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ANNEX 4. METHODOLOGY OF ANALYSING POVERTY

4.1. Monetary poverty

4.1.1. Definition

4.1.1.1. Objective approach

In the objective approach, the poverty line in May 2015 was based on the minimum of existence value for December 2014, adjusted with a relevant consumer price index, calculated by the Institute for Labour and Social Studies for a single-person household of employees. The poverty line for March 2013 constituted the value of the poverty line for May 2015 adjusted with a relevant consumer price index. For all other types of households, the poverty line was calculated as the product of the adjusted minimum of existence value and an appropriate equivalence scale.

The minimum of existence income is equivalent to the value of the basket of consumer goods established for a household having specific social and demographic features. The contents of such basket should provide the household with such living conditions which enable solely “survival” in good health and being able to work (Deniszczuk, Sajkiewicz, 1996). This means that the minimum value of existence is the borderline of extreme poverty.

4.1.1.2. Subjective approach

In the subjective approach to determining the poverty line, the subjective poverty line method was used (Goethart, Halberstadt, Kapteyn and Van Praag, 1997; Panek 2011). In this method, the households themselves indicate the lowest levels of income necessary for them to make ends meet, which are treated as their specific poverty lines. The levels of income declared by specific households depend mainly on their size (the number of persons in the household) and their actual income.

This relation may be presented in the form of the following regression equation:

$$\ln y_{\min} = \alpha_0 + \alpha_1 \ln L + \alpha_2 \ln y, \quad (1)$$

where:

L - number of persons in the household,

y - actual income of the household,

y_{\min} - the lowest level of income necessary to make ends meet, indicated by the household itself.

The parameters of the above regression function, estimated with the use of the least squares method, were the basis for calculating the poverty line for subsequent years of the study. The poverty line is obtained as the value of income y^* , which - when substituted for w , and v - satisfies equation (1). The values of the poverty line (y^*) dependent on the number of persons in the household were finally established on the basis of the following formula:

$$y^*(L) = \exp \frac{\alpha_0 + \alpha_1 \ln y}{1 - \alpha_2}. \quad (2)$$

4.2. Equivalence scales

4.2.1. Objective approach

The equivalence scales adopted in the objective approach were estimated, both under the unidimensional and multidimensional approach, on the basis of the procedure using the information on the amount of expenditure of the households (Szulc, 1996; Panek, 2011). This procedure takes into account the fact that the households of a different composition spend income in different ways. For example, in the households of young person less is spent on medical care and more on food, unlike the households of older persons. At the same time, it was assumed that the structure of consumption in the households reflects their actual needs.

An employee household of a single person aged between 30 and 59 was established as the point of reference (that is, as a “standard” household, with the equivalence scale of 1). The values of the equivalence scale for any other household may be then interpreted as the number of “standard” persons. The equivalence scales were estimated as follows:

$$\ln m_i = \frac{1}{2} \sum_{j=1}^m \sum_{s=1}^n [m_{sj} (w_{si} + w_{sr})] \ln \frac{A_{ji}}{A_{jr}}, \quad (3)$$

where:

m_i - equivalence scale for the i -th household.

w_{si}, w_{sr} – percentage of expenditure of the i -th and r -th household for the 5-th good or group of goods. In this case the r household is the standard household.

m_{sj} – elasticity of expenditure for the 5-th good in relation to demographic characteristic ($j=1,2,\dots,m$).

A_i, A_r – vectors of demographic characteristics of the i -th and r -th household.

In the presented study, the vectors of demographic characteristics were based on the number of adult persons in the household (above 16 years), the number of children (below 10 years and from 10 to 15 years) and the age of the head of household (16-29 years, 30-60 years and above 60).

The m_{sj} parameters are obtained through the estimation of the consumption demand model, with the following explanatory variables: the household expenditures, the number of adult persons and children in the household and the prices of consumer goods. These are interpreted as the demographic elasticities of expenditure on specific goods. Thus, the equivalence scale obtained on the basis of equation (3) is a geometric mean of the elasticities of expenditure in relation to the demographic variables weighted with the shares of expenditure on specific goods in the total expenditure.

4.2.2. Subjective approach

In the subjective approach, the estimates for the equivalence scales were based on the poverty lines calculated for households with different numbers of persons in the household, with the use of formula (2). A single-person household was assumed as the “standard” household being the point of reference (with the equivalence scale of 1). The value of the equivalence scale for a L -person household is obtained by dividing the value of its poverty line by the value of the poverty line for a one-person household:

$$m_L = \frac{y^*(L)}{y^*(1)}. \quad (4)$$

4.3. Poverty measurement

4.3.1. Unidimensional (monetary) approach.

In the unidimensional (monetary) approach taking into account only current household income, we can concentrate on the assessment of the actual phenomenon of poverty if we take into consideration household equivalent incomes and the poverty line.

Aggregate poverty indices (Panek 2011) have the widest application in poverty analysis. These are statistical formula aggregating individual poverty measures (for individual households or persons) and allowing assessment on the national scale in terms of territory or typological household groups. Because there is no single, universal formula applicable here, studies should use various formula of aggregated index providing information on various aspects of poverty.

Because in the multidimensional approach to the measurement of poverty we measure its both monetary and non-monetary (material deprivation) aspects, in order to avoid confusion, all the indices measuring monetary poverty will be explicitly called monetary poverty indices. The most popular index assessing the incidence of monetary poverty () is the *headcount monetary poverty ratio*, which is the share of units (persons or households) with income below the poverty line:

$$H^{um} = \frac{n_{um}}{n}, \quad (5)$$

gdzie:

n – number of individuals in the analyzed population,

n_{um} – number of monetary impoverished individuals in the analyzed population.

This index has the value of 0 when there are no poor households and 1 if all units studied have equivalent incomes below the poverty line.

The percentage of those in poverty tells us nothing about other aspects of poverty, as its equals the same value of whether the impoverish household’s incomes are close to the poverty line or close to zero. In the presented study we propose widening the analysis of monetary poverty to the three other aspects beyond its incidence.

The basic measure of monetary poverty depth is the *monetary poverty gap index* defined as:

$$I^{um} = \frac{1}{n_{um}} \sum_{i=1}^{n_{um}} \left(\frac{y^* - y_i^e}{y^*} \right), \quad (6)$$

where:

y^* - is the monetary poverty line,

y_i^e - equivalent income of the i -th individual.

This measure is different to the monetary poverty gap as it is for the entire population of households, not only those in poverty. The sum of poverty gaps of all individuals (the income gaps of nonmonetary- poor individuals are naturally 0) is here divided by the number of all studied individuals. The income gap index measures the costs of eliminating monetary poverty (in relation to the poverty line), since it indicates the amount of equivalent income (measured as a percentage of the poverty line) which should, on average, be transferred to each of the poor for the income of all studied individuals to move above the poverty line. This index assume values in the interval [0,1] like the poverty income gap index, indicating no poor monetary households as 0 in the population and 1 when the income of all households in poverty equals zero.

Another aspect of monetary poverty is monetary poverty intensity, the most frequently used index of which is the *income gap index*:

$$IT^{um} = \frac{1}{n} \sum_{i=1}^{n_{um}} \left(\frac{y^* - y_i^e}{y^*} \right). \quad (7)$$

This index may be also presented as the product of the monetary poverty headcount ratio and the poverty gap as it describes both the incidence and depth of poverty index:

$$IT^{um} = H^{um} \cdot I^{um}. \quad (8)$$

This measure is different to the poverty gap as it describes of the entire population of households, not only the impoverished sub-population. The sum of monetary poverty gaps of all units (the poverty gaps of non-poor units are naturally 0) is here divided by the number of all studied units. The income gap index measures the costs of eliminating monetary poverty (in relation to the poverty line), since it indicates the amount of equivalent income (measured as a percentage of the poverty line) which should, on average, be transferred to each of the poor for the income of all studied units to move above the poverty line. This index uses 0-1 values like the poverty income gap index, indicating no poor households as 0 in the population and 1 when the income of all households in poverty equals zero.

The fourth group of indexes assesses monetary poverty severity. The indices of monetary poverty severity, measure not only the monetary incidence and the distance between poor households' income and the poverty line (monetary poverty depth) but also income inequalities among the poor.

The basic index of monetary poverty severity most often applied in practice is the *squared income gap index*:

$$SE^{um} = \frac{1}{n} \sum_{i=1}^{n_{um}} \left(\frac{y^* - y_i^e}{y^*} \right)^2. \quad (9)$$

It may also be presented in a form that shows the impact of specific aspects of poverty on the analysed phenomenon:

$$SE^{um} = H \left(\frac{y^* - \overline{y_i^{eum}}}{y^*} \right)^2 + \frac{S^2(y_i^{eum})}{(y^*)^2}, \quad (10)$$

where:

$\overline{y_i^{eum}}$ - mean equivalent income of the monetary poor,

$S^2(y_i^{eum})$ - variance of equivalent income of the monetary poor.

As opposed to the income gap index, in this index the greater the distance from the income determining the poverty line and the equivalent income of the monetary poor, the greater the weights assigned to such individual. Therefore, monetary poverty severity among the monetary poor, and at the same time the value of this index, rise together with the increase in the distance between monetary poor equivalent income and the poverty line. The weights assigned to the households are directly proportional to the size of their income gaps. For example, if the income gap of a given individual is 10% of the poverty line, the individual receives a weight of 10% of all studied individuals weights. This index is 0 when there are no monetary poor in the studied population. The value of the index increases together with the number of monetary poor individuals, their income gaps rise and increase of the income inequalities between them. The index has its maximum value of 1 when all studied individuals have income equal to zero.

4.3.2. Non-monetary poverty (material deprivation)

The first step to measuring non-monetary poverty is defining its non-monetary dimensions closely linked to the need-groups of the studied units (persons and households), followed by the selection of variables that are symptoms of non-monetary poverty in each of its dimensions. The study considered the following dimensions of deprivation and their symptoms:

1. Satisfaction of household nutritional requirements (a lack of requirement satisfaction for financial reasons). Lack of financial means to satisfy nutritional requirement for:
 - 1.1 Vegetables and vegetable products
 - 1.2 Fruit and fruit products.
 - 1.3 Meat and poultry.
 - 1.4 Meat and poultry products.
 - 1.5 Fish and fish products.
 - 1.6 Butter and other edible fats.
 - 1.7 Milk.
 - 1.8 Milk products.
 - 1.9 Sweets.
 - 1.10 Confectionaries.
 - 1.11 Stimulants including alcohol and cigarettes.
2. Household equipment and durable goods (lack of equipment or goods for financial reasons). Lack of financial means to satisfy the need for:
 - 2.1. Washing machine.
 - 2.2. Dishwasher.
 - 2.3. Microwave oven.
 - 2.4. LCD/plasma TV.
 - 2.5. Pay TV (satellite or cable).
 - 2.6. Computer (desktop or laptop).
 - 2.7. Passenger car.
 - 2.8. Access to home internet.
 - 2.9. Landline.
3. Housing conditions and payment.
 - 3.1. Too high density (less than 5m² per person).
 - 3.2. Lack of mains water.
 - 3.3. Lack of flushing toilet.
 - 3.4. Lack of bathroom with bath or shower.
 - 3.5. Lack of hot running water.
 - 3.6. Lack of mains or bottled gas.
 - 3.7. Lack of central heating (collective or individual).
 - 3.8. Non-payment of rent.
 - 3.9. Non-payment of gas or electricity bills.
 - 3.10. Non-payment of mortgage instalments.
4. Children's education (forgone for financial reasons).
 - 4.1. Resignation from extra-curricular activities.
 - 4.2. The limitation or suspension of school fees.
 - 4.3. Resignation from school lunches.
 - 4.4. Resignation from private lessons.
 - 4.5. Changing to a cheaper school.
 - 4.6. Other restrictions.
5. Culture (forgone for financial reasons).
 - 5.1. Cinema.
 - 5.2. Theatre, opera, operetta, philharmonia, concert.
 - 5.3. Museum or exhibition.
 - 5.4. Purchase of book.
 - 5.5. Purchase of press.
6. Leisure (forgone for financial reasons).
 - 6.1. Camp and other children's group trips.
 - 6.2. Holidays, trips adults.
 - 6.3. Family outings and trips.
7. Healthcare (forgone for financial reasons).
 - 7.1. Prescriptions or doctor's recommended medicine.
 - 7.2. Dental treatment.
 - 7.3. Dental prosthetics .

7.4. Visits to the doctor.

7.5. Medical tests.

7.6. Rehabilitation.

7.7. Sanatorium therapy.

Symptoms of material deprivation included in analysis are measured on a nominal scale and are binary except for one symptom. This symptom is too high flat density (3.1) We assumed that the household involves exclusion due to too high density in their flat, if there is less than 5m².

The measures of monetary poverty presented in 5.3.1 can be used, after the appropriate modification, to analyse non-monetary poverty (material deprivation).

In the first step, each household was assigned to the number of existing symptoms of deprivation, independently for each of the material deprivation dimensions distinguished in the study.

In order to evaluate different aspects of material deprivation in each of its dimensions, we adopted the material deprivation line for each dimension of material deprivation, i.e. an upper limit of deprivation symptom numbers at which the individual is in deprivation (table 4.1).

Table 45.1. Material deprivation lines for particular dimensions of material deprivation.

Deprivation dimensions	Material deprivation lines
1. Satisfaction of nutritional needs	At least 5 symptoms of deprivation
2. Durable goods	At least 4 symptoms of deprivation
3. Housing conditions and payment of rent	At least 4 symptoms of deprivation
4. Children's education	At least 2 symptoms of deprivation
5. Culture	At least 2 symptoms of deprivation
6. Leisure	At least 1 symptom of deprivation
7. Health care	At least 3 symptoms of deprivation

A household is considered to be materially deprived in a given dimension if it is characterized by the number of deprivation symptoms in this dimension which is at least equal to the material deprivation line.

A general assessment of material deprivation (in all dimensions altogether) requires an analysis of the number of deprivation dimensions in which tested individuals are subject to deprivation. We assume that the risk of material deprivation for an individual (person or household) grows if the number of reported deprivation dimensions increased. Next, after arranging the number of material deprivation dimensions by decreasing degree of deprivation (from the 7 non-dimensions of material deprivation to the absence of deprivation in any dimension) we define a variable by assigning successive natural numbers to these numbers of non-monetary material deprivation dimensions ($z = 0, 1, 2, \dots, k$). Next, we have to define the value of the material deprivation line, i.e. the lower limit of the number of deprivation dimensions with which a unit is subject to deprivation. It was adopted that an individual is non-monetary poor (subject to material deprivation) if it experiences material deprivation in at least three dimensions.

The index measuring the incidence of material deprivation is the *headcount material deprivation ratio* in this dimension, that is, the percentage of individuals subject to material deprivation:

$$H^{dm} = \frac{n^{dm}}{n}, \quad (11)$$

where:

n^{dm} – the number of individuals subject to material deprivation.

The evaluation of material deprivation depth of materially deprived is the *material deprivation gap index for materially deprived individuals* defined as follows:

$$I^{dm} = \frac{1}{n^{dm}} \sum_{i=1}^{n^{dm}} \left(\frac{(z^* + 1) - z_i}{(z^* + 1)} \right), \quad (12)$$

where:

z_i – value of the z -th variable for the i -th individual (the number of material deprivation dimension in which the i -th individual is materially deprived),

z^* – the material deprivation line.

The measurement of the intensity of material deprivation is conducted with the *material deprivation gap index*:

$$IT^{dm} = \frac{1}{n} \sum_{i=1}^{n^{dm}} \left(\frac{(z^* + 1) - z_i}{(z^* + 1)} \right). \quad (13)$$

The material deprivation severity is measured with the *squared material deprivation gap index*:

$$SE^{dm} = \frac{1}{n} \sum_{i=1}^{n^{dm}} \left(\frac{(z^* + 1) - z_i}{(z^* + 1)} \right)^2. \quad (14)$$

4.3.3. Measurement of co-occurrence of monetary and non-monetary poverty (material deprivation)

The final stage of a multidimensional analysis of poverty is the assessment of the co-occurrence of monetary poverty and non-monetary poverty. The incidence of both monetary poverty and material deprivation substantially worsens the severity of this phenomenon. If the household does not achieve both current income at least equal to the monetary poverty line and is subject to material deprivation, its financial resources, including not only current income, but also income from previous periods and accumulated non-cash assets are not sufficient to satisfy its basic needs at the minimal acceptable level. This poverty will be labelled as *manifest poverty*.

A number of measures of manifest poverty is applied to conduct an evaluation of different aspects of cumulative monetary poverty and non-monetary poverty. A measurement of the incidence of combined monetary and non-monetary poverty, that is manifest poverty incidence, is the proportion of individuals both in monetary poverty and material deprivation, that is, the *manifest poverty headcount ratio* defined as follows:

$$H^{uo} = \frac{\sum_{i=1}^{n_u} n_i | x_i \in X^{dm}}{n}, \quad (15)$$

where:

X^{dm} - set of materially deprived individuals,

$x_i \in X^{dm}$ - i individual that belongs to materially deprived individuals set.

The measure of manifest poverty depth is the *manifest poverty gap of manifestly poor index*, i.e. the monetary poor and also subject to deprivation:

$$I^{uo} = \frac{1}{2n^{um}} \sum_{i=1}^{n^{um}} \left(\frac{y^* - y_i^e}{y^*} \right) | x_i \in X^{dm} + \frac{1}{2n^{dm}} \sum_{i=1}^{n^{dm}} \left(\frac{(z^* + 1) - z_i}{(z^* + 1)} \right) | x_i \in X^{um}, \quad (16)$$

where:

X^{um} - set of monetary poor individuals,

$x_i \in X^{um}$ - the i -th individual that belongs to monetary poor individuals.

The measure of manifest poverty intensity is the *manifest poverty gap index*:

$$IT^{uo} = \frac{1}{2n} \sum_{i=1}^{n^{um}} \left(\frac{y^* - y_i^e}{y^*} \right) | x_i \in X^{dm} + \frac{1}{2n} \sum_{i=1}^{n^{dm}} \left(\frac{(z^* + 1) - z_i}{(z^* + 1)} \right) | x_i \in X^{um}. \quad (17)$$

The measure of manifest poverty severity is the *squared manifest poverty gap index*:

$$SE^{uo} = \frac{1}{2n} \sum_{i=1}^{n^{um}} \left(\frac{y^* - y_i^e}{y^*} \right)^2 | x_i \in X^{dm} + \frac{1}{2n} \sum_{i=1}^{n^{dm}} \left(\frac{(z^* + 1) - z_i}{(z^* + 1)} \right)^2 | x_i \in X^{um}. \quad (18)$$

4.4. Analysis of changes in poverty

When analysing the dynamic phenomena related to poverty, it is particularly important whether a specific household is suffering poverty temporarily or whether this condition is of a permanent character (Panek, 2011). This is particularly significant when formulating the tasks under social policy aimed at fighting poverty, as these should focus on counteracting permanent poverty. Identifying the character of poverty is possible solely by means of a panel approach which consists in the observation of the same households in all periods (years). Hence, in the presented study on poverty, the assessment of the changes in poverty was based on the information concerning only those households which took part in all last two study phases in 2013 and 2015.

In analyses conducted as part of the study, the character of poverty by means of analysing the mobility of the household in terms of its position above or below the poverty line was examined.

The assessment of household mobility in terms of its position above or below the poverty line is based on the analysis of household flow between statuses of belonging to the poverty sphere (belonging or not belonging to the poverty sphere) in two comparable periods (years). The scheme of flows of households between the status of being below or above the poverty line under the conventional (unidimensional) approach is presented in table 4.2.

Table 4.2. Scheme of household flows between statuses of belonging to the sphere of poverty.

Belonging to the poverty sphere in the period $t-1$	Belonging to the poverty sphere in the period t		$n_{j,t-1}$
	non-poor household ($j=0$)	poor household ($j=1$)	
Non-poor household ($j=0$)	$n_{00,t-1,t}$	$n_{01,t-1,t}$	$n_{0,t-1}$
Poor household ($j=1$)	$n_{10,t-1,t}$	$n_{11,t-1,t}$	$n_{1,t-1}$
$n_{j,t}$	$n_{0,t}$	$n_{1,t}$	n

In the case of poverty analysis in relation to the income situation of households, the values on the diagonal of the matrix of flows $N = [n_{jj',t-1,t}]$ indicate the number of households which did not change their status of belonging to the poverty sphere in the two comparable periods (i.e. in both comparable periods (years) these households were or were not below the poverty sphere). The number of households which “entered” to the poverty sphere is below the diagonal, and the number of households which “left” below the poverty sphere is above the diagonal.

The indices of mobility, which are synthetic assessments of the scale of mobility of the households in relation to their belonging to the poverty sphere, are calculated on the basis of the matrix of flows. A classical mobility index often used in practice and calculated based on the matrices of flows is the Shorrocks index (1978), described with the following formula:

$$M^S = \frac{n - tr(\mathbf{N})}{n}, \tag{19}$$

where:

$tr(\mathbf{N})$ – trace of the matrix of flows ¹¹³,

while:

$n_{jj',t-1,t}$ – number of individuals which moved from the status of belonging to poverty sphere to the j' -status.

Index (27) may have the j -th value from the range of [0,1]. The higher the value of the index, the greater the mobility of the households.

When decomposing index (27), and expanding its analytical capacities, we obtain the following:

$$M^S = \frac{n - tr(\mathbf{N})}{n} = \frac{\sum_{j>j'} n_{jj'} + \sum_{j<j'} n_{jj'}}{n} = \frac{\sum_{j>j'} n_{jj'}}{n} + \frac{\sum_{j<j'} n_{jj'}}{n} = M^{S+} + M^{S-}, \tag{20}$$

The first of the components on the right side of the equation indicates the percentage of households which “left” the poverty sphere in the comparable periods. The second component of the sum is the percentage of households which “entered” the poverty sphere in the studied period. As a supplementation for mobility index (27), T. Panek (2001) proposed the index of the character of the households’ mobility:

$$CM = \frac{\sum_{j>j'} n_{jj'}}{n} - \frac{\sum_{j<j'} n_{jj'}}{n} = M^{S+} - M^{S-}, \tag{21}$$

This index assumes values from the range of [-1; 1]. Its positive values mean that the flows of households from the poverty sphere beyond the poverty sphere prevail. On the other hand, its negative values mean that the flows of households from outside the poverty sphere to the poverty sphere prevail. The higher the absolute value of the index, the greater the prevalence of one type of flows over the other.

4.5. Determinants of poverty

A widely used method of establishing the determinants of poverty divides the researched population into groups according to selected social and economic features, and then assesses this phenomenon inside these groups by means of poverty indices most often by means of the percentage of the poor. High values of the poverty index in the given group of households, with a concurrent high diversity of such values between the groups under the given classification suggest that this variant of the feature characterising the selected group of households generates poverty.

However, the assessments of the impact of specific variables on generating poverty may independently be biased since the relation of such variables with other variables is not taken into account. For example, high values of poverty index in the group of rural households indicate that living in the countryside generates poverty. However, a high value of poverty index for this group of households is a combined effect not only of the place of residence, but also of other

¹¹³ Values on the diagonal of the matrix, i.e. the number of households, which have not changed their poverty sphere status in the periods under comparison.

factors; e.g. a higher number of children in rural households in comparison to urban households, a lower level of education of the members of such households in comparison with the households from the cities. Thus, in order to specify the determinants of poverty necessary to estimate the “net” impact of specific variables on generating poverty requires the application of multidimensional methods of analysing interdependence and the multiple regression in particular.

In order to specify the impact of the features underlined in the study on the degree of the risk of poverty, probit or logit models may be applied (Greene, 1997). In these models, the dependent variable is the dummy variable which has the value of 1 if the household was in the poverty sphere and otherwise the value of 0.

The probit model may be defined as follows:

$$\Phi^{-1}[p(\mathbf{X})] = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \alpha_k X_k + \varepsilon, \quad (22)$$

where:

\mathbf{X} – vector of the potential determinants of poverty (explanatory variables),

$p(\mathbf{X})$ – probability of the household’s “entered” the poverty sphere, at a specified set of potential determinants of poverty (independent variables),

$\Phi^{-1}(p)$ – inverse cumulative standard normal distribution function,

ε – the model residual.

The explanatory variables included in the models as the potential determinants of poverty may be presented, similarly as the explanatory variable, by means of a set of dummy variables. When estimating the models with the sets of dummy variables, in each such set one of the variable category is omitted in order to avoid multicollinearity. This means that the parameters in the model are relative indicators of the risk of entering the poverty sphere. The higher the positive value of the parameter the higher the risk of “entering” the poverty sphere among the households displaying this variable category, in comparison with the households whose does not contain this variable category. On the other hand, the negative value of the parameter indicates a lower risk of “entering” the poverty sphere (in relation to the omitted variable category).