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INEQUALITIES AND THEIR MEASUREMENT*

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Abstract

This paper is a review of the recent advances in the measurement of inequality. Inequality can have several dimensions. Economists are mostly concerned with the income and consumption dimensions of inequality. Several inequality indices including the most widely used index of inequality namely the Gini coefficient is discussed. Non-income inequality includes inequality in skills, education, opportunities, happiness, health, wealth, and others. The direct and indirect effects of inequality in non-income factors on earnings and health are discussed. Results from review of the literature suggest relationship between inequality in income and non-income dimensions. This indicates that one should account for the interrelationship between the different dimensions in the measurement and analyses of inequalities.

Keywords: Income inequality, inequality indices, income distribution

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1. INTRODUCTION

There is ongoing and increasing interest in measuring and understanding the level, causes and development of inequality during the 1990s. This period signified a shift in research previously focused on economic growth, the identification of the determinants of economic growth and convergence in GDP per capita across countries to analysis of distribution of income, its development over time and identification of factors determining the distribution of income. This shift in focus is specifically from the issues of convergence or divergence of per capita incomes to the long-term equalisation or polarisation of incomes across regions and countries of the world. This shift is not only a reflection of technological change and raised human capacity to create growth, wealth and in the effective use of resources, but also due to awareness of the growing disparity and importance of redistribution and poverty reduction. The growing disparity calls for analysis of possible trends in global income inequality.

Inequality can have many dimensions. Economists are concerned specifically with the economics or monetarily-measurable dimension related to individual or household income and consumption. However, this is just one perspective and inequality can be linked to inequality in skills, education, opportunities, happiness, health, life expectancy, welfare, assets and social mobility. This paper will, in reviewing the literature, give attention to the relationship between income inequality and the non-income inequality dimensions.

Remaining parts of the paper is organised as follows. In Section 2 distribution and inequality of income is illustrated in the Lorenz diagram. Section 3 introduces several inequality indices. Generalizations of Gini index is discussed in Section 4. Section 5 and 6 discuss income and non-income inequalities. The final Section concludes.

2. THE LORENZ CURVE

Income inequality refers to the inequality of the distribution of individuals, household or some per capita measure of income among the population of a country.[1] In illustrations we follow the notation found in Anand (1997). An income distribution is a vector of incomes, $x = (x_1, x_2, ..., x_n)$, where x_i indicate the income of the *i*th individual in a society consisting of *n* individuals. The mean of the distribution of x and its dimensionality are written as $\mu(x)$ and $n(x)$. Here income is a continuous random variable bounded in the interval $x_0 (\geq 0)$ and $\bar{x}$. The density, distribution and the first moment functions are $f(x), F(x),$ and $\Phi(x)$. Where $f(x), F(x) = \int_{x_0}^{\bar{x}} f(y)dy$, and $\Phi(x) = 1/\mu \int_{x_0}^{\bar{x}} yf(y)dy$ are the proportion of the population with income x, cumulative proportion of the population with income x, and cumulative share in total income, respectively. The mean of the distribution is $\mu = \int_0^{\infty} yf(y)dy$.

[1] For a review of the notion of inequality and alternative ethical theories see Subramanian (1997). Cowell (2000) provides a comprehensive survey where analysis of inequality is placed in the context of recent developments in economics and statistics. The focus is on inequality measurement to give meaning to comparisons of income distributions. The natural limitations of the subject and answers to a number of questions raised are discussed.

The graph of $F(x)$ against $\Phi(x)$ is the Lorenz (1905) curve representing the inequality of income distribution. The divergence of a Lorenz curve for perfect equality and the Lorenz curve for a given income distribution is measured by some index of inequality. The most widely used index of inequality is the Gini coefficient. The distribution and inequality of income is illustrated in the Lorenz diagram, Figure 1.

Figure 1 about here

The Lorenz curve plots the cumulative share of total income against the cumulative proportion of income receiving units. It is used for analysing the size distribution of income and wealth, to estimate the Gini index and other measures of inequality and poverty. However, an important drawback of the traditional models of the Lorenz curve is a lack of satisfactory fit over the entire range of a given income distribution. There are two parametric approaches to estimate the Lorenz curve (Ryu and Slottje, 1999). In the first approach one assumes a hypothetical statistical distribution for income distribution on which to base the estimate of the Lorenz curve (McDonald and Xu, 1995). In the second approach, a specific functional form is fit to the Lorenz curve directly to estimate the empirical Lorenz curves (Ryu and Slottje 1996; and Chotikapanich and Griffiths 2002).

The estimated Lorenz curve is sensitive to errors in survey data. The robustness properties of inequality and poverty measures assuming contaminated data and using parametric and non-parametric methods with illustrations are considered in Cowell and Victoroa-Feser (1996a and 1996b). Hasegawa and Kozumi (2003) propose an alternative approach to Lorenz curve estimation with contaminated data using Bayesian non-parametric analysis and present a method for removing the contaminated observations. Results obtained using both simulated and real data suggest that this approach estimated the Lorenz curve and Gini indices adequately.

A further drawback of the traditional models of the Lorenz curve is that they lack satisfactory fit over the entire range of a given income distribution. Ogwang and Rao (2000) propose two hybrid Lorenz curve, namely the additive models and the multiplicative models by combination of traditional models written as:

$$(1) \qquad \begin{array}{l} y = f(p) = \delta\, f_1(p) + (1-\delta) f_2(p) \quad \text{and} \\ y = f(p) = f_1(p)^{\gamma}\, f_2(p)^{\lambda} \end{array}$$

where $0 \le \delta \le 1, \gamma \ge 1, \lambda \ge 1$, and the subscripts 1 and 2 denote the two additive and multiplicative descriptions of a Lorenz curve. A comparison of the performance of the hybrid and traditional curves shows that the hybrid models are flexible and perform better in fitting different portion of the observed income distribution well. This is illustrated using US income data for 1977.

3. INEQUALITY INDICES

Several inequality indices can be derived from the Lorenz diagram. The Lorenz Curve construction also gives us a rough measure of the amount of inequality in the income distribution. The measure is called the Gini Coefficient. Computation of the Gini Coefficient is illustrated by Figure 2. The Gini coefficient is a standard measure of inequality defined as the area between the Lorenz curve and the line of perfect equality divided by the area below the perfect equality line expressed as:

(2) $$Gini = 1 - \sum_{i=0}^{n-1} (F_{i+1} - F_i)(\Phi_{i+1} + \Phi_i)$$

where F and Φ are as previously defined (see Figure 2). The index lies in the interval 0 (perfect equality) and 1 (perfect inequality). Among the other notable measures of inequality are: the range, the variance, the squared coefficient of variation, the variance of log incomes, the absolute and relative mean deviations, and Theil's two inequality indices (see Anand 1997).

Figure 2 about here

The range and the variance are the two common statistical measures of dispersion for a distribution in general. These are useful measures in the context of income. The range is defined as the absolute difference between the highest and the lowest income levels divided by the mean income:

(3) $$RGE = (x_{\max} - x_{\min}) / \mu$$

where the arithmetic mean income is $\mu = 1/n \sum_{i=1}^{n} y_i$. The method is very sensitive to extreme observations. The variance of income is written as:

(4) $$VAR = \text{var}(y) = \frac{1}{n} \sum_{i=1}^{n} (y_i - \mu)^2 .$$

The squared coefficient of variation is obtained by dividing the variance with squared mean:

(5) $$SCV = VAR / \mu^2 .$$

In similarity with the range, the variance and squared coefficient of variation are sensitive to extreme observations. The variance of logarithm of income can be written as:

(6) $$VLI = \text{var}(\log y) = \frac{1}{n} \sum_{i=1}^{n} (\log y_i - \log \tilde{\mu})^2$$

where

(7) $$\log \tilde{\mu} = \frac{1}{n} \sum_{i=1}^{n} \log y_i$$

is the geometric mean income of the distribution. Finally, the first Theil's entropy index of inequality is defined as:

(8) $$T1 = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{\mu} \log \frac{y_i}{\mu} .$$

This can be directly computed from the Lorenz curve of income distribution. The second measure can be written as:

(9) $$T2 = \sum_{i=1}^{n} (1/n) \log \frac{(1/n)}{(y_i / Y)} = \frac{1}{n} \sum_{i=1}^{n} \log \frac{\mu}{y_i}$$

where $Y = n\mu$ is the total income. The $T2$ is analogous to $T1$ except that it reverses the role of income shares (y_i / Y) and population shares $(1/n)$. Both Theil's indices measure the divergence between income shares and population shares, but using different distance functions.

Anand (1997) discuss indices based on the Lorenz diagram and also several other indices. The Absolute Mean Difference index is among the indices based on the Lorenz diagram as an alternative definition to the Gini coefficient (AGC) is specified as:

(10) $AGC = 1/2(AMDiff / \mu)$

where $AMDiff = \int_0^\infty \int_0^\infty |x - y| f(x) f(y) dxdy$ is the absolute mean difference of two income distributions of *x* and *y*. AGC can also be defined as one-half of the relative mean difference:

(11) $AGC = 1/2(AMDev / \mu)$

where $AMDev = \int_0^\infty |y - \mu| f(y) dy$ is the absolute mean deviation. These absolute and relative definitions are equivalent. Another measure of inequality based on the Lorenz diagram is the value of the maximum discrepancy (p^*) between the line of perfect equality and the Lorenz curve written as:

(12) $MD = [P^* - L(p^*)] = 1/2(AMDev / \mu) = RMDev / 2$

where $RMDev$ is the relative mean deviation. Another divergence measure proposed is based on the area of the largest triangle between the Lorenz curve and the line of equality and the area below the line of perfect equality. This measure reduces to the value of *MD*.

We have listed several inequality indices and showed how these are measured. The indices have different properties that can be used in their ranking, relevance and performance evaluation. There are three basic properties that one would expect that the above indices of inequality to satisfy: mean or scale independence, population size independence and the Pigou-Dalton condition. According to the first two properties the index remains invariant if everyone's income or if the number of people at each income level is changed by the same proportion, respectively. The third condition states that the value of an index is reduced if the transfer from richer to the poorer does not result in a changed ranking.

The Gini coefficient and the squared coefficient of variation satisfy all three conditions, while the relative and absolute mean difference and the range measures satisfy only the first two conditions but violate the Pigou-Dalton condition by ignoring the distribution inside the range. The variance measure violates the mean independence property. Unlike the variance of income, the variance of log income is a mean independent measure. The two Theil's inequality measures also satisfy each of the three desirable properties.[2]

[2] For more details on the properties of the different indices of inequality see Anand (1997).

4. GENERALIZATIONS OF THE GINI COEFFICIENT

A generalization of the Gini coefficient, called the extended Gini coefficient, was introduced by Yitzhaki (1983). The new index accommodates differing aversions to inequality. Empirical estimation of the extended index has been limited to the covariance formula suggested by Lerman and Yitzhaki (1989):

$$(13) \qquad \hat{G}_1(v) = -\frac{v}{\bar{x}} \sum_{i=1}^{M} p_i (x_i - \bar{x}) \left[(1-\hat{\pi}_i)^{v-1} - m \right]$$

where $\hat{\pi}_i = (\pi_i + \pi_{i-1})/2$, $p_i = 1/M$ is the proportion of observation in each of the M income groups, $\pi_i = p_1 + p_2 + ... + p_i$ is the cumulative proportion of observations in income groups, $m = \sum_i p_i (1-\hat{\pi}_i)^{v-1}$, and $v > 1$ is an inequality aversion factor. The extended Gini is equal to the original Gini coefficient when the aversion factor $v = 2$. Chotikapanich and Griffiths (2001) suggest an alternative estimator, obtained by approximating the Lorenz curve by a series of linear segments:

$$(14) \qquad \hat{G}_2(v) = 1 + \sum_{i=1}^{M} \left(\frac{\phi_i}{p_i} \right) \left[(1-\pi_i)^v - (1-\pi_{i-1})^v \right]$$

where $\pi_i = p_1 + p_2 + ... + p_i$ is the cumulative proportion of observations, and $\phi_i = p_i x_i / \sum_j p_j x_j$ is the proportion of income. The covariance and the linear segment estimators are identical for the original Gini coefficient ($\hat{G}_1(v) = \hat{G}_2(v)$ if $v = 2$) but differ for the extended Gini coefficient where $v > 1$. In a Monte Carlo experiment designed to assess the relative bias and efficiency (relative variance and mean-squared-error) of the two estimator Chotikapanich and Griffiths show that the two estimators have similar properties when calculated from individual observations or from grouped data where the number of groups is 30 or more. The dimensions over which sensitivity was assessed were: (i) the distribution function, (ii) value of aversion parameter ($v = 1.33, 1.67, 2, 3, 5$), (iii) number of income groups ($M = 10, 20, 30$), and (iv) drawing 5000 samples each of size 2000. However, when calculated from grouped data with 20 or fewer groups, the linear segment estimator outperforms the covariance estimator in terms of both bias and mean-squared-error. The log-normal where $\log(x)$ is normally distributed with mean $\mu = 5$ and standard deviation $\sigma = 1.5$, and Singh and Maddata (1976) distributions:

$$(15) \qquad \pi = F(x) = 1 - \frac{1}{\left(1 + a_1 x^{a_2}\right)^{a_3}}$$

are used as hypothetical income distributions, where $a_1 = 1/b$, $a_2 = a\alpha$, $a_3 = 1/a$, and $b = 1/e^{c_1}$, where c_1 is a constant of integration in the three parameters of the distribution. Empirical results in Singh and Maddala (1976) based on US income data show that the function suggested above give a better fit than the log-normal and gamma distributions.

5. INCOME INEQUALITY

Traditional measures of inequality, such as the Gini coefficient computed for a single year, do not capture much about what is happening over time and/or within particular societies' income distribution. Two societies with exactly the same Gini coefficient, could be extremely different in terms of mobility, individual opportunity and vulnerability and their intergenerational differences over time (see Graham, 2002).

In reviewing the literature on income inequality it is important to distinguish between inequality measured at different levels, its decomposition into different components and to identify their determinants. Pyatt (1976) introduced a decomposition where the overall Gini is broken into three components

(16) $Gini = (m' p)^{-1} p' E p$

where p and m are the k-element column vectors of population proportions (p_i) and average income of individuals in population group i (m_i), and E is a $k \times k$ matrix with (i, j) elements. An empirical illustration of the disaggregation based on a 1973 household survey of income distribution in Sri Lanka in which the total population of income receivers is classified geographically by location in urban, rural or estate areas. The Gini is sum of three non-negative parts. The components are between-groups due to differences in mean incomes between groups, the within-group due to variations in income within groups, and overlapping component due to overlaps between the income ranges in different groups. It is also suggested that the method may have relevance to studies of migration from one group to another and discrimination.

The above decomposition is applicable to aggregate levels of data where inequality is decomposed into three components. At the country level these are within country, between country and overlapping components. The first component reflects inequality due to the differences in income between the recipients in individual countries. The second component accounts for differences in mean incomes among the countries, while the third component reflects the homogeneity of the population (Yitzhaki, 1994) and appears because the Gini coefficient is not exactly decomposable by recipients. Using a similar Pyatt-type decomposition technique the index of world inequality can be decomposed into international, national and overlapping or residual inequality components. At the disaggregate level the overall inequality is decomposed into within-subgroup, between-subgroup, and overlapping components. Here the subgroup refers to sub-groups of a population.

International inequality refers to inequality across countries due to differences in per capita income among them. Here the unit of analysis is country and the intra-country income differences among its citizens ignored. Among important methodological considerations in studies of inter-national inequality are the exchange rates used, the source of income data, the reference unit, data coverage and how to weight countries by their population. In the measurement of world inequality the unit of analysis is preferably the citizens of the world rather than countries (Milanovic, 2002). Here the distribution of income is the outcome of all three (within country, between country and overlapping) components. The decomposition formula is:

$$
\begin{aligned}
Gini &= \sum_{i}^{n} G_i p_i \pi_i + \sum_{i}^{n} \sum_{j>i}^{n} \left(\frac{y_j - y_i}{y_i} \right) \pi_i p_j + L \\
&= \sum_{i}^{n} G_i p_i \pi_i + \frac{1}{\mu} \sum_{i}^{n} \sum_{j>i}^{n} (y_j - y_i) p_i p_j + L
\end{aligned} \tag{17}
$$

where y_i is mean income of country *i*, G_i is Gini coefficient of country *i*, π_i is income share of country *i* in total income of the region, p_i is country's population share, μ is the mean income of the region, and L is the overlapping component. The national inequality component refers to the disparity of the distribution of income within a country. It serves as an informative complement to the two extreme cases of international and aggregate world income inequalities.

6. NON-INCOME INEQUALITY

Income inequality is just one dimension of inequality. Other dimensions include inequality in skills, education, opportunities, happiness, health, life-years, welfare, assets and social mobility. A selection of studies analyzing different non-income inequalities, their interrelationship and their relations with income inequality found in the economic and sociology literatures are briefly given.

6.1 Relationship between inequality in income and education

Education has positive effects on earnings. Differences in opportunities to invest in human capital, its levels and quality, together with poor redistributive policies may result in increased inequality. Higher educational attainment and more equal distribution of education should enhance economic growth and more equal income distribution.

Castello and Domenech (2002) provide new measures of human capital inequality for a panel of countries. Taking school attainment levels they compute Gini coefficients and the distribution of education by quintiles for 108 countries over five-year intervals from 1960 to 2000. The human capital Gini coefficient is computed as:

$$
Gini^h = \frac{1}{2\overline{H}} \sum_{i=0}^{3} \sum_{j=1}^{3} \left| \hat{x}_i - \hat{x}_j \right| n_i n_j = n_0 + \frac{n_1 x_2 (n_2 + n_3) + n_3 x_3 (n_1 + n_2)}{n_1 x_2 + n_2 (x_1 + x_2) + n_3 (x_1 + x_2 + x_3)} \tag{18}
$$

where $\overline{H}$ is the average schooling years of the population aged above 15 years, *i* and *j* denote different levels of education (no schooling (0), primary (1), secondary (2), and higher education (3)), n_i and n_j are the shares of population with a given level of education, x_i and x_j are average schooling years of each educational level and $\hat{x}_i$ and $\hat{x}_j$ are their cumulative averages, $\hat{x}_0 \equiv x_0 = 0$, $\hat{x}_1 \equiv x_1$, $\hat{x}_2 \equiv x_1 + x_2$, and $\hat{x}_3 \equiv x_1 + x_2 + x_3$. The results show that most countries have tended to reduce the inequality in human capital distribution. Moreover, human capital inequality measures provide more robust results than income inequality in the estimation of growth and investment equations. Yemen and the US are found to be at the extremes of the distribution. In a regression of human capital inequality accounting for country specific effects Castello and Domenech estimate the following simple linear trend model:

(19) $Gini_{it}^{h} = \alpha_i + \beta Trend_t + \nu_{it}$

where they test for stability of within country and between country variability. The test results show that differences in the distribution of education across countries $(\alpha_i \neq \alpha, \forall i)$ are substantial, and countries have tended to reduce the inequality in human capital over time $(\beta < 0)$. A process of convergence in human capital equality has taken place. Inequality in education is associated with lower investment rate and lower income growth rates. They conclude that, it is desirable that policies aimed to promote growth take both the level and distribution of education into account.

The effects of inequality in skills on inequality in earnings across advanced major English-speaking and a number of continental European Union countries was investigated by Devroye and Freeman (2001). Using standard adult literacy test scores the results indicate that skill inequality explains only about 7 per cent of the cross-country differences in earnings inequality. Aghion (2002) argues that wage inequality between educational groups in developed economies has increased. The within educational groups inequality is larger, but unlike the between group it affects the temporary component of income. The persistence of increased inequality in transition countries is expected by Aghion and Commander (1999) to depend on the pace at which the acquisition of skills takes place and on the evolution of the educational system in the transition economies. Education policies can dampen the increase in wage inequality.

The relationship between inequality in education and inequality in income is investigated by Cornia and Kiiski (2001) using aggregate country level data. Empirically, inequality in education (see references cited therein) rises until the average number of years of schooling reaches 6.3 and declines thereafter. However, the threshold increases with economic development and adoption of skill-intensive technologies. Differences in educational achievement in Latin America and sub-Saharan Africa are identified to be important sources of income inequality in the two regions. Empirical evidence shows that increased educational attainment increased inequality in other geographical regions as well (see Cameron, 2000). At the international level De Gregorio and Lee (2002) using cross-section and time-series of countries present evidence on how higher educational attainment and more equal distribution of education make income distribution more equal.

Eicher and Garcia-Penalosa (2001) examine how human capital accumulation influences both economic growth and income inequality. They argue that the stock of educated workers determines both the rate of growth and income inequality. Parameters of the demand and supply of labour are crucial determinants of direction and changes in inequality as an economy accumulates human capital. Empirical evidence from Latin America show that educational attainment in addition to its impacts on inequality affects the future prospects of mobility, opportunity and vulnerability by increasing the probability of moving out of poverty or reducing the probability of not falling into poverty (Graham, 2002). At the micro-level based on data from Holland Hartog and Oosterbeek (1998) show that the group with non-vocational intermediate level of education score highest on health, wealth and happiness. Clark and Oswald (1996) in testing the hypothesis that utility depend on income relative to a comparison or reference level. Results based on British workers data presented in Clark and Oswald

suggest that satisfaction levels being inversely related to their comparison wage rates, and satisfaction declining in levels of education.

6.2 Relationship between income inequality, (un)employment and (un)happiness

Employment is not only a source of income; it also provides individuals with social relationships and identity. Unemployment thus has both economic and social costs to individuals and societies; it affects income, inequality and happiness. Joblessness is expected to be negatively correlated with individual wellbeing and health.

The extent of joblessness in advanced countries has caused concern about the direct monetary costs to both the employers and employees, social costs and the costs of an economy operating below its production potential among others. Concerning the social cost, it is suspected that unemployment imposes additional burdens on the individual, a burden referred to as the non-pecuniary cost[3] of unemployment. Winkelmann and Winkelmann (1998) test for the importance of non-pecuniary costs of unemployment using the longitudinal German Socio-economic Panel Study data-set on life-satisfaction of about 10000 working age men in Germany for 1984-89. The results from a logit analysis show that unemployment has a larger detrimental effect on satisfaction. The non-pecuniary effect is much larger than the pecuniary direct effect that stems from the loss of income; for instance, adverse psychological wellbeing affects job search strategies and lowers productivity.

The relationships between unemployment and unhappiness is investigated by Clark and Oswald (1994) using mental wellbeing scores. The British Household Panel Study for the 1991 touched upon various questions like presence of differences in concerns about being unemployed by different characteristics. These characteristics include age, location, unemployment rate, duration of unemployment, gender, and level of education. Results from an ordered probit regression of individual wellbeing on a set of personal characteristics, as expected, show that the effect of being jobless is negatively correlated with wellbeing.[4] Clark and Oswald reject the hypothesis that unemployment is voluntary. There is a U-shape in mental wellbeing with respect to age. On average happiness is lowest in a person's mid-thirties. The high-educated individuals show more distress while married people have the lowest degree of mental distress. Wellbeing is higher among healthy persons. Hartog and Oosterbeek (1998) show that the Dutch group with a non-vocational intermediate level of education score highest on health, wealth and happiness. Fathers working independently and women are healthier and happier.

The relationship between inequality and happiness[5] is analysed by Alesina, DiTella and MacCulloch (2001). The issue is whether Europeans and Americans are different with

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[3] Among the non-pecuniary effects of employment are direct costs of decreased psychological wellbeing and its adverse individual outcomes are increased mortality, suicide risk, crime rates, decreased marital stability, etc.

[4] Wellbeing is measured based on the General Health Questionnaire (GHQ) survey containing several indicators of psychological distress or 'disutility'. Here 'Caseness scores' are calculated based on answers to 12 indicators. The highest level of wellbeing (0) corresponds to a caseness level of 'feeling (fairly or highly) stressed', to the lowest level category of 12. The former would benefit from psychiatric treatment.

[5] For reviews of research on the index measures of happiness and mental health see Fordyce (1998), and Ng (1996).

respect to inequality and happiness. Inequality is measured as a Gini coefficient of gross family income in the US but is calculated using expenditure, gross or net income for the European countries. Using a large random sample survey of 128106 answers they find a large, negative and significant effect of inequality on happiness in Europe but not in the US. The period of study covers 1972-94 for the US and 1975-92 for Europe. In an ordered logit model happiness is regressed against inequality, macro and micro variables and personal and subgroup characteristics. The differences in happiness are potentially explained by European preference for more equal societies and higher social mobility in the US. They test these hypotheses by partitioning the sample across income and ideological lines. Low social mobility in Europe is found to be a source of unhappiness among the subgroups of poor and socialist with preference for more equal societies.

6.3 Relationship between income inequality and (ill) health

The connection between income inequality and health is explored by Deaton (2001).[6] The empirical analysis is based on both rich and poor countries. Here ill health is defined as the rate of mortality. In exploring the theoretical basis for such a relationship Deaton discusses a range of mechanism including education, economic growth, land-holdings, politics, crime, non-linear income effects, credit restrictions, nutritional traps, public goods provision and relative deprivation. Given the poor data quality underlying inequality, the conclusion is that there is no direct link from income inequality to ill health. However, in the design of redistributive policies the importance of income and other inequalities, and the social environment, should not be neglected. Income inequality is an indicator of the quality of social arrangements, of stress in rich countries, and of mortality in poor countries. Deaton and Lubotsky (2002) argue that the correlation between mortality rates and income inequality across the cities and states of the US is confounded by the effects of racial composition. For instance, conditional on the percentage of blacks neither city nor state mortality rates are correlated with income inequality. White mortality and incomes are lower in places where the fraction of blacks is higher. This result is present within geographical regions of the country and for all age groups (except boys aged 1-9), and for both sexes and is robust to conditioning on income, education and unobserved state fixed effects. However, it remains unclear why white mortality is related to racial composition.

Pradhan, Sahn and Younger (2003) explore global inequality in health status and decompose it into within- and between-country inequality components. The data used in their analysis are representative from the demographic and health surveys on child health, fertility, contraceptive use and related demographic. It covers 55 developing

[6] The literature on the relationship between health and economic development begin with the Preston curve (Preston, 1975), that shows the cross-country relationship between life-expectancy and income per head. Life-expectancy increase with income for poor countries, but at a decreasing rate, and it is weaker or absent for rich countries. For a selection of other (cross-country) studies on economic and social correlates of suicide rates see Chuang and Huang (1997) and Rodriguez-Andres (2003), on income distribution and life expectancy see Wilkinson (1992) and Mellor and Milyo (2001), and on income inequality and population health see Judge, Mulligan and Benzeval (1997). An excellent example of the relationship between inequality in health and economic development based on individual data including income information using Swedish data is by Gerdham and Johannesson (2000). In examining the existence of a negative association between income and mortality they find that inequalities in health favour higher income groups.

countries and OECD countries since 1989. Health is an important indicator of wellbeing; there is extensive literature on the measurement of health differences across socioeconomic dimensions and linking inequality in health to income and socioeconomic status. Morbidity, mortality and life expectancy are traditionally used as health indicators and income and expenditure as welfare indicators. However Pradhan, Sahn and Younger use standardized height of pre-school children to examine health inequality; an abundance of medical and public health research shows that height is a good objective indicator of the general health status of children determined by nutrient intake, disease and deprivation. Results indicate that in contrast with income inequality research, within-country variation is the source of most inequality, rather than between-country differences. The relationship between income and health when measured by nutrition indicators, is a strongly concave function.

Kakwani, Wagstaff and van Doorslaer (1997) clarify the relationship between two widely used indices of socioeconomic inequality in health, namely the relative index of inequality and the concentration index, and explain their superiority to other indices. On individual-level data the concentration index (C) is calculated as:

$$(20) \qquad C = \frac{2}{n\mu}\sum_{i=1}^{n} x_i R_i - 1$$

where x_i is ill health score of the ith individual, n is the number of individuals, $\mu = 1/n\sum_{i=1}^{n} x_i$ is the mean level of ill health, and R_i is the relative rank of the ith person. As indicators of ill health the authors used chronic illness (dummy variable) and a self-assessed health variable (categorical). They also develop distribution-free asymptotic estimators of the standard errors of both the relative index of inequality and concentration index. The role that demographic standardization by gender and age interval plays in the analysis of socioeconomic inequality in health is clarified. Health interview survey data from Holland covering 10232 individuals for 1980 and 1981 is used in the empirical illustration. The result of their study suggests that extra precision allowed for by individual-level data is to be retained but the gain may not always be that large.

Income-related inequality in self-assessed health in nine industrialized countries[7] was estimated by van Doorslaer *et al*. (1997). Here the concentration index is used as a measure of inequality, and the results show that inequality in heath significantly favoured the higher income groups in all countries. Gerdtham and Johannesson (2000) find the concentration index to be an incomplete measure of health since it ignores the length of life. They investigate income-related inequalities with respect to life years and quality-adjusted life-years. In the health literature there is evidence of the existence of a negative association between income and mortality. Results based on 40000 Swedish individuals followed up for 10-16 years, show that inequalities in health favour higher income groups. A Dutch study (Hartog and Oosterbeek, 1998) also indicates the presence of gender effects in the wealth–health–happiness relationship. Women in comparison with men are less wealthy, equally healthy but are happier.

[7] East Germany, Finland, Spain, Sweden, Switzerland, the Netherlands, UK, USA, and West Germany.

6.4 Relationship between inequality in wealth and growth

The growth and inequality literature has recognized that it may be the distribution of assets, rather than income, that underlies effects of inequality on growth by restricting access to credit markets (Stiglitz and Weiss, 1981). In testing the robustness of the inequality–growth relationship using country level data for 108 countries during 1960-92 on income and land distribution Deininger and Squire (1998) show that there is a strong negative relationship between initial inequality in asset distribution and long-term growth. Inequality reduces income growth for the poor, but not for the rich. Growth and inequality are affected by the redistribution of assets and increased aggregate investment. Distribution of land is characterized by more cross-country variation than that of income. Distribution of income, assets and government redistributive policies are among important factors determining the level of income inequality.

Available evidence on the distribution of personal wealth,[8] referring to material assets that can be sold in the market, and its evolution over time for a number of countries is summarized by Davies and Shorrocks (2000). The results, despite deficiencies of survey data on wealth, reconfirm the known fact that wealth is more unequally distributed than income and points to a downward trend in wealth inequality in several European countries over most of the twentieth century. In addition to lifecycle accumulation and inheritance which plays a major role in the explanation of wealth differences, they also give attention to several factors: the reasons for holding wealth, individual differences in wealth holdings, an examination of the causes of these differences, the link between wealth status across generations, and motives for leaving bequests. Inheritance is found to account for about 35-40 per cent of aggregate wealth in the US. Contributions from demographic trends, and changes in assets and housing prices are found to affect the distribution of wealth.

Static analysis of distributions does not provide information about changes in the relative positions of different units over time. Measures of mobility are constructed when data are provided in the form of a transition matrix illustrating the dynamic movements of different units over time. Shorrocks (1978) explores some of the issues involved in the construction of mobility measures, presenting a number of properties required of an index of mobility, a proposed set of axioms and discussion of the problems of comparing matrices defined over different time intervals. Shorrocks discusses an index that is incompatible with an objective notion of perfect mobility but able to compensate for differing time periods important to the observed mobility.

King (1983) discusses horizontal equity and social mobility, proposing an alternative index of overall inequality which is possible to be decomposed into vertical and horizontal equity components. King derives a functional form for the social welfare function and presents results from an application of the index to UK households to a model of optimum lump-sum taxation. The proposed index is expected to supplement analysis of tax reform effects on the level and distribution of welfare by explicitly accounting for horizontal equity or social mobility. Maasoumi (1996) surveys the two main welfare theoretic approaches to the measurement of mobility. One is based on

[8] Total wealth consists of human plus non-human capital. Here the human capital component is excluded and the focus is on material assets in the form of real property and financial claims. Less attention is paid to private pensions, social security wealth and its link to demographic factors.

transition matrices (Shorrocks, 1978) and their reduction to a scalar measure, and the other is a generalization of the index initiated by Shorrocks (1978) labelled the Maasoumi–Shorrocks–Zandvakili 'inequality reducing' measure applied to long-run incomes and describes statistical methods for their implementations. Some popular mobility indices are also analyzed.

7. SUMMARY

Inequality can have different dimensions. Economists are mostly concerned with the income and consumption dimensions of inequality. Among other non-income inequality dimensions we can include inequality in skills, education, opportunities, happiness, health, life-years, welfare and assets.

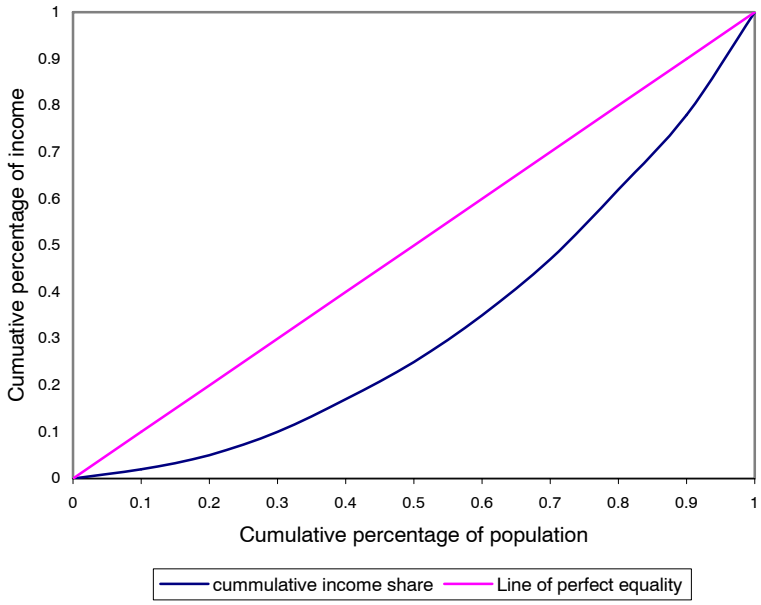
Several inequality indices can be derived from the Lorenz diagram. The divergence of a Lorenz curve for perfect equality and the Lorenz curve for a given distribution is measured by some index of inequality. Several inequality indices follow along with some basic properties that one would expect the indices to satisfy. These properties are to be used in their ranking, relevance and performance evaluation. The most widely used index of inequality is the Gini coefficient. Gini is generalized to accommodate differing aversions to inequality.

Income inequality can be decomposed at different levels of aggregation. At the national level it can be decomposed into within-subgroup, between subgroup, and overlapping components. In a similar way at the international level it can be decomposed into within-country, between-country, and overlapping components. In the measurement of world income inequality it is desirable that the unit of analysis is the citizens of the world rather than countries. Representative individual based micro data is preferable.

The effects of inequality in non-income factors on earnings can be summarized variously. Inequality in education explains a minor fraction of differences in cross-country earnings inequality. The impact decreases by the level of education and depends on the economic development and skill-intensive nature of production technologies. It also negatively affects the investment rate and growth rate of income. There is no direct link from income inequality to ill health measured as mortality, but a range of mechanism and social arrangements indicate the presence of an indirect link. Unlike in the case of income inequality, within country health inequality is a dominating source of inequality. Regions differ with respect to the effects of inequality on happiness; the differences in happiness are associated with preferences for equal societies and higher social mobility.

Employment in addition of being a source of income is also is a provider of social relationships and individual social identity. Joblessness has a direct cost to the employee and employers, social costs and a cost in in-optimal operation of an economy. The additional burden of unemployment on individual wellbeing, the non-pecuniary cost, is an important non-monetary cost of joblessness and much larger than the pecuniary effect that stems from the loss of income, though the negative effect varies by personal characteristics. Inequality in the distribution of assets is found to affect long-term growth. In sum the results suggests that one should account for the interrelationship between the different dimensions in the measurement and analyses of inequalities.

Figure 1. The Lorenz diagram.



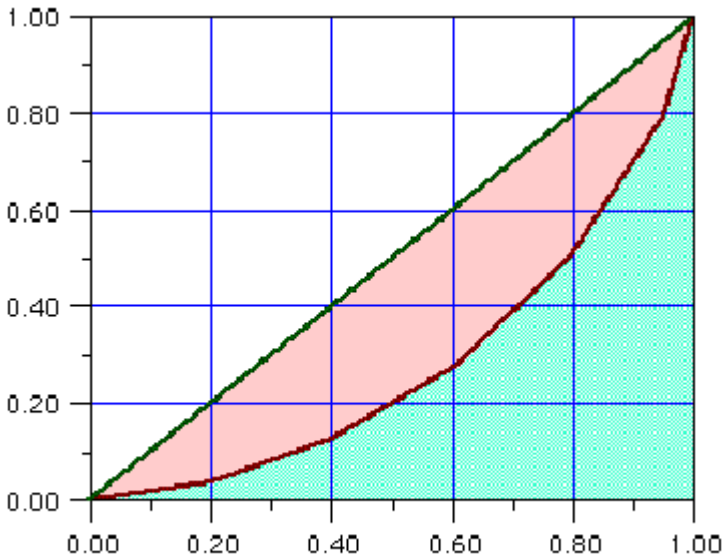


Figure 2. Lorenz Curve and Gini Coefficient

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