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A multivariate analysis of the distribution of individual's welfare in China: What is the role of health?

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ABSTRACT

Many economists have argued that income is an inadequate indicator of welfare. In this paper, we conduct a multivariate analysis of the distribution of individual welfare in China at three selected time points: 1991, 1997 and 2006. Instead of using income as the only welfare indicator as in most distributional analyses, we explicitly consider the role of health in welfare distribution. We adopt the Naga and Geoffard (2006) decomposition method by which we can decompose a bidimensional welfare inequality index into two univariate Atkinson–Kolm–Sen indices that measure the inequalities in health and income, and a third term that measures the contribution from the joint distribution of the two attributes to total inequality. We show that the third term might be used as an alternative to the concentration index to measure the income-related inequality in health.

1. Introduction

Income inequality across populations, nations or regions has been a subject of long-standing interest among economists. The key reason for this is that income is considered to be the most important welfare indicator of individuals. However, utilization of income as the sole measure of well-being has begun to fall under criticism in recent years (see, e.g., Sen, 1985, 1987, 1992). Many economists have argued that income is an inadequate indicator of welfare and should be supplemented by other attributes such as indicators of health, literacy and available public services, etc., which may not be necessarily related to individual income.

In this paper, we conduct a multivariate analysis of the distribution of individual welfare in China at three selected time points: 1991, 1997 and 2006. We explicitly take into account another important welfare indictor, health, as well as income, in the distributional analysis. China has experienced impressive growth over the examined time period, with a commensurate increase in average household income. However, there are mounting concerns over whether the fruits of development have been equally shared among the Chinese. Numerous studies on income inequality in China have reflected this concern. Most studies show that there was an increase in income inequality in China between the 1980s and mid-1990s, and no significant variation between the mid-1990s and 2002 (e.g., Bramall, 2001; Khan and Riskin, 1998, 2007). Due to data limitation, the information for the period after 2002 is scarce. The basic needs approach in development economics argues that rapid economic growth may not necessarily be accompanied by improvements in other attributes of welfare, such as health or education (see, e.g., Streeten, 1981). Moreover, income growth may even be at the cost of those welfare attributes. Inequality analyses that focus exclusively on income may therefore be inadequate for a full understanding of the impact of the social and economic changes that occurred during this period. Health is an important indicator of human well-being. The factors that can contribute to health include, among others, genetic endowments, health care, living standards, epidemiological environment, working conditions, education and socioeconomic status. Therefore, we may also consider health as an indirect indicator of many other attributes of welfare. The impacts of China's recent socioeconomic transformation on these health determinants are significant. The improvement in living standards, collapse of the public health system and fast process of industrialization, as well as significant environmental changes, have influenced individual health in different directions. Changes to an individual's health do not necessarily correspond with his or her change in income earnings. Consequently, the results of

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income inequality analyses do not fully reflect the changes of welfare distributions.[1]

In the two most important political conferences in China that were held recently in October 2007 and March 2008, the National Party's Congress and the National People's Congress expressed unprecedented concerns over social welfare issues. Among those issues, reduction of income inequality and reform of the health care system received the most attention. It is the first purpose of this study to provide useful information to policy makers on the interaction between these two issues.

Kolm (1977) and Atkinson and Bourguignon (1982) are the first two studies that explored the theoretical foundation of multivariate inequality. Later studies such as Maasoumi (1986), Tsui (1995), Tsui (1999) and Naga and Geoffard (2006) explicitly derived various multidimensional inequality indices. However, very few of those theoretical results have been applied in empirical inequality analyses. This study is an early attempt to employ one of those indices to conduct a multidimensional inequality analysis. We will follow the method proposed in Naga and Geoffard (2006) to measure the bivariate inequality in China. This method allows us to decompose the welfare inequality into two univariate Atkinson–Kolm–Sen indices that measure the inequalities in health and income, and a third term that measures the contribution from the joint distribution of the two attributes to total inequality in welfare. The second purpose of this study is to propose that this third term might be used as an alternative to the concentration index to measure the income-related inequality in health. This welfare-based measurement satisfies a set of basic axioms that is usually required by an inequality measurement, which includes principle of transfers, anonymity, population principle and ratio-scale invariance. Moreover, similar to the concentration index, it satisfies the requirements identified in Wagstaff et al. (1991) for a desirable measurement of socioeconomic-related inequality in health: (i) it reflects the socioeconomic dimension of inequality in health; (ii) it reflects the experiences of the entire population; and (iii) it is sensitive to the changes in the distribution of the population across socioeconomic groups. Furthermore, it is also sensitive to changes in the distribution of the socioeconomic variables. This particular property addresses one limitation of the concentration index.[2]

The paper is organized as follows. In the next section, we describe the methods used in this analysis. The third section explores the properties of the welfare-based measurement of income-related health inequality. Section 4 describes data and empirical strategies used in this study. Empirical results are reported in Section 5. The last section contains our conclusion and discussion.

2. Method

One of the primary weaknesses in the early studies on multivariate inequality was the need to use the imputation of income methodology. As Sen (1976) notes, the standard procedure is to use market prices to aggregate different goods allocated to a given person. In this way, a multi-dimensioned comparison of distributions is reduced to a single dimension. This approach is either problematic or impossible in many situations, such as in the presence of nontraded goods or the non-existence of market prices. A multi-dimensioned formulation therefore becomes inevitable. In this context, Kolm (1977) and Atkinson and Bourguignon (1982) laid the theoretical foundation for the study of multidimensional inequality in the social welfare approach pioneered by Atkinson (1970), Kolm (1976a,b) and Sen (1973). They analyzed the properties of the social welfare functions and the conditions of first and second-order stochastic dominance of multivariate distributions. However, they stopped short of explicitly deriving inequality indices. Maasoumi (1986) proposed a class of multivariate General Entropy (GE) inequality measures based on a two-stage approach. In the first stage, an individual is represented by an "aggregate" function of all the attributes received. This aggregate function is derived based on information theory and has the closest distribution to the multivariate distribution of those attributes. In the second stage, the class of unidimensional GE inequality measures is then chosen to measure the dispersion in the aggregate function for each individual. Tsui (1995) generalized the relative and absolute Atkinson–Kolm–Sen indices to the multidimensional setting. Tsui (1999) derived the multidimensional GE inequality measures using an axiomatic approach. Unlike Maasoumi (1986) and Tsui (1995), the indices derived in this study explicitly satisfy a correlation-increasing majorization criterion; that is, the value of the index goes up if there is an increase in the correlation between the attributes in question. Later, Naga and Geoffard (2006) provided a way to decompose a bivariate Atkinson–Kolm–Sen index into two univariate Atkinson–Kolm–Sen indices that measure the inequalities in the two attributes, and a third term that measures the contribution from the joint distribution of the two attributes to total inequality. This third term also satisfies the correlation-increasing criterion.

In the context of our study, the correlation-increasing property of an inequality index is necessary. The large volume of studies on income-related inequality in health reflects this concern. Moreover, the relative contribution of each attribute to the total welfare inequality may be of interest to policy makers. We therefore employ the Naga and Geoffard (2006) method in the present study.

Suppose a population consists of n individuals, and individual i's income and health are denoted by x_{i1} and x_{i2}. The joint distribution of the two variables is a $n \times 2$ matrix $X \doteq \begin{bmatrix} x_{11} \ldots x_{i1} \ldots x_{n1} \\ x_{12} \ldots x_{i2} \ldots x_{n2} \end{bmatrix}'$ with strictly positive elements. Underlying the bidimensional inequality

[1] Although most researchers agree that health is an important aspect of well-being, there might be some concerns on whether it should be included as a dimension of individual welfare, particularly if public policies are concerned. John Rawls pointed out that health is not "a basic freedom" (Rawls, 1982, cited in Bommier and Stecklov, 2002). There is no utility to impose equal health among populations of different age, gender, and genetic dispositions. Many economists argue that aside from access to healthcare, most of the variances in health are not due to unjust and there is not much policy options one can address it. However, this argument may be more pertinent in the context of developed countries. As discussed in this section, in a society that has experienced dramatically social and economic changes in the past three decades, the changes in the distribution of health may be crucially related to no only health care access, but also to the changes in many other factors such as industrialization and pollution, variation of public policies across jurisdictions, working conditions, environmental changes, education policies, living standards, etc. Many aspects of those factors are related to unjust. The over time changes in welfare and health inequality can shed useful information to policy makers, and then they could track down the roots of such inequalities, and address the inequalities with appropriate policy interventions. Moreover, our main focus is not on the measuring of health inequality, but rather in providing an analysis on the over time changes in the welfare inequality and the role of health in the welfare distribution. As we will show latterly, the welfare inequality at a given time point can be decomposed into contributions from three factors: income inequality, health inequality, and the joint distribution of income and health. While not all the contribution from health inequality should be considered as unfair, the contribution from the last factor is clearly related to inequity.

[2] The concentration index measures the correlation of health and income rank. It is not sensitive to the change in the income distribution (see, e.g. Erreygers, 2006). Suppose we have an economy in which there are three persons with income distribution (1, 5, 10) and health distribution (1, 2, 3). For another income distribution (4.9, 5.0, 5.1), the concentration indices of income-related inequality in health are the same. However, we may have reason to believe that the policy makers give different weight to the two distributions.

index $I(X)$ is a social welfare function $W(X)$, which has the following properties: (i) $W(X)$ is additively separable. $W(X) = 1/n(\sum_i u(x_i))$, where u is not an individual's utility function, rather it is the social planner's criterion that measures an individual's utility. By following Atkinson and Bourguignon (1982), we assume that the social criterion makes no use of information on each individual's relative valuation of different elements in x. The social welfare function is defined over the named vector x_i.[3] From the perspective of a social planner, everyone has the same utility function. (ii) $W(X)$ is continuous and strictly increasing in all arguments. (iii) $W(X)$ is strictly quasi-concave. This property implies that society has a preference on equality. (iv) $W(X)$ is ratio-scale invariant. Tsui (1995) showed that if a social welfare function satisfies those properties, then the social planner's criterion u must take the following forms:

$$u(x_{i1,}x_{i2}) = x_{i1}^{\alpha}x_{i2}^{\beta} \quad \alpha, \beta > 0, \text{ and } \alpha+\beta \leq 1 \tag{1}$$

$$u(x_{i1,}x_{i2}) = -x_{i1}^{\alpha}x_{i2}^{\beta} \quad \alpha, \beta < 0 \tag{2}$$

$$u(x_{i1,}x_{i2}) = \alpha \ln x_{i1} + \beta \ln x_{i2} \quad \alpha, \beta > 0 \tag{3}$$

Let us denote the vector of sample means as $\mu = (\mu_1, \mu_2)$, and let $w^e = W(X)$ be the level of welfare attained by X. We can then define a scalar $\theta(X)$ such that $u(\theta\mu) = w^e = 1/n(\sum_i u(x_i))$. θ can be considered as a measure of equality in X, which means that; if each attribute were equally distributed in the population, we would need a fraction θ of the sum-total of each attribute to attain the same level of welfare as X. The corresponding Atkinson–Kolm–Sen inequality index is

$$I(X) = 1 - \theta(X) \tag{4}$$

The sign of the cross derivative u_{12} of the social planner's criterion is crucial to whether the inequality index satisfies the correlation-increasing criterion. Eq. (1) has $u_{12} > 0$, which implies that the social welfare goes up when the correlation between health and income increases. For Eq. (2), $u_{12} < 0$ implies that the social welfare falls when the correlation between health and income increases. For Eq. (3), $u_{12} = 0$ implies that the social welfare is not sensitive to the correlation between the two variables. Therefore, only Eq. (2) can lead to an inequality index that satisfies the correlation-increasing criterion; that is, when the positive correlation between health and income increases, the bidimensional inequality index $I(X)$ increases (a smaller θ). To reflect the aversion to income-related health inequality in most societies, we do not therefore use Eq. (1) to measure individual's utility in this study. For Eq. (2), individuals' utility is measured on a scale between $-\infty$ and zero. The closer to zero, the higher the individual's utility.

Naga and Geoffard (2006) showed that the equality measure θ can be decomposed as follows:

$$\ln \theta = \frac{\alpha}{\alpha+\beta}\ln \theta_1 + \frac{\beta}{\alpha+\beta}\ln \theta_2 + \frac{1}{\alpha+\beta}\ln k \tag{5}$$

where α and β are the parameters of the utility function, θ_1 and θ_2 are the univariate Atkinson–Kolm–Sen inequality indices for income and health respectively and k is a term that measures the contribution of the correlation between the two variables to total inequality, which is defined as:

$$k = \frac{n\sum_i x_{i1}^{\alpha}x_{i2}^{\beta}}{\sum_i x_{i1}^{\alpha}\sum_i x_{i2}^{\beta}} \tag{6}$$

If everyone has the same level of income and health, we have perfect equality and $\theta_1, \theta_2, k = 1$. The bidimensional equality index θ is also equal to 1 (inequality index I is 0).

3. A measure of income-related inequality in health

How to measure income-related inequality in health (or health care access) has long attracted the attention of researchers. The concentration index (CI), first introduced by Wagstaff et al. (1989), has been used extensively in this area. The CI has the desirable properties of accurately representing income-related inequality in the distribution of a health variable and being easy to calculate. We argue that k can be used as an alternative to the CI. Wagstaff et al. (1991) show that the CI satisfies the following requirements that are necessary for a desirable measurement of socioeconomic-related inequality in health: (i) it reflects the socioeconomic dimension of inequality in health; (ii) it reflects the experiences of the entire population; and (iii) it is sensitive to the changes in the distribution of the population across socioeconomic groups. However, one limitation of the CI is that it takes into account only the ranks, and not the levels, of income. A relatively equal and a relatively unequal distribution of income may have the same ranking of income, and consequently the same CI. We may have reasons to believe that policy makers may have less concern for income-related inequality in health when the income distribution is relatively equal. As a measurement of income-related inequality, k not only satisfies the three properties identified by Wagstaff et al. (1991), but it is also sensitive to changes in the distribution of income. Moreover, like the CI, this k also satisfies the following set of axioms deemed desirable for an inequality index[4]:

Axiom 1. *Anonymity*: This axiom is also known as symmetry. In our context, it requires that the inequality measures use only the information about the income and health, and not about some other characteristics of an individual. In other words, if an inequality index I satisfies this axiom then

$$\begin{aligned}&((x_{11}, x_{12}), (x_{21}, x_{22}), (x_{31}, x_{32}), \ldots, (x_{n1}, x_{n2})) \sim_I ((x_{21}, x_{22}),\\&(x_{11}, x_{12}), (x_{31}, x_{32}), \ldots, (x_{n1}, x_{n2})) \sim_I ((x_{11}, x_{12}), (x_{31}, x_{32}),\\&(x_{21}, x_{22}), \ldots, (x_{n1}, x_{n2}))\end{aligned} \tag{7}$$

where (x_{i1}, x_{i2}) are individual i's income and health, and $\sim_I$ represents distributionally indifferent.

Axiom 2. *The population principle*: This axiom was first introduced by Dalton (1920). It states that a distribution is to be considered as distributionally equivalent to a distribution formed by replications of it. In other words, if an inequality index I satisfies this axiom, then

$$\begin{aligned}&(x_1, x_2, \ldots, x_n) \sim_I (x_1, x_1, x_2, x_2, \ldots, x_n, x_n) \ldots\\&\sim_I (x_1, \ldots x_1, x_2, \ldots x_2, \ldots, x_n, \ldots x_n)\end{aligned} \tag{8}$$

Axiom 3. *Principle of transfers*: This axiom is also known as the Pigou–Dalton transfer principle (Pigou, 1912; Dalton, 1920). It requires that, if we want to use an index I as a measure of income-related inequality in health, a mean-preserving transfer of health from a poorer individual to a richer individual should increase the value of I.

Axiom 4. *Ratio-scale invariance*: This is a property of those relative inequality measures. It requires that the inequality index is unaffected by scalar transformations of involved variables.

[3] Actually, most studies in this strand of literature explicitly or implicitly make this assumption (e.g. Maasoumi, 1986; Tsui, 1995 among others).

[4] For details on the axioms that an inequality index ought to satisfy, please refer to Cowell (2000).

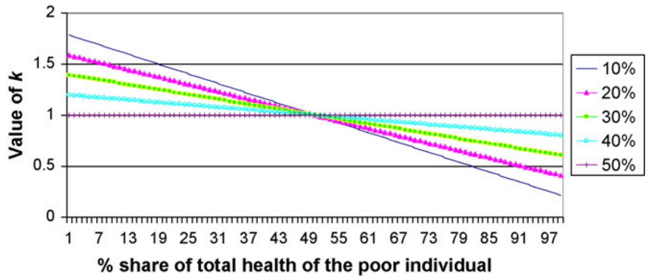

Fig. 1. Property of k for a two-person economy. *Note*: Curves 10–50% represent that the poor individual has 10–50% of total income respectively.

Proposition. *Let k denote the index (6). Then k satisfies Axioms 1–4.*

Proof. For Axiom 1, let x be an n dimensional matrix as $((x_{11},x_{12}), \ldots (x_{k1},x_{k2}), \ldots (x_{i1},x_{i2}), \ldots, (x_{n1},x_{n2}))$, and y be any permutation of x as $((x_{11},x_{12}), \ldots (x_{i1},x_{i2}), \ldots (x_{k1},x_{k2}), \ldots (x_{n1},x_{n2}))$, then

$$k(x) = \frac{n(x_{11}^{\alpha}x_{12}^{\beta} + \ldots + x_{k1}^{\alpha}x_{k2}^{\beta} + \ldots + x_{i1}^{\alpha}x_{i2}^{\beta} + \ldots + x_{n1}^{\alpha}x_{n2}^{\beta})}{(x_{11}^{\alpha} + \ldots + x_{k1}^{\alpha} + \ldots + x_{i1}^{\alpha} + \ldots + x_{n1}^{\alpha})(x_{12}^{\beta} + \ldots + x_{k2}^{\beta} + \ldots + x_{i2}^{\beta} + \ldots + x_{n2}^{\beta})} \quad (9)$$

and

$$k(y) = \frac{n(x_{11}^{\alpha}x_{12}^{\beta} + \ldots + x_{i1}^{\alpha}x_{i2}^{\beta} + \ldots + x_{k1}^{\alpha}x_{k2}^{\beta} + \ldots + x_{n1}^{\alpha}x_{n2}^{\beta})}{(x_{11}^{\alpha} + \ldots + x_{i1}^{\alpha} + \ldots + x_{k1}^{\alpha} + \ldots + x_{n1}^{\alpha})(x_{12}^{\beta} + \ldots + x_{i2}^{\beta} + \ldots + x_{k2}^{\beta} + \ldots + x_{n2}^{\beta})} \quad (10)$$

Eqs. (9) and (10) show that $k(x)$ equals to $k(y)$, Axiom 1 is therefore satisfied. For Axiom 2, if we replicate the population by ϕ times, Eq. (6) becomes

$$k = \frac{\phi n(\phi \sum_i x_{i1}^{\alpha}x_{i2}^{\beta})}{(\phi \sum_i x_{i1}^{\alpha})(\phi \sum_i x_{i2}^{\beta})} = \frac{n \sum_i x_{i1}^{\alpha}x_{i2}^{\beta}}{\sum_i x_{i1}^{\alpha} \sum_i x_{i2}^{\beta}} \quad (11)$$

Therefore, k satisfies the population principle. Axiom 3 is equivalent to the correlation-increasing criterion, and has already been proved in Naga and Geoffard (2006).[5] Finally, if we multiply income by γ_1 and health by γ_2, then Eq. (6) becomes

$$k = \frac{n \sum_i [(\gamma_1 x_{i1})^{\alpha}(\gamma_2 x_{i2})^{\beta}]}{\sum_i (\gamma_1 x_{i1})^{\alpha} \sum_i (\gamma_2 x_{i2})^{\beta}} = \frac{n \gamma_1^{\alpha}\gamma_2^{\beta} \sum_i x_{i1}^{\alpha}x_{i2}^{\beta}}{\gamma_1^{\alpha}\gamma_2^{\beta} \sum_i x_{i1}^{\alpha} \sum_i x_{i2}^{\beta}} = \frac{n \sum_i x_{i1}^{\alpha}x_{i2}^{\beta}}{\sum_i x_{i1}^{\alpha} \sum_i x_{i2}^{\beta}} \quad (12)$$

Therefore, k satisfies the axiom of ratio-scale invariance. □

Index k takes a value of one if we have perfect equality. When everyone has the same level of income (μ_1) and health (μ_2), Eq. (6) becomes

$$k = \frac{n \sum_i x_{i1}^{\alpha}x_{i2}^{\beta}}{\sum_i x_{i1}^{\alpha} \sum_i x_{i2}^{\beta}} = \frac{n \sum_i \mu_1^{\alpha}\mu_2^{\beta}}{\sum_i \mu_1^{\alpha} \sum_i \mu_2^{\beta}} = \frac{n(n \mu_1^{\alpha}\mu_2^{\beta})}{(n\mu_1^{\alpha})(n\mu_2^{\beta})} = 1 \quad (13)$$

If there is a pro-rich (pro-poor) income-related inequality, according to the correlation-increasing criterion, k is greater (smaller) than one. The upper bound of k is n.[6] As n goes to infinity, value of k can ranges from zero to $+\infty$.

Alternatively, we may use $\ln(k)$ as the inequality measure. The value of $\ln(k)$ ranges from $-\infty$ to $+\infty$. When we have perfect equality, $\ln(k)$ equals to zero. This inequality measure therefore satisfies one more axiom; that is, the axiom of normalization.

We can use a simple example to illustrate the properties of index k. In Fig. 1, we assume that we have a two-person economy. The vertical axis measures the values of k, and the horizontal axis measures the percentage share of total health of the poor individual. We use curve "10%" to "50%" to represent the cases that the poor individual has 10–50% of total income respectively. For a given income share below 50% (curve "10%" to "40%"), the value of k is greater than 1 when the poor individual's share of health is below 50%. There is a pro-rich income-related inequality in health. As the health share of the poor individual goes up, the value of k becomes smaller. When it reaches 50%, we reach perfect equality ($k = 1$). When the poor individual's health share is greater than 50%, there is a pro-poor income-related health inequality and k is smaller than one. Values of k are sensitive to both the distribution of health and income. For a given health share, when the income distribution becomes more equal (as the poor individual's income share increases from 10% to 40%), the values of k become smaller. When there is no income inequality (curve 50%), there is also no income-related inequality in health. The value of k is always equal to one. Although we have inequality in health, there is no income-related inequality in health.

The above analysis shows that the index k could be used as an alternative to the CI in the measurement of income-related health inequality. However, compared to the CI, the index k has several limitations in the practical applications. First, in the calculation of the index k, true values of income replace the fractional ranks of income in the CI. Consequently, researchers are unable to measure income-related inequalities in health using the index k when only grouped income measures are available. Secondly, the use of CI can avoid the subjective choices on specifying a marginal rate of substitution between income and health. Thirdly, similar to some other inequality indices (for example, the Theil index), values of the index k are not bounded, which may add difficulty to compare inequalities across different studies. Finally, the interpretation of concentration index might also be easier (Koolman and van Doorslaer, 2004).[7] Although with those limitations, we believe that the index k is still a useful measurement tool for income-related health inequality when researchers have particular interest in the systematic relationship between income and health rather than that between income rank and health. At the same time, many aspects of this index need to be further studied. Even for the CI, the most popular indicator of the income-related health inequality, various suggestions and discussions have been made to remedy some of its limitations from its introduction until to now (Clarke et

[5] Please refer to the proof of Proposition 2 in Naga and Geoffard (2006).

[6] If we denote $x_{i1}^{\alpha} = x'_i$ and $x_{i2}^{\beta} = y'_i$, then $k = \frac{n \sum_i x'_i y'_i}{\sum_i x'_i \sum_i y'_i}$

$= n \cdot \frac{(x'_1 y'_1 + x'_2 y'_2 + \ldots + x'_n y'_n)}{(x'_1 + x'_2 + \ldots + x'_n)(y'_1 + y'_2 + \ldots + y'_n)}$

$= n \cdot \frac{(x_1' y_1' + x_2' y_2' + \ldots + x_n' y_n')}{(x'_1 + y'_1 + x'_2 y'_2 + \ldots + x'_n y'_n) + (x'_1 y'_2 + \ldots + x'_1 y'_n) + (x'_2 y'_1 + x'_2 y'_3 \ldots + x'_2 y'_n) + \ldots + (x'_n y'_1 + \ldots + x'_n y'_{n-1})}$

Since the value of the second term in the above equation ranges between zero and one (zero and one are not included since all elements of the X matrices are strictly positive), the values of k are between zero and n.

[7] Another limitation of the index k is that it is not decomposable. Policy makers may have special interests to particular population groups in the distribution. In this case, a decomposition analysis may shed useful information. The CI, however, is also not perfectly decomposable. The large residual term often leads to ambiguous decomposition results.

al., 2002; Erreygers, 2009a,b; Wagstaff, 2005, 2009). To be a well-established inequality measure, the index k still needs a long way to go.

4. Data and empirical strategy

4.1. Data

The China Health and Nutrition Survey (CHNS) is an international collaborative project conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. It is an ongoing survey that covers nine provinces in China: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shandong. The covered provinces vary substantially in geography, economic development and public resources. The survey follows a multistage, random cluster sampling design. Consequently, the data contain much of the social, economic and institutional variation that present in China.

The CHNS contains detailed information on the household and individual economic, demographic and social factors. Currently, seven cycles of the data are available: 1989, 1991, 1993, 1997, 2000, 2004 and 2006. Since not all the cycles contain information on self-assessed health (SAH) or some detailed household characteristics that are required by our study, we use the 1991, 1997 and 2006 cycles to identify the trend of welfare inequality in the past decade and a half. Given that the 2006 cycle of the CHNS only contains SAH information for those respondents aged 12 or older, and the 1997 cycle does not include province Liaoning, we exclude the observations aged below 12 in the 1991 and 1997 cycle, and observations from Liaoning in the 1991 and 2006 cycle in order to make the results comparable. After omitting unusable observations, the sample sizes are 10,147, 12,908 and 8846 for 1991, 1997 and 2006 respectively.

4.2. Empirical strategies

The unit of analysis in this study is the individual. We assume that individual's utility is derived from two variables: income and health. In the CHNS, questions on income and time allocation probe for any possible activity each person might have engaged in during the previous year, both in and out of the formal market. Total income from market and non-market activities can be imputed. Inclusion of non-monetary government subsidies such as state-subsidized housing is an especially important advance. Household income in the CHNS is defined as the sum of all market earnings across the household and then the total value of all other non-market goods and services produced within that household is added. Total household incomes are deflated by using region/year specific deflators. The regional deflators are not provided in 2006 data, so we deflate the incomes by 2004 deflators. Since the CHNS uses the household as a unit of observation in the measurement of income, in order to get individual-level estimates it is necessary to adjust household income to reflect household size and composition. This is done by using a deflator, or equivalence scale. There are numerous approaches to doing this, but little consensus on what approach is most appropriate. In this study, we use the OECD equivalence scale to generate equivalent per capita household income. This scale (also called the "Oxford scale") was recommended by OECD (1982) for possible use in "countries which have not established their own equivalence scale". It assigns a value of 1 to the first household member, of 0.7 to each additional adult and of 0.5 to each child. Individual income is defined as total household income divided by this scale.

In the CHNS, health is measured as a categorical variable. The self-assessed health contains four categories: excellent, good, fair and poor. However, in order to be able to calculate inequalities in health, a continuous variable is needed. Several methods to transform a categorical health variable have been developed: (i) dichotomize the variable into a healthy/non-healthy distinction; (ii) estimate ordered probit regressions using the SAH categories as the dependent variable and to rescale the categorical variable (Cutler and Richardson, 1997; Groot, 2000); (iii) use the assumption of a latent unobservable health variable with a standard lognormal distribution (Wagstaff and van Doorslaer, 1994); (iv) interval regression. The dichotomization approach has well-known disadvantages. Not all variations contained in the SAH variable are used and it therefore makes comparisons of inequality unreliable (e.g., Wagstaff and van Doorslaer, 1994). As for the ordered probit method, no evidence on the validity of this method has yet been produced. The interval regression approach is also not appropriate for use in our study as it requires continuous external data to determine the limits for the thresholds, and this data is not available for our study. We therefore adopt the Wagstaff and van Doorslaer (1994) (hereafter WvD) method in this analysis. The health inequality results obtained using this scaling procedure have been demonstrated to be comparable to those obtained using continuous generic health measures (Gerdtham et al., 1999).

The WvD method assumes that the categorical health variable H is related to a latent, continuous but unobservable health variable H^*, which has a standard lognormal distribution. When an individual's health status H^* lies between α_{j-1} and α_j, the categorical health variable H records category j. Thresholds α_j are estimated as:

$$\widehat{\alpha}_j = \Phi^{-1}\left(\sum_{i=1}^{j}\frac{n_j}{N}\right), \quad j = 1, 2, \ldots j-1 \tag{14}$$

where Φ^{-1} is the inverse standard normal cumulative density function, n_j is the number of observations in category j and N is the total number of observations. All individuals within each category are assigned equal health. The mean values in each interval are estimated as normal scores $\widehat{Z}_j$ using the formula:

$$\widehat{Z}_j = \left(\frac{N}{n_j}\right)[\phi(\widehat{\alpha_{j-1}}) - \phi(\widehat{\alpha}_j)] \tag{15}$$

where $\phi(\cdot)$ is the standard normal density function. Since the distribution of health is assumed lognormal, so that the health status assigned to individuals within each category is finally calculated as $H^* = \exp(-\widehat{Z}_j)$.

As we mentioned in the last section, the bidimensional Atkinson–Kolm–Sen inequality index is increasing in the correlation between income and health only if the utility function takes a form as Eq. (2). The marginal rate of substitution (MRS) for such a utility function can be interpreted as the number of units of health that is required to compensate the loss of one unit of income. The ratio between the inequality aversion parameters α/β is related to the MRS. Therefore, when we evaluate welfare inequalities, different values of α/β can be viewed as the different weights that the social planner attached to the two attributes of an individual's welfare for a given health and income ratio. For example, a greater than one value of α/β implies that we assign higher weight to income in the utility function. It means that, comparing with the case of $\alpha/\beta = 1$, we need more units of health to compensate the loss of income for a given health and income ratio. How to assign the weights depends on the MRS chosen by the policy makers. If data available, the policy preferences could be estimated from government policies in the past in a similar way as in Gouveia and

Table 1
Inequality in welfare, income, health and *k*, 1991–2006.

	1991	1997	2006	1991	1997	2006	1991	1997	2006	1991	1997	2006
Case 1: $\alpha = \beta$	$\varepsilon_1 = 1.0, \varepsilon_2 = 1.0$			$\varepsilon_1 = 1.25, \varepsilon_2 = 1.25$			$\varepsilon_1 = 1.5, \varepsilon_2 = 1.5$			$\varepsilon_1 = 2.0, \varepsilon_2 = 2.0$		
Welfare equality (θ)	0.780	0.735	0.609	0.735	0.680	0.514	0.687	0.630	0.419	0.591	0.540	0.231
Income equality (θ_1)	0.816	0.766	0.560	0.776	0.708	0.457	0.724	0.650	0.347	0.611	0.560	0.130
Health equality (θ_2)	0.746	0.704	0.663	0.703	0.658	0.595	0.666	0.620	0.535	0.605	0.533	0.433
k	–	–	–	1.003	1.002	1.008	1.011	1.008	1.029	1.058	1.025	1.049
Case 2: $\alpha \leq \beta$		–		$\varepsilon_1 = 2.0, \varepsilon_2 = 1.25$			$\varepsilon_1 = 2.0, \varepsilon_2 = 1.5$			$\varepsilon_1 = 2.0, \varepsilon_2 = 2.0$		
Welfare equality (θ)	–	–	–	0.620	0.552	0.175	0.616	0.555	0.205	0.591	0.540	0.231
Income equality (θ_1)	–	–	–	0.611	0.560	0.130	0.611	0.560	0.130	0.611	0.560	0.130
Health equality (θ_2)	–	–	–	0.703	0.658	0.595	0.666	0.620	0.535	0.605	0.533	0.433
k	–	–	–	1.015	1.008	1.011	1.029	1.015	1.022	1.058	1.025	1.049
Case 3: $\alpha \geq \beta$		–		$\varepsilon_1 = 1.25, \varepsilon_2 = 2.0$			$\varepsilon_1 = 1.5, \varepsilon_2 = 2.0$			$\varepsilon_1 = 2.0, \varepsilon_2 = 2.0$		
Welfare equality (θ)	–	–	–	0.629	0.584	0.426	0.632	0.583	0.387	0.591	0.540	0.231
Income equality (θ_1)	–	–	–	0.776	0.708	0.457	0.724	0.650	0.347	0.611	0.560	0.130
Health equality (θ_2)	–	–	–	0.605	0.533	0.433	0.605	0.533	0.433	0.605	0.533	0.433
k	–	–	–	1.011	1.007	1.033	1.023	1.014	1.060	1.058	1.025	1.049

Note: ε_1 is inequality aversion parameter for income, and ε_2 is inequality aversion parameter for health.

Strauss (1994). Unfortunately, we do have such data. Therefore, we consider three different cases in our analysis to show all the possibilities. First, we assume that health and income are equally important to an individual from the perspective of policy makers ($\alpha = \beta$). In the second case, we assume that α is smaller than β (the absolute value of α is greater than β). This is equivalent to assume that policy makers assign higher weight to income in an individual's welfare function. In the last case, we assume that policy makers assign higher weight to health (α is greater than β).

Another subjective issue associated with the Atkinson–Kolm–Sen inequality index is how to choose the inequality aversion parameter. The magnitude of α and β corresponds to different degrees of inequality aversion. If we denote the inequality aversion parameter for income by ε_1, and inequality aversion parameter for health by ε_2, the relationships are $\alpha = 1 - \varepsilon_1$ and $\beta = 1 - \varepsilon_2$. In a pioneering paper of welfare-based inequality measurement, Atkinson (1970) arbitrarily set the inequality aversion parameter equal to 1.0, 1.5 and 2.0 and showed how a change in this parameter affects the ordinal rankings. Following this paper came a body of literature that tried to identify the inequality aversion parameter from observed governmental policies. The findings on the values of this parameter range from 1.40 to 1.97 for Italy, Japan, West Germany, the US and the UK (Gouveia and Strauss, 1994; Stern, 1977; Young, 1990). Based on this strand of literature, we set the inequality aversion parameters to 1.0, 1.25, 1.50 and 2.0 in this study.

5. Results

Table 1 presents the bidimensional welfare *equality* indices (θ), univariate income and health *equality* indices (θ_1 and θ_2), and the term measures income-related health *equality* (k) for different values of inequality aversion parameters. Those terms are linked by Eq. (5). We report the results for three different cases: $\alpha = \beta$, $\alpha \leq \beta$, and $\alpha \geq \beta$. In the first case, we assign equal weights to the two attributes of an individual's welfare. Consequently, the inequality aversion parameters for the income and health are the same. In the second case, we assume that the policy makers are more averse on income inequality. The values of ε_1 are fixed at 2.0, and we vary the values of ε_2 from 1.25 to 2.0. In the third case, we assume that the policy makers are more averse on health inequality. The values of ε_2 are fixed at 2.0, and we vary the values of ε_1 from 1.25 to 2.0. When both of ε_1 and ε_2 are set to 1.0, the utility function takes a form as Eq. (3). In this case, the term measuring income-related health inequality makes no contribution to total inequality since the utility function is additively separable. If one of ε_1 and ε_2 is set to 1.0, the problems are reduced to univariate inequality problems. Therefore, we do not report the results when one of ε_1 and ε_2 is 1.0.

For the welfare *equality* indices θ and the income and health *equality* indices θ_1 and θ_2, in all the three cases, although the values of those indices are sensitive to different assumptions on inequality aversion parameters, the over time rankings of those indices are consistent. Equalities in income and health have continuously fallen overtime. The income-related health inequality first decreased from 1991 to 1997 and then increased from 1997 to 2001. The change in income-related health equality is relatively small compared to the changes in income and health equalities. Consequently, the equality of welfare has also fallen continuously overtime.

The increase of health inequality may be closely related to the collapse of the Cooperative Medical System in rural areas and erosion of the Labor Insurance Schemes in urban areas during the 1980s and 1990s. Three main types of medical insurance plan operated in China in the pre-reform era: the Government Insurance Plan, the Labor Insurance Plan and the Cooperative Medical System. The Government Insurance Plan was available to people working in government organizations, which was financed directly by governments at various levels. The Labor Insurance Plan was available to employees of state or collective enterprises and their immediate family members. This plan was financially supported by the welfare funds of enterprises. The Cooperative Medical System was established primarily in rural areas, and was generally funded by contributions from participants and was heavily subsidized by the collective welfare funds. This community-financed Cooperative Medical System once existed in 90 per cent of China's villages, but its coverage fell to less than five percent by the early 1990s (Zhao, 2006).

The increase of income inequality from 1991 to mid-1990s has been well documented,[8] and can be mainly explained by the increase in the urban-rural income gap and unequal development across regions. Due to data limitation, the recent trend of income inequality in China has barely been investigated. The causes of the sharp increase of income inequality from 1997 to 2006 deserve some further studies.

The U-shape change in income-related health equality may reflect the non-linear relationship between health and income. At

[8] For a detailed review, please see Benjamin et al. (2005).

Table 2
Percentage contribution of income, health and $k-1$ to total inequality in welfare.

	1991	1997	2006	1991	1997	2006	1991	1997	2006	1991	1997	2006
Case 1: $\alpha=\beta$	$\varepsilon_1=1.0, \varepsilon_2=1.0$			$\varepsilon_1=1.25, \varepsilon_2=1.25$			$\varepsilon_1=1.5, \varepsilon_2=1.5$			$\varepsilon_1=2.0, \varepsilon_2=2.0$		
Welfare inequality	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Income inequality	42.0%	44.1%	56.7%	42.1%	45.5%	55.5%	43.6%	47.0%	55.5%	46.3%	47.2%	58.6%
Health inequality	58.0%	55.9%	43.3%	55.9%	53.2%	41.3%	52.8%	50.9%	39.6%	46.9%	50.1%	38.2%
$k-1$	–	–	–	2.0%	1.4%	3.2%	3.6%	2.1%	5.0%	6.8%	2.7%	3.3%
Case 2: $\alpha\leq\beta$		–		$\varepsilon_1=2.0, \varepsilon_2=1.25$			$\varepsilon_1=2.0, \varepsilon_2=1.5$			$\varepsilon_1=2.0, \varepsilon_2=2.0$		
Welfare inequality	–	–	–	100%	100%	100%	100%	100%	100%	100%	100%	100%
Income inequality	–	–	–	81.3%	82.5%	88.6%	66.5%	68.2%	77.4%	46.3%	47.2%	58.6%
Health inequality	–	–	–	15.5%	16.0%	10.3%	28.5%	29.5%	20.7%	46.9%	50.1%	38.2%
$k-1$	–	–	–	3.1%	1.5%	1.1%	5.0%	2.3%	2.0%	6.8%	2.7%	3.3%
Case 3: $\alpha\geq\beta$		–		$\varepsilon_1=1.25, \varepsilon_2=2.0$			$\varepsilon_1=1.5, \varepsilon_2=2.0$			$\varepsilon_1=2.0, \varepsilon_2=2.0$		
Welfare inequality	–	–	–	100%	100%	100%	100%	100%	100%	100%	100%	100%
Income inequality	–	–	–	12.1%	13.3%	18.5%	24.8%	26.7%	34.2%	46.3%	47.2%	58.6%
Health inequality	–	–	–	85.5%	85.4%	77.1%	71.0%	71.2%	59.5%	46.9%	50.1%	38.2%
$k-1$	–	–	–	2.4%	1.3%	4.5%	4.1%	2.1%	6.3%	6.8%	2.7%	3.3%

Note: ε_1 is inequality aversion parameter for income, and ε_2 is inequality aversion parameter for health.

a low development level, living standards play a very important role in health. Income-related health inequality might therefore have been high in the 1980s as the number of individuals living in poverty was high. The incidence of extreme poverty has fallen dramatically in China since 1980 (Ravallion and Chen, 2007), and the fall of income-related health inequality from 1991 to 1997 may reflect this fact. At a higher income level, other factors such as health care may play more important roles in health than living standards. The increase of income-related health inequality from 1997 to 2006 may be related to the collapse of the public health care system and the sharp increase in the price of health care services in this period.

Compared to health equality indices, the income equality indices are more sensitive to the changes in the inequality aversion parameters. The distribution of income has a larger range and more extreme values than the distribution of health. As the concavity of the social welfare function goes up (a larger inequality aversion parameter), θ_1 falls at a more rapid rate than θ_2. Since the term measures income-related health equality is sensitive to the change of income distribution, k therefore is also more sensitive to the change in the values of inequality aversion parameter than θ_2. When we assign different weights to income and health in an individual's welfare function, case 2 and case 3 show that the magnitude of welfare equality θ is not very sensitive to the changes in the value of ε_1 and ε_2 in 1991 and 1997. The reason is that, at these two time points, the degrees of equality for the distribution of income and the distribution of health are relatively close. However, the degree of income equality is much lower than that of health equality in 2006. If we assign a higher weight to income, the degree of welfare equality is lower than the case in which we assign equal weights to income and health, and much lower than the cases in which we assign higher weights to health.

Although we can always observe a U-shaped change in income-related health inequality from 1991 to 2006 for all the choices on the values of ε_1 and ε_2, the rankings between the k in different years are sensitive to the those choices. For example, the value of k in 1991 is greater than that in 2006 for the case $\varepsilon_1=2.0$ and $\varepsilon_2=1.25$. However, this ranking is reversed when we set $\varepsilon_1=1.25$ and $\varepsilon_2=2.0$. In 1991, we have a pro-rich income-related inequality in health, and the health inequality is higher than income inequality. The value of k reflects the degree of correlation between income and health. When we assign a higher value of inequality aversion parameter to income than that to health ($\varepsilon_1=2.0$ and $\varepsilon_2=1.25$), the degree of income inequality is closer to that of health inequality. Consequently, we have a higher degree of correlation between income and health (a larger k) than the case in which we set $\varepsilon_1=1.25$ and $\varepsilon_2=2.0$. On the contrary, the income inequality is higher than health inequality in 2006. When we assign a higher value of inequality aversion parameter to health than that to income ($\varepsilon_1=1.25$ and $\varepsilon_2=2.0$), the degree of health inequality is closer to that of income inequality, and then we have a higher degree of correlation between income and health (a larger k) than the case in which we set $\varepsilon_1=2.0$ and $\varepsilon_2=1.25$. Different choices on ε_1 and ε_2 lead to the change in the ranking between k in different years. The implication of this result is that the choices on inequality aversion parameters are important to the comparison of inequalities when we use k as the inequality measure. Inequality aversion parameters are directly lined to the MRS of the utility function used in analysis, therefore, policy maker's choice on this MRS (in other words, the relative weights assigned to health and income) is crucial to this kind of analysis.

In order to figure out the relative contributions of each factor to total welfare inequality, we need to conduct a percentage decomposition. If we apply a linear approximation on both sides of Eq. (5)

Table 3
Percentage contribution of income, health and $k-1$ to overtime changes in welfare inequality.

	Δ_{97}	Δ_{06}	Δ_{97}	Δ_{06}	Δ_{97}	Δ_{06}	Δ_{97}	Δ_{06}
Case 1: $\alpha=\beta$	$\varepsilon_1=1.0$, $\varepsilon_2=1.0$		$\varepsilon_1=1.25$, $\varepsilon_2=1.25$		$\varepsilon_1=1.5$, $\varepsilon_2=1.5$		$\varepsilon_1=2.0$, $\varepsilon_2=2.0$	
Welfare	100%	100%	100%	100%	100%	100%	100%	100%
Income	54.2%	83.4%	61.4%	74.5%	65.5%	70.2%	55.7%	77.7%
Health	45.8%	16.6%	40.4%	18.7%	40.4%	19.9%	80.2%	18.1%
$k-1$	–	–	−1.8%	6.8%	−5.9%	9.9%	−35.8%	4.2%
Case 2: $\alpha\le\beta$	–		$\varepsilon_1=2.0$, $\varepsilon_2=1.25$		$\varepsilon_1=2.0$, $\varepsilon_2=1.5$		$\varepsilon_1=2.0$, $\varepsilon_2=2.0$	
Welfare	–	–	100%	100%	100%	100%	100%	100%
Income	–	–	92.3%	95.8%	85.0%	89.7%	55.7%	77.7%
Health			20.4%	3.5%	38.3%	8.9%	80.2%	18.1%
$k-1$	–	–	−12.7%	0.7%	−23.3%	1.5%	−35.8%	4.2%
Case 3: $\alpha\ge\beta$	–		$\varepsilon_1=1.25$, $\varepsilon_2=2.0$		$\varepsilon_1=1.5$, $\varepsilon_2=2.0$		$\varepsilon_1=2.0$, $\varepsilon_2=2.0$	
Welfare	–	–	100%	100%	100%	100%	100%	100%
Income	–	–	20.0%	33.2%	37.0%	50.9%	55.7%	77.7%
Health	–	–	84.7%	53.0%	72.0%	33.6%	80.2%	18.1%
$k-1$	–	–	−4.7%	13.8%	−9.0%	15.5%	−35.8%	4.2%

Note: ε_1 is inequality aversion parameter for income, and ε_1 is inequality aversion parameter for health.

around perfect equality ($\theta=\theta_1=\theta_2=k=1$), we get

$$1-\theta=\frac{\alpha}{\alpha+\beta}(1-\theta_1)+\frac{\beta}{\alpha+\beta}(1-\theta_2)+\frac{1}{\alpha+\beta}(1-k)+R \qquad (16a)$$

where R is the approximation residual. If we denote $1-\theta$ by I, $1-\theta_1$ by I_1, $1-\theta_2$ by I_2 and $1-k$ by k_I, we can write Eq. (16a) as

$$I=\frac{\alpha}{\alpha+\beta}I_1+\frac{\beta}{\alpha+\beta}I_2+\frac{1}{\alpha+\beta}k_I+R \qquad (16b)$$

where I, I_1, I_2 and k_I are the Atkinson–Kolm–Sen measures of *inequality*. The percentage contribution of a variable to total welfare inequality is calculated as the term associated with this variable on the RHS of Eq. (16b) divided by the sum of the first three terms on the RHS of Eq. (16b).

Table 2 presents the results of the percentage decomposition of welfare inequality at the three selected time points. For the case of equal weights, in 1991 and 1997, the most important contributor to welfare inequality was health. At these two time points, if we had used income as the sole indicator of welfare, we would have considerably underestimated the inequalities. However, the magnitude of the contributions of health to welfare inequality has fallen continually. In 2006, income became the most important contributor to welfare inequality. If we had used income as the sole indicator of welfare at this time point, we would have considerably overestimated the inequality. While both income inequality and health inequality increased over the examined period, the income inequality increased at a much more rapid rate. This trend can also be observed in Table 1. The contribution of income-related health inequality is relatively small in all three time points, but there is a trend of increase recently. Table 2 also shows that, the relative contribution of each attribute of welfare to the overall welfare inequality crucially relates to its weight in the welfare function. For example, when the policy makers attach a very low weight to health in individual's welfare, then almost all of the welfare inequality can be attributed to income at all the three time points. However, when individual's health becomes a more important policy concern (say, ε_2 increases to 1.5 or 2.0), a significant portion of the welfare inequality can be attributed to health.

To find the causes of overtime changes in welfare inequality, we use Eq. (16b) at time period t subtracts it at time period $t-1$, which gives us

$$\Delta I_t=\frac{\alpha}{\alpha+\beta}\Delta I_{1,t}+\frac{\beta}{\alpha+\beta}\Delta I_{2,t}+\frac{1}{\alpha+\beta}\Delta k_{I,t}+\Delta R_t \qquad (17)$$

The percentage decomposition of overtime changes in welfare inequality is reported in Table 3, which is calculated in the same way as those in Table 2.

In Table 3, we denote the changes in inequalities from 1991 to 1997 and 1997 to 2006 as Δ_{97} and Δ_{06} respectively. The most salient observation from Table 3 is that, for all the three cases, income inequality and income-related health inequality made more and more contributions to the changes in welfare inequality.

6. Conclusion and discussion

In this paper, we conduct a multivariate inequality analysis of the distribution of individual welfare in China. Instead of using income as the only indicator of welfare, we also consider the role of health in welfare distribution.

We found that from 1991 to 2006, equality in the distribution of welfare continued to decline. The reason for this result is that both the distribution of income and health became more and more unequal. Decomposition results reveal that in 1991 and 1997, if we had used income as the sole indicator of welfare, we would have underestimated the inequalities. At these two time points, the inequalities in health outweighed the inequalities in income. In 2006, due to the sharp increase of income inequality, we would have overestimated the welfare inequality if we had used income as the sole indicator of welfare. The relative contribution of health and income to the overall welfare inequality crucially relates to their weights in the welfare function. The heated debates in recent years on the reform of health care system in China reflect that health becomes a more and more pressing policy issue for the Chinese government. Therefore, it is important to take into account the other welfare indictor, health, as well as income, in the distributional analysis.

The decomposition results also contain a term that measures the income-related health inequality, which is in the U-shape across the three selected time points. We argue that, this measure can be used as an alternative to the concentration index to measure income-related inequality in health. It not only reflects the socioeconomic dimension of inequality in health, but it is also sensitive to the change of income distribution. Moreover, it satisfies a set of basic axioms that are required by a desirable inequality index.

There are several questions that need further exploration. First, like most studies on income inequality in China, our paper is descriptive rather than prescriptive. One area that deserves further research is the causes of the inequalities. The reduction of income inequality and the reform of the health care system will become important policy objectives for the Chinese government in the next a few years. For the purpose of setting effective policy priorities, it is necessary to investigate the determinants of those inequalities in China. Second, our study only focuses on two attributes of individual welfare—income and health. The key reason for this is that the Naga and Geoffard (2006) decomposition method adopted in this study can only be applied to bivariate inequality analysis. Individuals can derive utility from many other factors, which may include education, environmental factors, etc., and therefore, decomposition methods on more than two-dimensioned inequality indices are required. Finally, the empirical results show that rankings of the income-related inequality in health are sensitive to the choices on the weights assigned to health and income in the utility function. Which ranking should be used depends on policy makers' choice on the MRS of the given utility function. Therefore, policy preference of the Chinese government needs to be further explored.

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