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Methods of decision support of charitable organizations in area of designing aid programs.

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Introduction

Poverty is one of the most important social problems - on the one hand, it affects many groups of the population, and on the other hand, it has a significant impact on the lives of these groups. Attempts to solve this problem are undertaken, *inter alia*, by international organizations, and the reduction and elimination of global poverty are among the United Nations Millennium Development Goals and the United Nations Sustainable Development Goals, see World Bank (2018). Extent of poverty, understood as subsisting on less than USD 1.9 per day, according to World Bank estimates in 2015 it amounted to approx. 10% of the world's population, see World Bank (2018). In Poland, Statistics Poland estimated that in 2019 the extent of extreme poverty, i.e. when household expenses did not exceed the subsistence minimum, was 4.2% of households, and the extent of relative poverty, i.e. when household expenses did not exceed 50% of the average household expenditure in Poland, amounted to 13% of households, cf. Statistics Poland (2020). Moreover, the data shows that the COVID-19 coronavirus pandemic contributes to the increase in the extent of extreme poverty - it increased from 4.2% in 2019 to 5.2% in 2020, see Statistics Poland (2021).

In order to fight poverty and improve the financial situation of the poor, aid programs are implemented. Such programs are created by both state and non-governmental institutions. This paper will focus on the activities of non-governmental organizations that deal with counteracting poverty, and in this paper they will be called charitable organizations..

Charitable organizations operating in Poland significantly help the poor, and the help provided by the largest of them is worth millions of zlotys – e.g. in 2018 the Great Orchestra of Christmas Charity collected PLN 175 million, see The Great Orchestra of Christmas Charity (2019), and Spring Foundation in Noble Box action donated PLN 47 million worth of aid, see Spring Foundation (2018).

According to the data from the report of Charycka and Gumkowska (2019) in 2018 there were about five thousand non-governmental organizations in Poland dealing with social welfare and social services.

These organizations complement the social assistance system offered by the state, not only because of the scale in which they operate, but also because of their greater flexibility and a different profile of activity. Charities can decide for themselves which social groups they want to help and in what way. Thanks to this, on the one hand, they can reach social groups not covered by assistance from other sources, but on the other hand, there is a risk of a situation in which it will not be possible to reach all those in need, cf. works of Sierpowska (2018) or Grewiński (2010). It is worth noting that charities are funded in a different way than state aid programs and often rely on voluntary work. These differences have a significant impact on the operations of charitable organizations.

It is very important for charities to find donors because they are largely funded by voluntary donation, as opposed to government institutions. Literature shows that important factors for attracting donors are the way the funds are spent and the effectiveness of charities, see Bagwell et al. (2013), Trussel and Parsons (2007).

The literature offers several ways of understanding the effectiveness of charities – many works use measures of effectiveness based mainly on financial indicators, such as the share of aid program expenditure in the total expenditure of the organization, or the share of administrative costs in the total cost of the organization, cf. Tinkelman and Donabedian (2007), Trussel and Parsons (2007). Efficiency can also be understood as technical efficiency, ie the efficiency of converting the received funds into results, measured, for example, with the use of the data envelopment analysis (DEA) method, cf. Golden et al. (2012), Callen (1994). Bearing in mind the different ways of understanding efficiency, and especially the technical understanding of efficiency, it can be assumed that in order to obtain support, charities should be able to reach those in need while remaining cost effective.

Based on the report of Charycka and Gumkowska (2019), it can be concluded that as many as 78% of non-governmental organizations dealing with social welfare use the help of volunteers. The report by Adamiak (2014) shows that 65% of volunteers indicated that they were motivated to volunteer as a result of normative factors, and 46% indicated that they were motivated to help others. It follows that volunteers will be more willing to take part in actions aimed at people in need of help.

Research problem

In order to attract donors and volunteers, a charity must ensure that its activities are effective. Because of this specificity, this paper discusses issues from the point of view of a charity organization. This paper deals with two aspects of activities of charitable organizations – the first is how to address aid and the second is how to select the target group for the program.

The literature distinguishes two types of anti-poverty programs – using broad or narrow targeting, cf. Van de Walle (1998), Lavallée et al. (2010). Broadly targeted programs rely on investment in areas that will benefit low-income individuals more than high-income individuals. Such areas may include, for example, public health care or access to primary education. In the case of narrowly targeted programs, aid is aimed directly at supporting people in need, e.g. through money transfers or food aid. Narrowly targeted programs are often used due to budgetary constraints, cf. Besley and Kanbur (1990), and their supporters believe that by targeting aid directly to those in need, the program's effectiveness is improved and the proportion of funds going to the poor is increased.

Van de Walle (1998) notes that often narrowly targeted programs are considered more ef-

fective in eradicating poverty than broadly targeted programs, because they provide direct help to those in need with potentially less resources.

It turns out that narrowly targeted programs entail many different costs, such as the costs of gathering information, carrying out the selection or costs incurred by beneficiaries when applying to qualify for the program, cf. Coady et al. (2004a). An important potential cost in narrowly targeted programs is also the misclassification of potential beneficiaries. Due to the occurrence of these costs, questions arise about the actual effectiveness of programs with the selection of beneficiaries and whether the benefits of directly reaching the poor are not lower than the costs incurred during the program implementation.

To try to answer the question about the effectiveness of narrowly addressed programs, in work of Coady et al. (2004b) the authors analyze the results of 122 aid programs in which various methods of selecting beneficiaries were used. The obtained results indicate large differences in the effectiveness of these programs depending on the place and method of their implementation. Although 25% more funding went to people in need as a result of the use of selection, compared to the random or universal allocation of aid, 27% of the programs analyzed had less effect than the allocation of aid on the basis of random selection. However, it should be emphasized that it is very difficult to empirically estimate the benefits of a program with the selection of potential beneficiaries, if they cannot be related to the effects of the program without selection carried out on the same population, and such a possibility does not happen often, see Bougheas et al. (2007).

Work of Coady et al. (2004b) shows that one of the key factors influencing the effectiveness of aid programs is the possibility of effective program implementation. Appropriate tools are needed to successfully run the program, including data on the income of the population. Such data make it easier to identify groups of people in need and to use more sophisticated techniques of targeting help. Although in developed countries the state may use such data, it can be assumed that charities do not have access to it. That is why charities carry out the selection for the program with their own means. This is the case, for example, in the Szlachetna Paczka program of the Spring Foundation, where volunteers decide about the qualification of beneficiaries for the program. A well-conducted selection is especially important for charity organizations, because the effectiveness of the program depends on this factor, which influences the willingness of donors to support the organization.

There are many works dealing with issues related to donor acquisition by charities, e.g. research on the characteristics of people supporting charities cf. Bekkers and Wiepking (2011b), Wiepking and Bekkers (2012), or their motivations to support such organizations, cf. Bekkers and Wiepking (2011a). Unfortunately, the issue of how charitable organizations should distribute aid to the poor is not explored - the author, apart from his own work on this subject, see Witkowski (2017), does not know the works on this issue.

The second issue discussed in this paper is the identification of groups endangered by poverty using econometric methods, see Ravallion (1996) or Haughton and Khandker (2009). Conclusions from such analyzes are used to select the target group of aid programs.

There are two important areas in the econometric modeling of poverty. The first is the analysis of poverty at a specific point in time, e.g. in a specific year, and this type of analysis will be referred to in this paper as static analysis. The second area is the analysis of the dynamics of poverty - ie the analysis of poverty changes over the next years or periods, cf. eg Shaffer (2018). Both types of analyzes lead to qualitatively different conclusions. The conclusions from the static modeling of poverty indicate the factors influencing the risk of poverty in a given period of time, see eg Bogale et al. (2005), Czapiński and Panek (2009), Dudek and Lisicka (2013). In the case of the poverty dynamics analysis, the conclusions concern factors influencing the probabilities of entering and leaving the poverty zone and the length of stay in the poverty sphere. Analyzes of poverty over time can be found in works of Bane and Ellwood (1986), Jalan and Ravallion (2000), Valletta (2006), Finnie and Sweetman (2003) or Sączewska-Piotrowska (2013). The results of both types of analyzes can be used to define the target groups of aid programs.

The crucial issue in poverty modeling is to define exactly how poverty is understood and who will be considered poor. On a general level, it can be assumed that poverty is a state in which needs are not met at a certain level. What specific needs are and what is the minimum level of their satisfaction differs between definitions, so there is no single generally accepted definition of poverty in the literature, cf. Panek (2011).

For the purposes of this paper, it is assumed that poverty is a lack of satisfaction of material needs of the household. In this approach to understanding poverty, two approaches are usually used to determine poverty criteria - one-dimensional, also called classic, and multi-dimensional. The one-dimensional approach uses only monetary factors such as the level of income or consumption expenditure as poverty criteria. In the multidimensional approach, in addition to monetary factors, non-monetary needs are also taken into account, cf. Panek (2011). Both in the case of one-dimensional and multi-dimensional approaches, there are many ways to identify the poor, i.e. ways to classify households as poor or not poor on the basis of adopted criteria.

Due to the lack of a single, widely accepted definition of poverty, scientific studies use different methods of identifying the poor, which makes it difficult to compare the results obtained in the studies. In the literature, however, there are also works that take into account several ways of understanding poverty. For example in the work of Szulc (2019), the author studies the impact of social transfers on various indicators of poverty, both monetary and multidimensional. In the work of Rusnak et al. (2011) the author checks which social groups are at risk of poverty depending on how it is understood. In the works of Szulc (2008) or Czapiński and

Panek (2011) the authors carry out econometric modeling of poverty determinants for various methods of identifying the poor. It is worth noting, however, that these works concern the analysis of poverty in a given period of time, and there are no studies that analyze chronic poverty in this way.

Static analysis of poverty allows to determine which features increase the risk of poverty in a specific period of time, and the analysis of chronic poverty allows to determine whether the household is more exposed to long-term or temporary poverty. Since the analysis of chronic poverty draws conclusions different from the static analysis of poverty, also in this case a question should be asked about the impact of the adopted method of identifying the poor on the obtained conclusions. Therefore, in order to find an answer to this question, this paper presents econometric modeling of chronic poverty in Poland for various methods of identifying the poor.

The conducted research will indicate a certain set of features influencing the risk of chronic poverty in a household for a given method of identifying the poor. A selection process can then be based on this feature set. However, there may be a different set of characteristics, influencing risk of poverty, that would lead to different conclusions during the selection. To investigate this and to use different model specifications leading to different sets of characteristics explaining poverty, Bayesian model averaging (BMA) method will be used in this paper.

In econometric modeling, inference is made using the model which turned out to be the best on the basis of a selected criterion or procedure, e.g. the model with the highest value of R^2 . In such a situation models with other specifications, which value of the model evaluation criterion is lower than that of the best model, are rejected. Then the inference is based only on results from the best model. However, it may turn out that the rejected models were only slightly inferior to the best model, and their use would lead to different conclusions, cf. Raftery (1995). This problem is called *model uncertainty*. Since in this work the results from several models describing the determinants of poverty are compared, and the response variables for each of them are based on different methods of identifying the poor, it is worth checking whether the potential differences in the obtained results are not the result of basing conclusions only on the best models for a given method identification of the poor. Therefore, the work uses the Bayesian model averaging method, which allows for inference based on many models with different specifications. The use of this method will allow for a more reliable comparison of the results obtained in modeling different methods of identifying the poor.

In this paper, methods that charities can use to develop anti-poverty programs will be developed. The first part of the thesis will examine the conditions under which charitable organizations should introduce the selection of beneficiaries of the aid program. In order to facilitate selection process, features that contribute to the risk of poverty will be identified in the second part of the paper. As there is no single binding definition of poverty, different methods of identifying the poor will be considered. This will allow to see to what extent the method of

identifying the poor has an impact on the results obtained. In order to check the stability of the obtained results, it will be examined whether, on the basis of the data, it will be possible to identify other sets of features that contribute to the risk of poverty. For this purpose, the results obtained in the study will be compared with the modeling results carried out using the Bayesian model averaging (BMA) method. The subsequent stages of the research carried out in the work are summarized in the figure 1.

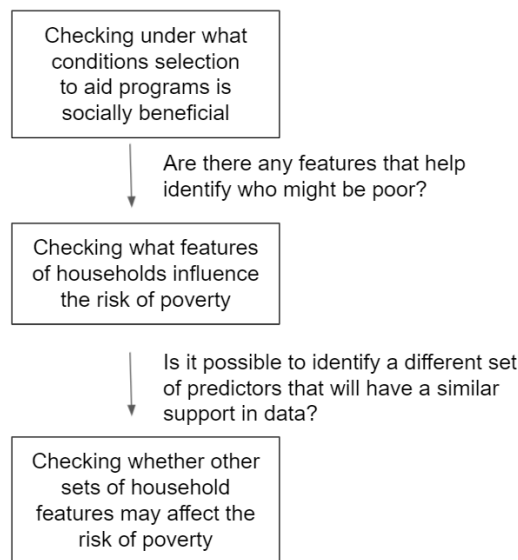


Figure 1: Stages of subsequent research in thesis.

Source: Own study

Aim and hypotheses of the thesis

The aim of the thesis is to develop methods that can be used to support decision-making by charities in the design of anti-poverty programs. In relation to the presented subject of the study, three research objectives were established:

1. To identify, using a theoretical model, how a decision of charitable organization to implement verification of potential beneficiaries into a program should depend on the conditions under which the program is conducted.
2. Finding, by means of econometric methods, the determinants of poverty that can be used for the construction of anti-poverty programs, for different methods of identifying the poor.
3. To investigate whether model uncertainty affects the results of econometric modelling relating to the second research objective and to make the results obtained robust to the effects of this problem.

First research objective

The first research objective of the paper is to indicate in which conditions in aid programs the selection of beneficiaries should be applied.

Research Hypothesis 1: On the basis of the theoretical model, it is possible to infer the conditions of social profitability of selection of beneficiaries, and it depends on the conditions of conducting the aid program such as the average amount of aid, the proportion of eligible people in the population, the cost of verification, the efficiency of verification, the size of the budget, the loss aversion of society and the value of social utility obtained from the aid.

Introducing selection in aid programs can increase the efficiency of aid allocation, but also increases program costs, cf. Coady et al. (2004a), Van de Walle (1998), Cornia and Stewart (1993). Since the empirical results are inconclusive, cf. Coady et al. (2004b), it is not clear whether such a solution should be applied universally. A theoretical model can be used to try to answer the question of whether the introduction of selection increases the efficiency of the program, – e.g. in the paper Bougheas et al. (2007) the authors use a theoretical model to assess the impact of different strategies on the efficiency of aid allocation and on the consumption of program recipients. In this paper also a theoretical model will be proposed, which is a continuation of the author's previously published work, cf. Witkowski (2017). On the basis of this model it is possible to infer the effects of introducing a selection mechanism for the utility of society and to determine the conditions under which a charity should introduce such a mechanism. The model takes into account the specificity of a charity's operation by including a mechanism linking the erroneous granting of aid, and thus the inefficiency of the organisation, with a decrease in social utility. Declining social utility means lower public satisfaction with the organisation's activities and may in future result in, for example, lower donations for the organisation.

Second research objective

The second research objective of the paper is to identify potential target groups for aid programs by identifying groups at risk of poverty, depending on the adopted method of identifying the poor.

Research hypothesis 2: Findings from the modelling of determinants of chronic poverty will indicate the same group of poverty predictors in models describing poverty defined by monetary methods of identifying the poor, but these will be different variables than in the case of a model describing poverty defined by a multidimensional method of identifying the poor.

This work models the determinants of chronic poverty. The ways in which it is defined and modelled are described in, for example, the work of Rodgers and Rodgers (1993), McKay and Lawson (2003). Many different methods of identifying the poor are used in the literature, which can have a significant impact on the results obtained in modelling. Therefore, in this work

modelling will be carried out for four different methods of identifying the poor, and the aim of the analysis is to identify differences in the results obtained and to interpret them. Data from the panel survey *Diagnoza Społeczna*, cf. *Rada Monitoringu Społecznego* (2015). The results from the modelling carried out in this paper will allow to determine whether there is a single set of factors influencing the risk of chronic poverty, regardless of the way the poor are identified. This knowledge can be used by charities to identify the poor more effectively and improve the selection process.

Third research objective

The third research objective of the paper is to analyze what effect the problem of model uncertainty has on the conclusions obtained and to make the conclusions robust to the effects of this problem. Since economic modelling is significantly exposed to the problem of model uncertainty, cf. Steel (2020), therefore the paper assumes that there will not be one dominant model, i.e. a model that will have significantly higher values of goodness of fit metrics than other models, but that there will be multiple models with similar fit to the data.

Research hypothesis 3: There is no single dominant model for the studied topic.

In econometric studies, inference is usually based on one model that has been chosen in a selection process that usually involves choosing the best model in terms of some quality criterion. As a result of such a procedure, all other models are discarded, which may e.g. contain a slightly different set of explanatory variables than the selected model. Such an action may lead to omitting additional information about the dependencies occurring in the process under study, cf. Raftery (1995), Moral-Benito (2015). In order to check whether the modelling carried out in this paper is affected by this problem, the Bayesian model averaging method will be used, cf. Hoeting et al. (1999), Fragoso et al. (2018), Steel (2020). Using this approach will allow to examine the stability of the results and check that existing models do not miss important relationships in the data. This will give charities greater confidence that the way to improve selection proposed from the modelling is appropriate.

In order to verify the research hypotheses, appropriate research methods will be used in the paper. The first hypothesis will be verified on the basis of a theoretical economic model describing the efficiency of selection into aid programs. Econometric methods will be used to verify the second research hypothesis: using a multinomial logistic model, the determinants of chronic poverty in Poland will be identified. A separate model will be built for each of the four methods of identifying the poor considered in the paper, and their results will be compared with each other. In order to verify the third research hypothesis, the Bayesian model averaging method will be used, thanks to which econometric inference will be carried out on appropriately averaged results of models with different specifications.

Verification of research hypotheses

Verification of the first research hypothesis

In order to verify the first research hypothesis, a theoretical model describing the problem of resource allocation by a charity was used. The model indicates which way of allocating funds between three possible decisions, i.e. allocating aid to all persons reported, allocating aid preceded by verification or leaving funds in the budget, will bring the highest utility to the society. Each of the possible decisions will produce different effects on society depending on the values of the parameters of the charity: the average amount of aid, the proportion of eligible people in the population, the cost of verification, the efficiency of verification, the size of the budget, the loss aversion of society and the value of social utility obtained from the aid.

In the model, the charity allocates aid funds to a group of people in need. However, only a certain percentage of those wishing to receive assistance meet the requirements of the scheme, such as a low income level. The assumption is that allocating aid to a person who meets the program criteria increases the utility of society, and allocating aid to a person who does not meet the criteria will cause a decrease in the utility of society. How large this decrease will be is modelled by the parameter k , describing society's aversion to misallocated aid. Such a mechanism is meant to illustrate the specificity of charity, where erroneously granted aid may affect the public's evaluation of the organisation's activities, and hence less support for the organisation in the future.

An organisation may decide to carry out verifications of some, or all, of the potential beneficiaries. Verification involves additional costs and errors may occur during the process, i.e. misclassification of potential beneficiaries of the program. If the conditions are not favourable, e.g. high verification costs and a high proportion of potential beneficiaries who do not meet the program's criteria, the organisation can also leave the funds in the budget and invest them in other ways.

The model described in the paper is written as a linear optimisation model, which aims to optimise the utility of society. The analysis of the model indicates three possible optimal solutions, and which of these will yield the highest utility depends on the values of the parameters. The first possible solution is to allocate all resources to granting without verification. This solution is more likely to be optimal in situations where the average amount of aid is low (also with respect to the cost of verification), verification of the poor is ineffective, the proportion of people meeting the program criteria is high, and social loss aversion is low. A second possible solution is to allocate all resources to the allocation of aid after prior verification of the needy. This solution is more likely to be viable in situations where the effectiveness of verification is high or very high, loss aversion is low and the average amount of aid is high (also in relation to

the cost of verification). The third possible optimal solution is to leave all funds in the budget and allocate them to another purpose. This solution will be optimal more often when the utility derived from allocating aid is low, loss aversion high, verification efficiency low and the average aid amount low. Of course, the parameters also interact with each other, so what specifically a low or high value of a parameter means will also depend on the values of the other parameters. Another conclusion of the model is that organisations operating on a small scale should follow a single decision strategy, i.e. to allocate all available resources to one type of action.

The results obtained from the theoretical model confirm the first research hypothesis of the paper – *on the basis of the theoretical model, it is possible to infer the conditions of social profitability of selection of beneficiaries, and it depends on the conditions of conducting the aid program such as the average amount of aid, the proportion of eligible people in the population, the cost of verification, the efficiency of verification, the size of the budget, the loss aversion of society and the value of social utility obtained from the aid.* This means that the charity, on the basis of the model, can decide whether to introduce a selection mechanism. Effectiveness of such mechanism can be improved by finding what groups are the most endangered by poverty. This will be achieved by the models created to verify the subsequent research hypotheses of the paper.

Verification of the second research hypothesis

Econometric modelling techniques were used to verify the second and third research hypotheses: multinomial logit models and Bayesian model averaging method. Modelling was carried out on data from the Social Diagnosis survey, Rada Monitoringu Społecznego (2015). Data from the four waves of the survey conducted between 2009 and 2015 were used for the analysis. For modelling purposes, four response variables were created to describe the poverty status of a household based on one of four methods of identifying the poor: extreme poverty (based on subsistence minimum), monetary deprivation (based on social minimum) , subjective poverty and material deprivation (multi-dimensional method). Since the focus of the study is the persistence of poverty over time, the response variables are discrete variables with three levels that describe categories of household poverty: non-poor, periodically poor and permanently poor. These levels were determined by the number of survey periods in which the household was poor, according to a given method of identifying the poor. The explanatory variables used in the modelling are household characteristics such as the socio-economic group of the household, the number of unemployed people in the household or the educational level of the head of the household. The relationships between the explanatory variable and the explained variables are modelled using a multinomial logistic model, and its final specification was chosen based on the value of the BIC criterion. Bayesian model averaging was also used in the paper to base inference on the results obtained from models with different specifications. Also two variants

of the approximation of the a posteriori weights of the models were used – based on the values of the information criteria BIC and AIC, cf. Steel (2020).

The verification of the second research hypothesis is based on the results of modelling chronic poverty using both multinomial logistic models and the Bayesian model averaging method. The modelling carried out showed that there is a set of variables that are predictors of poverty for all considered methods of identifying the poor. The set of these variables includes the educational level of the head of the household, the socio-economic group of the household, the presence of an unemployed person in the household and the biological type of the family. The characteristics described by these variables, therefore, can be used in the design of assistance programs by charitable organisations. The results obtained allow for partial positive verification of the second research hypothesis - it turned out that the modelling results were consistent in the models for different monetary methods of identifying the poor, but they also did not differ significantly from the results obtained for non-monetary method. It is also worth noting that even in the case of models for monetary methods of identifying the poor, the results obtained are not identical – the models differ in the set of variables used, but these differences relate to variables with less impact on poverty risk, so the results obtained can be considered consistent. This means that no matter how the charity understands poverty, i.e. which method of identifying the poor it uses, it can check whether a household is at risk of poverty based on the same characteristics.

Verification of the third research hypothesis

The third research hypothesis of the paper is verified using the results from the BMA method. For each of the methods of identifying the poor, we found that the BMA results are dominantly influenced by a single model. Although in the case of material deprivation and monetary deprivation the results are also influenced by two other models, their a posteriori weights are not large enough to significantly change the results obtained. Therefore, the effect of uncertainty in the model specification on the results obtained was considered to be small. This implies a negative verification of the third research hypothesis. Such a result shows that the set of variables indicated by the previous modelling does not solely depend on the chosen model specification, which reinforces the previous recommendation to use this set of variables by charities in the selection process.

Concluding remarks

The conclusions obtained in this work can be used by a charity organisation to plan its aid programs in two aspects: the introduction of a beneficiary selection mechanism and selection of the target group of the programme. The mathematical model built in the study indicates under

which conditions an organisation should introduce beneficiary selection into the program and under which conditions it should not decide to do so. In the case of the target group selection aspect, the research conducted in this paper has made it possible to identify the groups most at risk of chronic poverty for different methods of identifying the poor. Characteristics that influence risk of poverty, consistent for all of considered methods of identifying the poor, are low level of education of the head of the household, membership of a group living on unearned sources, the type of household (incomplete families and families with many children are particularly at risk) or unemployment of at least one person from the household. Comparing the results from the models for the different methods of identifying the poor and conducting the analysis using the BMA method confirmed the stability of these results. Based on this information, the charity can select the target group of a program to counteract chronic poverty.

The research has its limitations, which concern both the theoretical model and the econometric modelling. The theoretical model used in this study does not include all possible factors influencing the described process and is limited to one period only, which does not allow for a full description of the impact of the charity's decisions on its situation in subsequent periods. Also, the econometric modelling does not include all potential variables that influence poverty risk, such as psychological factors. The limitations of the modelling are also due to the data used in the study - the „Social Diagnosis” survey used in the study was conducted every two years, so using data from a survey conducted more frequently would improve the quality of the data. Unfortunately, the "Social Diagnosis" was discontinued, and thus the models presented in this paper will not be able to be updated with subsequent waves of the survey. Further limitations arise from the methods adopted in the paper – the paper uses a version of the BMA method that is based on a posteriori approximations of model probabilities using information criteria. This approach, although sufficient in the paper, does not allow the full potential of the method to be realised, e.g. by not being able to model a priori distributions.

Further directions for the work are determined by the limitations encountered. The first direction is to include a time dimension in the theoretical model and see how such a change would affect the charity's behaviour. The continuation of research in the field of econometric modelling, on the other hand, should focus on the estimation of models on another set of data, covering the years after 2015, which would allow to check how the risk of poverty was affected by such factors as the introduction of the „Family 500+” program or the COVID-19 coronavirus pandemic. Another interesting direction of research would be to check how the use of a variant of BMA based fully on Bayesian estimation affects the obtained results and conclusions from the modelling.

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