "branches" of the tree-like visualization supports the claims of Eichengreen (1991) and Krugman (1993).

The conclusion of the research is in line with the other empirical analyses we are familiar with (e. g. Jondeau, 2008; Coudert, 2020). Where we see our contribution to the strand of literature is the extended list of countries we analysed and in the moving window, which brings the time perspective. The paper offers an extensive view on macroeconomic and monetary conditions inside the EU per se.

In the study we do not account for the labour mobility, which has been seen as the prerequisite of any monetary union that aims to be successful (e. g. McKinnon 1963). We purely rely on statistical modelling, which did not accommodate for more complex relations among countries. We simply calculate the dissimilarity matrix of selected macroeconomic indicators and plot the obtained results. Considering the rationale of the OCA, we see this as a room for improvement in proposed modelling approach.

Furthermore, we recommend, if further research takes on, applying PCA analysis to uncover and to better understand which indicators and variables contribute to the formation of such clusters. The analysis of HAC, which was presented in the paper, is not the most transparent in regard to variables that were decisive in clustering. PCA helps to identify variables, which are loaded to any given component helping reduce dimensionally to the level which is visually understandable – two-dimensional data.

Conclusion

To summarize, the empirical results do not provide any supporting evidence that countries are moving structurally closer to each other since the inception of monetary union, in turn, the rising dissimilarities have been identified. According to the results of the research, we presume the specialization hypothesis of the OCA prevails. The study unveils the European single-currency project is characterised by the heterogeneity of its members, which should be of interest of European Union policymakers in post-pandemic planning to combat the asynchronous business cycle.

Moreover, the paper presents the significant resemblance of countries that were part of the simultaneous accession in 2004. The uniformity of the group has the appearance of being even stronger after global financial crisis. European Union appears to be partitioned into couple of groups of relatively homogenous countries. Besides the so-called A10 countries, which exhibited high degree of similarity, the other moderately homogenous group that stands out from the sample is formed by Portugal, Spain, Greece, Ireland, and Cyprus. These countries experienced major financial distress after 2009 and since that time showed eminent dissimilarity from the rest of the EU members. We identify the cluster of Germany, France, Finland, and Austria and associate it with the core of EU. However, the cluster is not stable across different time windows we analysed in the paper. Hence, we believe that the core is more fragmented than before.

Acknowledgment

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