MONETARY POVERTY IN POLAND – A FUZZY APPROACH

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Abstract: Poverty is still a current social issue in Poland and other countries. Due to the lack of one universally accepted definition of poverty, there are many ways to identify and measure poverty. In addition to the classic approach to identifying poor units, a fuzzy approach is also used. The aim of the article is to analyze the problem of monetary poverty in Poland in the IFR (Integrated, Fuzzy and Relative) approach using data from the Household Budget Survey, in which the risk of poverty is assessed on the basis of the cumulative distribution function of the income or expenditure and the value of Lorenz's function. In the article, these two functions were determined on the basis of one of the theoretical distributions (the Dagum distribution). This approach allowed for the estimation of the parameters of the conditional theoretical distribution due to the characteristics of households. This provided the opportunity to determine the factors determining the risk of poverty in Poland.

Keywords: poverty, households income, fuzzy approach.

1. Introduction

The problem of poverty is discussed in the broadly understood social space as well as in scientific literature. This is due to the fact that poverty in its perception, understanding and research cannot be limited only to the individual perception of deprivation by members of society. It is also a social problem that affects society as a whole – not only those who are deprived, but also those who can hardly be called economically poor.

Social problems can be defined as those phenomena which "evoke a certain resonance in the consciousness of people of a given society or community" (Sztumski, 1977, p. 215), due to the fact that they are

undesirable and harmful both in an individual and social dimension. According to the concept by Horton and Leslie (1970), a social problem:

a) is a phenomenon that is undesirable and socially troublesome,

b) affects a significant part of society,

c) seems to be possible to overcome,

d) is possible to overcome through collective actions – not only the activity of experts on given problems is necessary, but also massive social support (see Kaźmierczak-Kałuża, 2012, p. 148).

The above concept of a social problem combines two perspectives of its perception: objectivist and subjective. In this first approach, the assessment of the existence and intensity of the problem is made by people who should exclude their subjective views on the problem. The second way of perceiving a social problem is to assume its existence when it is recognized and defined in the broadly understood social space. This approach takes into account the subjective perception of individual members of society about the existence and scale of the problem (cf. Kaźmierczak-Kałuża, 2012, p. 148).

Undoubtedly the problem of poverty in Poland and in every other country of the world is a social problem. It is an undesirable and troublesome phenomenon, both from an individual and social perspective. It touches a large part of society, namely those who are directly affected by poverty and those who do not experience poverty directly and express solidarity with those who are affected by it. Naturally, poverty is a problem that, at least in theory, can be overcome both through the actions of individuals and through appropriate social policy programs, which in this case can enjoy massive social support.

Therefore taking into account the above considerations, it can be concluded that poverty is an important and still current research issue. This topicality results mainly from the fact that the problem of poverty is constantly present in the societies of all countries, regardless of their socio-economic development. The changing reality either reduces or increases the scope, intensity and nature of poverty.

The aim of the article is to present and analyse the problem of poverty in Poland. Obviously, poverty is such a broad research issue that it is impossible to present its problems in depth in a short article, therefore it was decided to identify and analyse poverty in monetary terms using the IFR (Integrated, Fuzzy and Relative) approach and based on theoretical models of income distribution. The statistical data for individual households come from the Household Budget Survey conducted in Poland in 2018.

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2. Poverty – dilemmas of measurement

Poverty, like other social problems, does not have a clear definition. This is a significant inconvenience as adopting a specific definition of poverty and the way it is understood is essential for the identification of poor individuals, and thus for the measurement and analysis of poverty (Carbonaro, 1992, p. 18). Poverty can be associated with the lack of satisfaction of certain needs at the desired level (Drewnowski, 1978, p. 263). This obvious observation leads to a simple and universally accepted definition of poverty, which unfortunately is of little use without specifying the type, scope and level of satisfaction of needs. Due to the fact that there is no universally accepted list of these needs – both in the time and space perspective – and a consensus as to the degree of their satisfaction, it is difficult to provide a universally accepted definition of poverty.

Initially the list of needs taken into account in research on poverty was limited to the basic needs of a human being, i.e. food, housing and clothing. Due to the fact that meeting any need is associated with having an appropriate level of income, a monetary approach was adopted to identify poor individuals by determining the minimum income that an individual should have to meet a certain level of basic needs. Establishing a monetary criterion for identifying the poor has become commonplace and is still the most frequently used approach, especially when identifying who is poor and who is not is associated with acquiring social welfare rights.

With the passage of time researchers began to notice that in order to live with dignity, people as social beings need to satisfy their existential n, as well as cultural and social needs. This was expressed in the definition of poverty included in the Council of the European Communities of 19 December 1984, which says that "'the poor' shall be taken to mean persons, families and groups of persons whose resources (material, cultural and social) are so limited as to exclude them from the minimum acceptable way of life in the Member States in which they live.[1]" (Council for the European Communities, 1985).

Along with expanding the range of needs that a person should satisfy so that the standard of his/her life would not fall below the acceptable minimum, poverty was perceived not only as a lack of adequate funds, but as the inability to fulfill the vital functions necessary to lead a valuable life. This concept was most fully expressed in the works of Sen (dated 1985, 1997, 2000). According to Sen, poverty does not only result from the lack of basic goods, but above all from the asymmetric distribution

[1] A similar definition of poverty is contained in Decision No. 75/458/EEC (July 22, 1975), but it does not explicitly mention cultural and social resources.

of rights and the inability to transform a set of resources into the desired ways of functioning resulting from social and personal conditions, the ways of functioning necessary to lead a valuable life. (Sen, 1997, p. 209) The disadvantage of this approach is the difficulty in measuring the abovementioned possibilities of transforming the available goods into the ways of functioning of an individual, leading to a lifestyle corresponding to that person. In general, introducing the understanding of poverty beyond its material dimensions raises serious problems in determining how to identify poverty in a given society. For this reason, in many scientific studies and publications of national and international institutions, the monetary approach to the identification of poor individuals, both in absolute and relative terms, is most often used.

Hence, poverty can be understood in an absolute as well as a relative way. The main difference lies in how the poverty line is established. Under the absolute approach, the poverty line is a fixed cut-off point applied to all potential resource distributions. Basically, it is not related to the current statistical data carrying information about these resources, so the change in the standard of living in a given society, reflected in changes in the level of resources, has a significant impact on the characteristics of poverty, which could be seen in Poland in relation to the so-called statutory poverty line. On the other hand, in the relative approach, current data on resources (income, expenditure or wealth in general) are used to determine the poverty line, assuming its level as a specific share of a selected quantile of distribution (Foster, 1998, pp. 336-337). The relative approach is used by Eurostat as well as by Statistics Poland. Criticism of this approach is related to the fact that the poverty line is changing both in time and space, which causes difficulties in the assessment of the effectiveness of social policy programs, and positive changes in poverty may result not so much from an increase in the level of satisfaction of needs, but from a decrease in inequalities of this level in the studied society (Panek, 2011, p. 19).

Both in absolute and relative terms, poverty can be measured objectively or subjectively. In the first case, the level of meeting the needs of the surveyed units is assessed regardless of their preferences in this regard. The second approach assumes that the level of meeting the needs is assessed by the surveyed entities. One of the best-known methods of subjective poverty measurement is that related to the so-called Leyden method of subjective measurement of welfare (income utility) using the Income Evaluation Question (Van Praag, 1971). By associating poverty with a low level of welfare (utility), it is possible to define a poverty line based on subjective assessments of the utility of income. Another popular approach in identifying poverty from a subjective perspective is to answer the query about the level of monthly income that can make ends meet (Goedhart, Halberstadt, Kapteyn, and Van Praag, 1977).

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As already mentioned, poverty can be studied in a one-dimensional perspective on the basis of income or expenditure data (monetary approach) or in a multi-dimensional perspective using non-monetary factors. In both approaches, it becomes necessary to define the rule of identifying who is poor and who is not. In the one-dimensional monetary approach, this is done using the so-called poverty line; in the multidimensional approach the procedure is more complicated. An alternative way to identify poor individuals is to use the fuzzy set theory approach. The main difference in relation to the classic approach to the identification of poverty (based on the poverty line) lies in the fact that basically the population of the surveyed individuals is not divided into the poor and the non-poor, but the so-called function of belonging to the sphere of poverty indicating the degree of risk of poverty for a given individual is determined.

In this study, a fuzzy one-dimensional monetary approach was used to assess poverty.

3. Statistical data and research method

In order to analyze poverty in monetary terms using the IRF (Integrated, Relative and Fuzzy) approach, data from the Household Budget Survey from 2018 were used. This survey is one of the oldest surveys conducted by Statistics Poland, providing a wide range of data on income in general, expenses, economic activity and living conditions of the population. The survey is continuous, based on a representative annual sample of approximately 37,000 households and approximately 100,000 members of these households. With individual data on the income and characteristics of the households, it is possible to conduct a study of the income situation of the population in Poland, including an analysis of the level of poverty and its differentiation due to selected characteristics of the surveyed population. Thus the set of the analysed data included 36,166 individual household observations.

A fuzzy approach to the study of poverty and other social problems is associated with the work of Cerioli, Zani (1990), Cheli, Lemmi (1995), Betti and Verma (2008), Chiappero Martinetti (1994), Silber (2011) and Betti et al. (2015). In Poland this approach was used by Panek (2010), Dudek and Landmasser (2011) and Ulman and Wałęga (2014). In most of these works the fuzzy approach was used in the multidimensional approach, although the monetary dimension, according to Betti and Verma (2008), is important for the identification of poverty and should be given a correspondingly greater importance.

The fuzzy approach basically ignores the dichotomous division of individuals into poor and non-poor. Using the function of belonging

to the poverty sphere taking values from the range [0; 1] one obtains information about the risk of poverty of a γgiven individual (person, household). It should be emphasized that the assessment of the risk of poverty is performed in a relative approach, i.e. in relation to other units of the surveyed population. Finally, the risk of poverty in monetary terms was assessed using the IRF approach according to the formula (Betti and Verma, 2008):

$$\lambda_i(y^e) = \left(1 - F_i^{MI}\right)^{\alpha-1}\left(1 - L_i^{MI}\right), \;\; i = 1, 2, \ldots, n \tag{1}$$

wherein:

$$(1 - F_i^{MI})^{\alpha} = \left(\frac{\sum_{\gamma=i+1}^{n} w_\gamma}{\sum_{\gamma=2}^{n} w_y}\right)^{\alpha}; \;\; (1 - L_i^{MI})^{\alpha} = \left(\frac{\sum_{\gamma=i+1}^{n} w_\gamma y_\gamma^e}{\sum_{\gamma=2}^{n} w_y y_\gamma^e}\right)^{\alpha},$$

where: F_i^{MI} is the value of cumulative distribution function calculated on the basis of the equivalent income for the *i*-th household; L_i^{MI} – the value of the Lorenz function for the distribution of equivalent income $L(F(y_i^e)$ calculated for the *i*-th household; w_γ, y_γ^e are respectively, the weight and the equivalent income of a household with a rank γ in the ascending order of equivalent income, α – parameter.

The aggregation of the function (1) leads to the formula for the Fuzzy Monetary Incidence (FMI) indicator:

$$FMI = \frac{\sum_{i=1}^{n} \lambda_i(y^e) w_i}{\sum_{i=1}^{n} w_i}, \tag{2}$$

where w_i is the weight of the *i*-th household.

The previously mentioned parameter α can be set at such a level that the FMI equals the poverty rate calculated on the basis of the classical approach. Equivalent income is determined on the basis of the OECD equivalence scale.

The cumulative distribution and the Lorenz function in formula (1) were determined on the basis of the theoretical Dagum distribution[2]. The cumulative distribution function can be written as:

$$F(y) = (1 + \exp(-a)\, y^{-b})^{c}, \tag{3}$$

where: *a*, *b*, *c* are ML estimated parameters. The Lorenz function:

$$L(p) = I_x\left(c + \frac{1}{b},\, 1 - \frac{1}{b}\right), \tag{4}$$

where I_x is an incomplete Beta function computed at $x = [F(y)]^{\bar{c}}$.

[2] A wide range of theoretical income distributions can be found in (Kleiber and Kotz, 2003). The Dagum distribution is one of the most widely used income distribution models.

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These parameters can be made functions of the household characteristics and thus one obtains conditional distributions due to these characteristics.

4. Poverty risk in Poland – results of analyses

First, the parameters of the Dagum distribution were estimated for equivalent income for all households. All these parameters were statistically significantly different from zero. In order to check the level of fit of the model to empirical data, the values of two measures were determined: A1 and W. The former is based on the mean absolute difference between the empirical and theoretical frequencies and its value was 0.0526. The latter is the sum of the minimum values determined for the empirical and theoretical frequencies calculated for each income class, the value of which is 0.9737. Both of these measures indicate a high level of matching the distribution to the data. The Dagum distribution density function is shown in Figure 1.

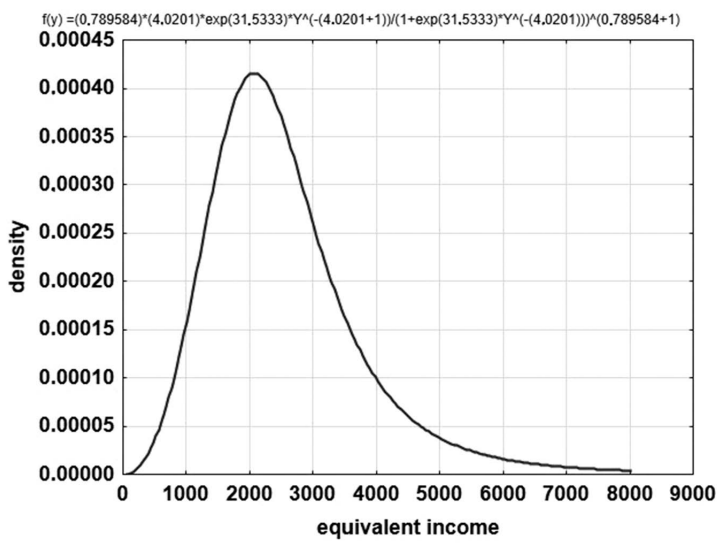

Fig. 1. The Dagum distribution density function for equivalent income in Poland in 2018

Source: own study.

As could be expected, the distribution of equivalent income is clearly positively skewed. In turn the function of belonging to the poverty sphere (Figure 2) is decreasing in terms of income. In the range of equivalent income from 0 to approximately PLN 1,000, the risk of poverty is very high, next one can observe a dynamic decrease in the risk of poverty in range of income to PLN 3,000. For higher equivalent incomes, the risk of poverty function flattens out at a low level. The following tables (1 to 3) present the

mean values (FMI) of the function of belonging to the poverty sphere in terms of selected socio-economic features of the surveyed households. In these calculations, it was assumed that parameter α (in formula 1) is equal to 2. In other words, the FMI results were not calibrated to reflect the value of the poverty rate obtained in the classical way.

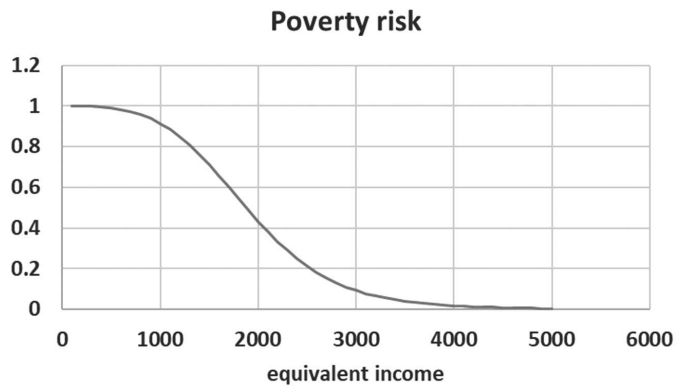

Fig. 2. The function of belonging to the sphere of poverty in terms of the equivalent income

Source: own study.

Table 1. FMI values by socio-economic group of households and the class of the place of residence

Specification	FMI	Specification	FMI
Socio-economic group		Class of the place of residence	
Household of employees	31.73	Town >500 thous.	25.61
Farmers	46.75	200-499 thous.	31.80
self-employed	24.63	100-199 thous.	35.02
retired	48.06	20-99 thous.	38.97
pensioners	66.99	<20 thous.	42.21
living on unearned income	68.53	Country	47.54
Total	40.35	Total	40.35

Source: own study.

Table 2. FMI values according to the biological type of the household

Specification	FMI	Specification	FMI
1	2	3	4
Biological type of the household			
Married couple without children	33.53	Married couple with children and others	43.43

1	2	3	4
with 1 child	30.15	Mother with children and others	50.78
with 2 children	33.09	Father with children and others	46.67
with 3 children	38.00	Other people with children	49.96
with 4 children and more	46.65	Single-person household	52.42
Mother with children	48.45	Others	40.44
Father with children	39.60	Total	40.35

Source: own study.

Table 3. FMI values by age and education of the household head

Specification	FMI	Specification	FMI
Age		Education level	
24 and less	42.02	basic education at best	66.12
25–34	30.73	basic vocational	48.02
35–44	33.44	secondary	38.40
45–54	36.26	higher	19.38
55– 64	42.97	x	X
64 and more	49.25	Total	40.35

Source: own study.

The obtained results indicate which social groups in relation to others are more at risk of poverty and which are less. Thus households living primarily on a disability pension, as well as those living on unearned income are at the highest risk of poverty. It is worth noting that the households living on disability pension and the retired clearly differ in the scale of the aforementioned risk. The lowest degree of poverty risk concerns households that derive income mainly from work, i.e. self-employed and employed. In the case of the breakdown of the researched households according to the size of the place of residence, it can be observed that the risk of poverty increases in line with the size of the place. However, in this case it is worth emphasizing that in order to present a full picture of the possibility of satisfying the needs, one should take into account the territorial differentiation of the price level. Large cities usually have higher incomes for their inhabitants, but also higher costs of living. Taking this differentiation into account would probably reduce somewhat the variation in the risk of poverty, while taking into account the biological type of the household, it is easy to indicate that the lowest risk of poverty concerns households of married couples with one dependent child. The increase in the number of children increases the risk of poverty. However, poverty

most frequently affects households with single parents or parents with children who live with other people, and single-person households. The latter are often households of older or very young people – their income situation is relatively often worse than in other households. This conclusion is confirmed by the FMI results related to the age of the household's head. The young and the older people are characterized by a high level of poverty risk. The education level of the household head is definitely the most discriminating feature of the group of households in terms of the risk of poverty. In relative terms, the risk of poverty in households of people with primary education at most is several times higher than the risk for households of people with higher education. Therefore, the result of the analysis of poverty in conditional terms due to the education level of the household head is presented below[3]. For this purpose, the conditional Dagum distribution was used by establishing parameters *b* and *c* by functions of household characteristics (see formula 3). This consisted in replacing the aforementioned parameters with functions in which the explanatory variables were a set of binary variables identifying individual levels of education. This procedure was not completed for parameter *a* because it does not affect the values of the variability measures, including the Lorenz function (formula 4). All parameters of the conditional Dagum distribution were statistically significant. The density functions of the aforementioned distribution are presented in Figure 3. On the basis of these estimates, the functions of belonging to the sphere of poverty were also determined. They are presented according to the equivalent income in Figure 4.

Along with the increase in the level of education of the household head for a given income level, the risk of poverty increases. However, this result should be viewed a little differently. Namely, a given level of risk of poverty is obtained with the lowest income in the case of households where the head has primary education and with the highest income, in the case of higher education. For example, the at-risk-of-poverty level of 0.4 refers to the income equivalent to about PLN1,400 for households managed by a person with primary education and to an income equal to PLN 2,448 for households where the head is a person with higher education. Therefore, in order to compare the level of the risk of poverty between the distinguished groups of households, it is possible to calculate the surface area over the poverty risk functions in the range of income from PLN 0 to PLN 5,000 by relating them to the area of the rectangle in the aforementioned income range and the value of the poverty function. The smaller this field, the lower the general level of poverty risk in a given subset. The result of such

[3] Similar conditional distributions were analysed in terms of different characteristics of households.

calculations, taking into account selected characteristics of households, is included in Tables 4 and 5.

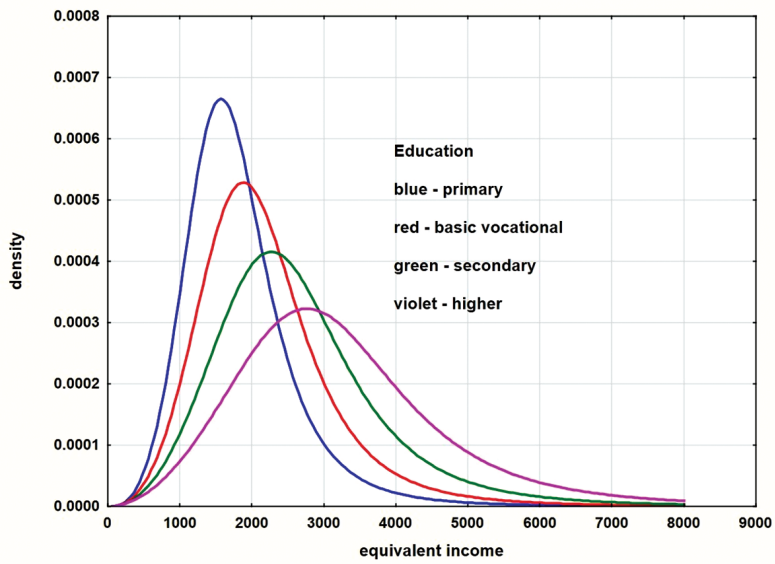

Fig. 3. The Dagum conditional distribution density functions according to the education level of the household head for the equivalent income in 2018

Source: own study.

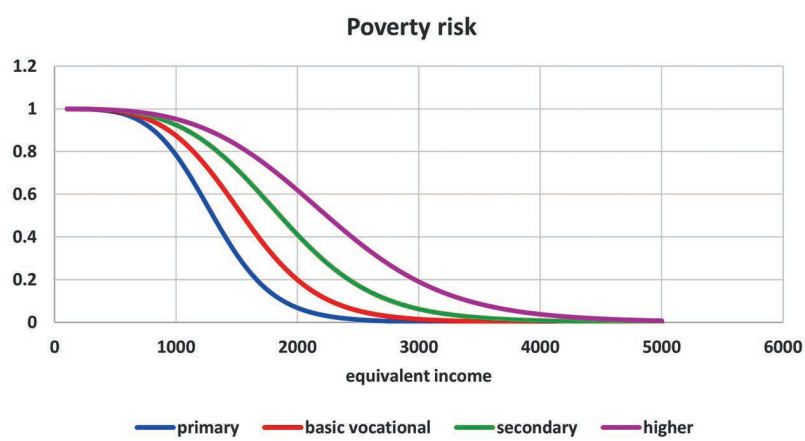

Fig. 4. The function of belonging to the poverty sphere in terms of equivalent income and the level of education of the head of the household

Source: own study.

Basically, the conclusions are the same as in the case of the results presented in Tables 1 to 3. Thus the greatest risk of poverty concerns households living mainly on unearned sources of income, in which the head of the household has at most primary education, and one-person households.

It should be emphasized, however, that the application of the conditional income distribution gives different information on the risk of poverty than that presented in Tables 1 to 3. This time the risk assessment is performed within the examined group of households, and not, as before, in relation to the entire population. In this way, one obtains a relatively easier tool to assess the risk of poverty within individual groups.

Table 4. Values of the at-risk-of-poverty index by socio-economic group of households and education of the household head

Specification	Poverty risk	Specification	Poverty risk
Socio-economic group		Class of the place of residence	
Household of emploeeys	0.5729	basic education at best	0.7431
farmers	0.5792	basic vocational	0.6922
self-employed	0.5092	secondary	0.6287
retired and pensioners	0.6396	higher	0.5489
living on unearned income	0.7142	x	x
Total		0.5885	

Source: own study.

Table 5. Values of the at-risk-of-poverty indicator by the biological type of a household

Specification	Poverty risk	Specification	Poverty risk
Biological type of the household			
Married couple without children	0.5368	Married couple with children and others	0.6193
with 1 child	0.5143	Mother with children and others	0.6442
with 2 children	0.5389	Father with children and others	0.6229
with 3 children	0.5769	Other people with children	0.6480
with 4 children and more	0.6320	Single-person household	0.6574
Mother with children	0.6341	Others	0.5721
Father with children	0.5877	Total	0.5885

Source: own study.

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5. Conclusion

Poverty is still a current and severe social problem not only in Poland but also in many other countries around the world, including those more developed than Poland. For this reason, poverty is an important research issue and a significant social problem in the field of practical approach to social policy. From the scientific point of view, it has not been possible to define one universally applicable way of understanding, measuring, determining criteria and generally defining poverty. As a result, the use of different approaches may result in different results and conclusions from these analyses, especially when it is necessary to assign a given person or household to a group of poor or non-poor individuals. However, when the purpose of the analyses is to identify the social groups most affected by poverty, the application of various research approaches should not fundamentally change the obtained conclusions.

As already mentioned, the identification of poor individuals can be done in a zero-one or a fuzzy manner. Naturally, there are advantages and disadvantages to both approaches. However, taking into account the fuzzy approach, one obtains a measurement of the statistical feature which is poverty on a stronger scale than the zero-one identification. This allows for the use of a wider range of statistical methods related, for example, to the analysis of the distribution of the value of the function of belonging to the sphere of poverty or inference about the determinants of poverty. Moreover, the fuzzy approach allows for a relatively easy construction of the function of belonging to the sphere of poverty in a multidimensional approach, although in this case it is also difficult to avoid arbitrary assumptions at the stage of aggregating partial information into a synthetic measure.

In this article, in addition to the standard approach to the construction of the function of belonging to the poverty sphere, the possibility of its estimation in a conditional form, that is for selected social groups within one income distribution model, is shown. In this way additional information is obtained about the poverty risk within the distinguished socio-economic groups of households and, moreover, it indicates – at least indirectly through the estimation and verification of the significance of individual parameters of the conditional income distribution – the features differentiating both the income distribution of different social groups and their risk of poverty. It can be assumed that research on poverty in a fuzzy approach, including the modelling of income distribution in the construction of the function of belonging to the sphere of poverty, is worth further research in this field of science.

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UBÓSTWO MONETARNE W POLSCE – UJĘCIE ROZMYTE

Streszczenie: Ubóstwo ciągle jest aktualną kwestią społeczną zarówno w Polsce, jak i w innych państwach. Z powodu braku jednej akceptowalnej powszechnie definicji ubóstwa istnieje wiele sposobów jego rozumienia, identyfikacji i pomiaru. Poza klasycznym podejściem do identyfikacji jednostek ubogich wykorzystuje się także podejście rozmyte. Celem artykułu jest analiza problemu ubóstwa monetarnego w Polsce w podejściu IFR przy wykorzystaniu danych z badania budżetów gospodarstw domowych, na podstawie których stopień zagrożenia ubóstwem ocenia się, bazując na dystrybuantach rozkładu dochodów lub wydatków oraz wartości funkcji Lorenza. W artykule te dwie funkcje będą określone na podstawie jednego z teoretycznych rozkładów (rozkładu Daguma). Takie podejście pozwala na oszacowanie parametrów warunkowego rozkładu teoretycznego ze względu na charakterystyki gospodarstw domowych. Daje to możliwość określenia czynników determinujących stopień zagrożenia ubóstwem w Polsce.

Słowa kluczowe: ubóstwo, dochody gospodarstw domowych, podejście rozmyte.