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Title	A Survey on Poverty Indicators: Features and Axiom
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Citation	長崎大学経済学部研究年報, 26, pp.25-47; 2010
Issue Date	2010-06-30
URL	http://hdl.handle.net/10069/24467
Description	
Rights	
Version	publisher

A Survey on Poverty Indicators: Features and Axioms

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Abstract

In September 2000, building upon a decade of major United Nations conferences and summits, world leaders came together at the United Nations Headquarter in New York to adopt the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets with a deadline of 2015 that have become known as the Millennium Development Goals (MDGs). One of the most important targets of MDGs relates to ending poverty and hunger. For instance, Target 1 is set to halve, between 1990 and 2015, the proportion of people whose income is less than \$1 a day. This study aims to summarize the essence of some major poverty indices and relating axioms to contribute to worldwide poverty reduction from academic aspects, surveying relevant literatures.

Key words: United Nations Millennium Development Goals, Poverty Indicators, Axiom, Inequality measures

JEL Classification: I32, D31, D63, E64, O12, C81, and C82

1 . Introduction

In September 2000, building upon a decade of major United Nations conferences and summits, world leaders came together at the United Nations Headquarter in New York to adopt the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets with a deadline of 2015 that have become well known as the Millennium Development Goals (hereafter, MDGs). One of the most important targets of MDGs relates to ending poverty and hunger. For instance, Target 1 is set to halve, between 1990 and 2015, the proportion of people whose income is less than \$1 a day.¹ Table 1 shows the Goal 1 of the Millennium Development Goals proposed by the United Nations, while Appendix reports the complete list.

¹ It is said that the Research Department of the World Bank has changed its global poverty line from \$1 a day to \$1.25 according to the study results of Ravallion et al (2008). In fact, some UN reports, including UN (2009), are based on this new poverty line. But it is not confirmed whether or not the official MDGs Target has been raised by the UN.

Table 1: Millennium Development Goals

<i>Goals and targets</i>	<i>Indicators</i>
Goal 1 . Eradicate extreme poverty and hunger	
Target 1. Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1. Proportion of population below \$1 per day
	2. Poverty gap ratio (incidence x depth of poverty)
	3. Share of poorest quintile in national consumption
Target 2. Halve, between 1990 and 2015, the proportion of people who suffer from hunger	4. Prevalence of underweight children (under five years of age)
	5. Proportion of population below minimum level of dietary energy consumption

Note: See footnote 1.

Source: UN (2001)

This study aims to summarize the essence of some major poverty indexes and relating axioms to contribute to worldwide poverty reduction from academic point of view, surveying both theoretical and empirical literatures as follows: At a standard textbook level, Atkinson et al. (2002) and Tachibanaki and Urakawa (2006) provide a comprehensive view on poverty and social indicators after the remarkable study on poverty indicators of Sen (1976, 1979); Amiel and Cowell (1997) re-examine empirically some of the standard axioms used in the literature on poverty measurement; Atkinson (1987) re-examines three basic issues in measuring poverty, i.e., the choice of the poverty line, the index of poverty, and the relation between poverty and inequality; Bellu and Liberati (2005) provide useful information derived from FAO studies; Blackburn (1989) evaluates several poverty indexes, including Theil measures, on the basis of the ability to satisfy five properties desirable for a poverty index; Bourguignon and Chakravarty (2003) suggest that an alternative way to take into account the multi-dimensionality of poverty is to specify a poverty line for each dimension of poverty and to consider that a person is poor if he/she falls below at least one of these various lines; Chakravarty, Deutsch and Silber (2008) consider poverty from a multidimensional perspective; Davidson and Duclos (2000) includes estimators of most of the poverty indices currently in use, as well as estimators of the curves used to infer stochastic dominance of any order, using the Luxembourg Income Study database; DeFina (2002) reports how aggregate economic conditions affect alternative poverty indexes; Deutsch and Silber (2005) present a systematic comparison of four approaches to multidimensional poverty analysis based respectively on the theory of

fuzzy sets, information theory, efficiency analysis and axiomatic derivations of poverty indices, based on the 1995 Israeli Census; Foster and Shorrocks (1991) characterize the class of subgroup consistent poverty indices, and identify the special features associated with this property; Foster (1998) evaluates the multiple notions of relative and absolute poverty that arise in choosing poverty lines and in aggregating the data into an overall index of poverty; Kakwani (1980, 1981) provides a generalization of Sen's poverty measure; The latter Kakwani (1981) demonstrates that the monotonicity axiom will be violated by this measure only in an unusual situation when the poverty line strictly exceeds the median income of the distribution; Kakwani (1993) provides distribution-free asymptotic confidence intervals and statistical inference for additive poverty indices based on the Living Standards Survey 1985 of Côte d'Ivoire; Pyatt (1987) identifies a class of poverty measures, the members of which are not badly behave in transfer process; Rietveld (1990) is addressed to comparing inequality in distributions of two or more variables; Ringen (1985) suggests that there is a need for alternative method of measuring poverty which corresponds the 'modern' conceptualization of the poverty problem; Rippin (2009) focuses on five axiomatically derived classes of multidimensional poverty measures; Silber (2007) attempts to review the main problems that have to be faced when taking a multidimensional approach to poverty and to give a survey of the solutions that have hitherto been proposed to solve these issues; Subramanian (2006) stresses a very simple point that apparently unexpectationable axioms of variable population inequality comparisons, such as the replication invariance property, can mitigate against other basic and intuitive plausible desiderata; Tsui (1996, 2002) focus on a class of subgroup decomposable poverty measures whose changes may be decomposed into a growth component and a redistribution component and explore the axiomatic foundation of multidimensional poverty indicators; World Bank (2005) summarizes some poverty and inequality measure and provides STATA programs; Zheng (1993, 1994, 1997, 2000) provides some foundation for axiomatic approach using poverty indicators based on Sen (1976, 1979); and, Biewen and Jenkins (2003) derive estimates for the sampling variance of two commonly-used classes of inequality indices, the Generalized Entropy and the Atkinson family of indices.

Moreover, some inequality measures are also surveyed because the absolute poverty is not widely observed in some developed countries, where inequality may be more problematic than poverty. Hereafter, income² is focused on in this study in spite of consumption and/or expenditure. Apart from this introduction section, the paper consists of four sections: The second section reveals some major poverty indicators, insensitive or sensitive to income distribution and decomposable to subgroup or not; the third section focuses on some important criteria that adopt the poverty indicators, which are called axioms; the fourth section, for supplemen-

2 Some literatures spotlight on expenditure or consumption. The argument, however, appears the same for expenditure/consumption or income when considering poverty indicators.

tary, treats some inequality measures and their criteria; and, the final section briefly concludes the paper and presents policy implications.

2 . Poverty Indicators

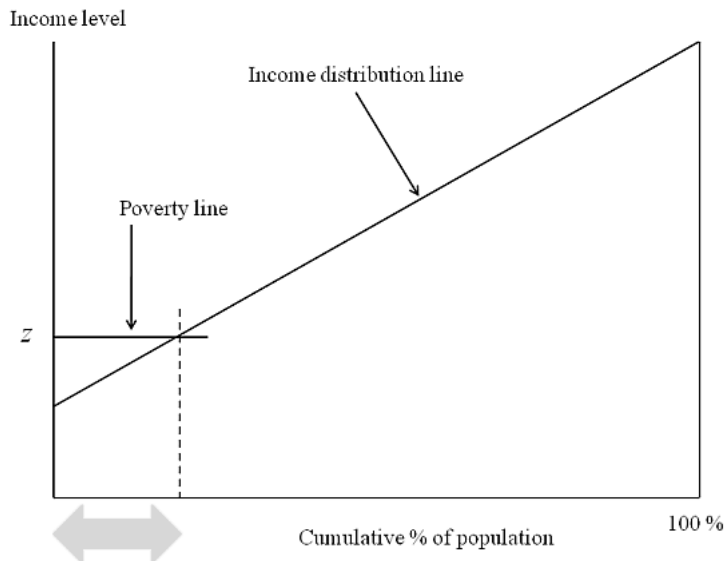
When analyzing poverty and/or inequality on income, it is required to employ equivalent income adjusted with the number of persons in household. This is because of the necessity to consider the scale of economy according to the number of persons of household.³ The equivalent income is given as follows:

$$(EQ-1) \quad y = \frac{Y}{n^e}$$

where	y	Equivalent income
	Y	Household income
	n	Number of persons in household
	e	Equivalent measure ⁴

Including Headcount ratio employed at the UN MGDs, this section deals with three types

Figure 1: Poverty Headcount



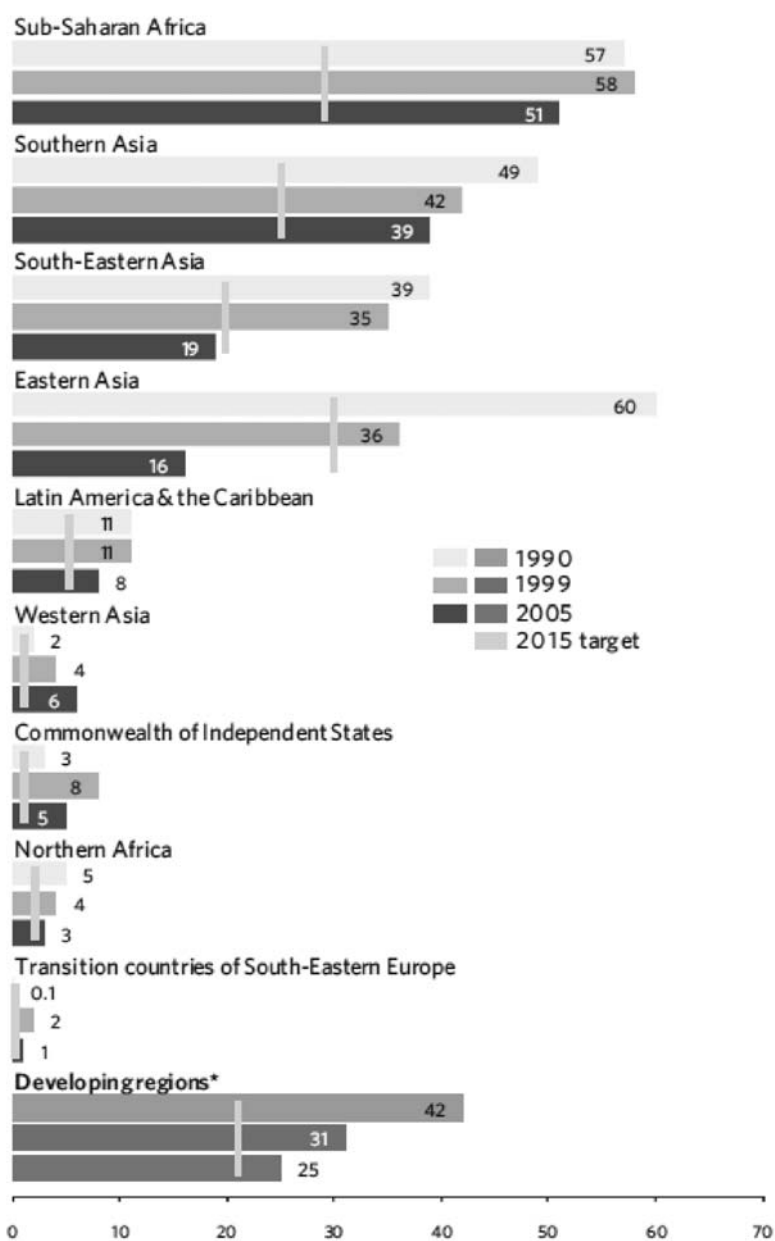
Note: The figure is not based on a tangible or specific data but a concept.

Source: Author

³ For more detail, see Lanjouw and Ravallion (1995).

⁴ In many cases, a square root of the number of persons in household is taken for the equivalent measure.

Figure 2: Proportion of People Living on less than the Poverty Line



Note: Although the poverty line of MDGs Target is set at \$1 a day, this figure is based on the poverty line of \$1.25 a day. For further information, see footnote 1.

Source: UN (2009) p.6

of general indicator, while other three indicators that are distribution-sensitive are also focused on at later part of the section.

2.1 Headcount Index

Target 1 of the UN MDGs is based on Headcount Index, which simply measures the proportion of the population living under the poverty line. In other words, this index counts the frequency of poverty. This indicator is expressed mathematically as follows:

(EQ-2) Headcount Ratio (HR)

$$HR = \frac{N_p}{N} = \frac{1}{N} \sum_{i=1}^N I(y_i < z)$$

where N Number of population
 N_p Number of the poor
 y Equivalent income
 z Poverty line

Here, $I(\cdot)$ is an indicator function that takes on a value of 1 if the bracketed expression is true, and 0 otherwise. So if income (x_i) is less than the poverty line (z), then $I(\cdot)$ equals to 1 and the household would be counted as poor. N_p is the total number of the poor as indicated.

Figures 1 and 2 depict image of Headcount Index and the proportion of people living on less than the poverty line reported in UN (2009), respectively.

2.2 Income Gap Ratio

Income Gap Ratio measures the gap between the poverty line and the average income of poverty group. Practically, this indicator is calculated as division of the average income of poverty group by poverty line as follows:

(EQ-3) Income Gap Ratio (IGR)

$$IGR = 1 - \frac{\mu_p}{z}$$

where μ_p Mean income of poverty group

2.3 Poverty Gap Ratio

IGR indicated at the former subsection does not satisfy decomposability axiom later mentioned, although it is useful for measuring strength of poverty at a glance. Hence, Poverty Gap Ratio, which adds up the extent to which individuals on average fall below the poverty line, and express it as a percentage of the poverty line, is developed as follows using the index function $I(\cdot)$:

(EQ-4) Poverty Gap Ratio (*PGR*)

$$PGR = \frac{1}{N} \sum_{i=1}^N \frac{G_i}{z}$$

$$\text{where } G_i = (z - y_i) \times I(y_i < z)$$

PGR can be divided to subgroups according to the poverty level of the population as follows:

(EQ-5) Division of Poverty Level

$$P(y; z) = \sum_{k=1}^m \frac{N^k}{N} P(y; z)$$

$$\text{where } P(y; z) \text{ Poverty level of population}$$

$$P(y_k; z) \text{ Poverty level of } k^{\text{th}} \text{ group}$$

(EQ-5) indicates that poverty level of the population is decomposed by the weighted average of that of each subgroup.

2.4 Squared Poverty Gap Ratio

To construct a measure of poverty that takes into account inequality among the poor, some researchers use the squared poverty gap index. This is simply a weighted sum of poverty gaps as a proportion of the poverty line, where the weights are the proportionate poverty gaps themselves. This index is also called Poverty Severity Index due to its nature and expressed as follows:

(EQ-6) Squared Poverty Gap Ratio (*SPGR*)

$$SPGR = \frac{1}{N} \sum_{i=1}^N \left(\frac{G_i}{z} \right)^2$$

2.5 FGT Index

Foster, Greer and Thorbecke (1984) proposed FGT Index, generalizing the former Square Poverty Gap ratio as follows:

(EQ-7) FGT Index (*FGT*)

$$FGT = \frac{1}{N} \sum_{i=1}^N \left(\frac{G_i}{z} \right)^\alpha$$

Apparently, FGT Index (FGT) is identical to Squared Poverty Gap when $\alpha=2$, and satisfies the Weak Transfer Sensitivity Axiom when $\alpha > 2$.

2.6 Watts Index

Zeng (1993) points out that the first distribution-sensitive poverty indicator was proposed

by Watts (1968). The discrete version of Watts Index takes the following form:

(EQ-8) Watts Index (WAT)

$$WAT = \frac{1}{N} \sum_{i=1}^{N_b} [\ln(z) - \ln(y_i)]$$

Watts Index (WAT) seems to express the degree of poverty gap among extremely poor group.

2.7 Sen Index

Sen (1976) proposed index of the product of poverty Headcount, Income Gap Ratio, and Gini coefficient among the poor, which considers income distribution among the poor as follows:

(EQ-9) Sen Index (SEN)

$$SEN = \frac{N_b}{N} \left[1 - (1 - GINI) \frac{\mu^p}{z} \right]$$

where $GINI$ Gini coefficient among the poor

Sen Index (SEN) falls when allover mean income increases, *ceteris paribus*.

2.8 Income Sensitivity and Decomposability

While further argument will be developed in next section, poverty indices can be classified into following three types:

- 1) Insensitive to income distribution among the poor: HR , IGR , and PGR ;
- 2) Sensitive to income distribution but non-decomposable to subgroup: SEN ; and,
- 3) Sensitive to income distribution and decomposable to subgroup: FGT^5 and WAT .

3 . Axioms

Above-mentioned major poverty indicators are required to satisfy some important criteria. They are called axioms. This study surveys fifteen axioms in fourteen subsections and finally, presents a table of axiom to adopt poverty indicators.

3.1 Focus Axiom

The Focus Axiom states that the poverty index should be independent of or insensitive to the income distribution of the non-poor above the poverty line. Considering a certain income

⁵ Hereafter, $SPGR$ will be included in FGT as a particular case of $\alpha = 2$, and omitted in argument in this study.

distribution, this axiom requires that the poverty indicator should be invariable for a fixed poverty line even if the non-poor income distribution is changed as follows:

$$(EQ-10) \quad P(x; z) = P(y_1; z)$$

where	P	Poverty indicator
	x	Initial income distribution vector
	y_1	Income distribution vector after change of non-poor income distribution
	z	Poverty line

3.2 Symmetry Axiom

The Symmetry Axiom states that the poverty index should depend on income levels of anonymous individuals. If the same income distribution is found, but with other individuals, this axiom requires that the poverty index should not be affected, in other words, when specific two individuals exchange their income with a pairwise manner, the index should be invariant.

$$(EQ-11) \quad P(x; z) = P(y_2; z)$$

where	y_2	Income distribution vector after exchange of two individuals
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The major poverty indices focused on in this study satisfy these first two axioms in general.

3.3 Replication Invariance Axiom

The Replication Invariance Axiom states that the poverty index should be invariant with respect to a k -fold replication of a specific income distribution, where k is any positive integer. In other words, this axiom requires that the index should be invariable when pooling identical groups.

$$(EQ-12) \quad P(x; z) = P(x \times k; z)$$

where	k	Positive integer number
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3.4 Continuity Axiom

The Continuity Axiom states that the poverty index should be a continuous function of individual incomes, which implies that a small change in a poor individual's income should not lead to a large change in the poverty level.

3.5 Increasing Poverty Line Axiom

The Increasing Poverty Line Axiom states that the poverty index should be an increasing function of the income level of the poverty line.

3.6 Regressive and Progressive Transfer Axioms

The Regressive Transfer Axiom states that the poverty index should rise by a regressive income transfer with at least the donor being poor. Otherwise, the poverty index subject to this axiom should fall by a progressive income transfer naturally, which is defined as the Progressive Transfer Axiom. These two axioms dealt with at this subsection can be described as two sides of the same coin.

3.7 Subgroup Consistency Axiom

The Subgroup Consistency Axiom states that the poverty index should be subgroup consistent, i.e., the poverty index, computed over the entire population, should rise/fall whenever, *ceteris paribus*, its value, computed over a subgroup of the population, rises/falls. Subgroup consistency may thus be viewed as the extension of monotonicity to groups: The Monotonicity Axiom requires that aggregate poverty rise when a poor person's poverty level is increased; the Subgroup Consistency Axiom requires that aggregate poverty should rise when a subgroup's poverty level is increased.

3.8 Weak Monotonicity Axiom

The Weak Monotonicity Axiom states that the poverty index should rise when the income of a poor individual decreases. Or, the poverty index should fall when the income of a poor individual increases, provided that this individual remains poor.

3.9 Strong Monotonicity Axiom

The Strong Monotonicity Axiom states that the poverty index should fall whenever the income of a poor individual increases. There is little difference between the Weak and Strong Monotonicity Axioms but it is important to distinguish. When the income of a poor individual increases, the Weak Monotonicity Axiom requires that the poverty index should fall only if the poor individual is not lifted out of poverty after the increase. On contrary, the Strong Monotonicity Axiom requires that the poverty index should fall also in the case that the poor individual is lifted out of poverty. Therefore, the Strong Monotonicity Axiom implies the Weak Monotonicity Axiom.

3.10 Minimal Transfer Axiom

The Minimal Transfer Axiom states that the poverty index should rise/fall after a regressive/progressive transfer among two poor individuals, provided that these two remain poor after the transfer, i.e., with the same number of poor people before and after the transfer.

3.11 Weak Transfer Axiom

The Weak Transfer Axiom states that the poverty index should rise/fall after a regressive /progressive transfer from an individual either above or below the poverty line to a relatively poorer individual. Also in this case, the number of poor people must be the same before and after the transfer.

3.12 Restricted Continuity Axiom

The Restricted Continuity Axiom states that the poverty index should be a continuous function of poor incomes. The former-mentioned Continuity Axiom in subsection 3.4 states that the poverty index should be continuous to individual income, while the Restricted Continuity Axiom states that the poverty index should be continuous to poor income. These two axioms aim that a small change in a poor individual's income should not lead to a large change in the poverty level.

3.13 Decomposability Axiom

The Decomposability Axiom states that the poverty index should be decomposable to subgroups as follows:

$$(EQ-13) \quad P(x; z) = \frac{N(x_1)}{N(x)} P(x_1; z) + \frac{N(x_2)}{N(x)} P(x_2; z) + \frac{N(x_3)}{N(x)} P(x_3; z) + \dots$$

where	x	Income vector	$x = (x_1, x_2, x_3, \dots)$
	N	Number of population	$N(x) = N(x_1) + N(x_2) + N(x_3) + \dots$

The Decomposability Axiom implies the Subgroup Consistency Axiom, i.e., whatever poverty index that satisfies the Decomposability Axiom will satisfy the Subgroup Consistency Axiom.

3.14 Non-Poverty Growth Axiom

The Non-Poverty Growth Axiom states that the poverty index should fall when a non-poor individual is added to a population as follows:

$$(EQ-11) \quad P(x; z) > P(y_3; z)$$

where	y_3	Income distribution vector after addition of a non-poor individual
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3.15 Axiom for Poverty Measurement and Poverty Indices

After overviews major poverty indices in the previous section, and axioms in this section, the relationship between poverty indices and axioms is provided in Table 2.

Table 2: Axiom Poverty Measurement and Poverty Indices

<i>Axioms</i>	<i>HR</i>	<i>IGR</i>	<i>PGR</i>	<i>SEN</i>	<i>FGT</i>	<i>WATTS</i>
Focus	○	○	○	○	○	○
Symmetry	○	○	○	○	○	○
Replication Invariance	○	○	○	×	○	○
Continuity	×	×	○	×	○	○
Increasing Poverty Line	×	×	×	○	○	○
Regressive Transfer	×	×	×	×	○	○
Progressive Transfer						
Subgroup Consistency	○	○	○	×	○	○
Weak Monotonicity	×	○	○	○	○	○
Strong Monotonicity	×	×	○	○	○	○
Minimal Transfer	×	×	×	○	○	○
Weak Transfer	×	×	×	○	○	○
Restricted Continuity	○	○	○	○	○	○
Decomposability	○	×	○	×	○	○
Non-Poverty Growth	○	×	○	○	○	○

Source: Tachibanaki and Urakawa (2006) Chapter 3 Table 3-1 p.72 arranged by author

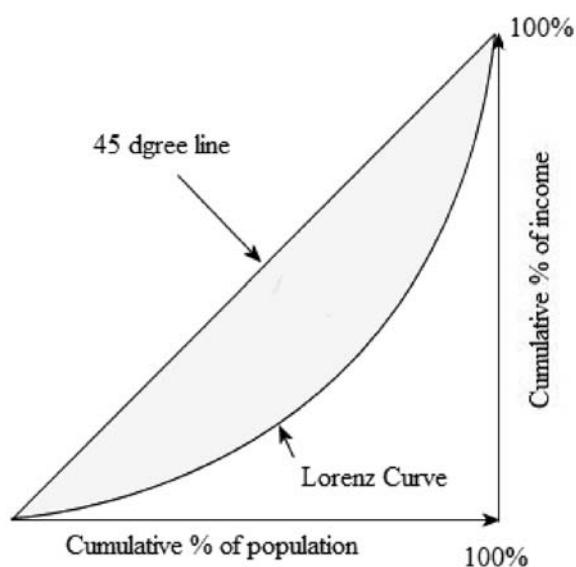
4 . Inequality measures

Inequality is a broader concept than poverty in that it is defined over the entire population, and not just for the population below a certain poverty line. Most inequality measures do not depend on the mean of the distribution, and this property of mean independence is considered to be a desirable property of an inequality measure. In many developed countries, absolute poverty is neither observed broadly nor a big problem, per se. For that reason, this study includes a brief section on measuring inequality. Four types of inequality measures such as Gini Coefficient, Generalized Entropy, Atkinson's Inequality Index, and Relative Poverty Rate will be focused on.

4.1 Gini Coefficient

The most widely used measure of inequality is the Gini Coefficient. It is based on the Lorenz curve, a cumulative frequency figure that compares the distribution of income with the uniform distribution that represents equality. To construct the Gini coefficient, graph the cumulative percentage of households, from poor to rich, on the horizontal axis and the cumulative percentage of income on the vertical axis. Figure 1 depicts the visual expression of the Gini Coefficient. The Gini Coefficient is calculated as the area framed by Lorenz curve and diagonal 45 degree line. The values of the Gini Coefficient vary between 0 and 1. The former means perfect equality, while the latter represents perfect inequality .

Figure 3: Lorenz Curve and Gini Coefficient



Note: The figure is not based on a tangible or specific data but a concept.

Source: Author

Mathematically, Gini Coefficient (*GINI*) is calculated according to following formula:

(EQ-12) Gini Coefficient (*GINI*)

$$GINI = 1 - \sum_{i=1}^N (x_i - x_{i-1})(y_i - y_{i-1})$$

where x_i i^{th} point on the X-axis⁶
 y_i i^{th} point on the Y-axis
 N Number of population

When there are n equal intervals on the X-axis this simplifies to follows:

$$(EQ-13) \quad GINI = 1 - \frac{\sum_{i=1}^n (y_i - y_{i-1})}{n}$$

where n Number of equal intervals⁷

6 In this section, some variables are differently defined from previous sections.

7 In usual, quintile or decile intervals are employed.

4.2 Generalized Entropy

There are a number of inequality measures that satisfy some criteria.⁸ Among the most widely employed are the Theil indexes and the mean log deviation measure, both of which belong to the family of Generalized Entropy inequality measures (*GE*). The general formula is given as follows:

(EQ-14) Generalized Entropy (*GE*)

$$GE(\alpha) = \frac{1}{\alpha(\alpha-1)} \left[\frac{1}{N} \sum_{i=1}^N \left(\frac{y_i}{\bar{y}} \right)^\alpha - 1 \right]$$

where α Distance weighting parameter
 \bar{y} Mean income

The values of *GE* vary between 0 and ∞ . The former represents an equal distribution and higher value implies a higher level of inequality. The parameter α in the *GE* class represents the weight given to distances between incomes at different parts of the income distribution, and can take any real value. For lower values of α , *GE* is more sensitive to changes in the lower tail of the distribution, and for higher values, *GE* is more sensitive to changes that affect the upper tail. The value of α practically takes natural numbers and the commonest values of α are 0, 1, or 2. *GE*(1) is identical to Theil's T index, which may be written as follows:

(EQ-15) Theil's T Index (*GE*(1))

$$GE(1) = \frac{1}{N} \sum_{i=1}^N \frac{y_i}{\bar{y}} \ln \left(\frac{y_i}{\bar{y}} \right)$$

GE(0), also known as Theil's L Index, and sometimes referred to as the mean log deviation measure, is given as follows:

(EQ-16) Theil's L Index (*GE*(0))

$$GE(0) = \frac{1}{N} \sum_{i=1}^N \ln \left(\frac{y_i}{\bar{y}} \right)$$

4.3 Atkinson's Inequality Index

Atkinson (1970) proposes another class of inequality measures that are used from time to time. This class also has a weighting parameter ϵ , which measures aversion to inequality and some of its theoretical properties are similar to those of the extended Gini index. The Atkinson Index (*A*) is defined as follows:

⁸ For more detail, see subsection 4.5.

(EQ-17) Atkinson Index ($A(\epsilon)$)

$$A(\epsilon) = \begin{cases} 1 - \left[\frac{1}{N} \sum_{i=1}^N \left(\frac{y_i}{\bar{y}} \right)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}} & \text{for } \epsilon \in [0, 1) \\ 1 - \frac{\prod_{i=1}^N \left(y_i^{(1/N)} \right)}{\bar{y}} & \text{for } \epsilon = 1 \end{cases}$$

where ϵ Aversion weighting parameter to inequality ($0 \leq \epsilon \leq 1$)

4.4 Relative Poverty Rate

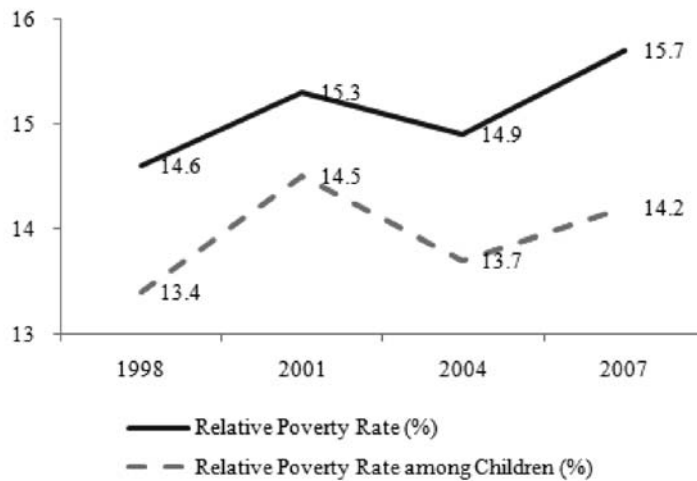
The Relative Poverty Rate is taken as a poverty measure in the OECD. According to Forster and d'Ercole (2005), the OECD sets the relative poverty line as the 50% level of the median income.

(EQ-18) Relative Poverty Rate (RPR)

$$RPR = \frac{N_{rp}}{N} = \frac{1}{N} \sum_{i=1}^N I(y_i < z_r)$$

where N Number of population
 N_{rp} Number of the relatively poor
 x Equivalent income
 z_r Relative poverty line

Figure 4: Relative Poverty Rate in Japan



Source: Ministry of Health, Labor and Welfare, Government of Japan

The Ministry of Health, Labor and Welfare released the Relative Poverty Rate in Japan based on the identical methodology to the OECD on October 20, 2009 as depicted in Figure 4.

4.5 Criteria for Inequality Measures

Each measure mentioned above is not entirely satisfactory. To see this, consider the criteria that make a good measure of income inequality, namely:

- 1) Mean Independence: This means that if all incomes were doubled, the measure would not change.
- 2) Population Size Independence: If the population were to change, the measure of inequality should not change, *ceteris paribus*.
- 3) Symmetry: If two persons exchange their incomes, there should be no change in the measure of inequality.
- 4) Pigou-Dalton Transfer Sensitivity: Under this criterion, the transfer of income from rich to poor reduces an inequality measure.
- 5) Decomposability: This means that inequality may be broken down by population groups or income sources or in other dimensions.
- 6) Statistical Testability: One should be able to test for the significance of changes in the index over time. This is less of a problem than it used to be because confidence intervals can typically be generated using bootstrap techniques.

Since this study at first focuses on poverty indicators, inequality measures will be treated as supplemental parts. It is, however, noteworthy that the Gini coefficient, for instance, satisfies above-mentioned former four criteria, and does not the latter two, while the Generalized Entropy does them all.

5 . Conclusion

This study overviews the poverty indexes and the axioms as criteria for them, surveying relevant literatures. Absolute poverty and hunger, as well as unacceptable inequality, translate a clear and present danger to social cohesion, political stability, and therefore the sustainability of growth as Ali (2008) insists.

For the first step to reduce poverty and inequality from macroeconomic viewpoints, economic growth should be aimed. For instance, Dollar and Kraay (2002) stress that “*standard growth-enhancing policies should be at the center of any effective poverty reduction strategy* (Dollar and Kraay (2002) p.219),” which many economists are supposed to agree to. World Bank (1990) denies so-called “Trickle Down” process or sequencing in which the rich get richer first and eventually benefits trickle down to the poor. From the macroeconomic viewpoint, so far, growth-enhancing policy, including the Poverty Reduction and Growth Facility (PRGF) of

the IMF and micro credit facility like those provided by the Grameen Bank,⁹ is expected to play an important role.

On contrary, some empirical studies point out that a variety of pro-growth macroeconomic policies, including low inflation, moderate size of government, sound financial development, respect for the rule of law, and openness to international trade, raise average incomes with little systematic effect on the distribution of income. If these pro-growth policies, as well as the market economy, fail to achieve moderate or acceptable inequality of income level, additional government measures on redistribution should be applied for this purpose.

Including all of these policy measures, the arguments must be based on a scientific viewpoint to reduce poverty and inequality. Hence, scientific poverty indicators are strongly required.

Appendix: Millennium Development Goals	
<i>Goals and targets</i>	<i>Indicators</i>
Goal 1. Eradicate extreme poverty and hunger	
Target 1. Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1. Proportion of population below \$1 per day 2. Poverty gap ratio (incidence x depth of poverty) 3. Share of poorest quintile in national consumption
Target 2. Halve, between 1990 and 2015, the proportion of people who suffer from hunger	4. Prevalence of underweight children (under five years of age) 5. Proportion of population below minimum level of dietary energy consumption
Goal 2. Achieve universal primary education	
Target 3. Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	6. Net enrolment ratio in primary education 7. Proportion of pupils starting grade 1 who reach grade 5 8. Literacy rate of 15-24-year-olds
Goal 3. Promote gender equality and empower women	
Target 4. Eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015	9. Ratio of girls to boys in primary, secondary and tertiary education 10. Ratio of literate females to males of 15-to-24-year-olds 11. Share of women in wage employment in the non-agricultural sector 12. Proportion of seats held by women in national parliament

⁹ Schreiner (2003) and Hulme (2008) provide further information on the Grameen Bank.

Goal 4. Reduce child mortality		
Target 5.	Reduce by two thirds, between 1990 and 2015, the under-five mortality rate	13. Under-five mortality rate 14. Infant mortality rate 15. Proportion of 1-year-old children immunized against measles
Goal 5. Improve maternal health		
Target 6.	Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio	16. Maternal mortality ratio 17. Proportion of births attended by skilled health personnel
Goal 6. Combat HIV/AIDS, malaria and other diseases		
Target 7.	Have halted by 2015 and begun to reverse the spread of HIV/AIDS	18. HIV prevalence among 15-to-24-year-old pregnant women 19. Contraceptive prevalence rate 20. Number of children orphaned by HIV/AIDS
Target 8.	Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	21. Prevalence and death rates associated with malaria 22. Proportion of population in malaria risk areas using effective malaria prevention and treatment measures 23. Prevalence and death rates associated with tuberculosis 24. Proportion of tuberculosis cases detected and cured under directly observed treatment short course
Goal 7. Ensure environmental sustainability		
Target 9.	Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources	25. Proportion of land area covered by forest 26. Land area protected to maintain biological diversity 27. GDP per unit of energy use (as proxy for energy efficiency) 28. Carbon dioxide emissions (per capita) [Plus two figures of global atmospheric pollution: ozone depletion and the accumulation of global warming gases]
Target 10.	Halve by 2015 the proportion of people without sustainable access to safe drinking water	29. Proportion of population with sustainable access to an improved water source

Target 11.	By 2020 to have achieved a significant improvement in the lives of at least 100 million slum dwellers	30. Proportion of people with access to improved sanitation 31. Proportion of people with access to secure tenure <i>[Urban/rural disaggregation of several of the above indicators may be relevant for monitoring improvement in the lives of slum dwellers]</i>
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Goal 8. Develop a global partnership for development		
Target 12.	Develop further an open, rule-based, predictable, non-discriminatory trading and financial system Includes a commitment to good governance, development, and poverty reduction — both nationally and internationally	<i>[Some of the indicators listed below will be monitored separately for the least developed countries (LDCs), Africa, landlocked countries and small island developing States]</i>
Target 13.	Address the special needs of the least developed countries Includes: tariff and quota free access for least developed countries' exports; enhanced programme of debt relief for HIPC and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction	32. Net ODA as percentage of OECD/DAC donors' gross national product (targets of 0.7% in total and 0.15% for LDCs) 33. Proportion of ODA to basic social services (basic education, primary health care, nutrition, safe water and sanitation) 34. Proportion of ODA that is untied 35. Proportion of ODA for environment in small island developing States
Target 14.	Address the special needs of landlocked countries and small island developing States (through the Programme of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly)	Official development assistance 36. Proportion of ODA for transport sector in landlocked countries Market access 37. Proportion of exports (by value and excluding arms) admitted free of duties and quotas 38. Average tariffs and quotas on agricultural products and textiles and clothing
Target 15.	Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term	39. Domestic and export agricultural subsidies in OECD countries 40. Proportion of ODA provided to help build trade capacity Debt sustainability

	41. Proportion of official bilateral HIPC debt cancelled
	42. Debt service as a percentage of exports of goods and services
	43. Proportion of ODA provided as debt relief
	44. Number of countries reaching HIPC decision and completion points
Target 16. In cooperation with developing countries, develop and implement strategies for decent and productive work for youth	45. Unemployment rate of 15-to-24-year-olds
Target 17. In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries	46. Proportion of population with access to affordable essential drugs on a sustainable basis
Target 18. In cooperation with the private sector, make available the benefits of new technologies, especially information and communications	47. Telephone lines per 1,000 people 48. Personal computers per 1,000 people [Other indicators to be decided]

Source: UN (2001)

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