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## Income and Poverty in Households in Selected European Countries

**Abstract:** Incomes of population and poverty are key elements of the EU cohesion policy which aims at reducing disparities between the levels of development of individual regions. The traditionally appropriate study to evaluate the convergence of the Member States is the European Union Statistics on Income and Living Conditions (EU-SILC). However, this is not the only source of information on income distribution and social inclusion in the European Union. In this article, the basis for calculations are the results of the fourth European Quality of Life Surveys (EQLS), whose purpose is to measure both objective and subjective indicators of the standard of living of citizens and their households.

The aim of the paper is to assess the diversity of distributions of household incomes and the level of income poverty due to the selected socio-demographic characteristics of the respondent or household in selected European countries in two periods: 2007 and 2016. Countries of the Visegrad Group (Poland, the Czech Republic, Slovakia and Hungary) were selected for the analysis, along with the Weimar Triangle (Poland, Germany, and France). Such a selection allowed us to compare the financial situation of households in Western Europe with those in Central and Eastern Europe. Poland becomes a natural link between all these countries.

The article uses modelling methods of income distribution, indicators of distance (overlapping) of distributions and aggregate indicators of the scope, depth and severity of poverty. Those ratios were determined on the basis of the use of relative. In order to ensure comparability of incomes of households with different demographic compositions, the analysis used equivalent incomes.

As a result of the preliminary analysis, differences were noted regarding the measured position, variation and asymmetry of equivalent incomes in the studied households. The applied gap measurements showed a significant disparity between the distributions of income in Western European countries (Germany, France) and the countries of the Visegrad Group, but the size of that differentiation de-

creased significantly in 2016 relative to 2007. Important differentiation was also noted in terms of income poverty risk within the Visegrad Group: the highest proportion of households at risk of poverty exists in Poland and the lowest in the Czech Republic.

**Keywords:** household income, analysis of income distribution, poverty

**JEL:** D31, I132

## 1. Introduction

Research and description of income distribution have more than a century old tradition in theory of economics, although they have remained on the margins of the mainstream for a long time. Strengthening interest in this topic falls on the '70s of the twentieth century. It was caused by, among others, the works of Amartya Sen, as well as the growing stratification of income within countries and between them (Desai, Potter, 2002: 183–187). Knowledge of income distribution and the extent and intensity of poverty is also a necessary element for the implementation of social policy.

The objective of social policy in the most general sense is a good of man. In the course of its development, this discipline prepared a specific catalogue of goals and values which are socially accepted and desirable, as well as tasks leading to their implementation. These goals are variously formulated in different countries and political systems, however, their universally recognised values can be distinguished and they include: social security, investing in human capital and harmonious social life (Wałęga, 2015: 15–17).

The cohesion policy is implemented by means of instruments and social policy entities. One of the priorities of the European Union's cohesion policy is the fight against poverty and all forms of discrimination. Its cohesion policy is implemented through projects financed by the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund. In the European Union, economic and social cohesion is understood as reducing disparities between regions and backwardness of the least favoured regions (Single European Act, 1986). The last EU Treaty, the Treaty of Lisbon, adds another aspect to cohesion, referring to economic, social and territorial cohesion. The EU's cohesion policy includes convergence (aimed at accelerating the development of the least-developed Member States and regions by improving their growth conditions), regional competitiveness and employment, as well as the European territorial cooperation <https://mfiles.pl/pl/index.php/Praca> (<https://ec.europa.eu/>).

Two main approaches to the study of social cohesion can be distinguished in the literature: the sociological approach, focusing on the study of integration and social stability, and the approach which has been adopted, among others, by European institutions and other international institutions that treats social cohesion as a prerequisite for economic well-being (Acket et al., 2011: 3).

The aim of the article is to assess the differentiation of income distributions of households and the level of income poverty due to the selected socio-demographic characteristics of a respondent or a household in selected European countries in two periods: 2007 and 2016. The countries belonging to the Visegrad Group (Poland, the Czech Republic, Slovakia, and Hungary) and the Weimar Triangle countries (Poland, Germany, France) have been analysed. This selection of countries allows for the comparison of the material situation of the population in the countries of Western Europe and Central-Eastern Europe, then Poland becomes a natural link between these countries.

## 2. Methodology and statistical data

Income distribution can be studied empirically or by using theoretical models for this purpose, i.e. density functions. An advantage of the model approach is a relative ease of calculating all the descriptive characteristics of income distribution even in a situation when we only have grouped empirical data about incomes in the form of a frequency distribution with open extreme intervals. In such a situation, it would not be possible (without closing these extreme intervals) to determine the values of descriptive characteristics of the distribution based on the average. The disadvantage of using models, however, is the selection of the appropriate density function adequately to the problem under examination and then the estimation of its parameters. In the age of computational calculation methods, the latter problem can be easily solved.

In this article, the theoretical distribution of Burr III, often known as the Daguma distribution, was adopted as the model of the distribution of equivalent incomes. The density function  $f(y)$  and the cumulative distribution function  $F(y)$  of this distribution may be written as follows:

$$f(y) = \frac{cb \exp(-a) y^{-(b+1)}}{[1 + \exp(-a) y^{-b}]^{c+1}}, \quad (1)$$

$$F(y) = \frac{1}{[1 + \exp(-a) y^{-b}]^c}, \quad (2)$$

where  $a$ ,  $b$ ,  $c$  are parameters which are most often estimated using MLE (Maximum Likelihood Estimation).

The Daguma distribution is recognised in the literature on income research as one of the best income distribution models. The frequency of its use and its usefulness have been confirmed in many works, it is documented in the study (Kleiber, Kotz, 2003: 221–222). Subsequently, the distribution was used in Poland, e.g.: by Jędrzejczak (2009) and Ulman (2015).

Distance measurement, overlapping or, in other words, stratifying distributions is a problem in the study of similarity of structures and tests verifying the hypothesis on the compatibility of the distributions of two communities. A lack of similarity of the income structure in terms of income distribution is related to a large distance between these distributions, and, in consequence, a lack of overlapping distributions and their significant or complete stratification (layer formation). Of the many distance measures (see Ostasiewicz, 2011: 147), the three approaches were selected to measure the differences in income distribution in the examined countries. The first one applies strictly to the measurement of distribution distances, the second and third ones to measuring the overlap or stratification of the distributions.

The distance Bhattacharyya ( $d_b$ ) was proposed by its author in 1943 (Bhattacharyya, 1943) and is based on a comparison of the density function of two distributions according to the following formula:

$$\rho = \int \sqrt{f_1(y) * f_2(y)} dy, \quad (3)$$

$$d_b(f_1, f_2) = -\ln \rho, \quad (4)$$

where  $\rho \in [0, 1]$ , and the distance Bhattacharyya takes values from the interval  $0 \leq d_b \leq \infty$ . The value of zero means the identity of distributions (their overlap), and the higher the value of this distance, the more the tested distributions differ.

The second approach to the study of the diversity of distributions was taken from the problem of criterion decomposition of inequalities in income distributions and in particular the decomposition of the Gini coefficient. Bhattacharyya and Mahalanobis (1967) were the first to present how to decompose inequality measured with the Gini coefficient, calculated on the basis of the Gini average deviation, for the purpose of studying regional variation. The problem, which was not solved, was the appearance of a residual element in the decomposition formula referring to the overlapping situation of distributions which the authors were unable to determine (Mukhopadhaya, 2014: 32–33). Many other authors have been discussing the problem of calculating and decomposing the Gini coefficient. In this study, a criterion of overlapping (stratification) of distributions will be applied according to the concept of decomposition of the Gini coefficient presented in Yitzhaki (1994). It can be presented as follows:

$$O_{ji} = \frac{cov_i[y, F_j(y)]}{cov_i[y, F_i(y)]}, \quad (5)$$

where:  $cov_i$  is the covariance calculated for income from the  $i$  (base) distribution and the  $j$  cumulative distribution function calculated for income from the  $i$  distri-

bution (numerator in formula (5)) or the  $i$  cumulative distribution function calculated for an income also from this distribution (denominator of formula (5)). This criterion has the following properties (Milanovic, Yitzhaki, 2002: 161):

- 1)  $O_{ji}$  belongs to the interval  $[0; 2]$ ,
- 2)  $O_{ji}$  is a growing function of the fraction of units from the  $j$  distribution which are located in the area of the  $i$  distribution,
- 3) for a given fraction of units from the  $j$  distribution, which are located in the area of the  $i$  distribution, the closer to the average from the  $i$  distribution observations belonging to the  $j$  distribution are, the higher the  $O_{ji}$  value,
- 4) the higher the value of the  $O_{ji}$  index, the lower the value of the  $O_{ij}$  index,
- 5)  $O_{ji} = 1$  means identical distributions,
- 6)  $O_{ji} = 2$  means that all units belonging to the  $j$  distribution are concentrated in the average from the  $i$  distribution.

The concept of the last criterion for the similarity of distributions used in this study is based on a comparison of quantile order (cumulative distribution function) of the examined distributions. It can be represented by the following formula (Ulman, 2011: 142–143):

$$O = 1 - \sum_{i=1}^k (G(p_i) + G(p_{i-1})) w_i, \quad (6)$$

where:  $w_i = p_i - p_{i-1}$ ,  $G(p_i)$  is the value of the cumulative distribution function of the studied distribution for the quantiles of the base distribution. This criterion assumes values from the range  $[-1, 1]$ . A negative  $O$  value means the increased distance of the examined distribution in relation to the base distribution towards lower income values, and conversely, the positive value of  $O$  means the shift of the examined distribution in relation to the base distribution towards higher income values.

In the area of poverty analysis in the examined countries, the relative poverty line was marked as 60% of the median of equivalent incomes. This approach is preferred and used by the EU to identify poor individuals (people, households, families) (*Portfolio*, 2015: 10). The use of the poverty line allows for identifying in a zero-one way poor individuals in the examined population. In order to determine the factors affecting the increase of probability that a given person will be included among poor individuals, one of the models for dichotomous variables can be used. The logit model is the most commonly used. The probability of being a poor individual depending on specific factors in the logit model is interpreted as the value of a cumulative distribution presented by the formula:

$$P(Y_i = 1) = \frac{\exp(\alpha_0 + \alpha_1 x_{i1} + \alpha_2 x_{i2} + \dots + \alpha_k x_{ik})}{1 + \exp(\alpha_0 + \alpha_1 x_{i1} + \alpha_2 x_{i2} + \dots + \alpha_k x_{ik})}. \quad (7)$$

The parameters of the above-presented model are most often estimated by using the highest likelihood method, which is maximising the logarithm of the likelihood function relative to model parameters by using iterative numerical procedures. More information on the subject of models for binomial qualitative variables can be found in (Gruszczyński, 2012).

Another approach to studying the impoverishment of society is the use of information about the material deprivation of individuals or their households. The degree of deprivation is most often measured by the number of elements of housing equipment or social services unavailable to respondents in their households, which, on the other hand, are usually available to the majority of people in the EU Member States. The variable of this type takes the form of a discrete variable that most often takes on natural numbers and rather low values starting from zero. The actual models for the explained count variable are the count variable models which include the Poisson regression model and the negative binomial regression model. These models allow us to estimate the probability of occurrence of a certain number of successes, that is, for example, the number of housing equipment unavailable for the respondent. The Poisson regression model has, however, the assumption of equality of the expected value and variance which in practice may not be satisfied. In the case of a higher value of variance than the expected value, in the situation of overdispersion, a negative binomial regression model should be used, as it more accurately reflects the situation of this excessive dispersion (Gruszczyński, 2012: 255–257). We receive it by assuming that the conditional distribution  $y_i$  versus  $x_i$  is the negative binomial distribution with the expected value  $E(y_i|\lambda_i, \alpha) = \lambda_i$  and the variance  $Var(y_i|\lambda_i, \alpha) = \lambda_i + \alpha\lambda_i^2$ , and, assuming that  $\lambda_i = \exp(x_i\beta)$  and  $\alpha = \sigma^2$  or  $\alpha_i = \sigma^2\lambda_i^{-1}$ . It is worth mentioning that in the situation when there is no difference between the expected value and the variance of the count variable, the negative binomial regression model boils down to the Poisson regression model.

The statistical data used for the realisation of the purpose of this article have been taken from the European Quality of Life Survey (EQLS), which contains information about the living conditions and social situation of people, the European citizens. So far, four rounds of this survey have been carried out: in 2003, 2007, 2012 and 2016. The EQLS examines a population of adults (aged 18 or over) who live in private households by using a statistical sample. Depending on the size of the country and national conditions, the sample in 2007 and 2016 ranged from 1,000 to 2,000 people in each country.

### 3. Income distributions and their differentiation

According to the presented methodological description, in order to model the distribution of net equivalent income expressed in Euro according to the purchasing power parity (PPP), the theoretical density function of Dagum distribution was applied. The parameter estimation was made by using MLE (Maximum Likelihood Estimation). In all countries and in both analysed periods, the obtained parameter evaluates were statistically significant, and the correlation coefficients of empirical and theoretical quantiles were at least 0.98, which allowed for the use of that model to describe the evolution of income in the examined countries. Charts 1 and 2 present graphs of the Dagum distribution density function for the Visegrad countries and the Weimar Triangle for the years 2007 and 2016.

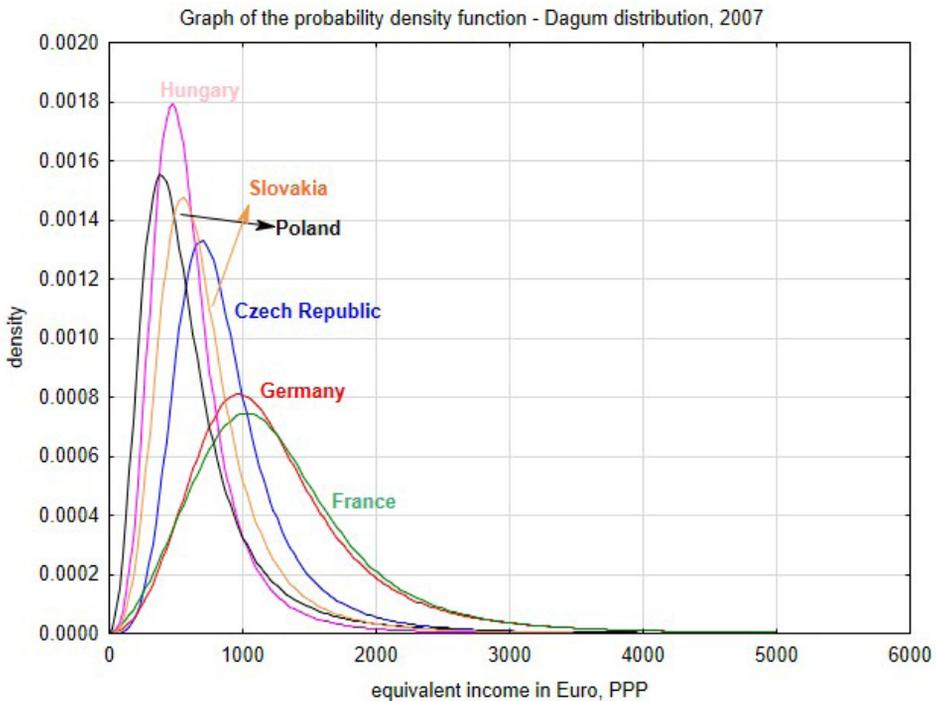


Diagram 1. Diagram of the density function for net equivalent income in Euro (PPP) for the Visegrad Group countries and the Weimar Triangle for 2007

Source: calculations and own elaboration based on data from the EQLS

Comparing charts 1 and 2, one can see that the income distributions in France and Germany are clearly different from those in the Visegrad countries, among which the Czech Republic is characterised by the most shifted distribution towards the countries from Western Europe. In each case, we see that the distributions are

characterised by positive asymmetry, which is a typical feature of the income distribution. In the scope of changes in time, one can notice the shift of these functions towards higher values of equivalent income. More precisely, these properties can be observed by reviewing the descriptive statistics of income distributions in Tables 1 and 2.

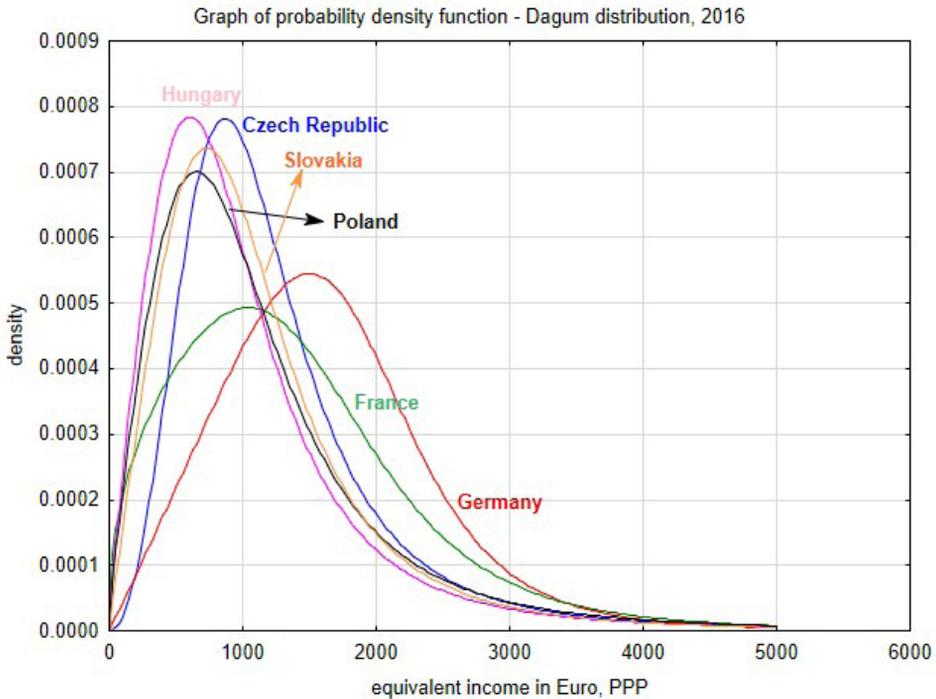


Diagram 2. Diagram of the density function for net equivalent income in Euro (PPP) for the Visegrad Group countries and the Weimar Triangle for 2016

Source: calculations and own elaboration based on data from the EQLS

In 2007, France was characterised by the highest average income and Hungary by the lowest average income (although the middle and most frequently recorded income was the lowest for Poland, which is also reflected in the high level of variability measures for Poland). One can see that due to the average level of equivalent income Poland, Hungary, and Slovakia were clearly distant from Germany and France, while the Czech Republic ranked more or less in the middle between those groups of countries. In 2007, the level of inequality was rather low, especially in comparison with the level of inequality in 2016. In the second period, the values of average measures increased (average, median and mode). This time, Germany followed by France were characterised by the highest average incomes, while the lowest income was observed in Hungary. If we compare the ratio of the

average income of Polish and German respondents, we may notice their visible convergence. In 2007, the ratio was 1.97, while in 2016, it was 1.33. The processes of convergence of income distributions for the examined countries confirm the results of the calculation of distance measures mentioned in the methodological part of the article. Tables 3 and 4 contain the results for the Bhattacharyya distance in the form of a symmetric with respect to the main diagonal matrix.

Table 1. Descriptive statistics of the Euro equivalent income distribution (PPS) in the Visegrad Group countries and the Weimar Triangle – 2007

Descriptive statistic	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Average	906.30	1286.58	1301.69	622.33	654.43	748.27
Median	802.80	1133.33	1169.02	550.05	516.17	652.60
Modal	691.97	972.00	1029.92	473.40	388.22	552.55
Standard deviation	504.60	790.30	767.18	363.64	651.56	466.28
Coefficient of variation	0.56	0.61	0.59	0.58	1.00	0.62
Relative average deviation	0.18	0.20	0.20	0.19	0.26	0.20
Gini coefficient	0.26	0.29	0.29	0.27	0.37	0.28
Asymmetry	0.43	0.40	0.35	0.41	0.41	0.42

Source: own calculations based on data from the EQLS

Table 2. Descriptive statistics of the Euro equivalent income distribution (PPS) in the Visegrad Group countries and the Weimar Triangle – 2016

Characteristic	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Average	1306.19	1639.28	1446.1	1101.65	1235.38	1173.84
Median	1084.84	1556.14	1261.92	851.86	940.39	954.54
Modal	865.59	1501.89	1039.98	604.65	652.47	728.90
Standard deviation	1035.48	834.33	1061.7	1195.61	1426.76	1050.61
Coefficient of variation	0.79	0.51	0.73	1.09	1.15	0.90
Relative average deviation	0.23	0.19	0.26	0.29	0.30	0.26
Gini coefficient	0.33	0.27	0.36	0.41	0.42	0.37
Asymmetry	0.43	0.17	0.38	0.42	0.41	0.42

Source: own calculations based on data from the EQLS

Taking, for example, Germany as a reference country, we can see that in both periods Hungary followed by Poland were characterised by the most distant distribution of equivalent incomes, while the smallest was observed in France and in the Visegrad Group, above all, in the Czech Republic. It is worth noting that

the distance of income distribution of the Polish population is clearly decreasing in relation to the distributions of countries with higher average values, especially Germany and France. These distributions in 2016 are much more similar to each other than in 2007. Similar conclusions can be drawn for Hungary.

Table 3. The Bhattacharyya distance between the distributions of equivalent income for the Visegrad countries and the Weimar Triangle – 2007

Country	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Czech Republic	0	0.071	0.082	0.092	0.116	0.031
Germany	0.071	0	0.011	0.256	0.232	0.149
France	0.082	0.011	0	0.259	0.226	0.155
Hungary	0.092	0.256	0.259	0	0.017	0.017
Poland	0.116	0.232	0.226	0.017	0	0.036
Slovakia	0.031	0.149	0.155	0.017	0.036	0

Source: own calculations based on data from the EQLS

Table 4. The Bhattacharyya distance between the distributions of equivalent income for the Visegrad countries and the Weimar Triangle – 2016

Country	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Czech Republic	0	0.067	0.048	0.051	0.045	0.032
Germany	0.067	0	0.042	0.125	0.101	0.094
France	0.048	0.042	0	0.056	0.045	0.043
Hungary	0.051	0.125	0.056	0	0.025	0.022
Poland	0.045	0.101	0.045	0.025	0	0.024
Slovakia	0.032	0.094	0.043	0.022	0.024	0

Source: own calculations based on data from the EQLS

The application of the next criterion of distribution distances, measures of overlapping distributions  $O$ , confirms the above-presented conclusions in principle. The advantage of this measurement is that it indicates the direction of displacement of distributions – a negative value is a shift of a given distribution from the base distribution towards the lower income values and, alternatively, a positive value indicates a shift towards a higher income. Tables 5 and 6 contain the results of the  $O$  criterion calculation.

In relation to Germany, we can see that each of the other countries, except France in 2007, has the most favourable distribution of equivalent income. On the other hand, in 2007, Poland was characterised by the most shifted distribution towards low incomes in relation to other countries. In 2016, the scale of that shift was substantially reduced and with regard to Hungary, the Polish distribution of income was even located somewhat more on the side of higher incomes. As in the

case of Bhattacharyya distance, one may notice a clear process of convergence of the Visegrad countries' distributions towards the examined countries of Western Europe. The leader of this process among the examined countries is Poland due to the process dynamics.

Table 5. Distribution distance criteria (overlap –  $O$ ) for equivalent income for the Visegrad Group countries and the Weimar Triangle – 2007

Base country	Country tested					
	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Czech Republic	0	0.384	0.395	-0.457	-0.448	-0.259
Germany	-0.384	0	0.023	-0.693	-0.658	-0.560
France	-0.395	-0.023	0	-0.688	-0.655	-0.562
Hungary	0.457	0.693	0.688	0	-0.062	0.205
Poland	0.448	0.658	0.655	0.062	0	0.235
Slovakia	0.259	0.560	0.562	-0.205	-0.235	0

Source: own calculations based on data from the EQLS

Table 6. Distribution distance criteria (overlapping –  $O$ ) for equivalent incomes for the Visegrad Group countries and the Wajmar Triangle – 2016

Basecountry	Country tested					
	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Czech Republic	0	0.316	0.092	-0.223	-0.136	-0.133
Germany	-0.316	0	-0.188	-0.469	-0.391	-0.408
France	-0.092	0.188	0	-0.268	-0.192	-0.197
Hungary	0.223	0.469	0.268	0	0.077	0.089
Poland	0.136	0.391	0.192	-0.077	0	0.008
Slovakia	0.133	0.408	0.197	-0.089	-0.008	0

Source: own calculations based on data from the EQLS

Two subsequent Tables 7 and 8 show the results for the overlap index (stratification) of distribution for the examined countries.

Let us note that the value of the  $O_{ji}$  index equal to one means the exact overlap of income distributions of the compared countries, while a smaller value of this index means that fewer units of the examined country are in the distribution area of the country of reference. This situation occurred in 2007 in the case of Poland and Hungary in relation to other countries, and in particular in relation to Germany and France. The larger index values for these two Western European countries with regard to Poland and Hungary show in the context of the earlier conclusion that more often individuals (persons) from Germany and France are observed in the area of Polish or Hungarian income

distribution than vice versa (Polish or Hungarian people in the area of German or French income distribution). The level of that stratification substantially decreased in 2016, which is an expected result in the context of the conclusions presented in Tables 1–6.

Table 7. Distribution distance criteria (layering –  $O_{ij}$ ) for equivalent incomes for the Visegrad Group countries and the Weimar Triangle – 2007

Base country	Country tested					
	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Czech Republic	1	1.011	0.987	0.666	0.597	0.817
Germany	0.837	1	0.995	0.508	0.483	0.650
France	0.788	0.998	1	0.4762	0.467	0.611
Hungary	1.099	0.933	0.909	1	0.875	1.054
Poland	1.196	1.050	1.029	1.117	1	1.159
Slovakia	1.116	1.044	1.021	0.895	0.794	1

Source: own calculations based on data from the EQLS

Table 8. Distribution distance criteria (layering –  $O_{ij}$ ) for equivalent incomes for the Visegrad Group countries and the Weimar Triangle – 2016

Base country	Country tested					
	Czech Republic	Germany	France	Hungary	Poland	Slovakia
Czech Republic	1	1.139	0.978	0.791	0.840	0.876
Germany	0.830	1	0.835	0.659	0.699	0.730
France	1.003	1.145	1	0.837	0.878	0.905
Hungary	1.179	1.201	1.088	1	1.023	1.072
Poland	1.148	1.163	1.060	0.978	1	1.046
Slovakia	1.109	1.132	1.024	0.927	0.953	1

Source: own calculations based on data from the EQLS

## 4. Poverty and material deprivation in the countries of the Visegrad Group and Weimar Triangle

Poverty analysis was carried out on the basis of the relative poverty line. Table 9 presents the values of aggregate poverty criteria, i.e. Headcount Ratio (HR), Poverty Gap Index (PGI), Income Gap Index (IGI) and Poverty Severity Index (PSI), which describe the range, depth, intensity, and severity of poverty in the examined countries (Wolf, 2009: 99–101).

Table 9. Poverty criteria in the countries of the Visegrad Group and Weimar Triangle in 2007 and 2016

Country	HR	PGI	IGI	PSI
<b>2007</b>				
Czech Republic	0.090	0.197	0.018	0.007
Germany	0.157	0.256	0.040	0.017
France	0.169	0.279	0.047	0.022
Hungary	0.107	0.274	0.029	0.013
Poland	0.175	0.281	0.049	0.021
Slovakia	0.116	0.277	0.032	0.013
<b>2016</b>				
Czech Republic	0.090	0.359	0.032	0.018
Germany	0.168	0.334	0.056	0.032
France	0.177	0.462	0.082	0.055
Hungary	0.148	0.317	0.047	0.033
Poland	0.194	0.320	0.062	0.038
Slovakia	0.130	0.379	0.049	0.031

Source: own calculations based on data from the EQLS

In 2007, the lowest poverty criteria among all surveyed countries were observed in the Czech Republic. Only 9% of Czech households were at risk of poverty and the average equivalent income of households experiencing poverty was 20% below the poverty line. The Income Gap Index was also the lowest, which is a criterion of the cost of poverty eradication. The highest values of all aggregate poverty criteria were observed in Poland. In 2007, the problem of poverty applies to 17% of Polish households, and their average equivalent income was lower by almost 30% from the poverty line.

In 2016, there was observed an increase in the poverty range in all the examined countries compared to 2007, the lowest increase concerned the Czech Republic (0.02 percentage point) and the largest increase was recorded in Hungary (4.11 percentage point). In Poland, there was an increase in households at risk of poverty by less than 2 percentage points, while the problem of poverty continued to affect the greater part of households than in the other examined countries. However, in terms of depth, intensity, and severity of the poverty indicator values, they were the highest in France. The direction of these changes should be related to the intensification of migration movements in Europe during the considered period.

Identification of factors affecting the risk of household poverty was carried out by using econometric modeling. Regarding the fact that the explained variable – the risk of poverty – is dichotomous:  $Y = 1$  (identifies households at risk of poverty) or  $Y = 0$  (households at no risk of poverty) a logit model was used. As explanatory variables, the features which characterise the household and the respondent were assumed:

- 1) the class of place of residence (3 zero-one variables, the reference group – households located in the countryside),
- 2) the respondent's age,
- 3) the number of children in the household,
- 4) the respondent's education (3 zero-one variables, the reference group – at most the basic vocational education),
- 5) the socio-economic group of households (3 zero-one variables, the reference group – households of employees and entrepreneurs),
- 6) the respondent's health (2 zero-one variables, the reference group – persons with good health).

Tables 10 presents the parameter estimates in the logit model for the years 2007 and 2016 in France. In 2007, in all the examined countries, except France, unemployment was the variable which significantly<sup>1</sup> contributed to the increase in the risk of poverty. However, the variable which significantly reduced the risk of poverty in all the analysed countries, except for the Czech Republic, was possession of higher education than basic education. Other variables which significantly increase the risk of poverty include the number of children (in the Czech Republic, France, Hungary, and Poland), staying in retirement (in the case of German households) and bad health (in Poland). In Germany, the factor limiting the likelihood of poverty risk was age and in Poland living in a big city.

Table 10. Estimation of the logit model parameters of household poverty in France

Specification	Parameter	Std. error	t statistic	p value	Parameter	Std. error	t statistic	p value
Constant	0.82	0.48	1.70	0.09	2.33	0.60	3.90	0.00
Small cities	-0.22	0.27	-0.80	0.42	-1.08	0.29	-3.66	0.00
Big cities	-0.10	0.34	-0.30	0.77	-1.51	0.28	-5.44	0.00
Age	0.00	0.01	0.35	0.73	0.00	0.01	0.22	0.83
Number of children	-0.24	0.10	-2.42	0.02	-0.47	0.10	-4.46	0.00
Secondary education	0.98	0.23	4.18	0.00	0.42	0.28	1.50	0.13
Higher education	2.23	0.33	6.82	0.00	1.08	0.28	3.93	0.00
Retirees	0.42	0.34	1.24	0.22	-1.04	0.37	-2.82	0.00
Unemployed	-0.64	0.36	-1.77	0.08	0.50	0.49	1.02	0.31
Bad health	-0.22	0.41	-0.54	0.59	-0.81	0.59	-1.36	0.17
Assessment of the model	McFadden $R^2 = 0.0909$ Chi <sup>2</sup> (9) = 69.89, $df = 9$ , $p = 0.0000$				McFadden $R^2 = 0.15489$ Chi <sup>2</sup> (9) = 95.54, $df = 9$ , $p = 0.0000$			

Source: own calculations based on data from the EQLS

1 A significance level of 0.05 was assumed.

In 2016, also for all the examined countries except France, the variable which was significantly increasing the risk of poverty was unemployment. Whereas education was the variable which was significantly reducing the risk of poverty in all the analysed countries except the Czech Republic, while in Germany, Hungary, and Slovakia secondary education was sufficient, and in France and Poland – higher education.

In the Czech Republic, in 2016, there were two new factors which significantly increased the risk of poverty i.e. age and being retired. However, the number of children lost its importance. In Germany, there were two new statistically significant factors that increased the likelihood of household poverty i.e. the number of children and bad health. A very interesting phenomenon was observed in France – the residence of a household in a small or a big city joined the list of variables significantly increasing the probability of poverty risk, this may be related to the mass influx of immigrants who settled mainly in big cities. Also, retirement is a factor that increases the likelihood of poverty. In the case of Hungary, living in a large city is a factor limiting the risk of poverty. In Poland, the importance of having secondary education (as a factor limiting the probability of poverty) became less important as well as the number of children (as a factor increasing the risk of poverty), which may be related to the introduction in 2016 of the parental benefit for the second and each subsequent child in the family. However, in Slovakia, there were two new factors that increased the risk of poverty – the number of children and poor health.

The last element of the research is the analysis of determinants of material deprivation of households. Due to the fact that the variable “deprivation index” had a count character, the negative binomial regression model was used to isolate the factors that influence its occurrence. The same set of variables was adopted as in the logit regression model. Table 11 contains the estimates of parameters of this model for Poland.

In 2007, unemployment and the number of children were factors which were significantly increasing the probability of material deprivation of households in all the examined countries. Also, the variable of bad health turned out to have a significant impact on the threat of deprivation in Germany, Hungary, Poland, and Slovakia. In all the examined countries, except the Czech Republic, secondary and university education was a factor reducing the risk of material deprivation. In the Czech Republic, the factor increasing the threat of deprivation was retirement. In Hungary, the factor limiting the probability of deprivation was living in a small or big city. In Poland, the households living in small towns were less exposed to deprivation, which can be combined with low living costs in a small city. The age variable turned out to be a factor limiting the probability of deprivation in Germany and France and it was favourable for deprivation in Poland and Slovakia.

Table 11. Estimation of the parameters of the negative binomial regression model for material deprivation of households in Poland in 2007 and 2016

Specification	Parameter	Std. error	t statistic	p value	Parameter	Std. error	t statistic	p value
	2007				2016			
Constant	0.27	0.14	2.01	0.05	-0.08	0.20	-0.39	0.70
Small cities	-0.14	0.07	-2.01	0.05	-0.03	0.10	-0.29	0.78
Big cities	-0.13	0.07	-1.74	0.08	0.15	0.10	1.51	0.13
Age	0.01	0.00	3.88	0.00	0.01	0.00	3.43	0.00
Number of children	0.12	0.02	4.94	0.00	-0.01	0.06	-0.14	0.89
Secondary education	-0.32	0.07	-4.86	0.00	-0.30	0.10	-2.99	0.00
Higher education	-1.14	0.13	-8.85	0.00	-0.96	0.17	-5.70	0.00
Retirees	-0.09	0.09	-1.03	0.30	0.07	0.12	0.55	0.58
Unemployed	0.52	0.08	6.43	0.00	0.73	0.13	5.62	0.00
Bad health	0.58	0.07	8.37	0.00	0.57	0.10	5.54	0.00
Alpha	0.75	0.09	8.46	0.00	1.02	0.13	7.66	0.00
Log likelihood = -2095.41					Log likelihood = -1269.21			
Akaike information criterion 4212.82					Akaike information criterion 2560.80			

Source: own calculations based on data from the EQLS

In 2016, the risk factors of material deprivation for all the examined countries included bad health and unemployment (the exception is Hungary). University education constituted a factor limiting the probability of deprivation in all the countries of the Weimar Triangle and the Visegrad Group. Secondary education significantly reduced the probability of deprivation in France, Hungary, Poland, and Slovakia. Living in a large house city reduced the threat of deprivation in Germany and Hungary, and in small cities – in Germany and France. Staying in retirement is a factor that increases the likelihood of deprivation in the Czech Republic and Slovakia. The same factor works the other way (i.e. it reduces the likelihood of deprivation) in France.

## 5. Conclusions

The conducted research on the development of equivalent income distributions in the countries of the Visegrad Group and the Weimar Triangle indicates that the convergence process is visible in this area of socio-economic life. In the analysed period of 9 years, the distribution of income substantially converges in all the countries of the Visegrad group to the income distribution of the population of France and Germany. In particular, Poland has become a leader in the dynamics of this

convergence. The income gap, whose idea manifests itself in the comparison of the average income of these communities, is a simple and often applied form of analysis in the study of variation between income distributions of two communities (countries). The criteria which have been used in the article, although more complex computationally, allowed for examining the similarity (distance) of distributions in a more comprehensive way, taking into account the whole income distribution and not just one of its characteristics.

On the other hand, the increase in the value of poverty scale and poverty intensity indicators were observed within the examined countries. Income of people earning relatively little grew slower during the analysed period than the income of people who were earning well or very well, which caused an increase in income inequality. The increase in prosperity in the examined societies is reflected in the decrease in the number of households for whom it is hard to make ends meet.

Analysis of income distribution does not exhaust the problem of research on the socio-economic convergence of countries, as it is only one of its elements. It seems that the level and diversity of income are key factors shaping the living conditions of the population. Therefore, they should be taken into account in measuring and assessing the processes of converging economies and societies of Central and Eastern European countries to those of Western Europe. The authors hope that the presented results have shed a new light on these processes in terms of their measurement and formation.

## References

- Acket S., Borsenberger M., Dickes P., Sarracino F. (2011), *Measuring and validating social cohesion: A bottom-up approach*, International Conference on Social Cohesion and Development, OECD, Development Center, Paris.
- Bhattacharyya A. (1943), *On a measure of divergence between two statistical populations defined by their probability distribution*, "Bulletin of the Calcutta Mathematical Society", no. 35, pp. 99–110,
- Bhattachaya N., Mahalanobis B. (1967), *Regional Disparities in Household Consumption in India*, "Journal of American Statistical Association", no. 62(317), pp. 143–161, <http://dx.doi.org/10.1080/01621459.1967.10482896>.
- Desai V., Potter R.B. (2002), *The Companion to Development Studies*, Oxford University Press, New York.
- Gruszczyński M. (2012), *Mikroekonometria. Modele i metody analizy danych indywidualnych*, Oficyna Wydawnicza Wolters Kluwer, Warszawa.  
<https://ec.europa.eu/> [accessed: 13.12.2018].
- Jędrzejczak A. (2009), *Comparing Income Distributions – Methods and their Application to Wage Distributions in Poland*, "Acta Universitatis Lodzianensis. Folia Oeconomica", no. 225, pp. 271–282.
- Kleiber C., Kotz S. (2003) *Statistical Size Distribution in Economics and Actuarial Sciences*, Wiley-Interscience, New Jersey.

- Milanovic B., Yitzhaki S. (2002), *Decomposing World Income Distribution: Does the World Have a Middle Class?*, "Review of Income and Wealth", no. 48(2), pp. 155–178.
- Mukhopadhyaya P. (2014), *Income Inequality in Singapore*, Routledge, Taylor & Francis Group, London–New York.
- Ostasiewicz W. (2011), *Badania statystyczne*, Oficyna Wolters Kluwer business, Warszawa.
- Portfolio of EU Social Indicators for the Monitoring of Progress Towards the EU Objectives for Social Protection and Social Inclusion* (2015), Publications Office of the European Union, Luxembourg, <http://dx.doi.org/10.2767/929097>.
- Single European Act (1986), Official Journal of the European Communities, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:11986U/TXT&from=EN> [accessed: 13.12.2018].
- Ulman P. (2011), *Wynagrodzenia kobiet i mężczyzn w Polsce i ich zróżnicowanie*, "Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie. Metody Analizy Danych", no. 876, pp. 133–148.
- Ulman P. (2015), *Income of household members in Poland*, "Folia Oeconomica Cracoviensia", vol. LVI, pp. 23–34.
- Wałęga A. (2015), *Spójność ekonomiczna gospodarstw domowych w Polsce. Analiza statystyczna*, Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Kraków.
- Wolf E. N. (2009), *Poverty and Income Distribution*, Wiley-Blackwell, Malden–Chichester.
- Yitzhaki S. (1994), *Economic Distance and Overlapping of Distributions*, "Journal of Econometrics", no. 61, pp. 147–159.

## Dochody i ubóstwo gospodarstw domowych w wybranych krajach europejskich

**Streszczenie:** Dochody ludności oraz ubóstwo stanowią kluczowe elementy polityki spójności Unii Europejskiej, której celem jest zmniejszenie dysproporcji w poziomach rozwoju poszczególnych regionów. Badaniem tradycyjnie stosowanym do oceny konwergencji państw członkowskich jest Europejskie badanie warunków życia ludności (EU-SILC). Nie jest to jednak jedyne źródło informacji na temat dystrybucji dochodów i integracji społecznej w Unii Europejskiej. W niniejszym artykule podstawę obliczeń stanowią wyniki czwartego Europejskiego badania jakości życia, którego celem jest pomiar zarówno obiektywnych, jak i subiektywnych wskaźników poziomu życia obywateli i ich gospodarstw domowych.

Celem artykułu jest ocena zróżnicowania rozkładów dochodów gospodarstw domowych oraz poziomu ubóstwa dochodowego ze względu na wybrane cechy społeczno-demograficzne respondentów lub gospodarstwa domowego w krajach europejskich. Do analizy wybrano państwa należące do Grupy Wyszehradzkiej (Polska, Czechy, Słowacja i Węgry) oraz państwa Trójkąta Wajmarskiego (Polska, Niemcy, Francja). Taki dobór krajów pozwala na porównanie sytuacji materialnej gospodarstw domowych w krajach Europy Zachodniej oraz Środkowo-Wschodniej, a Polska staje się naturalnym łącznikiem między nimi.

W artykule zastosowano metody modelowania rozkładu dochodów, mierniki odległości (nakładania się) rozkładów oraz agregatowe wskaźniki zakresu, głębokości i dotkliwości ubóstwa. Wskaźniki te wyznaczono na bazie zastosowania względnej linii ubóstwa. W celu zapewnienia porównywalności dochodów gospodarstw domowych o różnym składzie demograficznym w analizie zastosowano dochody ekwiwalentne.

Wstępne wyniki badań wskazują na zróżnicowanie w zakresie miar położenia, zmienności oraz asymetrii dochodów ekwiwalentnych w badanych gospodarstwach domowych. Zastosowane miary odległości wykazały znaczny dystans między rozkładami dochodów krajów Europy Zachodniej (Niem-

cy, Francja) a krajami Grupy Wyszehradzkiej, jednak wielkość tej różnicy znacznie spadła w 2016 roku w stosunku do 2007 roku. Ważne zróżnicowanie odnotowano także dla ryzyka ubóstwa dochodowego w ramach Grupy Wyszehradzkiej: najwyższy odsetek gospodarstw zagrożonych ubóstwem występuje w Polsce, a najniższy w Republice Czeskiej.

**Słowa kluczowe:** dochody gospodarstw domowych, analiza rozkładu dochodów, ubóstwo

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