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Human poverty – Measuring relative deprivation from basic achievements. A comparative study for 144 world countries in the time span 1990-2010

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GDAŃSK UNIVERSITY OF TECHNOLOGY
FACULTY OF MANAGEMENT AND ECONOMICS

**HUMAN POVERTY – MEASURING RELATIVE
DEPRIVATION FROM BASIC ACHIEVEMENTS.
A COMPARATIVE STUDY FOR 144 WORLD
COUNTRIES IN THE TIME SPAN 1990-2010.**

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Human poverty – measuring relative deprivation from basic achievements.

A comparative study for 144 world countries in the time span 1990-2010.

Ewa Lechman¹

Abstract

Poverty – differently defined and measured – still remains one the crucial parts of the world development debate. It's broadly perceived as multidimensional phenomenon which deprives people from basic capabilities and freedoms, limits their opportunity to educate and fully participate in the labor market contributing to overall country's socio-economic performance. Referring to seminal works of Sen and many others(see e.g. Morris 1979; Sen 1985, 1992; Desai 1991; Ravallion 1993), we present an specific approach to poverty issues, treating low incomes as consequence – not a cause – of poverty. The main target of the work is twofold. Firstly we aim to develop a new complex measure of relative poverty to set the most recent worldwide poverty estimates. For this purpose we deploy methods based on fuzzy sets (e.g. see works of Zadeh 1965; Dubois&Prade 1980; Bérenger&Verdier-Chouchane 2006), and we apply a wide array of non-income indicators (proxies) explaining level of socio-economic development. Following the logic of fuzzy sets theory, we explain poverty as deprivation from – for example – access to education or improved drinking water. Secondly, we run an analysis on disaggregated data, tracking for factors which contribute mostly to the level of poverty in different countries. Such approach let us to detect most backward areas of human development which shall be in the centre of interest of policy makers. All data applied in the estimates are derived from World Development Indicators Database 2012. The sample covers 144 world economies, and the set time framework is 1990-2010.

Keywords: *poverty, fuzzy sets, deprivation, comparative economics*

JELcodes: *I32, O15*

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1. Human poverty – concept clarification.

From historical perspective, poverty has wide economic connotations. The most common perception of the problem is perceived through the lens of low incomes which disables people to acquire “decent” life. However, using monetary estimates to explain the magnitude of poverty has substantial limitations, and cast doubts on conceptualization of poverty. Focusing on merely quantifiable sides of life, leads to various omissions and does not capture the problem adequately. Poverty debate shall turn more to aspects like social exclusion, material deprivation, and lack of capabilities, limited possibilities and horizons in education and work. Inability to fulfil basic human needs – e.g. enough food, shelter and clothing, prevents people from further achievements in welfare. To better understand the problem, poverty shall be defined broadly, and not expressed only in the economic sense. Many authors, starting from seminal works of Sen (1975, 1976, 2000) and Morris (1979), argue that poverty is multidimensional phenomenon, which encompasses social context, and has various manifestations (see works of Ravallion (1996), Brady (2003), Lister (2004), Sengupta (2005)). Ravallion (1996) states that full understanding of poverty requires including both economic (money-metric) and non-economic factors. As consequence, poverty, can be seen as composite structure, including a wide set of capabilities, functionings (see Sen 1976), and other dimensions which constitute individual’s well-being. Since capabilities and functioning are latent variables and cannot be observed directly, they yield for being measured using observable variables. Theoretically, a set of relevant indicators might include: consumption (Gordon 2000, Pradhan and Ravallion 2000), nutrition status (Wagle 2006), education and health (Clark 2005, Sen 2002), or many others which constitute a proxy variables of human well-being.

Surely, such approach calls for appropriate measurement methods. So far, a wide array of measures² (indices) has been developed to help to capture and understand the magnitude of poverty, as well as to enable inter-country comparisons and observing in-time progress in poverty eradication. In the following section we elaborate a composite measure, based on the fuzzy set theory (Zadeh, 1965).

2. Data explanation and methodological overview

Inspired by the Sen's contribution to poverty analysis (Sen 1985), in the paper we analyze the phenomenon through the lens of functionings and capabilities. We assume that poverty goes far beyond low *per capita* income, and shall be defined as deprivation covering multitude aspects of human well-being. In the empirical part, we aim to detect the magnitude of countries' deprivation in 7 selected dimensions which approximate living standards and welfare of societies, constituting an approximation of human poverty. To be clear, we apply a bundle of 7 different variables, for 144 world countries which are following: Birth Crude Rate ($BRC_{c,y}$), Births Attended by Skilled Health Staff ($BAD_{c,y}$), Fertility Rate ($FE_{c,y}$), Improved Water Source ($IWS_{c,y}$), Life Expectancy at Birth ($LE_{c,y}$), Mortality Rate³ ($MR_{c,y}$), Physicians⁴ ($Phy_{c,y}$), where c denotes country and y – year. All data applied in the study are derived from *World Development Indicators Database 2012*⁵. Using the data we construct a composite measure, which allows reporting on the degree of deprivation (deficiency) for selected countries in each of the domain (dimensions). The construction of the measure is based on the fuzzy sets approach. The concept of fuzzy sets theory, primary described by Zadeh (1965), lately

² The most commonly recognized is Human Development Index – developed and yearly calculated by United Nations Development Programm (see: <http://hdr.undp.org/en/humandev/>).

³ Total.

⁴ Per 1000 inhabitants.

⁵ In case of Any missing data we have applied the variable's value from the closest year.

adjusted and adapted for analytical purposes in social sciences, see i.e. works of Balamoune (2003), Cerioli and Zani (1990), Berenger and Verdier-Chouchane (2007). The mathematical tool of fuzzy sets is highly appropriate for quantitative analyses of phenomenon like poverty, as it allows capturing its multidimensionality, by estimating the value of composite indices covering selected aspects of life. The indices are constructed in two sequent stages. The first stage involves defining a membership function, estimated separately for each country in the sample and each variable (dimension), which stands for deprivation of a country in given dimension. Afterwards, in the second stage, we define a composite measure of total deprivation of country in all selected dimensions (for all variables).

To formalize the above, let us assume to have c – countries, where $c \in (1, C^6)$, and a set of variables (indicators) approximating welfare of societies, where j – stands for an indicator and $j \in (1, J^7)$. The principal thing is to transform a j – indicators, so that:

$$j^{\wedge}(c) = 1 - F(j) \quad (1).$$

while the $F(j)$ describes the distribution of j -indicator in the group of countries $c \in (1, C)$.

The formula $j^{\wedge}(c) = 1 - F(j)$ is called a membership function for c -country, and the (j^{\wedge}) values range from 0 to 1, $j^{\wedge} \in (1, 0)$. The values of $(1 - F(j))$ indicate the degree of deprivation of a c -country in j -dimension. If we rank values of j -indicators by increasing order⁸, then higher $j(c)$ stands for lower $j^{\wedge}(c)$. If ranking values of j -indicators by decreasing order⁹, the $j(c)$ and $j^{\wedge}(c)$ relationship is reverse. Then, the totally poor country takes the value of $j^{\wedge}(c) = 1$, while the totally rich – $j^{\wedge}(c) = 0$.

⁶ X – number of countries in the sample.

⁷ Y – number of variables (indicators).

⁸ Applicable for stimulant variables.

⁹ Applicable for destimulant variables.

Assuming that each j -indicator ($j \in (1, J)$) for each c -country ($c \in (1, C)$) is transformed according to formula (1), then we obtain a composite measure of deprivation of c -country in all j -dimensions. The composite measure is mathematically defined as the weighted average:

$$Y_{(c)} = \sum_{j=1}^J \omega_j j_j(c) \quad (2),$$

where:

$$\omega_j = \frac{\ln\left(\frac{1}{\theta_j}\right)}{\sum_{j=1}^J \ln\left(\frac{1}{\theta_j}\right)} \quad (3).$$

In the formula (3), the θ_j explains the average level of membership function of j -indicator in the C -country set.

Finally, for the assessment of the proportion of countries experiencing relatively highest deprivation in each dimension we estimate the threshold¹⁰:

$$F(j^{\text{crit}}) = 1 - \theta_j \quad (4).$$

Such approach let us to classify countries as those experiencing relatively low and high deprivation in each dimension (according to applied variables).

3. Human poverty – a worldwide perspective.

Our empirical outcomes encompasses multidimensional analysis of deprivation in 144 countries, regarding 7 arbitrary selected variables, which sheds more light on recent poverty estimates worldwide. The time coverage is 1990-2010. Following the methodology clarified in the previous section, we estimate the magnitude of poverty – defined as deprivation, which is assessed on solely non-income variables, both in year 1990 and then in 2010. Additionally,

¹⁰ Critical value (breaking value).

by weights estimates, we to track factors (variables) which contribute most to the overall deprivation of countries, again in 1990 and in 2010.

Below, in Table 1,2 and Charts 1,2 we present results of the empirical analysis. Table 1 explains summary statistics of degrees (levels) of deprivation in 144 countries, in 1990 and 2010. We estimate the total deprivation (Y_c) in a selected dimensions, for all countries in the sample. Note that lower values of Y_c determine higher welfare of country, while the high values of Y_c are met in case of countries which are relatively worse off.

Final results of the estimates are graphically presented in the scatter plot (see Chart 1). It shows jointly values of total deprivation (poverty) for each country in 1990 ($Y_{c,1990}$) and 2010 ($Y_{c,2010}$), allowing inter-country comparisons regarding the magnitude of poverty. In 1990, the 3 best performing countries were: Italy - $Y_{(Italy,1990)} = 0,02$, Japan - $Y_{(Japan,1990)} = 0,033$, and Spain - $Y_{(Spain,1990)} = 0,035$; while the 3 worst performers were: Angola - $Y_{(Angola,1990)} = 0,82$, Ethiopia - $Y_{(Ethiopia,1990)} = 0,86$ and Niger - $Y_{(Niger,1990)} = 0,86$. The 3 last countries in the classification are economies which experience extremely high deprivation (poverty) from basic achievements in society's welfare. In 2010, the 3 winning economies were: Greece - $Y_{(Greece,1990)} = 0,029$, Japan - $Y_{(Japan,1990)} = 0,031$ and Austria with the same score as Japan; while the 3 "last" countries were: Somalia - $Y_{(Somalia,1990)} = 0,903$, Niger - $Y_{(Niger,1990)} = 0,84$ and Angola - $Y_{(Angola,1990)} = 0,76$. The average value of the composite measure of deprivation ($\overline{Y_{c,year}}$), in 2010 is slightly lower than in 1990. It proves, that the whole group of countries has improved the general welfare in the analyzed period. In 1990, the total average deprivation in the sample reached the level of ($\overline{Y_{c,1990}}$) = 0,32, which corresponds to the proportion at 43,05% (62 economies, out of the 144), of all countries which are above the ($\overline{Y_{c,1990}}$) and are still lagging behind. The countries with the relatively worse (higher) score than (0,32), are classified as "poor" economies. After 20-year period, a slight drop in the deprivation degree is

observed. In 2010, the value of ($\overline{Y_{c,2010}}$) was at (0,266), which indicated that 55 countries (38,19% of all 144), were relatively worse off than the rest of economies in the sample. Such estimates justify a rough conclusion, that the gap between the rich and poor economies is persistent and huge. Slight progress in countries` welfare is visible, however in a great magnitude of countries the poverty problems remain widespread.

Table 1. Basic statistics on $Y_{(c)}$ values in 144 countries. Years 1990 and 2010.

	No. of observations.	Mean	Median	Min. Value	Max. Value	Std. Dev.
$Y_{(c)1990}$	144	0,323676	0,274532	0,020910	0,868181	0,240896
$Y_{(c)2010}$	144	0,266047	0,180717	0,029352	0,903315	0,227091

Source: own estimates.

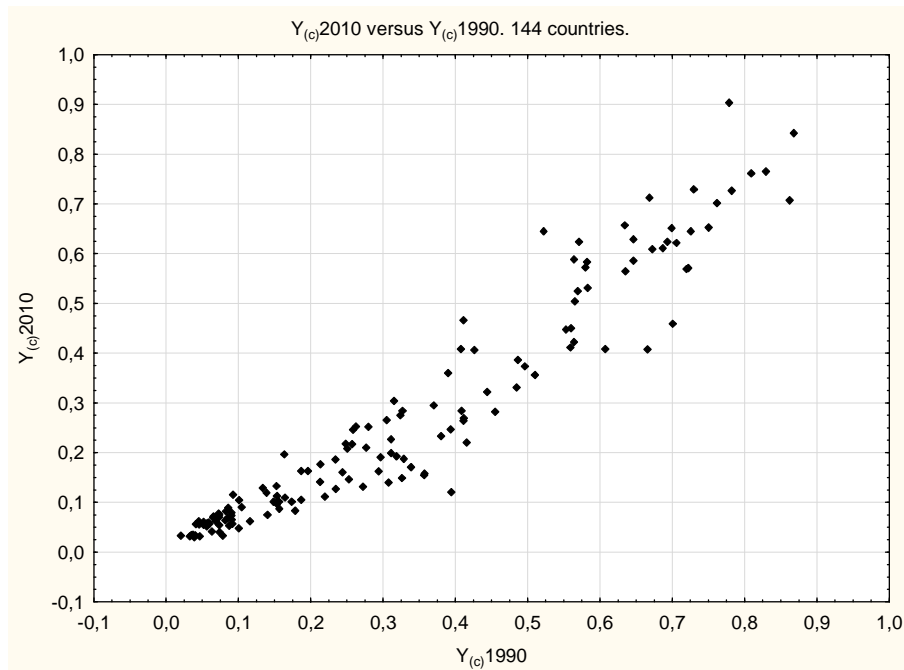
Presented in Chart 1, graphical analysis, reports on the statistical relationship between the values revealing individual country`s degree¹¹ of deprivation in 1990 (X-axis) and in 2010 (Y-axis). The research shows that the two variables are positively and highly correlated. Again it proofs that no tremendous changes were made in countries` achievements on the field of welfare. Countries which were classified as those of high deprivation (poverty) in 1990, remained as such in 2010. Chart 2 (see below), reports on changes in relative deprivation, showing the proportion of countries which have increased their well-being by improving achievements in selected dimensions. According to estimates¹², in the period 1990-2010, 76 countries have improved their position (52%), by decrease the level of relative poverty (the change ($Y_{c,2010} - Y_{c,1990}$) was negative) and can be classified as countries which are forging

¹¹ Each dot on Chart 1 presents a country.

¹² Author`s own calculations.

ahead in the sample. At a time, 68 countries (48%) has worsened its relative position, which as found are lagging behind countries¹³.

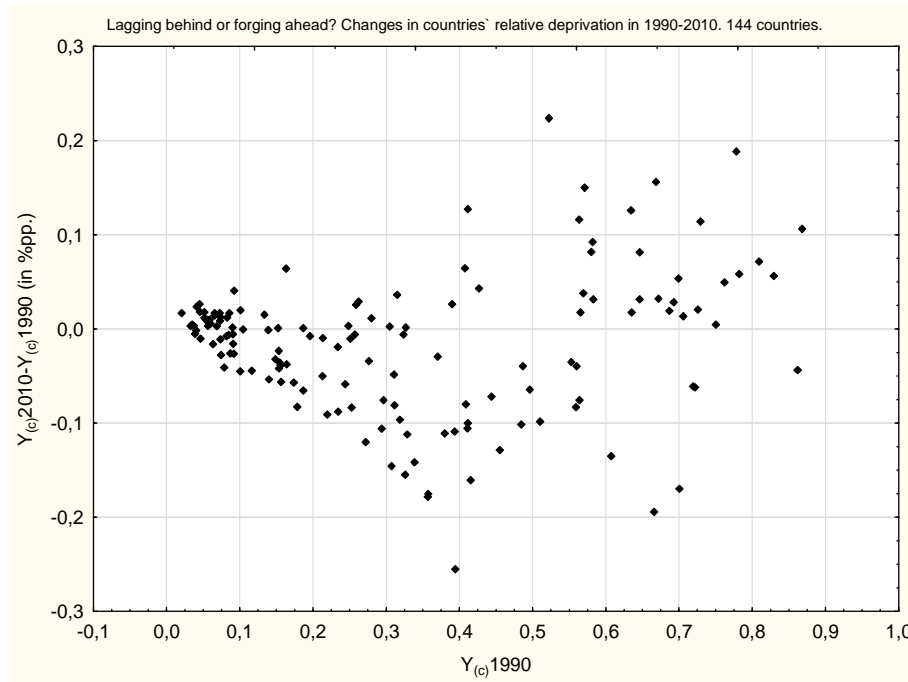
Chart 1. Total deprivation (poverty) in 144 countries. Years 1990 and 2010.



Source: own elaboration.

Chart 2. Lagging behind or forging ahead? Changes in countries` relative deprivation in 1990-2010. 144 countries.

¹³ Note – the methodology implies only relative changes in poverty (deprivation). It might occur that a country X has worsened its relative position, but – at the same time – the selected for the study variables have grown in absolute terms.



Source: own elaboration.

Finally, we contribute by investigating factors which influenced mostly the overall level of deprivation. Following the formula (3)¹⁴, we estimate the weights of each factor (variable) presenting dimensions of poverty (deprivation). The results are presented in Table 2 (see below). In 1990 and 2010, the 2 highest weights values are noted for Births Attended by Skilled Health Staff ($\omega_{(BAD,1990,2010)}$), and Improved Water Source ($\omega_{(IWS,1990,2010)}$), reaching even higher values in 2010 than in 1990. A decrease in weight value is reported for Life Expectancy variable - $\omega_{(LE,1990)}$ - 16%, and $\omega_{(LE,2010)}$ - 11%. Such change is probably due to significant increases in life expectancy in analyzed countries, while such positive changes are not reported in case of $BAD_{(c,y)}$ and $IWS_{(c,y)}$ variables. The poorest contribution to the degree of deprivation lies on the side of variable $Phy_{(c,y)}$ - only 4% and 3%, in 1990 and 2010 respectively.

¹⁴ See previous section.

Table 2. Weights (ω) of variables (indicators) in 1990 and 2010.

	$\omega_{(BRC)}$	$\omega_{(BAD)}$	$\omega_{(FE)}$	$\omega_{(IWS)}$	$\omega_{(LE)}$	$\omega_{(MR)}$	$\omega_{(Phy)}$
year1990	0,1237	0,1783	0,1400	0,1902	0,1611	0,1638	0,0425
year2010	0,1308	0,2002	0,1512	0,2003	0,1161	0,1668	0,0342

Source: own estimates.

4. Summary findings

The study covering 144 countries (period 1990-2010), was to show a general situation in the magnitude of human poverty and deprivation from access to basic facilities and elementary attainments which constitute human well-being. The problem was analyzed by adopting the methodology derived from fuzzy sets theory, which up till now, was relatively rarely applied on the ground of economic sciences. The findings are rather clear, illustrative however not exhaustive. The situation concerning poverty at the global level was not as stark as could have been expected. In 2010, still a great number of countries were classified as experiencing high degree of deprivation. And, what is tremendous, their situation has hardly changed since 1990. The evidence on persistent high global poverty is fact which shall be faced. Again, only slight fall in disparities among countries calls for better actions on the ground of education, healthcare system, better governance and many others. Access to education, information knowledge can provoke higher employment, productivity growth, encourage investments. These all enables countries to maintain robust growth in the long-run perspective, which helps to eradicate poverty more radically.

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