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CLUSTER ANALYSIS OF POVERTY AND SOCIAL EXCLUSION IN EUROPEAN COUNTRIES

ABSTRACT: Poverty and social exclusion are complex issues with serious consequences for both individuals and society. The aim of this paper was to identify groups of countries with similar levels of poverty. For this purpose, cluster analysis was applied, encompassing EU member states and several neighboring countries. Data were obtained from the official Eurostat database, and the level of poverty was measured based on key indicators, such as the at-risk-of-poverty rate, material and social deprivation, as well as low household work intensity. Three main clusters were identified. The results of the analysis clearly indicated the presence of regional disparities in poverty levels, with countries having lower GDP and higher unemployment rates standing out as particularly

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vulnerable. The results obtained provide insight into the structure of poverty in Europe and can serve as a starting point for future socio-economic policies aimed at reducing poverty.

KEYWORDS: Poverty, deprivation, social inequality, multivariate analysis, cluster analysis.

1. Introduction

Poverty is a complex and multidimensional social issue that not only involves a lack of material resources but also unequal access to basic life necessities such as adequate nutrition, healthcare, education, and housing. According to data from 2023, as many as 94.6 million people in the European Union, or 21.4% of the population, were at risk of poverty or social exclusion (Kotzeva, 2024). This indicator encompasses individuals facing low income, material and social deprivation, and those living in households with very low work intensity.

In Serbia, based on the latest available data for 2023, the at-risk-of-poverty rate was 19.9%, while the at-risk-of-poverty or social exclusion rate stood at 27.2%. These figures indicate a slight decrease compared to previous years, reflecting some progress in the fight against poverty, but still leaving a concerning percentage of the population in a vulnerable position. The poverty risk threshold, defined as 60% of the median equivalent disposable income, amounted to 29,100 dinars per month for a single-person household, while for a household of four, this threshold was 61,110 dinars (RZS Report, 2024).

Besides financial indicators, poverty analysis includes indicators of material and social deprivation, which provide deeper insight into the living conditions of the population. In Serbia, a significant percentage of households cannot afford basic needs such as adequate home heating, replacing worn-out furniture, or consuming meat or fish every two days. The rate of severe material and social deprivation further highlights the severity of the issue, as a considerable portion of the population is deprived of access to essential living conditions.

Sociodemographic factors, such as age, education level, and employment status, have a significant impact on exposure to poverty risk. According to 2023 data, individuals over the age of 65 were at a higher risk of poverty, with a rate of 23.5% (Kotzeva, 2024). Additionally, households with three or more children face a significantly higher poverty risk compared to households with fewer members.

These data indicate that poverty is not solely the result of economic inequality but also of broader social exclusion. Furthermore, the relative poverty risk gap, which measures the difference between the poverty threshold and the average income of those below that threshold, points to existing inequality in income distribution within society. This inequality further complicates efforts to lift the most vulnerable groups out of poverty, as they face limited opportunities to improve their economic and social conditions.

In the fight against poverty, it is necessary to apply an integrated and comprehensive approach that addresses the various dimensions of the issue—from improving educational and healthcare services to creating employment opportunities and reducing social exclusion. Only through the synergy of economic and social policies can significant progress be made in reducing poverty and improving the quality of life for the most vulnerable groups in society.

The aim of this paper is to identify groups of European countries that share similar characteristics in terms of poverty using multivariate statistical analysis methods. The methodology of cluster analysis was employed to classify similar European countries based on poverty indicators. The analysis covers the EU27, Switzerland, Iceland, Montenegro, North Macedonia, Norway, Serbia, Turkey, and the United Kingdom, with data sourced from EUROSTAT. The examined indicators include the number of people at risk of poverty or social exclusion, the at-risk-of-poverty rate, the severe material and social deprivation rate, the share of individuals living in low-work-intensity households, and the income quintile ratio (S80/S20). The findings of the poverty analysis in Europe indicate the existence of three country groups based on economic development, living standards, and social exclusion. The first group, which includes Serbia, is characterized by low GDP per capita,

high unemployment, and pronounced material deprivation. The second group consists of economically developed countries such as Germany, France, and Sweden, which feature stable market economies, low unemployment, and well-developed social welfare systems. The third group includes countries such as Spain, Italy, and Estonia, which rely on tourism and digitalization, but face challenges related to migration and demographic decline.

The remainder of this paper is structured as follows. The next section provides a brief review of the literature and previous research on this topic. The third section presents an overview of the applied analytical methods and the data used in the study. The fourth section contains an analysis and discussion of the results obtained. Finally, the concluding section summarizes the key findings of the research.

2. Literature review

Ravallion (2001) uses an absolute threshold of 1 dollar per day, expressed through purchasing power parity, to estimate global poverty. The author points out that while global growth has reduced poverty, there are significant variations in this number, with Africa and South Asia being the regions with the highest concentration of poor people.

Jean et al. (2016) use satellite images and machine learning to identify and predict poverty in the rural areas of Africa. With the help of satellite images, they identified infrastructural features, such as population density and agricultural land, which they subsequently analyzed using neural networks.

Filmer and Pritchett (2001) in their work use asset data to assess household wealth in the absence of consumption data. Their methodology is based on analyzing ownership of basic goods (e.g., bicycles, radios) and using principal component analysis to create an asset index, which has proven very accurate in estimating educational and economic outcomes.

Atkinson (2007) provides a detailed analysis of wage distribution in five countries—the United States, the United Kingdom, Sweden, Germany, and Canada—over a long period. The author points out that wag-

es over the decades have shown trends of increasing inequality in most countries analyzed, but to varying degrees. Income inequality has significantly increased in the US and the UK, while Sweden and Germany have seen a smaller rise. The key factors identified as influencing changes in wage distribution are technological changes and globalization. Technology has driven demand for skilled labor, increasing the wages of highly skilled workers compared to low-skilled workers. Atkinson also emphasizes that changes in wage distribution are long-term processes, not temporary trends. This analysis enables a deeper understanding of how economic, technological, and political forces affect wage distribution in the long run. Milanović (2011) offers an overview of global inequality throughout history, emphasizing how global trade, technology, and imperialism have contributed to the creation of large disparities between nations. Milanović distinguishes between two key forms of inequality: internal (within countries) and external (between countries). By the mid-20th century, global inequality depended primarily on differences between countries rather than within them. Milanović also introduces the concept of the inequality extraction index. The extraction index shows how much governments and elites exploit economic power at the expense of the poorest, further increasing social inequality. This concept is crucial for understanding how economic and political structures affect poverty.

Alkire and Foster (2011) develop the concept of the Multidimensional Poverty Index (MPI), which takes into account a broader range of deprivations than just income, including access to education, health, and basic services. This index allows for the identification of households that are poor not only due to low income but also due to limited access to key resources. The proposed methodology is particularly useful for analyzing poverty in rural and less developed areas where income may not be the only or best indicator of deprivation. MPI also enables comparability between different countries, facilitating the tracking of progress in poverty reduction at the global level.

Bourguignon (2004) highlights the interconnectedness of poverty, growth, and inequality, and the way these factors influence each other. According to the author, poverty can be reduced through a combination of economic growth and redistributive policies. However, relying solely

on growth without addressing inequality may limit the possibilities for poverty reduction. The author identifies three key elements for reducing poverty: a) higher economic growth, b) redistributive policies that reduce inequality, and c) reducing initial inequality before growth begins. Bourguignon emphasizes that inequality, if uncontrolled, can entirely neutralize the benefits of growth.

3. Methodology

To identify European countries that are similar in terms of poverty, the method of cluster analysis was used. This multivariate statistical analysis method is used to group objects into sets (clusters) based on their similarities. The goal of cluster analysis is to make objects within the same cluster as similar as possible, while objects from different clusters should be as different as possible. To conduct cluster analysis, it is necessary to define a metric for measuring similarity (or distance) between objects. The most used metrics are Euclidean, Mahalanobis, and Manhattan distances. After forming the distance matrix, the clustering process can be performed using a hierarchical method or by specifying a predefined number of clusters (*K*-means). In the first case, a hierarchical structure of clusters is created, where all objects start as individual clusters, which are then successively merged using nearest, furthest, average distances, and other techniques. The result of this method is a dendrogram, which visually represents the relationships between clusters. The second method starts with a predefined number of clusters, after which the allocation of objects into clusters is iteratively optimized to minimize the variability within each cluster.

The analysis includes EU 27 member states as well as Switzerland, Iceland, Montenegro, North Macedonia, Norway, Serbia, Turkey, and the United Kingdom. Data related to key indicators of poverty and social exclusion for the mentioned countries were obtained from the official EUROSTAT database.

The following indicators (with their EUROSTAT codes) were observed on an annual basis:

- The number of people at risk of poverty or social exclusion (ilc_peps01n) refers to people who are at risk of poverty, face severe material and social deprivation, or live in households with very low work intensity. This indicator can be expressed as an absolute number or as a percentage of the total population.
- The at-risk-of-poverty rate (ilc_li02) refers to the percentage of the population whose equivalent disposable income is less than 60% of the national median disposable income after social transfers. This rate measures relative poverty in comparison to other residents in the country or region, not necessarily a low standard of living.
- The severe material and social deprivation rate (ilc_mdspd18) measures the percentage of the population that cannot afford at least 7 out of 13 basic items necessary for an adequate life, such as the ability to heat their home or regular meals. According to EU goals by 2030, this is one of the key indicators for tracking progress in poverty reduction.
- People living in households with very low work intensity (ilc_lvhl21n) refers to working-age adults (18-64 years) who have worked less than 20% of their potential working time in the past 12 months. Households consisting only of children, students, and retirees are excluded from this calculation.
- The income quintile share ratio (S80/S20) (ilc_di11) measures income inequality and is calculated as the ratio of the income of the richest 20% to the income of the poorest 20%. All values refer to equivalent disposable incomes.

4. Results and discussion

The five selected indicators were aggregated into a single measure using Manhattan distance. Subsequently, the average linkage method was applied to construct a dendrogram, presented in Figure 1. The dendrogram structure indicates the existence of three clusters, with the longest branches between them serving as key markers of their differentiation.

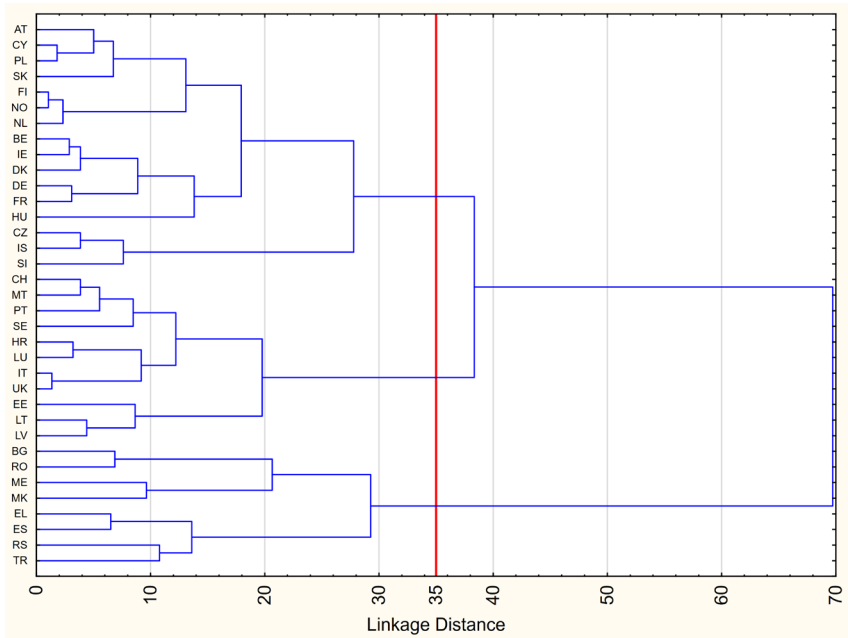


Figure 1. Hierarchical clustering

Source: Authors

Based on this auxiliary information, we conducted a *K*-means analysis with 3 predefined clusters. The results of the analysis of variance showed that all observed indicators contributed significantly to the separation of countries into clusters, as all *p*-values were less than 0.05.

Table 1. Analysis of variance for poverty indicators with 3 clusters

Indicator	Sum of squares between groups	Degrees of freedom	Sum of squares within groups	Degrees of freedom	<i>F</i> -test	<i>p</i> -value
ilc_peps01n	936.0236	2	214.4781	32	69.82705	<0.01
ilc_li02	398.0164	2	108.7305	32	58.56925	<0.01
ilc_mdsc18	829.5677	2	177.0911	32	74.95059	<0.01
ilc_lvhl21n	102.1048	2	308.1906	32	5.30087	0.01
ilc_di11	28.1080	2	16.4367	32	27.36127	<0.01

Source: Authors

As we can see in Table 1, the indicator “Number of people at risk of poverty or social exclusion” (ilc_peps01n) and the indicator “Severe material and social deprivation rate” (ilc_mdspd18) contribute the most to the formation of clusters. Figure 2 presents the average values of the indicators by cluster, providing further insight into the significance of individual indicators.

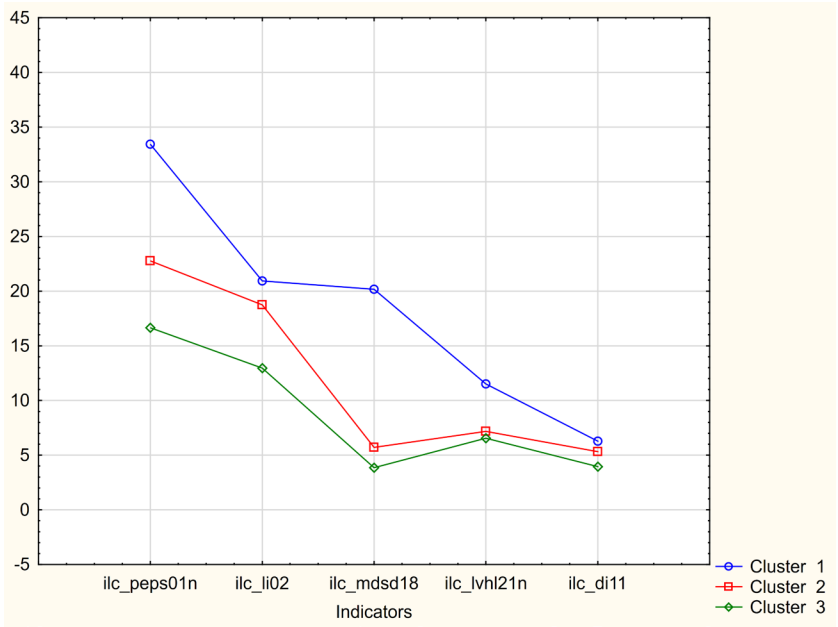


Figure 2. Average value of indicators by clusters
Source: Authors

Finally, Figure 3 shows the clusters on a map, which can suggest the roles of the neighboring territories in poverty generation.

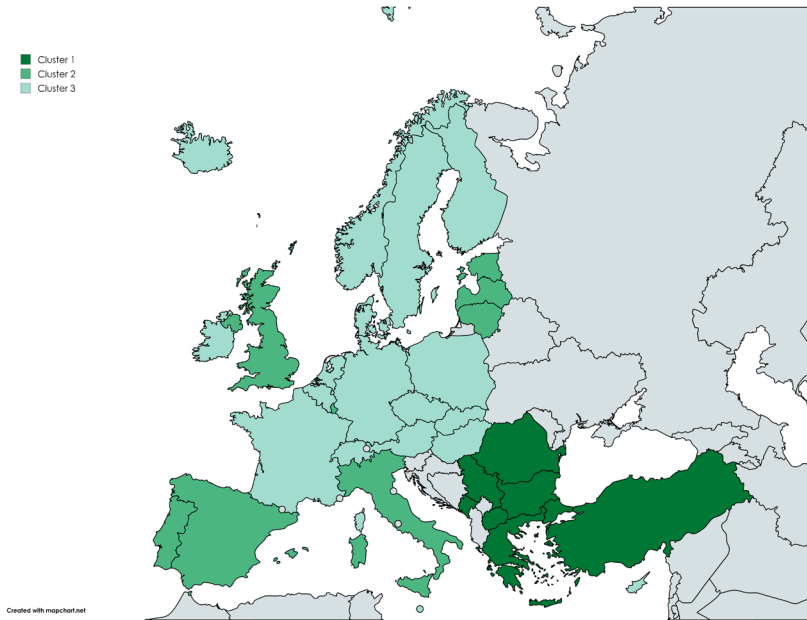


Figure 3. Map of countries by clusters
Source: Authors

The countries in Cluster 1 (Bulgaria, Greece, Montenegro, North Macedonia, Romania, Serbia and Turkey) are characterized by the transition from centrally planned to market economies. Bulgaria, Romania, North Macedonia, and Serbia were socialist countries, while Turkey, although not part of the socialist bloc, underwent structural reforms. The GDP per capita in this cluster is relatively low compared to more developed European countries, averaging 60.43⁵ (expressed in purchasing power parity, where 100 represents the EU average), significantly lagging behind Cluster 2 (116.79) and Cluster 3 (102.11). The Harmonized Index of Consumer Prices, an indicator of inflation, is also higher in Cluster 1 countries (3.48%⁶) compared to Cluster 2 (2.12%)

⁵ Author's calculation is based on the indicator GDP per capita (tec00114)

⁶ Author's calculation is based on the indicator Harmonized price index (prc_hicp_manr)

and Cluster 3 (1.76%). Labor productivity is lower in Cluster 1 at 60%⁷, compared to Cluster 2 (112%) and Cluster 3 (93%), and agriculture still plays an important role, especially in rural areas, which are significantly poorer and less developed than urban centers. This gap hampers social cohesion and contributes to differences in living standards. The recent wars in the Balkans and the slow progress of democratic, transitional processes have caused ongoing political turbulence and instability. Ercegovac and Beker Pucar (2022) emphasize that in emerging economies, the external deficit is commonly financed through Foreign Direct Investment (FDI) inflows. Furthermore, in the case of the Western Balkans, FDI is identified as a key factor in addressing external imbalances. High unemployment (10.60%⁸), especially among youth, drives migration to more developed EU countries, leading to demographic decline and brain drain.

The countries in Cluster 2 (Austria, Belgium, Switzerland, Cyprus, Czechia, Germany, Denmark, Finland, France, Hungary, Ireland, Iceland, Malta, the Netherlands, Norway, Poland, Sweden, Slovenia and Slovakia) are highly developed market economies with stable industrial and technological sectors. The Scandinavian countries (Denmark, Finland, Norway, and Sweden), Germany, and Switzerland lead in innovation, technology, and research, with significant investments in education. This allows for high productivity levels and relatively low unemployment (4.65%) compared to Clusters 1 and 3. Sotiroski et al. (2024), using DEA analysis, examined macroeconomic indicators such as the poverty rate, unemployment rate, and GDP, and concluded that the countries with the highest efficiency belong to this cluster. Among the most prominent are Finland, the Netherlands, Germany, and Sweden, which excel not only in economic performance but also in successfully balancing economic stability and social cohesion. Their efficiency is achieved through integrated policies that combine innovation, investments in human capital, and well-developed social systems. Politically, these are stable democracies with a long tradition of parliamentary governance (especially the Scandinavian countries and Germany), charac-

⁷ Author's calculation is based on the indicator Labour productivity per person employed (tesem160)

⁸ The author's calculation is based on the indicator Unemployment (une_rt_a)

terized by high levels of transparency. Most of these countries are key members of the European Union and the Eurozone, while Switzerland and Norway, though not EU members, maintain close political and economic ties with the Union. These countries have well-developed social protection systems, including healthcare, education, and pension systems, aimed at minimizing social disparities. Due to the high standard of living and economic opportunities, these countries attract migrants, though challenges in integration persist.

The countries in Cluster 3 (Estonia, Spain, Croatia, Italy, Lithuania, Luxembourg, Latvia, Portugal and the United Kingdom) are economically diverse, but they share a reliance on tourism (especially Spain, Italy, Croatia, and Portugal) and the service sector, while Estonia and Lithuania lead in digitalization. The Baltic countries (Estonia, Lithuania and Latvia) underwent political transitions after the collapse of the Soviet Union, while the Mediterranean countries experienced political crises during the 20th century. All countries, except the United Kingdom, are members of the EU and benefit from the common market. Brexit has caused political and economic changes in the UK. The Baltic countries and Croatia face emigration, particularly of young people, while the Mediterranean countries attract migrants from other parts of the world but face integration challenges.

5. Conclusions

Based on the cluster analysis of poverty in European countries, three main groups of countries have been identified, differing according to the levels of economic development, living standards, and degrees of social exclusion. The first cluster, including Serbia, is characterized by low GDP per capita, high unemployment, and more pronounced material deprivation. The second cluster comprises developed European countries such as Germany, France, and Sweden, which feature stable market economies, low unemployment, and well-developed social systems. The third cluster consists of countries with a prominent role in tourism and digitalization, such as Spain, Italy, and Estonia, which face challenges related to migrant integration and demographic decline.

The conducted cluster analysis clearly indicates that the countries are at different stages of economic development, and that tailored policies are needed to reduce poverty and inequality. Countries with lower economic standards may focus on increasing productivity and creating sustainable jobs, while more developed countries can enhance social cohesion through inclusive policies and strengthening social protection systems.

The conducted cluster analysis, while providing valuable insights into patterns of poverty and social exclusion in Europe, is subject to certain limitations. The reliance on a limited set of indicators may result in an incomplete representation of the poverty phenomenon, while the quantitative approach does not account for qualitative factors such as institutional and cultural influences. Grouping countries into three clusters may obscure intra-cluster differences, and the absence of longitudinal analysis limits the ability to capture long-term trends. Therefore, future research should expand the methodological framework and incorporate a broader range of indicators to ensure a more comprehensive analysis of poverty in Europe.

Future research on poverty in European countries could focus on several key areas, such as the role of migration and demographic changes, the impact of digitalization and technological changes on poverty reduction, and the analysis of rural and urban poverty.

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