Theoretical and Applied Economics
Volume XXXI (2024), No. 1(638), Spring, pp. 57-68

The analysis of the effects of income inequalities on the at-risk-of-poverty rate in the European Union

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Abstract. *Poverty is a challenge for all countries and its eradication is a common goal in the European Union. Our paper analyses the statistical and theoretical relationship between social inequalities and the at-risk-of-poverty rate. For a holistic understanding of the poverty phenomenon in the EU, other variables such as economic growth, social protection expenditure, and the old-age dependency ratio were also included in the analysis. The methodology is based on panel data models. A regression model was built with data for the period 2011-2022, for the 27 EU countries. The econometric model of the at-risk-of-poverty rate highlighted a series of factors, among which the Gini coefficient is one of the most influential. Other important factors were research and development expenditure, social protection expenditure, GDP per capita, the unemployment rate, and the old-age dependency ratio. The cluster analysis grouped the EU countries into three clusters. Understanding the phenomenon of poverty is a prerequisite for alleviating it, generating social solidarity, and rebuilding a fairer society. Our research contributes to the evaluation of the interaction between inequalities and poverty in Romania and the EU.*

Keywords: poverty rate, income inequality, panel data model, EU countries, clustering.

JEL Classification: J31, H21, H24.

1. Introduction

The poverty risk is a global challenge, its eradication being the first Sustainable Development Goal of the 2030 UN Agenda (United Nations, 2015). Many countries have been addressing this issue through diverse policies that require a great amount of well-coordinated measures, as well as economic effort. A number of 25 countries out of 81 countries for which the Global Multidimensional Poverty Index (MPI) is calculated successfully halved their MPI values from 2000 to 2022, most of them in Asia (India, China, Cambodia, Indonesia) and Africa (Congo, Morocco) (UNDP and Oxford Poverty and Human Initiative, 2023). The poverty risk is measured with a wide range of indicators, each focusing on different social aspects of this phenomenon. In a general view, the at-risk-of-poverty or social exclusion rate is the most significant indicator which shows how severe poverty is spread among the EU member states (Eurostat, 2021). The at-risk-of-poverty rate is also the main indicator addressed by the European Pillar of Social Rights, which aims to reduce poverty by at least 15 million people, out of whom at least 5 million should be children until 2030 (European Commission, 2021).

Inequalities are also part of the UN Agenda, being classified as the tenth Sustainable Development Goal (United Nations, 2015). In the last two decades, countries, economic organizations, and NGOs have been trying to tackle them, in their efforts to a more equitable world. Inequalities take many forms, such as gender or income inequalities as well as disparities between different regions by their degree of urbanisation and development, and can be found within and between countries. At the EU level, inequalities are closely monitored through a series of indicators that aim to offer a clear perspective on each form they take (Eurostat, 2023). The economic disparities trends measured using these indicators show that there is a long-term convergence of the member states when it comes to GDP and income. It is widely accepted that, during the COVID-19 pandemic, inequalities may have noticed a slight increase, especially the gap between the poor and the rich gap (Eurostat, 2023). The income quintile share ratio, one of the main inequality indicators that measure the difference between the 20% of people with the highest income and the 20% with the lowest has been decreasing from 2014 to 2020. During the COVID-19 pandemic, this indicator recorded an increase, meaning that the poor and the rich gap widened. Thus, not only is it essential to achieve overall income growth, but also to focus on how it is distributed.

Several studies (Amar et al., 2020; Bergstrom, 2020; Burke et al., 2019; Fosu, 2010; Kappel, 2010; Ram, 2007) have found a significant direct relationship between income inequality and poverty. A cross-country study (Burke et al., 2019) predicts that the percentage of people below the poverty line will increase as the Gini coefficient increases, which follows the economic intuition: if the gap between the extremely rich and the poor increases, then the number of people living below the poverty line is likely to increase as well.

Furthermore, Kappel (2010) and Ram (2007) observed that reducing inequality can lead to a decrease in poverty. Also, Amar et al. (2020) discovered a positive and significant relationship between income inequality and poverty and a negative one between

development and poverty by analyzing 5 ASEAN economies. In another comprehensive study, Bergstrom (2020) highlights the importance of reducing inequality and its effects on reducing poverty but also shows that it is essential to understand the relationship between inequality and growth to find the influence of changing inequality on poverty. Therefore, reducing inequality should have little negative effect or, even better, a positive one on growth to be a successful way of decreasing poverty. Fosu (2010) further emphasized the importance of income distribution in reducing poverty, with the elasticity of poverty inequality being greater than the elasticity of income. These findings underscore the need for policies that address income inequality as a means of reducing poverty.

However, Balvociute (2017) found that changes in income inequality do not always align with changes in the at-risk-of-poverty rate, with the latter increasing even in countries with stable income inequality. Further studies (Ilmakunnas, 2022) highlighted the variation in at-risk-of-poverty rates across age groups, suggesting that the relationship between these rates and income inequality may differ depending on demographic factors.

Because of the complexity of the phenomenon, the above studies indicated that the effects of inequalities on the risk of poverty must be studied from a multifactorial perspective. Therefore, the econometric analysis could also consider other factors of the risk of poverty, such as social protection expenditure, gross expenditure on research and development – GERD, GDP per capita, unemployment rate, and gender differences in labor market participation and incomes.

According to the literature (Chzhen et al., 2017; Maj-Waśniowska et al., 2020), high levels of social protection expenditure are associated with lower poverty rates and economic deprivation. This was especially highlighted in the context of the 2008 financial crisis, where social protection expenditure contributed to mitigating the negative impact of poverty (Chzhen et al., 2017). However, the specific impact of housing expenditures on poverty and the role of residual income in identifying at-risk-of-poverty households require further exploration (Haffner et al., 2014).

Other research (Kovács, 2018; Thirtle et al., 2003) has shown a significant impact of GERD on poverty reduction. Research-led technological change in agriculture, which is often funded through the GERD can substantially reduce poverty (Thirtle et al., 2003). Similarly, GERD boosts economic development and global competitiveness, which are key factors in poverty reduction (Kovács, 2018). Therefore, it can be inferred that higher GERD can contribute to poverty reduction by stimulating economic growth and addressing poverty-related health problems.

Research (Balvociute, 2017; Ilmakunnas, 2022; Ladislav, 2011) on the impact of GDP per capita on the at-risk-of-poverty rate produces mixed results. Balvociute (2017) finds a significant relationship, between GDP growth reducing poverty and income inequality influencing the risk of poverty. Furthermore, based on a multiple linear regression model, Burke et al. (2019) emphasize that the percentage of people living below the poverty line was predicted to decrease as GDP per capita increases because the living standard typically increases as GDP per capita increases. However, Kabát (2011) does not observe a

significant impact of economic growth on the population at risk of poverty in Slovakia. Ilmakunnas (2022) further increases the complexity of the phenomenon by showing that the at-risk-of-poverty rates by age group can vary, leading to different patterns.

Research (DeFina, 2004; Yusuf and Dai, 2020) on the impact of unemployment on poverty rates leads to mixed results. DeFina (2004) found that the unemployment rate had no significant impact on poverty, emphasizing the importance of measurement approaches. However, Yusuf and Dai (2020) found a positive but insignificant impact of the unemployment rate on poverty, suggesting that other factors such as the human development index may play a more significant role.

Other authors (Antczak and Zaidi, 2016) noted that the poverty rate among the elderly declined during the financial crisis, partly due to pension income.

Taking all that has been mentioned into account, our analysis focuses on studying the relationship between income inequality alongside some other linked factors and the at-risk-of-poverty rate in EU countries.

2. Methodology

The methodology is based on panel data models that provide greater precision of estimates by using a much larger number of observations compared to cross-sectional or time series data. The first step of the quantitative analysis was the descriptive analysis of the variables to identify possible extreme values or errors in the data. Then the multicollinearity was checked, and the explanatory variables were adjusted in such a way that the regression models were not affected.

Regarding the estimation of regression models with panel data, the first step is the use of the pooled least squares method (Pooled OLS). This provides efficient and consistent estimators when the errors are uncorrelated with the explanatory variables. However, this hypothesis is quite restrictive, considering the particularities of panel data, so testing individual effects is recommended. The F-test was performed, which suggested that the individual effects are significant, so it is appropriate to use estimation methods specific to panel data: fixed effects (FE) or random effects (RE) models. To decide between the two estimation options, the Hausman test was used which indicated that it is recommended to use models with fixed effects.

The final econometric models were estimated based on cluster regression with fixed effects, a method that allows the grouping of countries into homogeneous clusters and the estimation of the coefficients for each cluster. The procedure is justified by the fact that the countries may be different, and a single model cannot characterize well enough the complex socio-economic context (Sarafidis and Weber, 2015).

The econometric analysis sought to identify the influencing factors of the poverty risk. For this, a regression model was built with panel data for the period 2011-2022, for the 27 member states of the European Union. The dependent variable was the poverty risk rate,

and the explanatory variables that emerged as statistically significant were the Gini coefficient, research and development expenditures, social protection expenditures (from the social insurance system), GDP per capita, unemployment rate, old-age dependency ratio (Table 1 Description of the indicators). Within the econometric models, logarithmic values were used for all analyzed indicators. Since social protection expenditures were not available for the year 2022 as well, the estimates were made for the period 2011-2021.

In the analysis, the hypothesis of homogeneity of the slope parameters was investigated, using the clustering algorithm developed by Sarafidis and Weber (2015) for panel data.

Hypotheses

We would expect a significant positive relationship between income inequality and at-risk-of-poverty rate based first on the economic intuition that if the gap between the rich and the poor reduces, then the number of people living below the poverty line is likely to reduce as well. In other words, a decrease in the Gini coefficient would translate into a lower poverty risk. The increase in social protection and R&D expenditure should be beneficial to alleviating economic deprivation. As GDP is concerned, its growth might produce mixed results, yet overall should lead to a decrease in poverty. The unemployment rate is expected to negatively impact the risk of poverty. Last but not least, a lower old-age dependency ratio should be beneficial to decreasing the poverty risk among the elderly since there would be a more active population to sustain the pension income.

3. Results

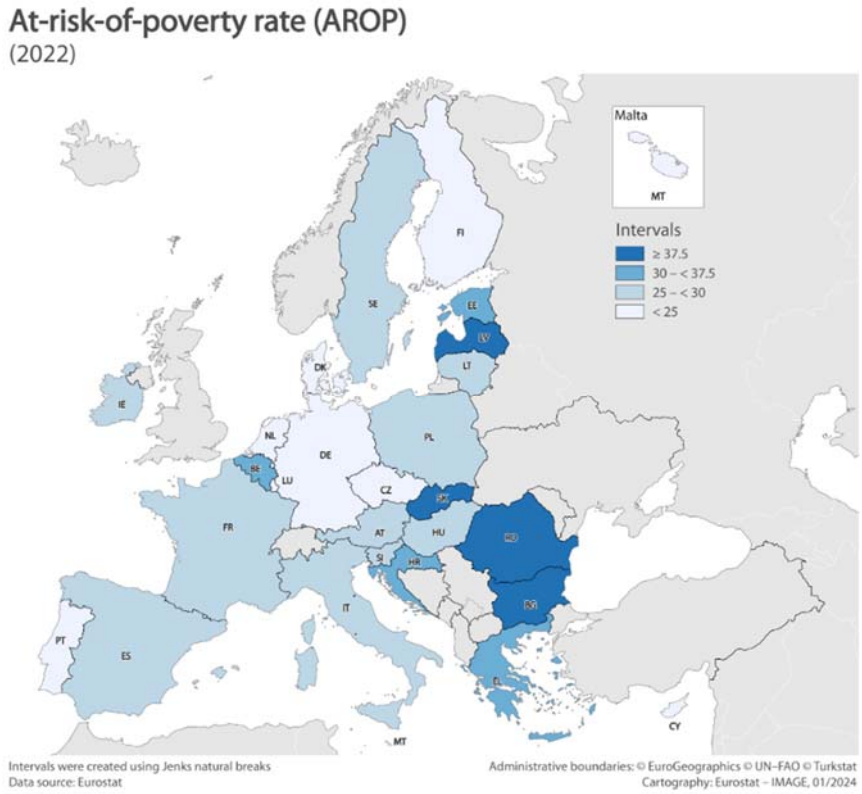
The analysis of the at-risk-of-poverty rate in dynamics and comparison among EU countries could provide a comprehensive picture of the poverty phenomenon in the EU. In 2022, the average at-risk-of-poverty rate was 29%. The lowest level of the indicator at the EU level was recorded in Denmark (15%). The next two lowest values were recorded in Malta (20.5%) and Finland (20.9%). On the other hand, the highest values of the indicator were recorded in Bulgaria (54.8%) and Romania (50.9%). The at-risk-of-poverty rate in Denmark is 14 percentage points below the average, while that of Bulgaria is 25.8 percentage points above the EU average. The difference between the highest and the lowest value was practically 39.8 percentage points. The evolution over time shows that the lowest values for this indicator were always recorded by Bulgaria and Romania.

The comparison among EU countries points out that the countries of Eastern Europe tend to register high rates of the indicator (Romania, Bulgaria, Slovakia, Latvia, Estonia, Croatia, and Greece).

The results of the cluster analysis indicated an optimal number of three clusters for the grouping of EU member states, depending on the indicators included in the analysis:

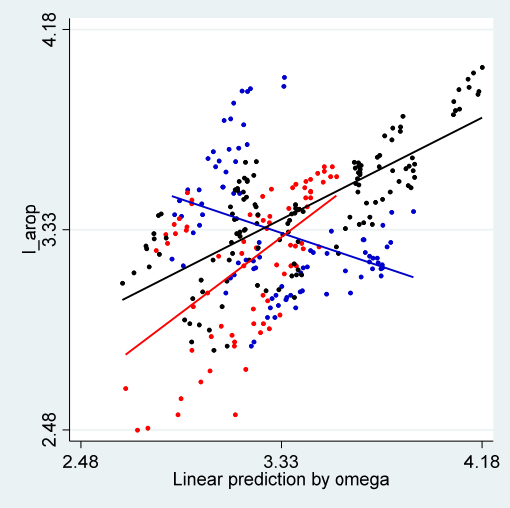
- Cluster 1: Austria, France, Hungary, Luxembourg, Malta, Poland, Romania, Slovenia;
- Cluster 2: Belgium, Denmark, Greece, Netherlands, Portugal, Spain, Sweden;
- Cluster 3: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Germany, Ireland, Italy, Latvia, Lithuania, Slovakia.

Figure 1. *At-risk-of-poverty rate (%) in EU member states in 2022*



Source: Authors' representation in Eurostat-Image with Eurostat data.

Figure 2. *Heterogeneous slopes for the three clusters*



Source: The authors' estimates in Stata based on Eurostat data.

Table 1. *Results of econometric estimations of panel data models for analyzing the influence of inequalities on the at-risk-of-poverty rate*

Independent variables	Cluster 1	Cluster 2	Cluster 3	TOTAL
Gini coefficient	0.349	1.912*	0.573*	0.853*
Social protection expenditure	0.400	0.126	-0.401*	-0.206*
Research and development expenditure	-0.248*	-0.174	0.004	-0.095**
GDP per capita	0.372*	0.448	-0.395*	-0.183*
Old-age dependency ratio	0.587*	1.512*	0.909*	1.147*
Unemployment rate	0.334*	0.088	-0.004	0.133*
Constant	*-5.293**	*-13.525**	*3.573**	*-1.122*
No of countries	8	7	12	27
No of observations	88	77	132	297
R^2 within	0.54	0.71	0.42	0.3

Source: The authors' calculations in Stata based on data from Eurostat.

Following the estimates, it emerged that the considered indicators including the Gini index explain a relatively small proportion of the evolution of the at-risk-of-poverty rate (R^2 is 0.3). However, the combined influence of these indicators is statistically significant (Table 1). The results obtained for the entire panel of countries differ from the results obtained for the clusters (in terms of the magnitude of impact, direction of impact, as well as statistical significance) due to the smaller number and the specificity of countries included in each cluster.

Among the indicators that influence the at-risk-of-poverty rate at the level of the entire panel, the Gini coefficient and old-age dependency rate influence the risk-of-poverty-rate positively and statistically significant: 1% increase in the Gini coefficient leads to a 0.85% increase in the dependent variable, a 1% increase in the old-age dependency ratio increases the at-risk-of-poverty rate increases by 1.15%. The unemployment rate also has a statistically significant impact on the at-risk-of-poverty rate, with a 1% increase producing an upward change of 0.13% in the dependent variable.

Social protection expenditure has a beneficial role in the at-risk-of-poverty rate: a 1% increase in this expenditure is followed by a decrease of 0.21% in the dependent variable. Also, the coefficients obtained for research and development expenditure and GDP per capita are negative and statistically significant: a 1% increase in the research and development expenditure leads to a 0.095% decrease in the at-risk-of-poverty rate; an increase of 1% in GDP per capita leads to a 0.18% decrease in the risk of poverty.

All the coefficients obtained in the case of the panel estimation that includes all EU member countries are statistically significant, with a level of significance of 5% or 10%.

The results obtained for each cluster separately are also in Table 1. Cluster 1 includes Austria, France, Hungary, Luxembourg, Malta, Poland, Romania, and Slovenia.

Not all indicators turned out to have a statistically significant influence on the at-risk-of-poverty rate. The Gini coefficient, together with the social protection expenditure, has a positive non-significant influence on the dependent variable. Other variables were of more influence. The relation between the old-age dependency ratio and the at-risk-of-poverty

rate is positive and statistically significant. The result is intuitive since the elderly are among vulnerable groups and an improvement in their situation would lead to a reduction in the at-risk-of-poverty rate. Also, the unemployment rate influences in a positive and statistically significant way the at-risk-of-poverty rate. The results are similar to other studies (Yusuf and Dai, 2020).

The influence of GDP per capita on the dependent variable seems surprising: a 1% increase in GDP per capita would lead to a 0.37% increase in the at-risk-of-poverty rate. The explanation could reside in the following: the link between economic growth and inequality – and subsequently poverty – is not linear; in the first stages of adopting new technology - the installation period - and in the context of a legislative void regarding that specific technology, the economic growth is generated by speculative investments, that conducts to increased inequalities and social polarization; as the use of that specific technology is regulated, the economic growth is better distributed among individuals, which reduces the social inequality and the poverty (Perez, 2003).

The impact of research and development expenditure is in line with the literature in the field (Kovács, 2018): an increase of 1% in this expenditure leads to a decrease of the at-risk-of-poverty rate by 0.25%.

Cluster 2 includes Belgium, Denmark, Greece, the Netherlands, Portugal, Spain and Sweden. In these countries, the at-risk-of-poverty rate had a rather increasing evolution since 2011 (it decreased during the analyzed period only in Hungary and Poland). Growth rates ranged from 3.2% (Malta) to 7.3% (France).

The results indicate that only two independent variables have a statistically significant influence on the dependent variables: the Gini coefficient and the old-age dependency ratio. The results are in line with the specialized literature (Burke et al., 2019): a 1% increase in the Gini index would contribute to a 1.9% increase in the at-risk-of-poverty rate, and a 1% increase in the old-age dependency ratio would contribute to a 1.5% increase in the at-risk-of-poverty rate.

Cluster 3 which includes most countries (Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Germany, Ireland, Italy, Latvia, Lithuania, and Slovakia) brings some novelties compared to the previous results. The indicators that turned out to be statistically insignificant are R&D expenditure and the unemployment rate. All other indicators are significant for a 5% threshold.

The coefficient for the Gini index indicates that when this variable increases by 1%, the at-risk-of-poverty rate would increase by 0.57%. The influence is positive and statistically significant, but the value is lower than the one obtained in the case of cluster 2, and even compared to the model that included all countries.

In contrast to the results obtained for the other clusters, the coefficient for social protection expenditure is also statistically significant: a 1% increase in social protection expenditure

would lead to a 0.4% decrease in the at-risk-of-poverty rate. The impact of this coefficient is greater than that obtained in the case of the estimation on the entire panel of countries. Dynamically, this indicator was placed on a downward trend during the analyzed period, among the countries in this cluster.

Another somewhat different aspect compared to the previous results is given by the impact of the GDP per capita: the coefficient is negative and statistically significant, as in the case of the general estimate (at the level of the first two clusters the coefficient obtained was positive and only in the case of the first cluster it was also significant) Thus, at a 1% increase in GDP per capita, the at-risk-of-poverty rate would decrease by 0.395% (the impact obtained is greater than in the case of the model with all countries).

The last indicator that appeared to influence the evolution of the at-risk-of-poverty rate is the old-age dependency ratio: a 1% increase in this variable would produce an increase of almost the same intensity in the dependent variable.

Conclusions

Accentuated inequalities in a society have a major negative impact on socio-economic variables such as the at-risk-of-poverty rate. To measure this influence, clustering algorithms and regression models with panel data for the EU member states in the period 2011-2022 were used.

The econometric model of the relationship between inequalities and the at-risk-of-poverty rate highlighted a series of factors that influence poverty: the Gini coefficient, research and development expenditures, social protection expenditures, GDP per capita, the unemployment rate, and the old-age dependency ratio. One regression model with all countries and three regression models on subsets of countries were obtained according to the results of the clustering performed. The clusters were: Austria, France, Hungary, Luxembourg, Malta, Poland, Romania, Slovenia (cluster 1), Belgium, Denmark, Greece, Netherlands, Portugal, Spain, Sweden (cluster 2), Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Germany, Ireland, Italy, Latvia, Lithuania, Slovakia (cluster 3).

Social inequalities measured with the Gini coefficient have a positive and statistically significant influence on the at-risk-of-poverty rate in two of the three clusters and on EU countries in general when analyzed together. That is to say that a decrease in inequalities is related to a decrease in the risk of poverty in the EU countries.

The old-age dependency ratio has a positive and statistically significant influence on the risk of poverty. Of smaller influence – but also statistically significant – is the unemployment rate, an increase in this indicator leading to an increase in the at-risk-of-poverty rate.

Other variables that influence the at-risk-of-poverty rate are social protection expenditure, research and development expenditure, and GDP per capita, a decrease in this variable leading to a statistically significant increase in the at-risk-of-poverty rate.

On the clusters, some of the previously significant indicators lost their significance. The Gini coefficient is not statistically significant for cluster 1, but it is significant for clusters 2 and 3.

For cluster 1, the only influence in terms of decreasing the at-risk-of-poverty rate comes from the research-development expenditure indicator. For cluster 2 and cluster 3, this indicator turned out to be insignificant, although the sign is negative. The social protection spending and GDP per capita indicators have a beneficial effect in terms of reducing the at-risk-of-poverty rate.

Understanding the phenomenon of poverty is a prerequisite for alleviating it, generating social solidarity, and rebuilding a fairer society. Our research contributes to the evaluation of the interaction between inequalities and poverty in Romania and the European Union. The results highlighted the importance of reducing inequalities together with increasing GDP per capita, social protection, and research and development expenditures for the reduction the poverty.

The present article includes an analysis of poverty not only for the EU in general, but also for the EU countries groups in three clusters. Reducing poverty in cluster one can be obtained through economic growth, increasing R&D expenditures, and reducing the old-age dependency ratio and unemployment. In cluster 2, decreasing inequalities and the old-age dependency ratio could conduct for the reduction the poverty. For cluster 3, decreasing inequalities and older-age dependency ratio and increasing growth and social protection expenditures could be beneficial for alleviating poverty. In our article, poverty is measured with the indicator at-risk-of-poverty rate. Future research could approach poverty from different perspectives and through different indicators.

Acknowledgment

Part of this work was supported by the NUCLEU Program funded by the Romanian Ministry of Research, Innovation and Digitization (PN-22100201).

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