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An experimental test of the concentration index

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ABSTRACT

The concentration index is widely used to measure income-related inequality in health. No insight exists, however, whether the concentration index connects with people's preferences about distributions of income and health and whether a reduction in the concentration index reflects an increase in social welfare. We explored this question by testing the central assumption underlying the concentration index and found that it was systematically violated. We also tested the validity of alternative health inequality measures that have been proposed in the literature. Our data showed that decreases in the spread of income and health were considered socially desirable, but decreases in the correlation between income and health not necessarily. Support for a condition implying that the inequality in the distribution of income and in the distribution of health can be considered separately was mixed.

1. Introduction

Reducing inequalities in well-being is an important aim of economic and social policy. Both the World Health Organisation (2000) and the World Bank (2006) explicitly mention it as a major objective. There exists a vast literature on the measurement of inequality. The common approach in this literature is to focus on inequality in one dimension, typically income or health. Well-being is, however, determined by several dimensions simultaneously, two of which are income and health. Focusing only on one dimension may give a misleading impression of the degree of inequality. Properly assessing the degree of inequality in well-being requires measures of inequality that account for the multifaceted nature of well-being.

Early contributions to measure multidimensional inequality were made by Kolm (1977) and Atkinson and Bourguignon (1982, 1987). Atkinson and Bourguignon used dominance criteria to assess whether one distribution was more equal than another. A drawback of using dominance criteria is that they only lead to a partial ordering, which means that the number of distributions that can be compared is limited. This is undesirable for social policy, where we would like to assess the distributional effects of any policy proposal.

An alternative is to start from a (complete) social preference relation, to derive a social welfare function that represents this preference relation, and to use the resulting social welfare function to derive an inequality index. This *normative approach* to inequality measurement was pioneered for one-dimensional distributions by Kolm (1969) and Atkinson (1970). Extensions to multidimensional inequality measurement were proposed among others by Kolm (1977), Tsui (1995), and Gajdos and Weymark (2005).

In health economics, an innovative approach to account for the multifaceted nature of well-being was suggested by Wagstaff et al. (1991). They measured income-related inequalities in health by the concentration index (Kakwani, 1980), which summarizes how cumulative shares of health are associated with cumulative shares of the population ranked by income. Bleichrodt and van Doorslaer (2006) provided a welfare economics foundation for the concentration index by showing which conditions it imposes on social preferences. The key condition they identified is the principle of income-related health transfers.

While the concentration index has been widely used both within and outside economics and has gained worldwide acceptance by policy makers (van Doorslaer et al., 1997; Anand et al., 2001; Gwatkin et al., 2007; Yazbeck, 2009), no insight exists into the

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validity of the principle of income-related health transfers, the condition that underlies it. Do people agree that this principle should govern social choices over multidimensional distributions? The lack of insight into the validity of the principle of income-related health transfers complicates ascertaining whether the concentration index should be used to guide social policy or whether other indices are more appropriate.

The main purpose of this paper is to experimentally test the validity of the principle of income-related health transfers and, hence, to obtain insight into the question whether reductions in the concentration index reflect increases in social welfare. The answer to this question was clearly negative; our experimental data violated the principle of income-related health transfers systematically.

We also explored the appeal of several other conditions that have been proposed in the literature. Two ways of looking at multidimensional inequality can be distinguished (Tsui, 1999), first, as the dispersion in the distribution of the different dimensions and second, as the correlation between the different dimensions. Our data suggest that people are concerned about the dispersion, but care less about the correlation. A majority of our subjects even seemed to favor increases in the correlation between income and health. In other words, our results provide no support for measures that assume that all increases in the correlation between income and health are undesirable. Examples of such measures are the concentration index and the measures that have been proposed by Maasoumi (1986), Tsui (1999), and Abul Naga and Geoffard (2006).

We also explored whether people evaluate the inequality in income and health separately. If so, this would offer support for a two-stage procedure where the first stage measures the inequality in each dimension by standard one-dimensional inequality measures and the second stage aggregates these dimension-specific inequality measures into one overall inequality measure. Our results on this question were mixed, with some tests offering support for such a two-stage procedure and others rejecting it.

2. Background

We consider a social planner who has to choose between allocations of income and life-expectancy. The number of people in society is $n \geq 2$. An *allocation* (y,l) is a vector $((y_1,l_1),\ldots,(y_n,l_n))$ of length $2n$, where y_j denotes the income of person j and l_j denotes his life-expectancy. Both y_j and l_j are positive numbers.

Let $\succcurlyeq$ denote the social planner's preference relation over allocations. As usual, $\succ$ denotes strict preference and $\sim$ denotes indifference. A *social welfare function* W *represents* $\succcurlyeq$ whenever for all allocations (y,l), (y',l'),

$$(y,l) \succcurlyeq (y'l') \Leftrightarrow W(y,l) \geq W(y'l').$$

Kolm (1969) and Atkinson (1970) showed how a normatively significant inequality index can be derived from the social welfare function. For a description of their and related approaches see Weymark (2006). By imposing conditions on the social preference relation, and, consequently, on the social welfare function W, the inequality index can be restricted to specific forms. We will consider several such conditions in this paper. First, we define the principle of income-related health transfers, the central condition underlying the concentration index.

2.1. Condition 1 (Principle of income-related health transfers, PIRHT)

The social planner's preference relation satisfies the *principle of income-related health transfers* if a transfer of health from a richer person to a poorer person increases social welfare, provided the transfer does not change the ranking of the individuals in terms of income.

PIRHT implies correlation increasing majorization, a condition that has frequently been used in the theoretical literature on multidimensional inequality measurement. Consider an allocation (y,l). The allocation (y',l') is obtained from (y,l) through a *correlation increasing majorization* when we rearrange two persons' allocations such that one person has at least as much income and life-expectancy as the other and strictly more of one of these, and the rearrangement is not just a permutation of the two persons. That is, if $y_i > y_j$ for two persons $i,j \in \{1,\ldots,n\}$ then we rearrange life-expectancy such that $l_i' = \max\{l_i,l_j\}$ and $l_j' = \min\{l_i,l_j\}$, or, if $l_i > l_j$ for two persons $i,j \in \{1,\ldots,n\}$ then we rearrange income such that $y_i' = \max\{y_i,y_j\}$ and $y_j' = \min\{y_i,y_j\}$.

2.2. Condition 2 (Correlation increasing majorization, CIM)

For all allocations (y,l), (y',l'), if (y',l') is obtained from (y,l) through a (sequence of) correlation increasing majorization(s) then $(y,l) \succ (y',l')$.

CIM and PIRHT both capture Tsui's (1999) idea that increases in the correlation between income and life-expectancy are socially undesirable. PIRHT is stronger than CIM[1], however, since it allows for all convex combinations of life-expectancy that keep the income rank unchanged, whereas CIM only allows for rearrangements of life-expectancy. In other words, CIM only concerns changes in correlation that do not alter the marginal distributions of income and life-expectancy, whereas PIRHT does allow for (some) changes in the marginal distributions of income and life-expectancy.

CIM was criticized by Bourguignon and Chakravarty (2003) and by Fleurbaey (2005, 2007) for its neglect of individual preferences[2]. If the dimensions are complements, e.g. better health increases the marginal utility of income, then a correlation increasing majorization might actually increase social welfare. In fact, there is some evidence that health and income are complements in the sense that the marginal utility of income increases with better health (Viscusi and Evans, 1990; Sloan et al., 1998).

PIRHT and CIM are conditions that imply that decreases in the correlation between income and life-expectancy are desirable. They are silent, however, about the effect of mean-preserving changes in the spread of income and life-expectancy. The next condition that we tested, uniform majorization, focuses on the effects of such changes in spreads.

Uniform majorization is the multidimensional extension of the well-known Pigou–Dalton principle of transfers for one-dimensional outcomes. The *Pigou–Dalton principle of transfers* says that a transfer of a good from a better-off person to a worse-off person increases social welfare provided that the transfer does not change the ranking of the individuals in terms of the good[3]. For one-dimensional outcomes, a social welfare function can only serve as a satisfactory foundation for an inequality measure when it satisfies this principle. The Pigou–Dalton principle of transfers implies that if allocation x is obtained from allocation y through a series of Pigou–Dalton transfers then x is socially preferred to y. An equivalent formulation is to say that x is socially preferred to y if x is obtained from y by multiplying y by a bistochastic matrix[4]

[1] In the sense that PIRHT implies CIM, but not vice versa.

[2] Obviously the same criticism applies to the stronger condition of PIRHT.

[3] In fact, we could relax the exclusion of rank reversals to demanding that the transfer should not lead to a situation in which the initially worse-off person ends up better than the initial position of the better-off person.

[4] A bistochastic matrix is a nonnegative matrix which rows and columns all sum to 1.