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A methodological rejoinder to “Does income relate to health due to psychosocial or material factors?”☆

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ABSTRACT

There is a presumption that when an individual's comparison of his income with the incomes of others in his comparison group yields an unfavorable outcome, the individual is dismayed and experiences stress that impinges negatively on his health. In a recent study, Hounkpatin et al. (2016) conduct an inquiry aimed at deciphering which measure of low relative income reflects better the adverse psychosocial effect of low relative income on health. Hounkpatin et al. pit against each other two indices that they characterize as “competing:” the “relative deprivation (Yitzhaki Index)” of individual *i*, RD_i; and the “income rank position” of individual *i*, R_i. In this Rejoinder we show that because a measure of rank is embodied in the RD_i index and the R_i index can be elicited from the RD_i index, these two indices need not be viewed as competing. Furthermore, we formulate a composite measure of relative deprivation, CRD_i, which can be used to assess more fully the psychosocial effect of individual *i*'s low relative income on his health.

1. Introduction

In a recent study, Hounkpatin et al. (2016) conducted an intriguing inquiry into which measure or characterization of low relative income better encompasses the adverse psychosocial effect of low relative income on health. This effect arises when the natural inclination of people to compare their income with the incomes of others who constitute their comparison group yields an unfavorable outcome. The consequent dismay and stress impinge negatively on people's health. Hounkpatin et al. pit against each other two indices that they characterize as “competing:” the “relative deprivation Yitzhaki Index,” henceforth the RD_i index; and the “income rank position” index, henceforth the R_i index. Hounkpatin et al. conclude (p. 81) that the psychosocial effect “is strongly supported when modelled by the rank but not [when modelled by the] Yitzhaki specification.”

In this Rejoinder we show that these two indices need not be viewed as competing: a measure of rank is embodied in the RD_i index, so the R_i index can be elicited from the RD_i index. We then outline a novel protocol for ascertaining the adverse psychosocial effect of individuals' low relative income on their health. We do this by defining and demonstrating the use of a composite measure of relative deprivation, *CRD*, which incorporates ordinal and cardinal dimensions of low relative income.

To begin with, in the next two sections we derive and illustrate the use of formulas that form the bases of the two indices used by Hounkpatin et al.

2. The RD_i index

Let $y = (y_1, ..., y_n)$ be an ordered vector of incomes in population *N* of size *n*: $y_1 < y_2 < ... < y_n$. We denote relative deprivation by *RD*. The relative deprivation of individual $i = 1, ..., n-1$ whose income is y_i, RD_i, is defined as the sum of the excesses of incomes that are higher than y_i divided by the size of the population:

$$RD_i \equiv \frac{1}{n}\sum_{k=i+1}^{n}(y_k - y_i). \tag{1}$$

The relative deprivation of individual $i = n$ whose income is y_n is nil: $RD_n \equiv 0$.

Taking as an example income vector $y = (1,2,3,4,5)$, the *RD* of the individual whose income is 3 is $RD_3 = \frac{1}{5}\sum_{k=4}^{5}(y_k - y_3) = \frac{1}{5}[(4-3)+(5-3)] = \frac{3}{5}$. By a similar calculation we get that, for example, the *RD* of the individual whose income is 1 is higher at 2, and that the *RD* of the individual whose income is 5 is nil.

☆ This Rejoinder is dedicated to Shlomo Yitzhaki on his 75th birthday, with heartfelt wishes for good health.

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3. The R_i index

Hounkpatin et al. (pp. 79-80) define the income rank of individual i as

$$R_i = \frac{j-1}{n-1}$$

"where $j-1$ is the number of individuals within individual i's reference group who have incomes lower than individual i and n is the number of people within that reference group." Assuming, for the sake of simplicity, that the reference group of an individual is the entire population of which the individual is a member, namely that $j-1 = i-1$, then the number of people who have incomes that are lower than the income of individual i, which is $i-1$, is compared with the total number of people within the individual's reference group (namely the size of the population but for the individual himself), $n-1$. The ratio $\frac{i-1}{n-1}$ gives the individual an income rank that is a number between 0 (the lowest rank when $i=1$) and 1 (the highest rank when $i=n$).

Prior to proceeding, we slightly tinker with the R_i index. Having already replaced j with i, we write the "mirror image" of R_i as $1-R_i = \frac{n-i}{n-1}$. The term $n-i$ expresses the distance of individual i from the top rank, where distance is measured by the number of individuals who occupy ranks higher up. In the example of income vector $y=(1,2,3,4,5)$, the individual whose income is 3 is placed two rungs below the individual whose income is 5, so that for that individual this distance is 2. When n is fairly large, $\frac{n-i}{n-1} \approx \frac{n-i}{n}$. We thus have a neat rank measure $\tilde{R}_i = \frac{n-i}{n}$ that for a large n is "complementary" to the R_i index. The $\tilde{R}_i$ of individual i is the share of the individuals in the population whose incomes are higher than the income of individual i. Suppose that there are 500 individuals with incomes 1,2,..., 500. For the individual whose income is 300 we get that $1-R_{300} = \frac{n-i}{n-1} = \frac{500-300}{499} \approx \frac{200}{500} = \frac{2}{5} = \tilde{R}_{300}$.

4. Congruence: RD_i as a rank-encompassing index

The relative deprivation measure of individual i defined in (1) can be rewritten in a slightly different form than in (1). Upon multiplying and dividing $\frac{1}{n}\sum_{k=i+1}^{n}(y_k - y_i)$ by $n-i$, we obtain

$$RD_i = \frac{n-i}{n}\left[\frac{1}{n-i}\sum_{k=i+1}^{n}(y_k - y_i)\right] = \frac{n-i}{n}\left(\frac{\sum_{k=i+1}^{n} y_k}{n-i} - y_i\right) = \tilde{R}_i(\tilde{y}_i - y_i) \tag{2}$$

where $\tilde{y}_i \equiv \frac{1}{n-i}\sum_{k=i+1}^{n} y_k$ is the average income of the individuals whose incomes are higher than the income of individual i (these are the individuals in the income distribution who are positioned to the right of individual i).

We can thus think of RD_i in (1) as $RD_i = \tilde{R}_i(\tilde{y}_i - y_i)$, namely viewing it as the product of a rank term $\tilde{R}_i = \frac{n-i}{n}$, and a cardinal term $(\tilde{y}_i - y_i)$. In the example of income vector $y=(1,2,3,4,5)$, for the individual whose income is 3 we have that $\tilde{R}_3 = \frac{5-3}{5} = \frac{2}{5}$. Because $\tilde{y}_3 = \frac{4+5}{2} = 4.5$, it follows that $RD_3 = \tilde{R}_3(\tilde{y}_3 - 3) = \frac{2}{5}(4.5-3) = \frac{3}{5}$, which is the same magnitude as the one calculated at the end of Section 2.

Seen this way, the measure of relative deprivation (1) has a pure rank preference component imbedded in it, and a cardinal preference component. This is revealing in the sense that the stress from trailing behind others can be decomposed into the stress from occupying a rank other than the top rank, which is measured by $\tilde{R}_i$, and the stress arising from a positive magnitude of the income differences between the higher incomes of others and one's own income, which is measured by $(\tilde{y}_i - y_i)$.

The measure presented in (2) is telling also in that it reveals an asymmetry: holding the incomes of other individuals constant, a reduced income rank of a given individual always implies an increase in the individual's relative deprivation RD_i, but the converse is not true, namely an increase of the individual's RD_i does not necessarily imply a decrease in the individual's income rank.

5. Ascertaining the psychosocial effect of individuals' income on their health using a composite measure of low relative income

Hounkpatin et al. report (p. 76) that "income rank was a stronger and more consistent predictor than … the Yitzhaki Index … of self-rated and objective health." To our mind, there is little doubt that individuals are concerned about having a low rank in the income hierarchy, and there is little doubt too that they are concerned about having a cardinally-measured low relative income. Perhaps a good way to think about these two dimensions of satisfaction and psychological sense of wellbeing is to consider a representation that encompasses both. Indeed, it is an open issue whether including a distinct measure of the excesses of incomes in conjunction with a distinct rank measure will not yield an even better prediction of (self-rated or objective) health than a rank measure alone. To this end we take the decomposition in (2) a step further. We do this by incorporating an exponential parameter $\gamma \in [0,1]$ to measure the relative importance of the rank term, and a complementary exponential parameter $1-\gamma \in [0,1]$ to measure the relative importance of the cardinal term. We then define the composite relative income measure $CRD_i(\gamma)$ as

$$CRD_i(\gamma) = \tilde{R}_i^{\gamma}(\tilde{y}_i - y_i)^{1-\gamma},\ \gamma \in [0,1]. \tag{3}$$

Had (3) been the basis of the approach of Hounkpatin et al., then they would have assigned to γ the value of 1 when they study the effect of income rank, and the value of $1/2$ when they study the effect of relative deprivation.[1] By using in (3) weights that sum up to one, $CRD_i(\gamma)$ has the characteristic that a strong "distaste" for a rank measure of low relative income correlates with a weak "distaste" for a cardinal measure of low relative income (and vice versa). This assumption can be interpreted as assigning 100 percent of weight to the importance of measures of ordinal income and cardinal income, permitting any split of the weight between these two shortfalls in the preference specification.

Referring once again to income vector $y=(1,2,3,4,5)$, for the individual whose income is 3 we already noted that $\tilde{R}_3 = 2/5$, and that $(\tilde{y}_3 - y_3) = (4.5-3) = 3/2$. Thus, for a low value of γ, say $\gamma = 1/4$, which reflects attaching quite low importance to the rank term and quite high importance to the cardinal term, we get that $CRD_3(1/4) = \tilde{R}_3^{1/4}(\tilde{y}_3 - y_3)^{3/4} = (2/5)^{1/4}(3/2)^{3/4} \approx 1.08$. Conversely, for a high value of γ, say $\gamma = 3/4$, which reflects attaching quite high importance of the rank term and quite low importance to the cardinal term, we get that $CRD_3(3/4) = \tilde{R}_3^{3/4}(\tilde{y}_3 - y_3)^{1/4} = (2/5)^{3/4}(3/2)^{1/4} \approx 0.56$.

The parameter γ can be estimated using goodness of fit statistics, similar to the estimation of the parameter ρ of the CRRA utility function in Hounkpatin et al. This procedure will identify tradeoffs and rates of substitution between the adverse psychological impacts of low income rank and low cardinal relative income on (self-rated or objective) health. Furthermore, self-rated health can be regressed on values of $CRD_i(\gamma)$ (for the estimated level of γ) and on the utility function of income used by Hounkpatin et al. It will be illuminating to find out whether a specification incorporating $CRD_i(\gamma)$ will deliver a better power of prediction than specifications based on the rank index alone or the "Yitzhaki index" alone.

6. Discussion and conclusion

By their very ordinal nature, the income ranks of individuals cannot encapsulate the extent of income inequality in a population. Consider two populations of equal size, P_1 and P_2, such that the income distribution in P_1 is more unequal than the income distribution in P_2, where inequality is measured by the Gini coefficient. For example,

[1] For $\gamma = 1/2$ we get that $CRD_i(\gamma) = \sqrt{RD_i}$.

think of P_1 with income vector (2,6,10), and of P_2 with income vector (2,3,4); the Gini coefficient of P_1 is twice as large as the Gini coefficient of P_2. But when we use an income-based rank to measure deprivation, this measuring rod records the same values for the corresponding individuals in the two populations. In other words, using income ranks alone, the two populations are indistinguishable. As a considerable body of research suggests, income inequality appears to have a negative effect on the health of populations; consult, for example, the reviews of a large number of studies by Wilkinson and Pickett (2006), and Pickett and Wilkinson (2015). From the perspective of a given individual *i*, the impact of income inequality on *i*'s health is embodied in / delivered by the cardinal component of the $CRD_i(\gamma)$ measure. In line with the aforementioned studies, this component plays a role that is complementary to the role of income rank in predicting the "grand total" effect of low relative income on individual *i*'s health, that the rank component alone has a better fit to the data, as found by Hounkpatin et al., notwithstanding.

Relatedly, the interplay between (absolute) income, income rank, relative deprivation, *RD*, and income inequality as measured by the Gini coefficient, *G*, requires care in formulating policies aimed at reducing the adverse psychosocial effect of low relative income on health. Suppose, for example, that the incomes in a two-person population are 1 and 3. While it is possible to increase all incomes and simultaneously to reduce *G*, it is also possible that at the same time the *RD* of the population will increase, as when incomes 1 and 3 change, respectively, to incomes 2 and 5. Then G decreases then from 1/4 to 3/14, whereas *RD* increases from 1 to 3/2. In other words, reducing income inequality in a population by means of a scheme in which every individual receives a mix of a proportional income growth (here 3/2) and a lump sum income transfer (here 1/2) may not deliver a relief where *RD*, and for that matter low rank, are the culprits.

It is worth adding that the specification $CRD_i(\gamma)$ draws on an assumption that a "rich" individual attaches the same weight to a measure of low income rank and to a measure of low cardinal income as does a "poor" individual. An intriguing topic for follow up inquiry would be to study possible variation in the γ factor across the income distribution. For example, a reasonable expectation could be that the components of the $CRD_i(\gamma)$ measure are accorded different importance for individuals at the top and at the bottom of the income distribution, perhaps with "rich" individuals assigning a higher weight to the rank term than "poor" individuals (consult Stark et al., 2019). In a similar vein, differentiation by gender could also be studied, presumably with men attaching higher weight to the rank term than women (consult Stark and Zawojska, 2015).

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