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Oded Stark

On a tendency in health economics to dwell on income inequality and underestimate social stress

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Genscherallee 3
D – 53113 Bonn
Germany
Phone: +49-228-73-1861
Fax: +49-228-73-1869
E-Mail: zef@uni-bonn.de
www.zef.de

The author:
Oded Stark, Universities of Bonn and Warsaw. Contact: ostark@uni-bonn.de

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Abstract

Social stress can cause physical and mental harm. It is therefore not surprising that public health policy makers have sought to identify and implement policies aimed at tackling this social ill. A frequently prescribed remedy is to reduce social stress by reducing income inequality, which is typically measured by the Gini coefficient. Decomposing the coefficient into a measure of a population's social stress and a population's income makes it possible to show that steps taken to lower the coefficient can actually exacerbate social stress. We formulate conditions under which lowering the Gini coefficient coincides with increasing social stress. If the aim of public policy is to improve public health and increase social welfare, and if social welfare is reduced by social stress, then lowering the Gini coefficient may not be the right course of action.

Keywords: Income inequality; Gini coefficient; Social stress; Public health policy; Social welfare

JEL classification: D01; D63; D91; I31; Z18

1. Introduction

On the face of it, there is an elegant complementarity between public health and economics: the former identifies a social ill, the latter provides a tool to quantify it. Public health policy makers can then use that tool to design interventions that will improve public health and boost social welfare.

Social stress is a social ill. Medical science tells us that stress arising from adverse social conditions can cause physical and mental harm. For example, with regard to physical harm, Cohen and Williamson (1991) present intriguing evidence for the influence of stress on infectious diseases. Segerstrom and Miller (2004) conduct a meta-analytic study that leads them to infer (p. 619) that "stressful experiences alter features of the immune response as well as confer vulnerability to adverse medical outcomes that are either mediated by or resisted by the immune system." Kivimäki et al. (2006) and Steptoe and Kivimäki (2013) conduct meta-analyses, demonstrating the significant influence of work-related stress on the risk of coronary disease. With regard to mental harm, Turner et al. (1995) find that exposure to stress is a significant explanatory variable of depressive symptoms and major depressive disorder, and Hammen (2005) reviews studies that show a robust and causal association between stressful life events and major depressive episodes. Medical science differentiates between two types of stress factors: internal, where stress is caused by illness and medical treatment, and external, which arises from adverse social conditions. In this paper we are concerned with social stress.

The social stress that we have in mind is income related and caused by the dismay that arises from having low relative income. This perception of social stress is in line with Sen's (1973, p. 33) interpretation of the manner in which the Gini coefficient is constructed. Inter alia, Sen writes: "In any pair-wise comparison the man with the lower income can be thought to be suffering from some depression on finding his income to be lower. Let this depression be proportional to the difference in income." For our current purposes, that Sen uses the term *depression* rather than *stress* is immaterial. We discuss the concept of social stress in greater detail later on in this section. In the next section we provide a formal definition.

Policy makers aiming to improve public health by keeping a contaminant in check quite often harbor little doubt about the correct policy prescriptions. In the recent past alone, addressing the infection and fatality rates of COVID-19, several studies noted a link between income inequality, social stress, and measures of infection and mortality, and recommended reducing income inequality by lowering the Gini coefficient. Examples of such studies include Elgar et al. (2020), Oronce et al. (2020), Liao and De Maio (2021), Tan et al. (2021), and Wildman (2021). In applying the prescribed reduction, these researchers claim, social welfare is likely to improve. For example, Tan et al. (2021, p. 2/8) write: "Targeted interventions should . . . focus on income inequality measured by the Gini coefficient to . . . flatten the [COVID-19 pandemic] curve." Wildman (2021), who identifies "a clear association between income inequality [measured by the Gini coefficient] and COVID-19 cases and deaths," concludes (p. 461) that "a goal of governments should be to reduce [income] inequalities and [thereby] improve the [COVID-19 outcomes and] underlying health of their populations." The recent studies echo a view expressed 25 years ago by Lynch et al. (1998), who, having examined associations between income inequality and mortality in US metropolitan areas, concluded (p. 1074) that "given the mortality burden associated with income inequality, public and private sector initiatives to reduce economic inequalities should be a high priority."

The purpose of this paper is to challenge this apparently seamless line of reasoning. What harms public health and social welfare is not necessarily a high Gini coefficient but a high level of a *component* of the Gini coefficient. A lowering of the Gini coefficient can actually *raise* the level of that component. Social stress will then rise, and so public health will not achieve its aims.

It is worthwhile to reemphasize exactly what this paper seeks to establish and to provide evidence that supports the argument of a causal link between a measure of social stress, which is a component of the Gini coefficient - as shown in what follows, this measure is aggregate relative deprivation - and adverse health outcomes.

A prevalent stance is that adverse health outcomes are associated - positively correlated - with an unequal income distribution, which is measured by the Gini

coefficient, and that reducing inequality by lowering the Gini coefficient will lead to improved health outcomes. We contest this stance. Not only do we argue that reducing the Gini coefficient may fail to improve health outcomes, but we go further, arguing that reducing the Gini coefficient can harm public health. We reason as follows. Adverse health outcomes are associated - positively correlated - with inequality of the income distribution as measured by the Gini coefficient. According to evidence presented in what follows, the *causal* link is between adverse health outcomes and *a component* of the Gini coefficient. This component is social stress. To improve health outcomes, social stress should be reduced. Attempts to reduce the Gini coefficient can constitute a misguided policy response, not only because such a reduction need not reduce social stress at all, but because the reduction can actually coincide with raising social stress. The correct policy response is to address social stress directly. A reviewer of this paper made the following assertion: "A reduction of social stress is a positive policy outcome, and should be pursued by public authorities because the likelihood that it will do good is overwhelmingly high."

Regarding a link between social stress as measured by relative deprivation - a component of the Gini coefficient - and adverse health consequences of relative deprivation, we draw on the following sample of research findings. Eibner et al. (2004) use data taken from the US national household survey component of HealthCare for Communities in order to evaluate the relationship between relative deprivation and mental health. They find that individuals who are more relatively deprived are at a higher risk of experiencing mental health disorders. Using data for males from the US National Health Interview Survey and from the US Behavioral Risk Factor Surveillance System, Eibner and Evans (2005) report that in many cases, relative deprivation has a greater impact on health than a person's absolute income, that high relative deprivation is related to an increased probability of smoking, and that relative deprivation is positively associated with cause-specific mortality, notably with deaths due to tobacco-related cancers and coronary heart diseases. Using longitudinal data for Sweden, Aberg Yngwe et al. (2012) find a significant association between relative deprivation and premature mortality. Using data on deaths by suicide in the United States to identify the importance of interpersonal comparisons and "relative status," Daly et al. (2013) find compelling

evidence that individuals care not only about their own income but also about the income of others in their local area: Daly et al. show that individual suicide risk rises with others' income. This finding was obtained using two separate and independent data sets, suggesting that it is not the product of a particular sample design of either data set. (The finding is robust to alternative specifications and cannot be explained by geographical variation in suicide classification, cost of living, or access to emergency medical care.) The finding is consistent with the idea that relative deprivation, rather than a person's absolute income, matters for wellbeing, and that the stress it causes can be severe enough to make people take their own life. Drawing on data from the US National Longitudinal Study of Adolescent Health, Balsa et al. (2014) find that relative deprivation is positively associated with substance abuse (heavy drinking and smoking) in adolescent males. Based on data from several countries, Beshai et al. (2017) find that stress arising from relative deprivation significantly predicts functional disorder symptoms such as fibromyalgia and functional gastrointestinal disorders. Gero et al. (2020, p. 665) find that in Japan "increased relative income deprivation [is] associated with a higher risk of all-cause mortality independently of absolute income."

The Daly et al. (2013) and Balsa et al. (2014) studies in economics align with several revealing studies in social psychology (for example, Callan et al., 2011; Smith et al., 2012) that document how the sensing of relative deprivation impacts negatively on personal wellbeing.

2. Measuring social stress

In a population $N = \{1, 2, \ldots, n\}$, $n \geq 2$, let $y = (y_1, ..., y_n)$ be the vector of incomes of its members. Let these incomes be ordered: $0 < y_1 < y_2 < \ldots < y_n$. Denoted by RD_i, the relative dismay (the income-related social stress) or the relative deprivation of individual i, $i = 1, 2, ..., n-1$, whose income is y_i, is defined as

$$RD_i \equiv \frac{1}{n} \sum_{j=i+1}^{n} (y_j - y_i), \tag{1}$$

where it is understood that $RD_n \equiv 0$.

The idea here is to aggregate income excesses (the differences between the incomes that are higher than the income of individual *i* and the income of individual *i*) and normalize this sum, dividing it by the size of the population. A detailed derivation of this representation of an individual's relative deprivation is presented in Appendix 1.

By definition and construction, the concept of relative deprivation is the dual of the concept of reference group or comparison group. There is a substantial body of literature on this topic, spanning from Stouffer et al. (1949) through Akerlof (1997) and all the way to our recent writings, for example, Stark et al. (2017) and Stark (2020). These writings include discussions about the identity of the reference group, and they provide references to related work. For the purposes of this paper, the reference group consists of people whose income distribution and social welfare are of concern to social planners. The incomes concerned are known to these people and to the social planners; otherwise, the income distribution and the social welfare function that incorporates that distribution will not be amenable to policy intervention by social planners.[1] In Appendix 2 we present a brief historical account of the "infiltration" into economics of the sociological-psychological concept of relative deprivation.

We denote the sum or the aggregate of the levels of RD_i in the population by total relative deprivation, *TRD*:

$$TRD \equiv \frac{1}{n}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(y_j - y_i). \tag{2}$$

Starting with Sen (1973), the Gini coefficient has been presented as

$$G \equiv \frac{\sum_{j=1}^{n}\sum_{i=1}^{n}\left|y_i - y_j\right|}{2n^2\bar{y}}, \tag{3}$$

where $\bar{y} = (1/n)\sum_{i=1}^{n} y_i$ is the population's average income.

[1] Calculating the level of relative deprivation as per (1) does not require that the individual concerned knows the incomes of all the individuals in his comparison group. Rather, the individual concerned needs to know the average income of the individuals in his comparison group who are positioned higher up in the income hierarchy.

Noting that $\sum_{j=1}^{n}\sum_{i=1}^{n}\left|y_i - y_j\right| = 2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(y_j - y_i)$, an equivalent representation of *G* in (3), which eliminates the need to operate with absolute values, is

$$G = \frac{\frac{1}{n}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(y_j - y_i)}{\sum_{i=1}^{n} y_i} = \frac{TRD}{TI}. \tag{4}$$

Hence, the Gini coefficient in (4) is a ratio: *TRD* as defined in (2) divided by aggregate (total) income $\sum_{i=1}^{n} y_i = TI$.

Remark 1. Jones and Wildman (2008, p. 313) draw on a presentation of a measure of the relative deprivation of an individual, $d_y(F)$, that appears to be different from the presentation in (1). Jones and Wildman use

$$d_y(F) = \mu[1 - F_1(y)] - y[1 - F(y)], \tag{5}$$

"where μ is mean income, $F_1(y)$ is the cumulative proportion of total income at income *y* and $F(y)$ is the cumulative proportion of the population up to the individual with income *y* (where the population is ranked by income)." However, (5) is equivalent to the intuitive and simpler (1). To see the equivalence, we replace a formal proof with an example. Let the vector of incomes be (1,2,3,4,5). We calculate the relative deprivation of an individual whose income is $y = 3.$ In this vector of incomes, mean income, μ, is 3; "the cumulative proportion of total income at income *y*," $F_1(y)$, is $\frac{6}{15}$; and "the cumulative proportion of the population up to the individual with income *y*," $F(y)$, is $\frac{3}{5}$. Thus,

$$d_y(F) = \mu[1 - F_1(y)] - y[1 - F(y)] = 3\left(1 - \frac{6}{15}\right) - 3\left(1 - \frac{3}{5}\right) = \frac{3}{5}.$$

By (1), we obtain straightforwardly

$$RD_3 = \frac{1}{5}(1 + 2) = \frac{3}{5}.$$

What is the most general condition under which lowering the Gini coefficient will coincide with increasing *TRD*? If we have *TRD* and *TI* as base data, then the condition is quite simple: whenever the relative increase in *TI* is larger than the relative increase in *TRD*, the Gini coefficient is reduced while *TRD* is increased. For example, if *TRD* increases by 5 percent while total income increases by 10 percent, then the Gini coefficient decreases. Thus, we have the following criterion.

Criterion 1. Assume that to begin with the incomes in a population are such that total relative deprivation is TRD_1 and total income is TI_1. Assume that some event induces a change of incomes in the population in such a way that total relative deprivation becomes $TRD_2 > TRD_1$ and total income becomes TI_2. Then the Gini coefficient decreases as a result of this change if and only if

$$\frac{TRD_2}{TRD_1} < \frac{TI_2}{TI_1} \ .$$

Proof. Let G_1 denote the Gini coefficient before the event, and let G_2 denote the Gini coefficient after the event. The inequality

$$\frac{TRD_2}{TRD_1} < \frac{TI_2}{TI_1}$$

is equivalent to the inequality

$$\frac{TRD_2}{TI_2} < \frac{TRD_1}{TI_1}$$

or to the inequality

$$G_2 < G_1.$$

Q.E.D.

We have seen that a population's social stress can increase when the Gini coefficient decreases. In such a situation, a policy aimed at reducing inequality can actually increase misery by exacerbating social stress. As a result, public health and social welfare can suffer.

We next examine the case of a population that consists of two individuals.

Criterion 2. Assume that the initial vector of incomes in a population consisting of two individuals, (x_1, x_2), is such that $x_1 < x_2$, and assume that the final vector of incomes, (y_1, y_2), is such that $y_1 < y_2$. Then the necessary and sufficient condition for a decrease in the Gini coefficient and a simultaneous increase in *TRD* is

$$\frac{x_2 y_1}{x_1} > y_2 > y_1 + x_2 - x_1.$$

Proof. The initial *TRD*, written as TRD_x, is

$$TRD_x = \frac{x_2 - x_1}{2},$$

and the final *TRD*, written as TRD_y, is

$$TRD_y = \frac{y_2 - y_1}{2}.$$

Therefore, the necessary and sufficient condition for an increase in *TRD* is

$$\frac{y_2 - y_1}{2} > \frac{x_2 - x_1}{2},$$

which is equivalent to

$$y_2 > y_1 + x_2 - x_1.$$

The initial Gini coefficient, G_x, is

$$G_x = \frac{x_2 - x_1}{2(x_1 + x_2)} = \frac{1}{2} - \frac{x_1}{x_1 + x_2},$$

and the final Gini coefficient, G_y, is

$$G_y = \frac{y_2 - y_1}{2(y_1 + y_2)} = \frac{1}{2} - \frac{y_1}{y_1 + y_2}.$$

Therefore, the necessary and sufficient condition for a decrease in the Gini coefficient is

$$\frac{1}{2} - \frac{y_1}{y_1 + y_2} < \frac{1}{2} - \frac{x_1}{x_1 + x_2},$$

which is equivalent to

$$\frac{x_1}{x_1 + x_2} < \frac{y_1}{y_1 + y_2}$$

and further to

$$x_1 y_2 < x_2 y_1$$

and finally to

$$y_2 < \frac{x_2 y_1}{x_1}.$$

In sum, then, the necessary and sufficient condition for a decrease in the Gini coefficient and a simultaneous increase in *TRD* is

$$\frac{x_2 y_1}{x_1} > y_2 > y_1 + x_2 - x_1.$$

Q.E.D.

It would be helpful to look at a numerical illustration in which two incomes rise in such a way that, in absolute terms, the larger income rises by more than the smaller income, whereas in relative terms the smaller income rises by more than the larger income: say incomes 5 and 2 are increased, respectively, by 3 and 2 to incomes 8 and 4. Because $x_1 = 2$, $x_2 = 5$, $y_1 = 4$, and $y_2 = 8$, the necessary and sufficient condition for a decrease in the Gini coefficient and a simultaneous increase in *TRD* is satisfied: the Gini coefficient is lower $\frac{\frac{1}{2}(8-4)}{8+4} = \frac{4}{24} = \frac{7}{42} < \frac{\frac{1}{2}(5-2)}{5+2} = \frac{3}{14} = \frac{9}{42}$, whereas *TRD* is higher $\frac{1}{2}(8-4) = 2 > \frac{1}{2}(5-2) = \frac{3}{2}$.

3. Discussion and conclusion

Observation 1. Equation (4) implies that if aggregate income increases while the Gini coefficient does not change, then social stress, as measured by *TRD*, increases. When on average a population is getting richer, this does not confer immunity against exposure to higher social stress.

Observation 2. When rewritten as $G \cdot TI = TRD$, (4) implies that a 1 percent decrease in the Gini coefficient accompanied by a 1 percent increase in aggregate income leaves social stress (roughly) unchanged.[2] This observation too implies that an indirect policy intervention aimed at reducing social stress can fail even when a reduction in

[2] We write "roughly" because there is a negligible decrease: $(100+1)\cdot(100-1) = 100^2 - 1 < 100^2$.

income inequality, where this inequality is measured by the Gini coefficient, is accompanied by an increase in aggregate income.

Observation 3. Criterion 1 implies that if, percentagewise, the Gini coefficient decreases by α and aggregate income increases by measurably more than α, then social stress, as measured by *TRD*, increases. As shown in an appendix available on request, such a scenario is not a figment of imagination. It turns out that in the past two decades around the world, aggregate income has increased at a faster rate than the Gini coefficient has decreased. Thus, worldwide, *TRD* has gained significance.

These observations further illustrate the need for directly reducing social stress as a cause of adverse health outcomes rather than relying for that purpose on indirect inequality-reducing measures.

Remark 2. A concern might be raised that if the stress experienced by individuals arises from both low relative income and low status, then (1) does not accommodate or acknowledge that. For example, Jones and Wildman (2008, p. 313) write that what (5) amounts to is that "individuals are only aware of low status . . . ." To check the validity of this statement, we expand (1), which, as we have shown, is equivalent to (5). Multiplying and dividing by $n-i$, we obtain

$$RD_i = \frac{n-i}{n}\left[\frac{1}{n-i}\sum_{k=i+1}^{n}(y_k - y_i)\right] = (n-i)\frac{1}{n}\left(\frac{\sum_{k=i+1}^{n} y_k}{n-i} - y_i\right) = (n-i)\left[\frac{1}{n}(\tilde{y}_i - y_i)\right], \qquad (6)$$

where $\tilde{y}_i \equiv \frac{1}{n-i}\sum_{k=i+1}^{n} y_k$ is the average income of individuals whose incomes are higher than the income of individual *i* (these are the individuals who are positioned to the right of individual *i* in the income distribution). We can think of the rightmost part of (6) in a novel way, viewing RD_i as the product of a pure rank impact term, $n-i$, and a cardinal impact term, $\frac{1}{n}(\tilde{y}_i - y_i)$. (The term $n-i$ expresses the distance of individual *i* from the top rank, where "distance" is measured by the number of ranks above individual *i*.) Seen this way, the measure of relative deprivation has a pure rank preference component and a cardinal preference component embedded in it. 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, and the stress arising from the income differences between the higher incomes of others and one's own income. The decomposition in (6) shows that people are aware both of "low status" (that is, their rank, here measured as the distance from the top rank, which is an ordinal measure) and of the distance from the mean income of individuals richer than they are (a cardinal measure). Thus, it is incorrect to assert that the meaning of (5), as expressed by the equivalent representation (1), is that individuals are "*only* aware of low status" (italics added). Status matters, but so does an income shortfall.

Remark 3. Here we comment on the choice of a measure of relative deprivation as a basis for investigating the association between social stress and adverse health outcomes. In addition to the measure presented in (1), we can think of at least one other measure: the relative deprivation of individual *i* can be quantified as the distance from below the mean income, that is, as $RD_i \equiv \max\{\bar{y} - y_i, 0\}$, where $\bar{y}$ is the average income of the reference group of individual *i* (consult Fan and Stark, 2007). The intuition yielding this measure is that the mean, if it exists and is finite, is the first-order statistics used to characterize a distribution. People will find it natural to calculate the mean as a benchmark against which to measure what they have and how they are faring. It is straightforward to see that in such a case, reducing inequality need not affect social stress at all, as when, for example, income is taken from a person whose income is higher than the average income and given to another, lower-income person whose income is also higher than the average income.

In conclusion, the amount of attention paid to reducing income inequality as a remedy for a host of health-related social ills might be misguided; the source of social pain is social stress. As mentioned in the Introduction, social stress is the cause of a great many ills. It is time to come to terms with this observation and to rethink the range of instruments used in public health policies.

Appendix 1: Construction of the index of relative deprivation

For the purpose of constructing a measure of relative deprivation, a natural starting point is the work of Runciman (1966), who argues that an individual has an unpleasant sense of being relatively deprived when he lacks a desired good and perceives that others with whom he naturally compares himself possess that good. Runciman (1966, p. 19) writes as follows: "The more people a man sees promoted when he is not promoted himself, the more people he may compare himself with in a situation where the comparison will make him feel deprived," implying that the deprivation from not having, say, income *y* is an increasing function of the fraction of people in the individual's reference group who have *y*. To aid intuition, we resort to income-based comparisons, namely an individual feels relatively deprived when others in his reference group earn more than he does. It is assumed here implicitly that the earnings of others are publicly known. Alternatively, we can think of consumption, which might be more publicly visible than income, although these two variables can reasonably be assumed to be strongly positively correlated.

As an illustration of the relationship between the fraction of people possessing income *y* and the deprivation of an individual lacking *y*, consider a population (reference group) of six individuals with incomes $\{1,2,6,6,6,8\}$. Imagine a furniture store that in three separate departments sells chairs, armchairs, and sofas. An income of 2 allows you to buy a chair. To buy an armchair, you need an income that is slightly higher than 2. To buy a sofa, you need an income that is slightly higher than 6. Thus, when you go to the store and your income is 2, what are you "deprived" of? Armchairs and sofas. Mathematically, this deprivation can be represented by $P(Y > 2)(6-2) + P(Y > 6)(8-6)$, where $P(Y > y_i)$ stands for the fraction of those in the population whose income is higher than y_i, for $y_i = 2,6$. The reason for this representation is that when you have an income of 2, you cannot afford anything in the department that sells armchairs, and you cannot afford anything in the department that sells sofas. Because not all those who are to your right in the income distribution sorted in ascending order can afford to buy a sofa, yet they can all afford to buy armchairs, a breakdown into the two (weighted) terms $P(Y > 2)(6-2)$ and $P(Y > 6)(8-6)$ is needed. In this way, we already get to the essence of the measure of relative deprivation: we take into account the fraction of the reference

group (population) of individuals who possess some good that you do not, and we weigh this fraction by the "excess value" of that good. Because income enables an individual to afford the consumption of certain goods, we refer to comparisons based on income.

Formally, let $y=(y_1,...,y_m)$ be the vector of incomes in population *N* of size *n* with relative incidences $p(y)=\left(p(y_1),...,p(y_m)\right)$, where $m\le n$ is the number of distinct income levels in *y*, and *n* and *m* are natural numbers. The relative deprivation, *RD*, of an individual earning y_i is defined as the weighted sum of the excesses of incomes higher than y_i such that each excess is weighted by its relative incidence, namely

$$RD_N(y_i)\equiv\sum_{y_k>y_i}p(y_k)(y_k-y_i)\,.$$

In the previously given example with income distribution {1,2,6,6,6,8}, the vector of incomes was $y=(1,2,6,8)$ and the corresponding relative incidences were $p(y)=(1/6,1/6,3/6,1/6)$. Therefore, the *RD* of the individual earning 2 was $\sum_{y_k>y_i}p(y_k)(y_k-y_i)=p(6)(6-2)+p(8)(8-2)=\frac{3}{6}\cdot 4+\frac{1}{6}\cdot 6=3$. By similar calculations, here we see that the *RD* of the individual earning 1 is higher at $3\frac{5}{6}$, and that the *RD* of each of the individuals earning 6 is lower at $\frac{1}{3}$.

We expand the vector y to include incomes with their possible respective repetitions, that is, we include each y_i as many times as its incidence dictates, and we assume that the incomes are ordered, that is, $y=(y_1,...,y_n)$ such that $y_1\le y_2\le...\le y_n$. In this case, the relative incidence of each y_i, $p(y_i)$, is $1/n$, and thus, for $i=1,...,n-1$, we obtain

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

This formula is analogous to (1) for RD_i presented in the main body of the paper.

Appendix 2: A brief historical account of the "adoption" by economists of the sociological-psychological concept of relative deprivation

A considerable amount of economic analysis has been inspired by the sociological-psychological concepts of relative deprivation (*RD*) and reference (comparison) groups.[3] Economists have come to consider these concepts as appropriate tools for studying comparisons that affect an individual's perception of wellbeing and behavior, in particular, comparisons with related individuals whose incomes are higher than that individual's own income (consult the large body of literature spanning from Duesenberry, 1949, to, for example, Clark et al., 2008). An individual has an unpleasant sense of being relatively deprived when he lacks a desired good and perceives that others in his reference group possess that good (Runciman, 1966). Given the income distribution of the individual's reference group, the individual's *RD* is the sum of the deprivation caused by every income unit that he lacks (Sen, 1973; Ebert and Moyes, 2000; Stark et al., 2017).

The pioneering study in modern times that opened the door to research on *RD* and primary (reference) groups is the 1949 two-volume set of Stouffer et al. titled *Studies in Social Psychology in World War II: The American Soldier*. That work documented the distress caused not by a low military rank and weak prospects of promotion (in the military police) but rather by the faster pace of promotion of others (in the US Air Force). It also documented the lesser dissatisfaction of black soldiers stationed in the South who compared themselves with black civilians in the South than the dissatisfaction of their counterparts stationed in the North who compared themselves with black civilians in the North. Stouffer's research was followed up by a large number of social-psychological studies. Economics has caught up relatively late, and only partially. This is rather surprising because eminent economists in the past understood well that people compared themselves to others around them, and that social comparisons were of paramount importance for individuals' happiness, motivation, and actions. Even Adam Smith (1776) pointed to the social aspects of the necessities of life and stressed the *relative* nature of poverty: "A linen shirt, for example, is, strictly speaking, not a necessary of life. The

[3] The reference (comparison) group of an individual is the set of individuals with whom the individual naturally compares himself. (Consult Runciman, 1966; Singer, 1981.)

Greeks and Romans lived, I suppose, very comfortably, though they had no linen. But in the present times, through the greater part of Europe, a creditable day-labourer would be ashamed to appear in public without a linen shirt, the want of which would be supposed to denote that disgraceful degree of poverty […]" (p. 465). Marx's (1849) observations that "Our wants and pleasures have their origin in the society; [… and] they are of a relative nature" (p. 33) emphasize the social nature of utility and the impact of an individual's relative position on his satisfaction. Inter alia, Marx wrote: "A house may be large or small; as long as the surrounding houses are equally small, it satisfies all social demands for a dwelling. But if a palace arises beside the little house, the house shrinks into a hut" (p. 33). Samuelson (1973), one of the founders of modern neoclassical economics, pointed out that an individual's utility does not depend only on what he consumes in *absolute* terms: "Because man is a social animal, what he regards as 'necessary comforts of life' depends on what he sees others consuming" (p. 218).

The relative income hypothesis, formulated by Duesenberry (1949), posits an asymmetry in the comparisons of income that affect individuals' perceptions of wellbeing: the individual looks upward when making comparisons. Veblen's (1899) concept of *pecuniary emulation* explains why the behavior of an individual can be influenced by comparisons with the incomes of those who are richer. Because income determines the level of consumption, higher income levels may be the focus for emulation. Thus, an individual's income aspirations (to obtain the income levels of other individuals whose incomes are higher than his own) are shaped by the perceived consumption standards of richer individuals. In that way, invidious comparisons affect behavior, that is, behavior that leads to "the achievement of a favourable comparison with other men […]" (Veblen, 1899, p. 33).[4]

[4] The empirical findings support the relative income hypothesis. Duesenberry (1949) already found that individuals' levels of savings depend on their positions in the income distribution, and that the incomes of richer people affect the behavior of poorer ones (but not *vice versa*). Later on, and for example, Schor (1998) showed that, keeping annual and permanent income constant, individuals whose incomes are lower than the incomes of others in their community save significantly less than those in their community who are relatively better off.

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