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Assessment of the relationship between regional variability in the level of education and population income: application of multivariate comparative analysis

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Abstract

Motivation: The relationship between the level of education and population income lies at the heart of current scientific and political debates on the social and economic development of countries. The issue is an important one, as the gap between countries in this regard is large and has widened even further amid the current economic crisis that started in 2020 and is a result of, among others, the Covid-19 pandemic.

Aim: The present article aimed to undertake a multivariate comparative analysis of population level of education (EL) and income (IL), construct synthetic measures of the phenomena under study, rank and classify the objects/countries studied, and investigate whether significant interdependencies exist between the level of education and income inequality. Additionally, an effort was made to determine the scale of changes and variability in the phenomena explored, both prior (before 2020) to and during the economic crisis (years 2020–2021).

Results: The study confirmed the existence of a significant interdependence between populations' education level (EL) and income level (IL) variability across EU regions. The marginalization of and disparity among several of the EU(27) countries has intensified even further during the current economic crisis. Significant correlations exist between countries with high population incomes and the percentages of individuals holding tertiary

education qualifications as well as the adults pursuing further education. Concomitantly, as the percentage of young people not in education or employment falls, countries' GDP and income levels increase, while income inequality and the risk of poverty decrease. The understanding of the aforementioned interdependencies is vital for the implementation of education policy as one of the biggest levers reducing educational disparities and thus income inequality in the population.

Keywords: education; income; inequality; multivariate analysis; synthetic measure
JEL: D31; I21; I24; I25

1. Introduction

The existing and unabated inter-country income inequality has been a long-standing problem for these countries, and the current economic crisis has exacerbated it even further. Never. Despite the many studies addressing the issue (Grzebyk et al., 2022; Maket et al., 2022; Murawska, 2014; Murawska et al., 2020), the knowledge available, and the corrective measures applied by institutions, the outcomes are not as anticipated. The causes of income inequality are many (Bartak, 2014; Polacko, 2021; Zhou & Song, 2016), one of which is the level of education (Bartak, 2019; Murawska, 2017; Suryadarma, 2011; Vintilă et al., 2017). The connection between countries' income inequality and the level and quality of education lies at the heart of current scientific and political debates on social and economic development. Research on the impact of the level and quality of education on income and income inequality as well as economic development has been undertaken by many academics (Ansari, 2016; Banzragch et al., 2019; Dao, 2020; Skubiak, 2013). The literature emphasizes the increasing importance of education and skills as determinants of life outcomes (Vandeplas, 2021), as well as the fact that economic development, prosperity and social cohesion can be achieved through well-designed and well-targeted investment in education (Algan et al., 2021).

Taking the above considerations into account, several research objectives were set. The first aimed to demonstrate, at a European scale, the changes in and regional variability of the indicators characterizing the levels of education and income, both prior to and during the economic crisis. The second objective entailed construction of synthetic measures of education level (EL) and income level (IL) in EU-27 countries, as well as the ranking and classification of countries with the highest and lowest levels of the phenomena under study. The third was to verify whether the level of education challenges the income level, income inequality and poverty risk in the IL population, and sustains the correlation.

The realization of the objectives set out in the article was to enable verification of two hypotheses. The first hypothesis assumed that in the European Union countries, during the crisis (from 2020), the growth of the levels of education and income slowed down, while country differentiation in this regard intensified. The second hypothesis, in turn, assumed the existence of a significant relationship between the level of education (EL) and the level of income

(IL), where the specific determinant of a country's prosperity and lower income inequality entails a higher percentage of individuals holding tertiary education qualifications, at a lower percentage of early school leavers, those not in education or employment, as well as those holding primary education at most.

Sixteen indicators describing the IE and IL in the EU-27 were used to assess the phenomenon under study. The research period covered the years 2012–2021, and the data were derived from Eurostat (2023) databases. In order to assess country differentiation and the trends occurring, a detailed statistical analysis of all variables was carried out. The principal research methods employed were the multivariate comparative analysis, which enabled the construction of synthetic measures of EL and IL, and the Hellwig (1981) method, utilized for the country classification. The correlation and multiple regression methods were used to explore the links between the phenomena under study.

The article consists of an introduction, a brief literature review and a detailed description of the research methods. This is followed by a presentation of the study results through the use of descriptive, comparative, graphical and tabular methods. This section also includes a discussion of the results. The article concludes with a summary and recommendations.

2. Literature review

Numerous studies addressing income inequality as well as the causes and consequences of its widening can be found in the literature (Kawachi et al., 1997; Kuźmar, 2023; Polacko, 2021; Topolewski, 2020; Tusińska, 2018; Welch, 2001; Zhou & Song, 2016). Not only is the importance of studying inequality evidenced by the international institutions' expressed concerns regarding the persistence and growth of inequity, which is considered a major challenge of our time, but there is increasing talk of inequality worsening as an effect of pandemic shock (Davidescu et al., 2022). The consequences of inequality growth and persistence have been summed up by Deaton (2015) as follows: inequality harms not only poverty reduction, but also development. As income inequality widens, such various related social problems as declining life expectancy and deteriorating prosperity of the population (of children in particular) arise, which leads in turn to declining educational performance or even school-quitting. As Neckerman and Torche (2007) stress, the social and political consequences of inequality are particularly pronounced in the domains of health, education, crime, social capital and political power.

The literature is replete with publications indicating that a population's level of schooling and education constitutes one of the important determinants of income inequality and high prosperity (Algan et al., 2021; Ansari, 2016; Kryk, 2016; Wędrowska & Muszyńska, 2022). In their study of East Asian countries, Lee and Lee (2018), for instance, noted that equalized education significantly contributes to the reduction of income inequality, whereas public spending on education reduces educational inequality. Goldin and Katz (2009), in turn, placed

emphasis on the gap between educational background and earnings, which has been widening since the early 1980s. Education-contingent wage inequality is widespread, and consequently reflected in income inequality. Education is both a determinant of prosperity and a core resource for sustainable development. The expectations regarding the redistributive role of the state, as well as the individual efforts to harmoniously integrate all the economic, social and environmental problems affecting each and every one of us, are largely dependent upon education (Biasutti & Frate, 2017; Bijl et al., 2010). Researchers have been also investigating the cause-and-effect relationship between educational and income inequality, as well as the correlation thereof with health inequality and mortality (Hoffmann et al., 2016). Turčínková and Stávková (2012), in contrast, focused on the relationship between educational attainment and the income situation of households in the Czech Republic, mainly those at risk of poverty. The study showed that primary education or no education households are the most vulnerable group. The factor differentiating the level of both education as well as income is residency (Beltrán Tapia & Martinez-Galarraga, 2018; Czapiewski & Janc, 2012; Roscigno et al., 2006; Wu & Zhang, 2010). In some countries, far more commonly than in other regions, the youth are considerably more successful in completing higher education, and adults are eager to raise their competencies. In other regions, the opposite is true, with relatively more young people leaving education early, not working or receiving any training. Amongst other causes of educational inequality, the literature identifies demographic factors, particularly gender inequality, lack of investment in higher education, or disparity in technological skills (Damon et al., 2016; Michalcewicz-Kaniowska et al., 2021; Walker et al., 2019). Given the polarization across regions, a need exists to refine the functioning of the entire system, in terms of an even conversion of knowledge into economic resources and the ability to use the acquired knowledge on the labour market. According to various micro and macro estimates, the rate of return on investment in human capital is substantial, compared to alternative investment opportunities in particular (Algan et al., 2021).

Meanwhile, it is worth considering whether the level of education is what contributes to income inequality and the scale of poverty risk, or conversely, is it the income inequality affecting the educational opportunities of countries and, consequently, the level of the residents' education? Clear identification of which aspect is the cause and which the result sometimes poses as a difficulty for researchers, nevertheless, it is the level of education which is oftentimes treated as a variable affecting income levels and inequalities.

3. Methods

In order to achieve the objectives, set out in the article, a selection of measures indicating the education levels (EL) and income levels (IL) in European Union countries was made. Since the phenomena explored in the article are multidimensional, many variables were taken into account in the characteriza-

tion thereof. Specifically, dozens of available indicators were collected, collated and analyzed, prior to the selection and final choice of indicators describing the two phenomena under study. The indicators selected were used to construct synthetic measures of EL and IL, develop a country ranking and classification, as well as check whether the level of education in each EU-27 country is reflected in the level of income and the inequality thereof.

The empirical data originated from the information collected by the European Statistical Office (Eurostat, 2023). Twenty-seven countries (objects) of the European Union were analyzed. The research period covered the years of 2012–2021. The study incorporated databases of figures last updated on February 13–16, 2023.

The specific data sources comprised:

- the Statistical Office of the European Union (EUROSTAT);
- European Union Statistics on Income and Living Conditions (EU-SILC);
- European System of National and Regional Accounts (ESA 2010);
- European Union Labour Force Survey (EU-LFS).

The descriptive and graphical analysis of the study results employs European Union Member State abbreviations accordant with ISO 3166 Alpha-2 codes developed by the International Organization for Standardization (ISO, 2023). The preparation of statistical data for the present study was carried out in several stages. In the first stage of the study, a database of dozens of indicators characterizing the phenomena under examination was developed. Subsequently, a thorough content analysis of the indicators collected was undertaken. The technique of expert evaluation was used, which consisted of discussions with several independent experts on the validity of the choice of variables. The selection of experts was non-random and intentional, thanks to which opinions were obtained from the most competent persons from the point of view of the researcher and the study. The decision on the target indicators was additionally contingent on the availability of complete and up-to-date data on all EU member states, as well as on the experts' positive assessment of the variable selection. Ultimately, two sets of statistical data were compiled. The first research focus area featured experimental variables X describing EL (9 indicators), whereas the second focus area involved dependent variables Y describing IL (7 indicators). Consequently, a database of raw figures from years 2012–2021, consisting of 16 indicators, was created (Table 1).

The second stage of the study entailed statistical analysis of all collected variables, based on substantive-formal criteria of variable properties (Zeliaś, 2000, pp. 36–37). Calculations of, inter alia, the relative growth rates (P_w) and absolute growth rates (P_a), coefficients of variation V_s, measures of dispersion R, asymmetry A and kurtosis K were carried out. The calculation of the P_w and P_a growth or decline rates was aimed at expressing the 2012–2021 scale of changes in the phenomena under study. To assess the variability (differentiation) of the countries in question, coefficient of variation V_s ($V_s = S/\overline{x} \cdot 100\%$), where $\overline{x}$ and S represent the arithmetic mean and standard deviation, respectively.

The variability among EU countries is significant when V_s>10%) (Nowak, 1997, p. 12) and the R measure of spread (*max–min*) were used.

The V_s coefficients of variation calculated for all variables throughout the 2012–2021 research period exceed the adopted threshold of 10%, therefore, the objects/countries exhibit sufficient variation to carry out further analysis thereon. A verification of the hypothesis regarding the normality of the variables' distribution was also carried out using the Shapiro–Wilk test (Shapiro & Wilk, 1965). The variables for which the Shapiro–Wilk test reached statistical significance (p<0.05) show a distribution deviating from the Gauss curve, and thus they were eliminated from the analyses entailing e.g., the construction of synthetic measures for the phenomena under study and the testing of the interdependencies between variables X and Y by means of multiple regression. These variables are X_{03}, X_{04}, X_{06}, X_{07} as well as Y_{01}, Y_{02}. Given the fact that data on some countries, or pertaining to particular years under study, were missing (n.d.), a decision was made to additionally remove variable Y_{03}. The variables were also assessed for their impact on the phenomena analyzed, and divided into stimulants (X_{02}, X_{04}, X_{05}, X_{06}, X_{09} and Y_{01}, Y_{02}, Y_{03}, Y_{04}) and destimulants (X_{01}, X_{03}, X_{07}, X_{08} and Y_{05}, Y_{06}, Y_{07}). (Table 2 and Table 3).

In the third stage of the study, coefficients of correlation r between the selected variables of relevant feature properties were calculated, to verify and eliminate those carrying the same information on the phenomenon under study (Murawska, 2014; Murawska et al., 2020; Zeliaś, 2000). The independent variables X (X_{01}, X_{02}, X_{05}, X_{08}, X_{09}) and dependent variables Y (Y_{04}, Y_{05}, Y_{06}, Y_{07}) selected were subjected to further analysis involving reduction of variables excessively correlated with one another. The reduction of the set of diagnostic variables was achieved through the Hellwig (1981) method. The assessment of the existence of relationships between the variables was carried out for all the studied years 2012–2021, while the reduction was carried out only for the data from 2021. Based on the correlation matrix, the threshold value of coefficient r* was calculated by following the rule proposed by Nowak (1997):

$$r^* = r_{02} - \lambda\left(r_{02} - r_{01}\right), \tag{1}$$

where: $r_{01} = \min_i \min_j \left|r_{ij}\right|$, $r_{02} = \max_i \max_j \left|r_{ij}\right|$,

and λ falls within the range 0<λ<1, representing the number chosen by the researcher (λ=0.5 was assumed). Variables for which the correlation coefficient in absolute value was higher than the critical value (the so-called satellite variables) were eliminated from the set of variables. Central and isolated variables, i.e., those for which the correlation coefficient r did not exceed the r* threshold value adopted, in contrast, formed the final set of diagnostic features, which consisted of the following independent variables X_{ij} and dependent variables Y_{ij}:

– X_{01}, X_{02}, which were selected for the construction of the synthetic measure of education level Z_iEL;

– Y_{04}, Y_{05}, which were selected for the construction of the synthetic measure of income level Z_iIL.

In stage four, transformation of destimulant variables D into stimulants S was performed. Construction of synthetic measures of multidimensional phenomena calls for qualification of the diagnostic variables into a set of stimulants S or destimulants D by means of an expert method, which was performed in the second stage of the study. If the set of diagnostic variables includes both stimulants (causing an increase in the phenomenon under study) as well as destimulants (causing a decrease in the phenomenon under study), all the destimulants should be transformed into stimulants, to ensure that the variables carry the information on the object under study in the same direction. The following variables were assigned to the set of stimulants: S:{X_{02}, Y_{04}}, while the set of destimulants comprised: D:{X_{01}, Y_{05}}. The transformation of the destimulants into stimulants was performed using formulas:

$$x_{ij} = c_j - x_{ij},\ \left(i = 1,\ldots,n; j = 1,\ldots,k\right), \tag{2}$$

$$x_{ij} = c_j \big/ x'_{ij},\ \left(i = 1,\ldots,n; j = 1,\ldots,k\right), \tag{3}$$

where x_{ij} (i=1,...,n; j=1,...,k) is the value of the j-th variable in the i-th multivariate object Q; x'_{ij} are the realizations of the destimulant variable, with c_j denoting a certain constant and indicating substitution (1, 100 or 1000, depending on how the index was expressed) (Murawska et al., 2020; Zeliaś, 2000).

In the fifth step, to translate the data into statistical language, variable standardization was performed, adopting a system of unit weights, in accordance with the formula:

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{s_j},\ \text{at}\ \overline{x}_j = \frac{1}{n}\sum\nolimits_{i=1}^{n} x_{ij},\ s_j = \left[\frac{1}{n}\sum\nolimits_{i=1}^{n}\left(x_{ij} - \overline{x}_j\right)^2\right]^{0.5}, \tag{4}$$

where z_{ij} is the standardized value of the diagnostic variable x_i.

The sixth stage involved establishment of a development pattern the coordinates of which are defined by the largest, maximum values of:

$$Z_{0j} = \max_i z_{ij}. \tag{5}$$

Relative to the resulting benchmark, multidimensional distances were calculated for each country under study, using Euclid's metric, which is written with the formula:

$$d_{i0} = \left[\sum\nolimits_{j=1}^{k}\left(z_{ij} - z_{0j}\right)^2\right]^{0.5}, \tag{6}$$

where d_{io} — the distance of the object Q_i (i=1,...,n) from the hypothetical (abstract) benchmark object Q_o.

In order to normalize the synthetic variable d_{io}, and obtain a measure whose increasing values would prove the growth of the phenomenon under study, so-called relative synthetic variables (synthetic measures) of the following form were constructed:

$$z_i = 1 - \frac{d_{i0}}{d_0}, \text{ where } d_0 = \overline{d}_0 + 3S_0, \tag{7}$$

at:

$$\overline{d}_0 = \frac{1}{n}\sum_{i=1}^{n} d_{i0},\ S_0 = \left[\frac{1}{n}\sum_{i=1}^{n}\left(d_{i0} - \overline{d}_0\right)^2\right]^{0.5}. \tag{8}$$

The resulting synthetic measures adopt values in the range [0,1] with probability close to unity. The closer the value thereof, calculated for a given country, is to unity, the higher the level, development or quality of the phenomenon under study, whilst as the value approaches zero, the phenomenon qualities become lower (Zeliaś, 2000).

The seventh stage of the study entailed a ranking and grouping of the EU-27 in terms of the phenomena under examination. The countries were ranked based on the synthetic Z_iEL and Z_iIL measures constructed, whereas to isolate typological groups consisting of countries characterized by similar levels of the phenomena under study, analysis of the differences in the level of the synthetic variable was employed by following the rule proposed by Nowak (1990). The basis for obtaining classes of spatial units are the ranges of the synthetic variable's values built using the arithmetic mean $\overline{z}$ the standard deviation s_z. The set of objects is divided into four groups comprising objects whose values of the synthetic variable fall into disjoint intervals. These groups satisfy the condition of separability and completeness:

- group I: ¶$_i \geq ^{-} + {}_z$;
- group II: $\overline{z} \leq z_i + \overline{z} + s_z$;
- group III: $\overline{z} - s_z \leq z_i < \overline{z}$;
- group IV: $z_i < \overline{z} - s_z$;

where:

$$\overline{z} = \frac{1}{n}\sum_{i=1}^{n} z_i,\ s_z = \left[\frac{1}{n}\sum_{i=1}^{n}\left(z_i - \overline{z}\right)^2\right]^{0\,5}. \tag{9}$$

Objects within a given typological group are arranged by the value of the synthetic measure. Isolation of homogeneous and disjoint groups of the most similar objects facilitates substantive analysis and inference. Immediate comparison

of different typological groups in terms of the level of the phenomena under study is likewise possible.

In the final, eighth stage of the study, analysis of the cause-effect correlation between the two phenomena (EL and IL) and the diagnostic characteristics selected was performed. For this purpose, Pearson's linear correlation coefficient r and the coefficient of determination r^2 were calculated, followed by a multiracial regression analysis.

4. Results and discussion

The levels of income and social inequality are strongly correlated with the differential access to universally recognized goods. In this context, education plays an important role as one of the most salient individual sorting machines (Gmerek, 2013, p. 74; Hanushek & Woessmann, 2010, pp. 60–68). Contemporary highly developed societies, which the EU-27 can be regarded as, provide their citizens with universal access to education. In this respect, it can be asserted that it represents a measure of the degree of these societies' democratization. Although access to education is meant to be "equitable" and "fair", this principle, as the results of the study show, is not fully realized and fulfilled in the EU-27 countries either.

4.1. Changes and variation in the 2012–2021 levels of education and income in EU-27 countries

Chart 1 shows the 2012–2021 trend of changes in the independent variables X characterizing the level of education and the dependent variables Y characterizing the level of income in the EU-27. The variables acting as destimulants were transformed into stimulants, to let the rising value thereof describe the development of and the growth in the level of the phenomena under study, namely EL and IL. The data were subsequently standardized for comparison on a single graphic. Variables with missing data for all years under examination (X_{05}, X_{06}) were omitted during the analyses. An upward trend can be observed in the entire period 2012–2021, yet the same cannot be confirmed for all variables when factoring in individual time periods and specific years.

Looking at the indicators characterizing EL, the upward trend continued dynamically until 2019, although in 2020, a noticeable unfavorable change was observed in variables X_{03} and X_{04}. The significant decline in the percentage of adults in post-education education, as well as the percentage of young people aged 15–24 who are either working or in education, may have resulted from the pandemic outbreak and the forced home isolation. In 2021, the EL rates began to rise again (Chart 1).

Observation of the changes in education levels is of great importance, given the fact that, as (Algan et al., 2021) emphasizes, well-educated (both quanti-

tatively and qualitatively) countries and regions recover faster from economic crises and have greater economic resilience.

With respect to the indicators describing IL, two trends can be observed, one of which, dynamically increasing through 2019, pertains to income values of real or purchasing power-adjusted GDP, net equivalent income, and gross disposable household income. In 2020, a drastic decline in GDP occurred, followed by a renewed indicator increase in 2021. Household income and net equivalent income, however, did not show any decline in 2019 and likewise continued to increase in subsequent years. The highest income inequality in the EU was recorded in 2014–2016, but the trend kept reversing thereafter until 2020, and in 2021 a decline in income equalization (an increase in income inequality and the Gini coefficient) occurred. The risk-of-poverty rate, in turn, had already increased significantly in 2020 and continued to rise in 2021 (the graphic shows a decrease resulting from the transformation of the variable Y_{07} into an IL stimulant) (Chart 1). Similar findings have been reported in an article by Zhou and Song (2016), who observed in China, that relatively high economic growth is accompanied by an increase in income inequality. The results of the present study likewise show that the crisis did not cause a decline (yet possibly a slowdown) in the economic/income performance of countries, nonetheless, a drastic increase in income inequality has followed.

The EU-27 differ significantly in terms of the indicators characterizing both EL and IL (Chart 2). The existence of considerable gaps in the levels of education and basic skills within Europe has also been studied by Bartak (2019), Vandeplas (2021) or Davidescu et al. (2022), on the example of Central and Eastern European countries, using a panel analysis of ten EU countries. The present research also confirms existence of significant disproportions across the countries. The greatest between-country disparities are visible in the variable X_{04}, i.e., the percentage of adults aged 25–64 and engaged in post-education education, and the variable Y_{01}, i.e., real GDP per capita. The smallest, but also significant, are the country-to-country variations in indicators X_{02}, X_{08}, X_{09}, i.e., the percentage of individuals holding tertiary and secondary education qualification in both the 25–34 and 15–65 age groups. By contrast, the least variation in the group of Y indicators applies to the EU countries described by Y_{06} (the Gini coefficient), Y_{07} (the poverty risk index) and Y_{05} (a measure of income distribution inequality).

Alarmingly, an increase in the between-country variation (V_s) has been observed for nearly all variables describing both EL and IL ever since the crisis began in 2020. Only for the variable X_{04} (percentage of adults in post-education education) the variation decreased in 2021. Similarly, the differentiation between only two indicators describing the level of income, namely Y_{01} (real GDP per capita in euros) and Y_{03} (adjusted gross disposable household income per capita in PPS), showed a slight decline (Chart 2).

The most popular indicator illustrating the level of education is the percentage of young people aged 25–34 who have successfully completed higher

education (X_{02}). The percentage of such individuals in the EU averaged 41.2% in 2021 (34.1% in 2012). The highest number of young people with tertiary education reside in Luxembourg (62.6%), Ireland (61.7%) and Cyprus (57.5%), and the lowest in Romania (23.3%), Italy (28.3%) and Hungary (32.9%). Consequently, there are far fewer tertiary education holders in the group of those aged 15–64 (X_{09}), while the percentage thereof in the EU was 29.5% in 2021 (in 2012 — 23.3%). The largest rise in the proportion tertiary education holders, between 2012 and 2021, occurred in Austria, Portugal and Croatia, while the smallest, even decline, occurred in Poland and Romania (Chart 3).

The databases, meanwhile, contain indicators evidencing a deceleration in the growth of EL, e.g., the percentage of 18–24 y/o early school leavers (X_{01}) (Chart 4), young people aged 15–24 who are neither working nor in education (X_{03}), or the percentage of 15–64 year-olds holding merely primary education (X_{07}). In terms of education level destimulants, EU countries show the most variability with respect to the number of 18–24 y/o early school leavers (X_{01}) (V_s=41.3%). The percentage of such individuals in the EU was 9.7% in 2021 (13.8% in 2012), with the highest in Romania (15.3%), Spain (13.3%), Italy (12.7%), and Bulgaria, Hungary and Denmark (about 12%), and the lowest in Croatia (2.4%) and Slovenia, Greece and Ireland (about 3%). One major area of concern for developed countries is the scale of young people under the age of 24 who are not in employment, education or training, i.e., the so-called NEETs (X_{03}). The 2021 percentage of such individuals in the EU was 10.8% (13.1% in 2021), with Italy (19.8%) and Romania (18.0%) showing the highest, and Sweden (5.1%) and the Netherlands (5.1%) the lowest percentage. The unwillingness to pursue further education is reflected in the scale of individuals with education at a mere level of 0–2 on the ISCED scale (X_{07}). The EU percentage of lowest-educated persons was 24.9% in 2021 (29.8% in 2012), with the highest in Portugal (40.3%) and Italy (39.2%) and Spain (37.9%), and the lowest in Lithuania (10.9%) and the Czech Republic (12.0%) as well as Poland, Slovenia and Slovakia (approx. 13%).

Referring to the relevance of the above issues, state welfare mentality as a challenge to Europe's sustainable development was explored by Iacobută and Ifrim (2020). The results of their study showed that welfare mentality negatively affects sustainability, as it is positively correlated with the risk of poverty and the percentage of young individuals not in education, employment or training (NEET). In parallel, countries such as Sweden, Denmark and Luxembourg, widely recognized as social policy countries, record low values of redistribution preferences. The main determinants of welfare mentality were found to lie in high levels of NEET and low levels of economic freedom.

The second group the indicators analyzed comprised those characterizing income levels (IL) in the EU-27 countries. The measures commonly used are gross domestic product per capita (Y_{01}), or real expenditures (Y_{02}) per capita, reported in Euros or Purchasing Power Standards (PPS). Another indicator is the average annual equivalent net income per capita (Y_{04}). Invariably for years,

Luxembourg has had the highest income (e.g., in 2021, Y_{01}=84,490 Euros per capita, Y_{02}=87,100, Y_{03}=36,319, and Y_{04}=48,220). The country diverges from the rest in terms of income, followed by Ireland with a real and purchasing power adjusted GDP of 70,000 Euros and PPS per capita. At the other extreme are countries such as Romania, Bulgaria, and Hungary, e.g., where the 2021 average annual equivalent net income per capita in Euros (Y_{04}) was 5,446 (RO), 6,730 (BG), 7,337 (HU) respectively (Chart 5).

Prosperity and living conditions are also reflected by inequality in income distribution (Tusińska, 2018; Włodarczyk, 2013). Income inequality can be quantified by an absolute measure of income distribution inequality (Y_{05}) and the Gini coefficient (Y_{06}). Societal prosperity can likewise be reflected by the poverty risk index (Y_{07}). Banzragch et al. (2019), for instance, used the Gini coefficient to analyze educational inequality changes in Mongolia. Their study showed that the reduction of household-income and spatial inequalities entailed the main factors that had led to a decline in the education Gini index.

Income distribution inequality (Y_{05}) averages 5.0 (–) in the EU-27, with the greatest in Bulgaria and Romania, where it exceeds 7.0, as well as Latvia and Estonia, where it tops 6.0. The smallest income distribution inequality has been observed in Slovakia, Slovenia, Belgium and the Czech Republic (oscillating at 3.0 in these countries) (Chart 6). The country-to-country inequality dichotomies (Y_{05}) are reflected in the Gini coefficient (Y_{06}) and the poverty risk index (Y_{07}). The largest increases in the P_w of income distribution inequality between 2010 and 2021 occurred in Bulgaria, Luxembourg and Malta, whereas the largest decreases — in Greece and Slovakia.

4.2. Synthetic measures of EL and IL — results of multivariate comparative analysis

The literature on the application of multivariate comparative analysis to study various phenomena is extensive. Many authors use the method for comparison of the socioeconomic development of countries or provinces (Barska et al., 2022), sustainable development (Bartłomowicz & Cheba, 2017), population growth (Sojka, 2008), or other aspects related to income, living standards and conditions, good health (Grzebyk et al., 2022; Murawska, 2014; Murawska et al., 2020). Multidimensional data analyses have also been used to assess education systems and levels (Vintilă et al., 2017).

The diagnostic variables isolated via the method proposed by Hellwig (1981) and Nowak (1990), outlined in the methodological section, allowed the calculation of synthetic Z_i measures of the multidimensional phenomena analyzed, namely the synthetic measures of education level Z_iEL and income level Z_iIL. Chart 7 illustrates the distributions of Z_iEL and Z_iIL as histograms, as well as verifies, via the Shapiro–Wilk SW–W Test, whether the distributions are normal. The SW–W test results and p probabilities calculated indicate a distribution of the analyzed variables similar to a normal distribution.

Based on the Z_i calculated for the two EL and IL aspects under study, an EU-27 ranking of the countries least and most distant from the benchmark was compiled. In addition, ranking groups of countries with high (group I), average (group II), low (group III) and very low (group IV) levels of the phenomena under study were formed (Table 4).

In light of the study findings presented, it can be concluded that the highest EL prevails in Ireland, Lithuania, the Netherlands and Slovenia. These countries are among the first four in the ranking (1–4) and fall into the first group (I) of countries with a high level of EL. Further down the ranking (5–13) nine countries followed, i.e., Belgium, Greece, Portugal, France, Luxembourg, Sweden. Latvia, Cyprus and Poland. These countries qualified for the second group (II) of average-level EL. Group III (low level of education), in turn, encompassed such countries as Denmark, Austria, Croatia, Slovakia, Finland, Estonia, the Czech Republic, Malta and Spain, i.e., another nine countries, ranked from 14th to 22nd. The group with a very low level of education (IV) included the countries ranked last (23–27), namely Germany, Bulgaria, Hungary, Italy and Romania.

The second multidimensional phenomenon, considered an effect of EL for research purposes, is the income level (IL). The synthetic IL measures constructed showed that the top ranks (1–6) and qualification as Group I countries apply to such countries as Belgium, Denmark, Finland, Ireland, the Netherlands and Luxembourg, which translates into the highest economic income and population income in these countries, and the lowest income inequality and poverty risk. In the second group of countries (II), characterized by average IL, 8 objects ranked between 7 and 14, i.e., Austria, Sweden, Slovenia, France, Germany, Cyprus, the Czech Republic and Slovakia. Group III (countries with low IL) included Malta, Poland, Estonia, Hungary, Italy, Croatia, Spain and Portugal, ranked from 15th to 22nd. Countries ranked as last (23–27), and assigned into Group IV characterized by very low IL, were Greece, Lithuania, Latvia, Romania and Bulgaria. The countries falling at the bottom of the ranking have the lowest GDP and population income of all EU countries and suffer the greatest income inequality and poverty risk (Table 4).

The above classification shows 4 groups of EU-27 countries, characterized by high, average, low and very low levels of education. Studies on the so-called educational opportunities were also conducted by (Palmisano et al., 2022) among 31 European countries. Their findings reveal a significant degree of heterogeneity, with Northern European countries showing a low level of opportunity inequality, while Mediterranean and Eastern European countries exhibit a significant degree of "unfair" educational inequality. In the vast majority of the countries examined, the most significant determinants of the phenomena under study are parental education level and occupation as well as educational system characteristics.

4.3. Analysis of the EL impact on IL

The scatter plot (Chart 8) and the regression analysis results (Table 5) confirm the existence of a positive significant correlation between EL and Il, at $r_{ZiILZiEL}$=0.474, with a significance level of p=0.0126. It can thus be concluded beyond doubt that the level of education in a given EU-27 country does affect the level of income and the scale of income inequality.

Research on the impact of education on inequality was also addressed by Abdullah et al. (2015), through a comprehensive meta-regression analysis of the extant empirical literature. According to their findings, education has proven particularly effective in reducing inequality in Africa. Ansari (2016) used the vector auto regression method to study the relationship between human capital accumulation and economic growth in Iran. The results revealed that an increase in the level of education exerts a significant impact on GDP growth. Similar findings were reported by Dao (2020), whose research provided empirical evidence of the impact of education on the Vietnamese economy and, more specifically, productivity. The links between education and income distribution were also studied by Gregorio and Lee (2002). Their results confirmed the important role of higher and more equitable distribution of education in equalizing income distribution. The impact of education on income inequality and health (death rates in particular), was also investigated by Hoffmann et al. (2016), who analyzed several European countries. They found no confirmation that increasing income inequality explains health inequality, nor that the impact of education is a more important mediator. To examine the role of age and education as determinants of income inequality in Poland, by contrast, Wędrowska and Muszyńska (2022) employed decomposition of mean log deviation. Their study likewise confirmed significant correlation between the aspects under investigation.

It should be emphasized, nevertheless, that EL is only one of the factors contributing to the growth in the income and prosperity of IL societies. The coefficient of determination r^2=0.2244 shows only a 22 percent effect of the variability in EL on the IL variability. Accordingly, it turns out that all alternative causal sources (other than the examined indicators characterizing the level of education) have an almost 78 percent impact on the level of income.

The impact of educational attainment on income inequality and intergenerational mobility in particular has also been confirmed by the results of a study conducted by Jerrim and Macmillan (2015) and Knight et al. (2013). The researchers found that income inequality is correlated with several key components of the intergenerational transmission process — including access to higher education, financial return to education, and residual effect of parental education level on labor market earnings. The research carried out by Rodríguez-Pose and Tselios (2009) on various regions of the EU also proved the correlation between high levels of educational inequality and higher income inequality. In addition to the significant impact of education on income inequality, the re-

searchers further list population aging, the share of female workers in the labor force, urbanization, as well as agriculture and industry, which are negatively correlated with income inequality, indicating that unemployment and prominence of a strong financial sector positively affect inequality. Lastly, income inequality is lower in socio-democratic welfare states, areas of Protestantism, and regions of Nordic family structure.

5. Conclusion

The research conducted allowed positive verification of the hypotheses posed. In the European Union countries (27), the growth in the levels of education (EL) and income (IL) decelerated during the crisis. A slowdown, or even a decrease, in the values of the indicators acting as stimulants of the phenomena under study, along with an increase in the destimulants, was observed in 2020. In 2021, a further slight increase in the level of educational and income could be observed, yet alarmingly, the income inequality deepened, and the risk of poverty worsened. In 2012 to 2019, a systematic decline in both educational and income inequality took place, and the inter-country gaps began to widen. This negative trend did not slow down in the following year. Therefore, the first hypothesis was confirmed. Since 2020, the growth rate of the level of education and income of the population living in EU countries has slowed down and diversified even more.

Meanwhile, the results of the dependency analyzes proved the second hypothesis to be true. There is a relationship between the level of education (EL) of the inhabitants of EU countries and the level of their income (IL). High levels of educational attainment show significant impact on high-level income, prosperity, lower social inequality and lower risk of poverty. Examples of such countries include Ireland, Belgium and the Netherlands. Conversely, in poorly educated societies, economic inequality worsens, while the level of population income and prosperity leaves much to be desired. This is the situation in such countries as Bulgaria, Romania, Hungary and Italy. The marginalization of certain social groups has intensified even more during the current economic crisis. Significant links exists between countries characterized by high population incomes and the percentage of individuals holding tertiary education qualifications and adults furthering their education even after having completed their schooling. In parallel, income inequality and the risk of poverty increase in countries with significantly higher numbers of early school leavers, those not in education or employment (so-called NEEDs), and those holding primary education qualifications at best.

Having demonstrated a significant relationship between education level and the level of income, one of the important challenges of development assistance to countries entails the strengthening of human capital low- and average-income countries, to positively affect economic growth and poverty reduction. What is more, education is a fundamental human right. It lies down

the foundation for more balanced and integral societies. To expand the prospects of quality education for all, educational policies, strategies and programs must be in place. In particular, labor market institutions face many challenges, especially in terms of supporting young people belonging to the NEET category (Saczyńska-Sokół, 2018). Algan et al. (2021) emphasize that the most important economic benefits to individuals, arising from high level education, involve superior skills, greater employability, increased productivity and better earnings. Non-economic benefits include better health, lower crime rates, and higher levels of trust, tolerance as well as civic and political engagement. On a societal scale, the most salient benefits of education entail higher GDP growth, better technology diffusion and adoption, higher innovation capacity, stable public finances and greater social cohesion. Accordingly, multivariate analyses should be expanded in future studies to include additional variables and verify the significance of the effects and benefits arising from high levels of education.

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Appendix

Table 1.
Independent variables X and dependent variables Y included in the study

Symbol	Abbreviation	Variable description
		Education level (EL)
X_{01}	ELET	early leavers from education and training 18–24 ages (%)
X_{02}	TEA(25–34)	tertiary educational attainment (ISCED level 5–8) of people aged 25–34 (%)
X_{03}	NEET	young people neither in employment nor in education and training (NEET rate) 15–24 ages (%)
X_{04}	APL	adult participation in learning 25–64 ages (%)
X_{05}	PLBDS	share of individuals having at least basic digital skills 16–74 ages (%)
X_{06}	STE	students in tertiary education — as % of 20–24 years old in the population
X_{07}	PEAL(0–2)	population by educational attainment level (less than primary, primary and lower secondary education — levels 0–2 ISCED 2011)
X_{08}	PEAL(3–4)	population by educational attainment level (upper secondary and post-secondary non-tertiary educations — levels 3–4 ISCED 2011)
X_{09}	PEAL(5–8)	population by educational attainment level (tertiary education — levels 5–8 ISCED 2011)
		Income level (IL)
Y_{01}	GDP EURO	real GDP per capita in euro
Y_{02}	GDP PPS	purchasing power adjusted GDP (real expenses) per capita in PPS
Y_{03}	AGDIH PPS	adjusted gross disposable income of households per capita in PPS
Y_{04}	MENI_EURO	mean equivalised net income per capita in euro
Y_{05}	IID	inequality of income distribution (–)
Y_{06}	GC EDI	Gini coefficient of equivalised disposable income (0–100) (%)
Y_{07}	RPR	at-risk-of-poverty rate (%)

Source: Own preparation based on Eurostat (2023).

Table 2.
Statistical characteristics of variables describing EL in EU-27 countries (data for 2021)

Variable	S/D	Mean	Min	Max	V_s	R	A	K	SW–W
X_{01}	D	8.2	2.4 (HR)	15.3 (RO)	41.3	12.9	0.1	–0.6	0.98 (ND)
X_{02}	S	44.5	23.3 (RO)	62.6 (LU)	22.2	39.3	–0.1	–0.3	0.98 (ND)
X_{03}	D	10.0	5.1 (SE)	19.8 (IT)	34.8	14.7	1.2	1.8	0.90
X_{04}	S	12.6	1.8 (BG)	34.7 (SE)	66.0	32.9	1.1	0.9	0.90
X_{05}	S	56.3	27.8 (RO)	79.2 (FI)	21.5	51.4	–0.3	0.5	0.97 (ND)
X_{06}	S	34.1	8.5 (LU)	45.1 (GR)	22.2	36.6	–1.6	4.0	0.89
X_{07}	D	21.6	10.9 (LT)	40.3 (PT)	37.9	29.4	1.1	0.7	0.87
X_{08}	S	46.3	25.6 (ES)	64.5 (CZ)	22.7	38.9	0.0	–0.8	0.97 (ND)
X_{09}	S	32.1	16.4 (RO)	45.2 (IE)	24.0	28.8	–0.3	–0.6	0.97 (ND)

Notes:

S — stimulant; *D* — destimulant; mean — average value UE (27); *min* — minimum value for the country; *max* — maximum value for the country; V_s — coefficient of variation in %; *R* — range (max-min); *A* — asymmetry; *K* — kurtosis; *SW–W* — Shapiro–Wilk test result; *ND* — normal distribution; EU country names: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE).

Source: Own preparation based on Eurostat (2023).

Table 3.
Statistical characteristics of variables describing IL in EU-27 countries (data for 2021)

Variable	S/D	Mean	Min	Max	V_s	R	A	K	SW–W
Y_{01}	S	28.182	6.950 (BG)	84.490 (LU)	65.1	77.540	1.6	2.7	0.85
Y_{02}	S	33.796	18.600 (BG)	87.100 (LU)	44.1	68.500	2.4	6.5	0.74
Y_{03}	S	22.757	n.d.	36.319 (LU)	23.1	20.403	0.7	0.2	0.94 (ND)
Y_{04}	S	19.593	5.446 (RO)	48.220 (LU)	55.0	42.774	0.7	0.1	0.92 (ND)
Y_{05}	D	4.8	3.0 (SK)	7.5 (BG)	25.6	4.4	0.7	–0.4	0.94 (ND)
Y_{06}	D	29.4	20.9 (SK)	39.7 (BG)	14.7	18.8	0.3	0.0	0.98 (ND)
Y_{07}	D	16.3	8.6 (CZ)	23.4 (LV)	24.8	14.8	0.1	–1.0	0.96 (ND)

Notes:

See Table 2 notes.

Source: Own preparation based on Eurostat (2023).

Table 4.
Classification (group ranking) of EU-27 synthetic measures of education level (Z_iEL) and income level (Z_iIL)

Education level EL				Income level IL			
Ranking	Z_iEL	Country	Group	Ranking	Z_iIL	Country	Group
1	0.922	Ireland	I	1	0.612	Belgium	I
2	0.781	Lithuania		2	0.607	Denmark	
3	0.761	Netherlands		3	0.598	Finland	
4	0.697	Slovenia		4	0.590	Ireland	
5	0.638	Belgium	II	5	0.571	Netherlands	
6	0.622	Greece		6	0.543	Luxembourg	
7	0.619	Portugal		7	0.534	Austria	II
8	0.579	France		8	0.517	Sweden	
9	0.573	Luxembourg		9	0.482	Slovenia	
10	0.539	Sweden		10	0.449	France	
11	0.536	Latvia		11	0.411	Germany	
12	0.512	Cyprus		12	0.406	Cyprus	
13	0.501	Poland		13	0.398	Czechia	
14	0.468	Denmark	III	14	0.386	Slovakia	
15	0.462	Austria		15	0.324	Malta	III
16	0.457	Croatia		16	0.298	Poland	
17	0.423	Slovakia		17	0.265	Estonia	
18	0.419	Finland		18	0.262	Hungary	
19	0.398	Estonia		19	0.259	Italy	
20	0.385	Czechia		20	0.224	Croatia	
21	0.334	Malta		21	0.216	Spain	
22	0.281	Spain		22	0.203	Portugal	
23	0.210	Germany	IV	23	0.161	Greece	IV
24	0.164	Bulgaria		24	0.159	Lithuania	
25	0.162	Hungary		25	0.124	Latvia	
26	0.066	Italy		26	0.040	Romania	
27	–0.111	Romania		27	0.040	Bulgaria	

Source: Own preparation based on Eurostat (2023).

Table 5.
Outline of dependent variable Z_iIL regression with independent variable Z_iEL (data for EU-27 countries in 2021)

Dependent variable regression: Z_iIL; r=0.474, r^2=0.224, Corrected r^2=0.193; F(1.25)=7.2317, p<0.0126 standard error of estimation (SEE): 0.161

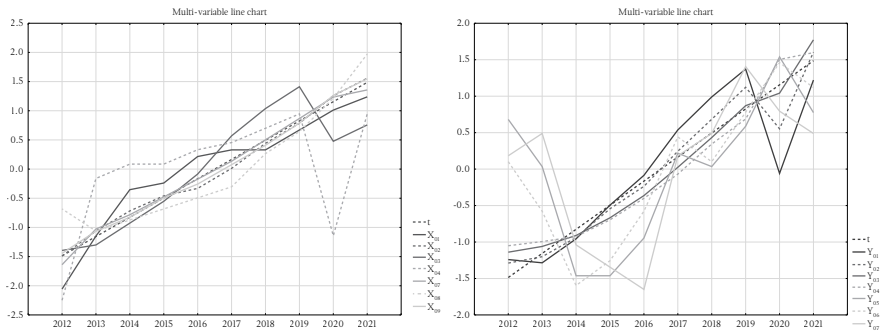
N=27	b*	SEE from b*	b	SEE from b	t(25)	p
constant word	–	–	0.189	0.070	2.683	0.013
Z_iEL	0.474	0.176	0.370	0.138	2.689	0.013

Note:

r — linear correlation coefficient; r^2 — coefficient of determination; F — F statistics; t — Student's t statistics; b — coefficient b for the independent variable; b * — BETA coefficient (standardized b coefficient); p — critical significance level.

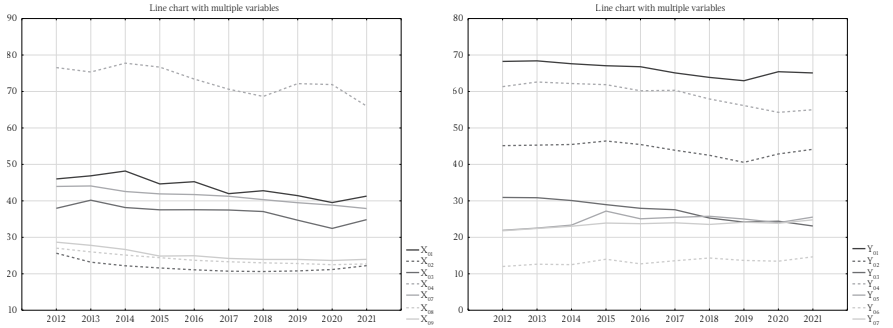
Source: Own preparation based on Eurostat (2023).

Chart 1.
2012–2021 changes in EL-describing independent variables X and IL-describing dependent variables Y (27 objects — EU countries — data transformed into stimulants, and standardized)



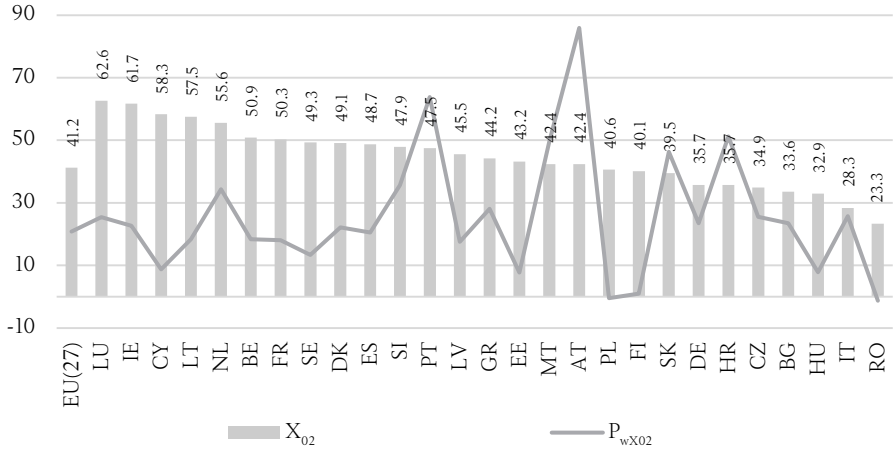
Source: Own preparation based on Eurostat (2023).

Chart 2.
Variation level and changes in EU-country-describing variables X and Y (27 objects in 2012–2021, based on the V_s coefficient of variation (raw data)



Source: Own preparation based on Eurostat (2023).

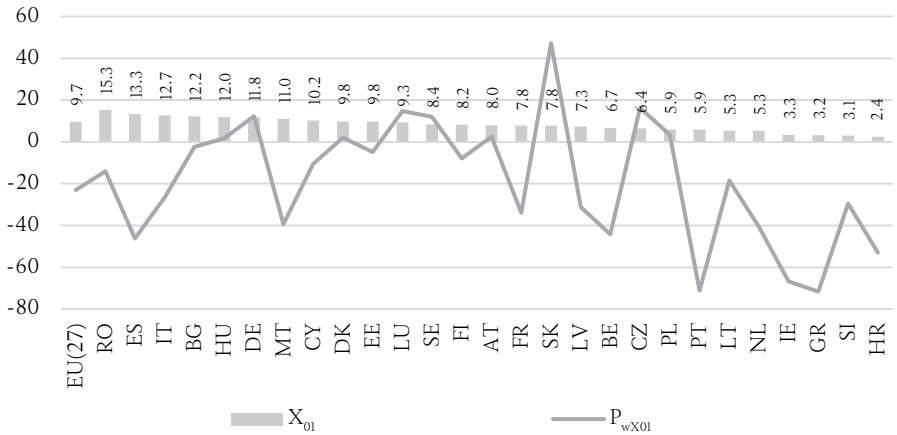
Chart 3.
Ranking of EU-27 percentage of 25–34 y/o tertiary education holders — ISCED levels 5–8 (X_{02}) in 2021 and P_{wX02} relative growth index for 2021 (2012=100)



Note:
EU country names are in Table 2.

Source: Own preparation based on Eurostat (2023).

Chart 4.
Ranking of EU-27 percentage of 18–24 y/o early leavers from education and training (X_{01}) in 2021 and the relative growth index P_{wX01} for 2021 (2012=100)

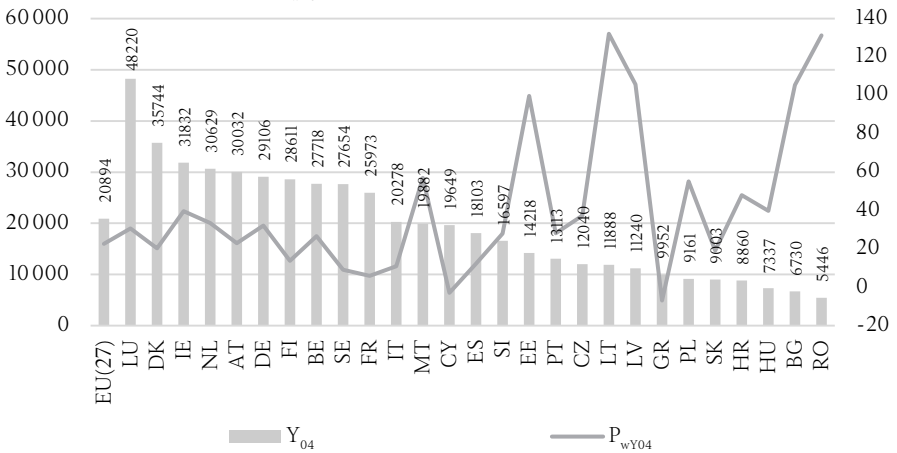


Note:

EU country names are in Table 2.

Source: Own preparation based on Eurostat (2023).

Chart 5.
Ranking of EU-27 countries' 2021 average annual net income per capita in EUR (Y_{04}) and relative growth index P_{wY04} (2012=100)

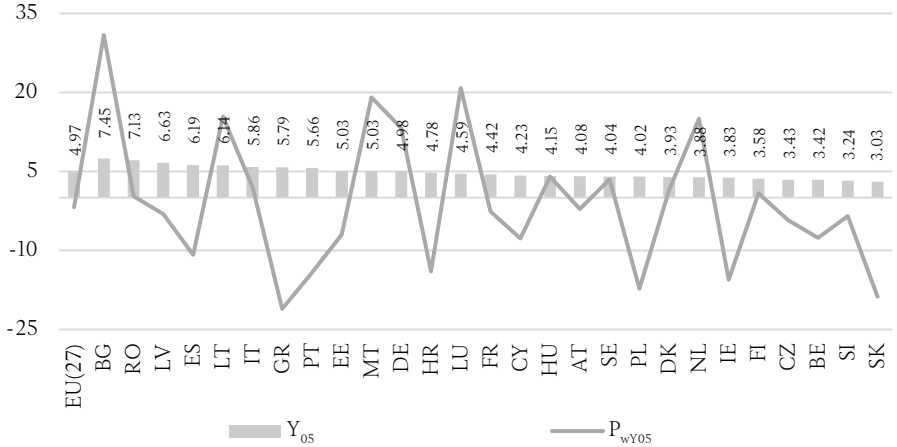


Note:

EU country names are in Table 2.

Source: Own preparation based on Eurostat (2023).

Chart 6.
Ranking of EU-27 income distribution inequality (Y_{05}) in 2021 and relative growth index P_{wY05} for 2021 (2012=100)

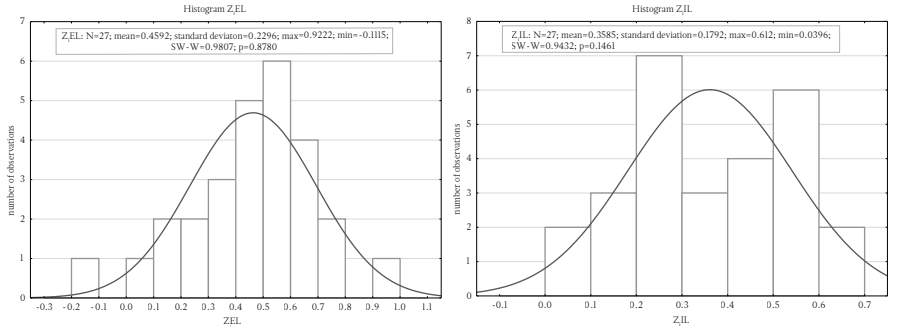


Note:

EU country names are in Table 2.

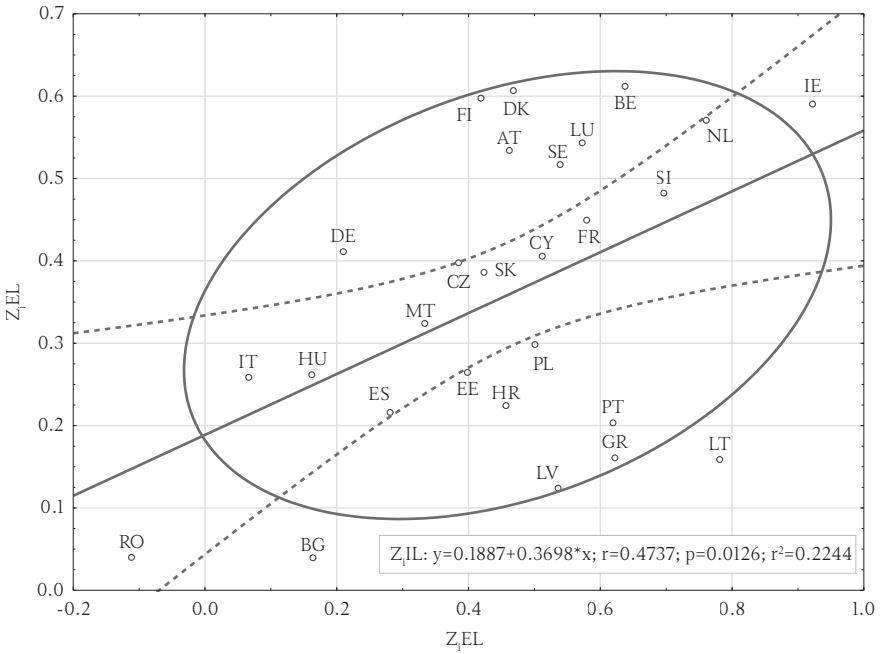
Source: Own preparation based on Eurostat (2023).

Chart 7.
Histograms of synthetic measures of Z_iEL education level and Z_iIL income level



Source: Own preparation based on Eurostat (2023).

Chart 8.
Correlation between the level of education (Z_iEL) and the level of income (Z_iIL) on the example of the EU(27) (data for 2021)



Note:

r — linear correlation coefficient; r^2 — coefficient of determination; EU country names are in Table 2.

Source: Own preparation based on Eurostat (2023).