Political Feasibility and Social Perception of Inequality

Xiangyu Qu

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Abstract

The actual level of income inequality and the scope of policy options influence the redistribution policy chosen by a social planner. We show how the interaction between the two attributes may lead to the formation of social perception of inequality. An axiomatic system on social preferences is suggested and demonstrated to characterize a measure of social perception of inequality. Our contention is that social perception, as conceptualized in this paper, is closely related to both the objective inequality and the prospect level of equality. The prospect equality reflects the ideal level of equality, among which are politically feasible, and serves as a reference point for perception. Our notion indicates that a social planner may not take action on inequality if the relevant policies are not politically viable. These insights may help explain the differential redistribution policies across the nations.

1 Introduction

At least since Meltzer and Richard [1981], many believe that as income inequality increases, a social planner would prefer greater redistribution policy to counter excessive income disparities. One stream of early study of inequality has focused on the development of objective measure of inequality as a tool for intervening inequality.[1] However, empirical support for objective inequality leading to more redistributive policies is generally ambiguous (Meltzer and Richard [1983], Borge and Rattsø [2004]). In particular, Alesina and Glaeser [2004] observed the *opposite* patten: western European countries have lower levels of objective income inequality than the US, but demand for higher redistribution policy. While the emphasis on income inequality as a driver of redistribution

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[1]For theoretical studies, to name a few, see Atkinson [1970], Kolm [1969], Sen [1997] and an excellent survey by Cowell [2000].

appeared to be largely unsupported, the more recent studies suggested that higher *perceived* level of inequality are positively connected to redistribution policy (Gimpelson and Treisman [2018], Page and Goldstein [2016], Kuhn [2020]). It makes sense that voting behavior would be shaped more by the perception of inequality than by an obscure inequality index. Because of cognitive limitation and frame effect, individuals or voters can rarely be guided to correctly track objective levels of income inequality. Therefore, a social policy, being an aggregation of individual opinions, has to legitimately reflect such limitation. All this suggests a need to pin down the mechanism of perception formation and, therefore, develop a theory of the measurement of inequality perception. Indeed, this measure can facilitate to separate societies who are economically similar in terms of income distribution, but actually fundamentally different in terms of redistribution demand. If such a measure become focal, we may achieve novel insights of redistribution policies.

In this paper, we concern with the formation and measurement of social perception of inequality. In fact, we have already known many attributes play some roles on the formation of perception. For instance, social beliefs (Alesina and Angeletos [2005]), experience (Roth and Wohlfart [2018]), and culture (Luttmer and Singhal [2011]) may affect the perceived inequality in different contexts. Ideally, a theory must include all attributes that are relevant for the formation of perception. But we will simplify the analysis enormously by restricting attentions to the attributes that potentially have effective influence on policy making. It is our contention that two attributes are closely linked to the generation of perception. The first attribute, with no surprise, is objective inequality. As Kerr [2014] demonstrated, in a country, growth in equality typically produces greater support for redistribution. Therefore, objective inequality has positive effect on redistribution *ceteris paribus*. The other attribute, we believe, is *prospect* equality. A prospect equality is derived from a prospect set, which consists of all the feasible income profiles a society *could* have. In our theory, prospect equality is regarded as the ideal equality level among the prospect set. As Almås, Cappelen, Lind, Sørensen, and Tungodden [2011], Cappelen, Hole, Sørensen, and Tungodden [2007] demonstrated, the view about what are feasible level of inequalities is also a critical determinant of distribution demand. Putting two pieces together, we propose that the prospect equality serves as a reference point to determine how the inequality is perceived. On one hand, the perceived inequality is higher as the actual level of inequality increase, all else being equal. On the other hand, as the prospect equality far outstrip the actual level, a social planner is likely to perceive excessively. As the prospect equality is close to the actual level, the perception of inequality tends to the actual level. Therefore, it is intuitive that a society with high actual level of equality but with even high level of prospect equality may perceive higher inequality than a society with low levels of both actual and prospect equality. In that sense, our theory can help explain the observation of

Alesina and Glaeser [2004] and many other similar observations.

To obtain the exact measurement of perceived inequality in practice, we need to measure separately the inequality of actual income profile and the prospect one. Given an income profile x, it is straight to measure its level of inequality by a classical index $I(x)$, such as Gini index. The critical part of our theory is how to determine the prospect set and then derive the prospect equality. In a democracy, due to societal and institutional reasons, a social planner can only select a redistribution policy from among policies that are politically acceptable at the time.[2] Therefore, a society would not expect the equality which is beyond the political feasibility. Given a pre-tax income profile, a prospect set A can be imagined as a set of post-tax income profiles which is generated by each feasible policy. A prospect equality is, therefore, regarded as the best feasible equality, i.e. $\min_{y \in A} I(y)$. As a result, social perception of inequality is measured by the difference between actual level of inequality $I(x)$ and (weighted) prospect equality $\min_{y \in A} I(y)$.

Though important, this paper has no intent to take a position on debate in terms of the prospect equality that a social planner presumes. We postpone our discussion on this issue to conclusion section. But one issue upon which our approach does shed some light is that it can narrow the gap between inequality and redistribution. In particular, the theory presented in this paper offers a theoretical foundation not only for the formation of perception, but to suggest an axiomatic characterization of perception measurement.

This paper is closely related to the literature that attempts to understand the determinants of inequality reduction pursued by a social planner. One stream of study is driven by individual behaviors, which tends to explain the policy making from the angle of individual altruism (Fehr and Schmidt [1999]), prospects of mobility (Benabou and Ok [2001]), belief in fairness (Bénabou and Tirole [2006]) and so on. The other stream of study is driven by political system such as clientelism (Lizzeri and Persico [2001]) or identity politics (Roemer [1998]). Therefore, our measure of social perception of inequality can, somehow, be regarded as a unified notion of both approaches. The first part of our measure, objective inequality, can be regarded as an aggregation of individual attitudes towards inequality reduction. The second part of our measure, prospect equality, can be regarded as a scope of political reality. Different from their game theoretical analysis, we adopt axiomatic approach to highlight the normative criterions that shape the social perception.

Our idea discussed above is well connected to certain developments in the decision theory. Specifically, it turns out that the so-called *prospect theory* of Kahneman and Tversky [1979] is relevant for the study of perceived inequality. As we claimed above, prospect equality is served

[2] Seguino, Sumner, van der Hoeven, Sen, and Ahmed [2013] reported a survey about inequality, which focus on policy makers' perspectives. In particular, the chapter 6 reported that policy makers' views about the political space are quite different. Also, the measures that policy makers desire to take are different.

as a reference point to evaluate the perception of inequality. Alternatively, the prospect set can be regarded as a *menu* of the type studied by Gul and Pesendorfer [2001]. Our task, therefore, consists of presenting a set of axioms for such a measurement and proving a representation result as they did. The analysis used in this endeavor is also related to other work on axiomatic foundations of measurement of income profile, which deviates from classic objective measures, notably conflict measurement of Esteban and Ray [1994]. However, our motivation, application and measurement are far from the previous studies.

We organize this paper as follows. Section 2 provides a basic setup and proposes a measure of perception of inequality. Section 3 develops an axiomatic foundation for the Gini index measure of social perception of inequality. The main result is also obtained. Section 4 concludes by discussing possible application in a broader context. Appendix contains all the proofs.

2 The Model

An income profile is a list of individuals and a list of corresponding incomes. Specifically, if a society consists of n individuals and x_i^n denotes the income of individual i for $i = 1, \ldots, n$, then an income profile is represented as a finite-dimensional vector $x^n = (x_1^n, \ldots, x_n^n)$. We denote $X = \{\mathbb{R}_+^n : n \geq 2\}$ the set of all possible income profiles.[3] For $x^n \in X$, we write $\mu(x^n) = \frac{1}{n}\sum_{i=1}^n x_i^n$ for the *mean* of x^n.

Let $\mathscr{A}$ denote the set of non-empty compact subsets X. Each element A in $\mathscr{A}$ is referred to *prospect* set of income profiles, representing the society's feasible income profiles. The objects of our analysis are the pairs of an income profile and associated prospect set. We analyze how a society perceives the inequality of an income profile x while the prospect set of income profiles is A. Formally, let

$$\mathbb{D} := \{(x, A) \in X \times \mathscr{A} : x \in A\},$$

and denote by $\succsim$ the social preference relation on $\mathbb{D}$. We interpret relation $(x, A) \succsim (y, B)$ in a way that a society "perceives less inequality" from profile x among A than from y among B. We say a function $J : \mathbb{D} \to \mathbb{R}$ represents social perception of inequality $\succsim$ if, for all $(x, A), (y, B) \in \mathbb{D}$,

$$(x, A) \succsim (y, B) \text{ if and only if } J(x, A) \leq J(y, B).$$

Recall that we say a function $I : X \to \mathbb{R}$ an index of *objective measure* if (i) $0 \leq I(x) \leq 1$ for

[3] We adopt the assumption that a society consists of finite number of individuals and allow different societies may have different size of individuals. In contrast, Yaari [1988] and Aaberge [2001] deal with a continuum society.

all $x \in X$; (ii) $I(x) = 0$ iff $x = c \cdot \mathbb{1}$ where $c > 0$ and $\mathbb{1}$ is a unit vector in X; and (iii) $I(x) < I(y)$ while x is a Pigou-Dalton transfer of y.[4]

Definition 1. A function $J : \mathbb{D} \to \mathbb{R}$ is an index of *social perception of inequality* if there exists an index of objective inequality I such that for $(x, A) \in \mathbb{D}$,

$$J(x, A) = I(x) - \theta \min_{y \in A} I(y), \tag{1}$$

where $0 \leq \theta \leq 1$. In particular, we say J to be a *Gini index* of social perception of inequality if I is an objective Gini coefficient defined as following: for all $x^n \in X$,

$$I_g(x^n) = \frac{\sum_{1 \leq i < j \leq n} \left| x_i^n - x_j^n \right|}{n^2 \mu(x^n)}. \tag{2}$$

According to the definition, the source of the social perception of inequality are twofold. One is the *objective* inequality of real income profile, which is measure by $I(x)$. The other is the *prospect* equality, which is measured by $\min_{y \in A} I(y)$. The parameter θ measures the degree of prospect equality affects the social perception. When $\theta = 0$, the social perception coincides with the objective inequality.

Proposition 1. *The function J defined in eq (1) satisfies the following properties:*

(i) *for all $(x, A) \in \mathbb{D}$, $0 \leq J(x, A) \leq 1$;*

(ii) *if $\theta = 1$, then $J(x, A) = 0$ if and only if $I(x) = \min_{y \in A} I(y)$; if $\theta < 1$, then $J(x, A) = 0$ if and only if $x = c \cdot \mathbb{1}$ where $c > 0$ and $\mathbb{1}$ is a unit vector in X;*

(iii) *if x is a Pigou-Dalton transfer of y, then $J(x, \{x, y\}) < J(y, \{x, y\})$;*

(iv) *if for all $x \in X$ and all $c > 0$, **I(cx)=cI(x)**, then for all $(x, A) \in \mathbb{D}$ and $c > 0$, $J(cx, cA) = c \cdot J(x, A)$.*[5]

This proposition first says that function J lies between zero and one as the objective measure. The second property says that if objective and prospect inequalities are evaluated equally, then the perception of equality is the best whenever two inequality values are the same. If the prospect equality is evaluated at a discount, then the best perception of equality is obtained when

[4] If $x, y \in X^n$, we say x is a Pigou-Dalton transfer of y if for some $i, j \in \{1, \ldots, n\}$ we have $x_k = y_k$ for $k \notin \{i, j\}$ and $x_i + x_j = y_i + y_j$ and $|x_i - x_j| < |y_i - y_j|$.

[5] For $x \in X^n$ and $c > 0$, define $cx \in X^n$ by $(cx)_i = cx_i$ for all $i = 1, \ldots, n$. Similarly, for $A \in \mathscr{A}$ and $c > 0$, let $cA = \{cx : x \in A\}$.

the incomes are equally distributed. The third property confirms that Pigou-Dalton transfer also improves the perception of equality. The final property says that if objective measure is scale invariance, then so is J. The proposition shows that our proposed measure J has the plausible properties that are appreciated in the literature of inequality.

Actually, we can rewrite eq (1) in the following way:

$$J(x, A) = (1-\theta)I(x) + \theta\big(I(x) - \min_{y\in A} I(y)\big).$$

In this way, we can see clearly that social perception of inequality is a weighted sum of objective inequality and the shortfall of objective inequality from prospect equality. If the objective inequality is the same as prospect equality, then the perception of inequality is the same as the objective inequality. However, if the objective inequality is larger than the prospect equality, then the perceived inequality is beyond the objective inequality. Therefore, an alternative with high objective equality and higher prospect equality may perceives more inequality than another alternative with high objective inequality and much higher prospect inequality. The next example illustrates this point numerically.

Example 1. A society consists of two individuals. There are four possible income profiles: $x = (7, 3)$, $y = (5, 5)$, $x' = (9, 1)$ and $y' = (8, 2)$. Their corresponding Gini indices are $I_g(x) = 0.4$, $I_g(y) = 0$, $I_g(x') = 0.8$ and $I_g(y') = 0.6$. Consider two alternatives $(x, \{x, y\})$ and $(x', \{x', y'\})$. In the first situation, x is the final income profile, which is more equal than x' in terms of objective measure I_g. Also, the prospect equality in the first situation $\{x, y\}$, which is $\min\{I_g(x), I_g(y)\} = 0$, is more equal than the prospect equality in the second situation $\{x', y'\}$, which is 0.6. However, the high prospect in first situation counteracts the high objective equality, which may lead to the low perceived equality. Formally, let $\theta = 0.8$,

$$J(x, \{x, y\}) = I_g(x) - 0.8 \times I_g(y) = 0.4 > 0.32 = I_g(x') - 0.8 \times I_g(y') = J(x', \{x', y'\}).$$

Hence, the perceived inequality from $(x, \{x, y\})$ is larger than that from $(x', \{x', y'\})$ although the objective inequality of x is less than that of x'.

3 Characterization of perception measurement

In this section, we set forth the ethical axioms of egalitarian relation and discuss how the principles shape the social perception of inequality, which can be measured by a Gini index of social perception of inequality. In particular, we are interested in Gini index because of its simply form and widely application.

Axiom 1. (*Weak order.*) $\succsim$ is complete and transitive.

Axiom 2. (*Continuity.*) For all $(x, A) \in \mathbb{D}$, the sets $\{(y, B) \in \mathbb{D} : (x, A) \succsim (y, B)\}$ and $\{(y, B) \in \mathbb{D} : (y, B) \succsim (x, A)\}$ are closed.

Preference relation $\succsim$ satisfying weak order and continuity appear in many divergent contexts throughout economic theory and do not need further elaborations.

The next axiom makes use of the notion of a distribution of the normalized measure that weights individuals by their ranked incomes. Let $\tilde{x}$ be the income distribution obtained from x by rearranging the incomes in an increasing order, *i.e.* $\{x_1^n, \ldots, x_n^n\} = \{\tilde{x}_1^n, \ldots, \tilde{x}_n^n\}$ and $\tilde{x}_1^n \leq \ldots \leq \tilde{x}_n^n$.

Definition 2. If $n \geq 3$ and $x^n \in X$, then the function L_{x^n} defined by, for $p \in [0, 1]$ and $k = 0, 1, \ldots, n$,

$$L_{x^n}(p) = \frac{1}{n\mu(x^n)} \sum_{i=1}^{k} \tilde{x}_i^n \qquad \text{if } \frac{k}{n} \leq p < \frac{k+1}{n}$$

is called the *Lorenz measure* associated with x^n and its graph is referred to as the corresponding Lorenz curve.

For each $x \in X$, L_x is increasing and satisfies $L_x(0) = 0$ and $L_x(1) = 1$. If $n, m \geq 2$, then for every income profiles $x^n, y^m \in X$, we say profile x^n *Lorenz dominates* y^m if $L_{x^n}(p) \geq L_{y^m}(p)$ for all p. For every prospect set of income profiles $A, B \in \mathscr{A}$, we say A *weakly Lorenz dominates* B if for any $y \in B$ there is $x \in A$ such that x Lorenz dominates y and for any $x \in A$ there is $y \in B$ such that x Lorenz dominates y.

Axiom 3. (*Lorenz principle.*) For all $(x, A), (y, B) \in \mathbb{D}$, if x Lorenze dominates y, then $(x, \{x\}) \succsim (y, \{y\})$; and if further B weakly Lorenz dominates A, then $(x, A) \succsim (y, B)$.

The Lorenz principle consists of two parts. The first part simply says that if one income profile Lorenze dominates the other income profile, then the former profile without other prospect profiles is preferred to the latter one without other prospect profiles. This statement actually includes two classic principles assumed in inequality literature. First, if an income profile is a permutation of another profile, then they must have the same Lorenze measures. Our principle requires they are indifferent, which implies symmetry. Second, if an income profile is a Pigou-Dalton transfer of another profile,[6] then the Lorenze measure of the former one dominates that of the latter one. Therefore, our principle requires the former is preferred to the latter, which satisfies the Pigou-Dalton principle.

The second part of Lorenz principle says that if x is Lorenze dominates y and A is weakly Lorenze dominated by B, then a social planner perceives x with prospect set A to be more equal than y with prospect set B. In other words, if x is more equal than y and the prospect set A associated with x is less equal than the prospect set B associated with y, then the actual inequality is not far from the ideal inequality in (x, A) compared to (y, B). Hence, it is very natural that a social planner perceives (x, A) as a more equalized alternative.

The next axiom is motivated by the specific transfer method motivated by Ben Porath and Gilboa [1994], in which the mean and the dimension of every feasible income are constant. If $c > 0$ and $n \geq 2$, let

$$X_c^n = \{x^n \in X : \mu(x) = c\}$$

be the prospect set of income profiles in which each profile has the same n individuals and the same average income c. Let

$$\mathbb{D}_c^n = \{(x, A) \in \mathbb{D} : A \subseteq X_c^n\}.$$

For $x^n \in X$ and $1 \leq i, j \leq n$, we say i precedes j in x^n if $x_i^n \leq x_j^n$ and there is no $1 \leq k \leq n$ such that $x_i^n < x_k^n < x_j^n$.

Axiom 4. (*Ben-Gilboa Transfer Principle.*) For all $n \geq 2$ and $c > 0$, take any $x, y, x', y' \in X_c^n$ and $1 \leq i, j \leq n$. If (a) i precedes j in x, y, x', y' and (b) $x_i = x_i' + s$, $x_j = x_j' - s$ and $y_i = y_i' + s$, $y_j = y_j' - s$ for some $s > 0$ and (c) $x_k = x_k'$ and $y_k = y_k'$ for $k \notin \{i, j\}$ are satisfied, then

- **(i)** $(x, \{x\}) \succsim (y, \{y\})$ if and only if $(x', \{x'\}) \succsim (y', \{y'\})$;
- **(ii)** $(z, \{x, z\}) \succsim (z, \{y, z\})$ if and only if $(z, \{x', z\}) \succsim (z, \{y', z\})$ for all $z \in X_c^n$.

In this axiom, we consider a Ben-Gilboa transfer of income, in which a transfer is made in two income profiles between a pair of individuals who have the same adjacent ranks in both profiles. This axiom requires that when comparing income profiles without other prospect income profiles, the ranking of the post-transfer profiles is invariant to the ranking of pre-transfer profiles. Furthermore, when comparing an income profile associated with various prospect sets, the ranking of this income profile with the post-transferred prospect sets is also invariant to the income with the pre-transfer prospect. An implication of the axiom is that the direction of preference is invariance

[6] See footnote 1 for the formal definition of Pigou-Dalton transfer.

when the compared incomes or compared prospects are changed by the Ben-Gilboa transfers. It is interesting to note that by successive applications of this axiom, we can extend to an arbitrary number of transfers which would possibly involve all the individuals.

The next axiom makes use of the two notions. The first is the notion of a nondecreasing order of incomes in X. For $n \geq 2$ and $c > 0$, define

$$\tilde{X}_c^n = \{x^n \in X_c^n : x_1^n \leq x_2^n \leq \cdots \leq x_n^n\}$$

and

$$\tilde{\mathbb{D}}_c^n = \{(x, A) \in \mathbb{D} : A \subseteq \tilde{X}_c^n\}.$$

The second notion is the mixture of alternatives. For $x, y \in \tilde{X}_c^n$ and $\alpha \in [0, 1]$, we define $z := \alpha x + (1-\alpha)y$ by $z_i = \alpha x_i + (1-\alpha)y_i$ for $i = 1, \ldots, n$. Define $\alpha A + (1-\alpha)B := \{z = \alpha x + (1-\alpha)y : x \in A, y \in B\}$ for $A, B \subseteq \tilde{X}^n$ and $\alpha \in [0, 1]$.

Axiom 5. (*Order-preserving Independence*) For all $n \geq 2$ and $c > 0$, take any $A, B, C \in \tilde{X}_c^n$ and $\alpha \in (0, 1)$. if $(x, A) \succsim (y, B)$, then $(\alpha x + (1-\alpha)z, \alpha A + (1-\alpha)C) \succsim (\alpha y + (1-\alpha)z, \alpha A + (1-\alpha)C)$.

Axiom 5 corresponds to the comonotonic independence axiom of the choquet expected utility theory under uncertainty (Schmeidler [1989]), and requires that the ranking between two alternatives is invariant with respect to certain mixture of order-preserving alternatives. Consider three arbitrary alternatives $(x, A), (y, B), (z, C)$ that have the same mean incomes and are order-preserving. If (x, A) is preferred to (y, B), then this axiom states that any mixture of (x, A) and (z, C) is preferred to the same mixture of (y, B) and (z, C). This means that identical mixing on the mean constant and order-preserving alternative do not affect the ranking of any pair of alternatives.

In fact, most axioms in the inequality literature are stated in the way of income transfer among individuals, not in the way of income mixture. We use an example to illustrate the meaning of axiom 5, which can be equivalently derived through tax collection and redistribution. Since the mixture of prospect sets are income-wisely mixture, it is sufficient to discuss the mixture of two income profiles. Let x and y be income profiles with identical means and same order-preserves. Now suppose that these income profiles are affected by the following tax and transfer rule. First, a proportional tax with tax rate $1 - \alpha$ is introduced. Second, a redistribution rule, in which the ranking of the post-transfer and pre-transfer must be invariant, is introduced. This means that the collected taxes are redistributed according to the scale $1 - \alpha$ of some order-preserved income profile z. Notice that the same tax rate imposes on two income profiles x and y would lead to the identical tax collection, which is $(1-\alpha)nc$. The redistribution of collected taxes are based on the same rule, which is $(1-\alpha)z$. It is understood that $(1-\alpha)z_i$ is the transfer received by the individual i. At one extreme, $z=(c/n,\dots,c/n)$ is a complete equalized income profile, the transfers to each individual are the same and equal to the average tax $(1-\alpha)c$. At the other extreme, $z=(0,\dots,0,(1-\alpha)cn)$, all the collected tax will transfer to the richest individual in the society. Therefore, the mixture of two income profiles have two consequences: (i) for the tax collecting αx, the taxes paid by the poor cannot exceed those paid by the rich; and (ii) for the post-tax profile $\alpha x+(1-\alpha)z$, the income position of each individual is invariant. Hence, if (x,A) is preferred to (y,B), then Axiom 5 states that any order-preserving tax-transfer reform as illustrated above will not affect the ranking of two alternatives.

Axiom 6 (*Dominance*.) For all $(x,A),(y,B)\in\mathbb{D}$, if $(x,\{x\})\succsim(y,\{y\})$ and for each $x'\in A$ there exists $y'\in B$ such that $(y',\{y'\})\succsim(x',\{x'\})$, then $(x,A)\succsim(y,B)$.

The final axiom states that if x is more equalized than y and there is more equalized prospect in B than in A, then (x,A) is preferred to (y,B). Suppose one society has a very equalized income allocation and a low prospect for equalized allocations. In contrast, another society has a very unequalized income allocation, but has a high prospect for equalized allocation. Since the formal society has better outcome with lower expectation, this axiom claims that the social in the latter society perceives higher inequality.

Now, we state the main result of this paper, which is a characterization of a Gini measure of the social perception of inequality.

Theorem 1. *A social perception of inequality relation $\succsim$ satisfies Axioms 1-6 if and only if there exists J as in eqs (1) and (2) represents $\succsim$.*

The theorem states that Axioms 1-6 provide a complete characterization for the evaluation of the social perception of inequality. The social perception of inequality is represented by a shortfall of the discounted prospect equality from an objective income inequality. Moreover, both inequalities are evaluated by the most common objective instrument, which is Gini index. In fact, the objective measure of I does not necessarily take the form of Gini. We can easily extend it by using different form of function I. For example, an alternative form, so-called *linear measure*, which generalizes Gini coefficient, is given by, for all $x^n\in X^n$,

$$I(x^n)=\frac{\sum_{i=1}^n\beta_i\tilde{x}_i^n}{\mu(x^n)},$$

for $\beta_1 > \beta_2 > \cdots > \beta_n$. One may easily verify that by restricting Axiom 4 on set $\tilde{X}_c^n$, our set of axioms can characterize representation function J as in eq (1) where I has a linear measure form.

Since the preferences over income profiles is most noteworthy in the field of redistribution policy, we next discuss how social perception of inequality affects tax or redistribution policy. Suppose that social preferences are represented by J as in eq (1). Now, let $x \in X^n$ be the pre-tax income profile. Consider the choice of a tax policy. A tax scheme t is a function from X^n to X^n such that $\mu(t(x)) = \mu(x)$ for all $x \in X^n$. Let T be a set of tax schemes, which is politically acceptable. Therefore, a prospect set is given by

$$A = \{t(x) : t \in T\}.$$

Suppose y is the post-tax income profile generated by some tax scheme t. We can re-write J in the following way:

$$J(y, A) = (1-\theta)I(y) + \theta\big(I(y) - \min_{z \in A} I(z)\big).$$

If social planner selects a tax scheme such that $I(y) = \min_{z \in A} I(z)$, then the social perception of inequality is the same as the objective inequality of post-tax income profile. However, if $I(y) > \min_{z \in A} I(z)$, then the social perception of inequality consists of two parts: the objective inequality of post-tax income profile and the shortfall of prospect equality from post-tax inequality. In fact, the latter is somehow related to Arthur Okun's famous metaphor. The measure $I(y) - \min_{z \in A} I(z)$ can be interpreted as how much of a "leaky bucket" a social planner is willing to accept. Based on this explanation, our notion can distinguish leaky bucket from inequality reduction, which is measured by I. This provides a sharp contrast to the idea that both inequality reduction and leaky bucket are represented by the form of I as in Yaari [1988] and many followers.

4 Concluding Remarks

It has been acknowledged for long time that objective inequality differs from social perception. In this paper, an axiomatic method on the social perception is proposed and demonstrated to characterize a measure of inequality perception. This method suggest that the formation of perception consists of objective and prospect inequalities, which can well explains the puzzle that why a society with better objective equality requires more redistribution than a society with worse objective equality. This is because redistribution hinges on the social perception of inequality rather than the objective inequality. Therefore, if the prospect equality is very high, then the social may still perceive low equality even the objective equality of income profile is high.

While we propose a measure of perceived inequality based on prospect equality, our paper does not formally address the issue of prospect set. However, there are two possible approaches to define the feasible policies, which can be related to data. One could take redistribution schemes implemented in the history as the acceptable policies. For each scheme, we could take a structural stance of specifying a redistribution mechanism, and then use the formula to estimate the post-tax income distribution. Therefore, all the post-tax income profiles generated by historical redistribution schemes form the prospect set. Under a less structural view, one can treat prospect equality in a looser way: the ideal level of inequality obtained through survey might be used as a prospect equality, and then measure the perception of inequality. We remain agnostic about either way.

APPENDIX: PROOFS

Proof of Proposition 1

Suppose that J has the form as in eq (1). To see (i), take arbitrarily $(x, A) \in \mathbb{D}$. Notice that $x \in A$. So $I(x) \geq \min_{y \in A} I(y)$. Since $0 \leq \theta \leq 1$, we have $0 \geq I(x) - \min_{y \in A} I(y) \geq I(x) - \min_{y \in A} I(y)$,which is $J(x, A) \geq 0$. Since $I(y) \geq 0$ for all $y \in A$, we have $J(x, A) \leq I(x) \leq 1$. To see (ii), first suppose $\theta = 1$. Then $J(x, A) = 0$ is equivalent to $I(x) = \min_{y \in A} I(y)$. Suppose $\theta < 1$. Then $J(x, A) = I(x) - \theta \min_{y \in A} I(y) \geq (1 - \theta) I(x)$. Hence $J(x, A) > 0$ if $I(x) > 0$. So $J(x, A) = 0$ implies that $I(x) = 0$, which is $= c \cdot \mathbb{1}$ for $c > 0$. It is immediate to see $I(x) = 0$ implies $J(x, A) = 0$. To see (iii), assume that x is a Pigou-Dalton transfer of y. So, $I(x) < I(y)$. It is immediate to have $J(x, \{x, y\}) < J(y, \{x, y\})$. To see (iv), suppose I is scale invariance. Take any c, we have $I(cx) = cI(x)$ and $\min_{y \in cA} I(y) = c \min_{z \in A} I(z)$. Hence, $J(cx, cA) = cJ(x, A)$.

Proof of Theorem 1

The proof of necessity part is routine and, therefore, we omit it. We only prove the necessity part. Our proof consists of three parts. First, we show the existence of representation. Second, we restrict on the set $\mathbb{D}_c^n$ and show that preferences on it can be represented by a Gini index of social perception of inequality. Finally, we extend the representation to the whole domain $\mathbb{D}$.

Lemma 1. *There exists a continuous function $J : \mathbb{D} \to \mathbb{R}$ that represents $\succsim$ on $\mathbb{D}$.*

Proof. Since the preference $\succsim$ on $\mathbb{D}$ is a weak order and satisfies continuity, the Debreu Theorem implies that there must exist a continuous function J that represents $\succsim$. □

Definition 3. A preference relation $\succsim^*$ on X_c^n is a *BG-preference* if the following hold:

(i) $\succsim^*$ is a week order;

(ii) $\succsim^*$ is continuous: the sets $\{y : x \succsim^* y\}$ and $\{y : y \succsim^* x\}$ are closed.

(iii) $\succsim^*$ is symmetric: if x is a permutation of y, then $x \sim^* y$;

(iv) $\succsim^*$ satisfies Pigou-Dalton Transfer Principle: for all $x, y \in \tilde{X}_c^n$ and all $i \neq n$, if $x_j = y_j$ for all $j \notin \{i, i+1\}$ and for some $s > 0$, $x_i = y_i + s$ and $x_{i+1} = y_{i+1} - s$, then $x \succsim^* y$.

(v) $\succsim^*$ satisfies order-preserving transfer: for all $x, y, x', y' \in X_c^n$, if (a) i precedes j in x, y, x', y' and (b) $x_i = x_i' + s$, $x_j = x_j' - s$ and $y_i = y_i' + s$, $y_j = y_j' - s$ for some $s > 0$ and (c) $x_k = x_k'$ and $y_k = y_k'$ for $k \notin \{i, j\}$, then $x \succsim^* y$ if and only if $x' \succsim^* y'$.

We define *objective* inequality preference $\succsim_I$ on X_c^n by for all $x, y \in X_c^n$,

$$x \succsim_I y \Leftrightarrow (x, \{x\}) \succsim (y, \{y\}).$$

Lemma 2. *Objective inequality preference $\succsim_I$ is a BG preference.*

Proof. By definition, it is immediate to see that $\succsim_I$ is a weak order and satisfies continuity. Since every x has the same Lorenz measure as its permutation, then Axiom 3 implies that if y is a permutation of x, then $(x, \{x\}) \sim (y, \{y\})$. Therefore, by definition $x \sim_I y$, which demonstrate that symmetry property holds. To see Pigou-Dalton transfer principle, let $x, y \in \tilde{X}_c^n$ be such that there is $i \neq n$ such that $x_j = y_j$ for all $j \notin \{i, i+1\}$ and for some $s > 0$, $x_i = y_i + s$ and $x_{i+1} = y_{i+1} - s$. Note that for any $p \in [0, 1]$ and $p \notin [\frac{i}{n}, \frac{i+1}{n})$,

$$L_x(p) = L_y(p).$$

But, for $p \in [\frac{i}{n}, \frac{i+1}{n})$,

$$L_x(p) = \frac{1}{n\mu(x)} \sum_{k=1}^{i} \tilde{x}_k^n = \frac{1}{n\mu(y)} \big[\sum_{k=1}^{i-1} \tilde{y}_k^n + y_i + s \big] > L_y(p).$$

Since the Lorenz measure of x is higher than that of y, x Lorenz dominates y. By Axiom 3, $(x, \{x\}) \succsim (y, \{y\})$. Therefore, Pigou-Dalton Transfer Principle is satisfied. Finally, order-preserving transfer follows straightforward from Axiom 4(i). □

Accordint to Ben Porath and Gilboa [1994] Theorem B, there exists a function $u : X_c^n \to \mathbb{R}$, defined by for all $x \in X_c^n$

$$u(x) = \alpha \sum_{1 \leq i < j \leq n} |x_i - x_j| + \beta,$$

where $\alpha > 0$ and β is a real number such that $x \precsim_I y$ if and only if $u(x) \leq u(y)$.

Let $x^* = (nc, 0, \cdots, 0)$ be the most unequal allocation in X_c^n. We now define *prospect* inequality preference $\precsim_P$ on X_c^n by for all $x, y \in X_c^n$,

$$x \precsim_P y \Leftrightarrow (x^*, \{x^*, y\}) \precsim (x^*, \{x^*, x\}).$$

Lemma 3. *prospect equality preferences* $\precsim_P$ *is a BG-preference.*

Proof. The proof that $\precsim_P$ is a weak order and satisfies continuity is routine. To see symmetry, note that if x is a permutation of y, then Lorenz measure of x and y are the same. Therefore, Axiom 3 implies that $(x^*, \{x^*, x\}) \sim (x^*, \{x^*, y\})$, which is $x \sim_P y$. To see Pigou-Dalton transfer principle, let $x, y \in \tilde{X}_c^n$ be such that there is $i \neq n$ such that $x_j = y_j$ for all $j \notin \{i, i+1\}$ and for some $s > 0$, $x_i = y_i + s$ and $x_{i+1} = y_{i+1} - s$. By the calculation in the above proof, we know that the Lorenz measure of x is higher than that of y. Hence $\{x^*, x\}$ Lorenz dominates $\{x^*, y\}$. By Axiom 3, $(x^*, \{x^*, x\}) \precsim (x^*, \{x^*, y\})$. Hence, Pigou-Dalton Transfer Principle is satisfied. Finally Axiom 4(ii) implies order-preserving transfer holds for $\precsim_P$. □

Again, accordint to Ben Porath and Gilboa [1994] Theorem B, there exists a function $v : X_c^n \to \mathbb{R}$, defined by for all $x \in X_c^n$

$$v(x) = \alpha' \sum_{1 \leq i < j \leq n} |x_i - x_j| + \beta',$$

where $\alpha' > 0$ and β' is a real number such that $x \precsim_P y$ if and only if $v(x) \leq v(y)$. For all $A \in \mathscr{A}$ with $A \subseteq X_c^n$, define

$$v(A) = \min_{x \in A} v(x).$$

Finally, note tht $u(x)$ and $v(x)$ are cardinally equivalent.

Lemma 4. *For all* $(x, A), (y, B) \in \mathbb{D}_c^n$*, if* $u(x) = u(y)$ *and* $v(A) = v(B)$*, then* $(x, A) \sim (y, B)$*.*

Proof. Let $(x, A), (y, B) \in \mathbb{D}_c^n$. Suppose that $u(x) = u(y)$ and $v(A) = v(B)$. Then there exists $y' \in B$ such that $v(y') \leq v(x')$, hence $u(y') \leq u(x')$, for all $x' \in A$. So according to the definition of $\precsim_I$, $(y', \{y'\}) \precsim (x', \{x'\})$ for all $x' \in A$. Therefore, by Axiom Dominance, we have $(x, A) \precsim (y, B)$. Similar argument implies that $(y, B) \precsim (x, A)$. Hence, $(x, A) \sim (y, B)$. □

Lemma 5. *The function J restricted on $\mathbb{D}_c^n$ coincides with a Gini index of social perception of inequality.*

Proof. First restrict $\succsim$ on $\widetilde{\mathbb{D}}_c^n$. According to the above results, we can plot indifference curves of (x, A) in $\widetilde{\mathbb{D}}_c^n$ on (u, v) plane as in Figure (1), in which u axis represents $u(x)$ and v axis represents $v(A)$. Let (x, A) and (y, B) be in $\widetilde{\mathbb{D}}_c^n$ such that $(x, A) \sim (y, B)$. We first claim that in the figure the straight line that connects point (x, A) and point (y, B) is an indifference curve. According to Axiom 5, we know that for all $\alpha \in (0, 1)$,

$$(\alpha x + (1 - \alpha)y, \alpha A + (1 - \alpha)B) \sim (y, B).$$

Comonotonic additivity of u implies that

$$u(\alpha x + (1 - \alpha)y) = \alpha u(x) + (1 - \alpha)u(y).$$

Similarly, comonotonic additivity of v implies that

$$\begin{aligned} v(\alpha A + (1 - \alpha)B) &= \min_{x \in \alpha A + (1-\alpha)C} v(x) \\ &= \alpha \min_{x \in A} v(x) + (1 - \alpha) \min_{y \in C} v(y) \\ &= \alpha v(A) + (1 - \alpha)v(B) \end{aligned}$$

Therefore, it is clear to see that the point $(\alpha x + (1 - \alpha)y, \alpha A + (1 - \alpha)B)$ in the (u, v) planes lies between point (x, A) and (y, B). Hence, all indifference curves in the figure are straight lines.

We also claim that any indifference curves in the figure parallel to each other. To see this, take any $(z, C) \in \widetilde{\mathbb{D}}_c^n$ which is not indifferent to (x, A). According to Axiom 5, we know that for all $\alpha \in (0, 1)$,

$$(\alpha x + (1 - \alpha)z, \alpha A + (1 - \alpha)C) \sim (\alpha y + (1 - \alpha)z, \alpha B + (1 - \alpha)C).$$

Comonotonic additivity of u implies that

$$\begin{aligned} u(\alpha x + (1 - \alpha)z &= \alpha u(x) + (1 - \alpha)u(z) \\ u(\alpha y + (1 - \alpha)z &= \alpha u(y) + (1 - \alpha)u(z) \end{aligned}$$

Also, the comonotonic additivity of v implies that

$$\begin{aligned} v(\alpha A+(1-\alpha)C) &= \min_{x\in\alpha A+(1-\alpha)C} v(x) \\ &= \alpha \min_{x\in A} + (1-\alpha)\min_{y\in C} v(y) \\ &= \alpha v(A) + (1-\alpha)v(C) \end{aligned}$$

Similarly, we have

$$v(\alpha B+(1-\alpha)C) = \alpha v(B) + (1-\alpha)v(C).$$

In Figure (1), it is clear that point $(\alpha x+(1-\alpha)z, \alpha A+(1-\alpha)C)$ and point $(\alpha y+(1-\alpha)z, \alpha B+(1-\alpha)C)$ are between the line connecting $(x, A), (z, C)$ and the line connecting $(y, B), (z, C)$, respectively. Furthermore, we know that both $(\alpha x + (1-\alpha)z, \alpha A + (1-\alpha)C)$ and $(\alpha y + (1-\alpha)z, \alpha B + (1-\alpha)C)$ are indifferent. Therefore, the line connecting both points is an indifference curve. By elementary geometry, we know immediately that both indifference curves are parallel to each other.

Since indifference curves in $\widetilde{\mathbb{D}}_c^n$ are straight and parallel, the representation function J on $\widetilde{\mathbb{D}}_c^n$ should have the following form: for all $(x, A) \in \widetilde{\mathbb{D}}_c^n$,

$$J(x, A) = u(x) + \theta_c^n \cdot v(A),$$

where θ_c^n is a real number. Recall the form of function u and v on X_c^n. Therefore, we can normalize the two functions such that

$$\begin{aligned} J(x, A) &= \alpha \sum_{1\le i<j\le n} |x_i - x_j| + \beta + \theta_c^n \max_{y\in A}\{\alpha' \sum_{1\le i<j\le n} |y_i - y_j| + \beta'\} \\ &= \alpha\Big[\sum_{1\le i<j\le n} |x_i - x_j| + \frac{\theta_c^n \cdot \alpha'}{\alpha} \min_{y\in A}\{\sum_{1\le i<j\le n} |y_i - y_j|\}\Big] + (\beta + \beta') \end{aligned}$$

Define function I on X_c^n by

$$I(x) = \frac{1}{n^2 c} \sum_{1\le i<j\le n} |x_i - x_j|.$$

Let $\beta + \beta' = 0$, $\alpha = 1/n^2 c$ and $\alpha' = \alpha^2$. Then, the normalized J can be written in the following form: for all $(x, A) \in \widetilde{\mathbb{D}}_c^n$,

$$J(x, A) = I(x) + \theta_c^n \min_{y\in A} I(y).$$

Now, we want to show that $-1 \le \theta_c^n \le 0$. Suppose that $(x, \{x\}) \succsim (y, \{y\})$. Then we have

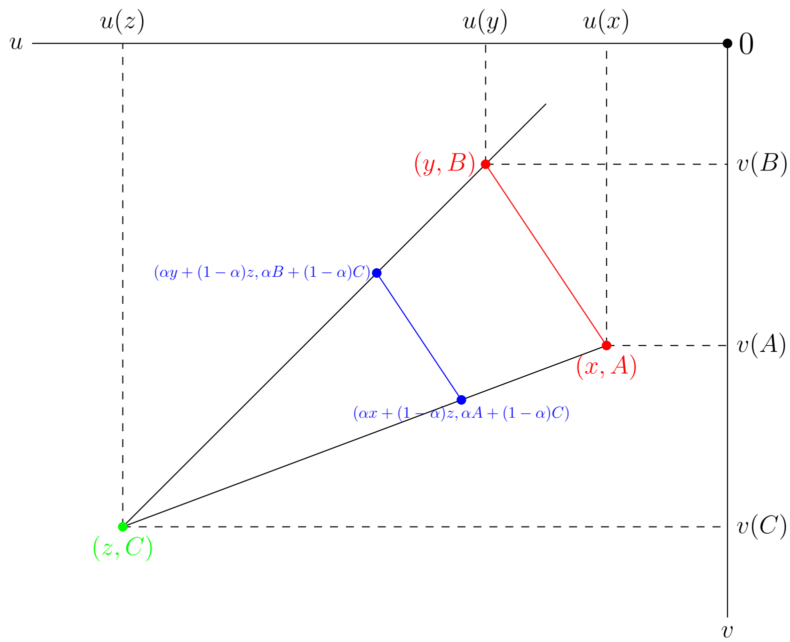

Figure 1: Indifference curve.

$I(x) \leq I(y)$. According to representation function J, we have

$$I(x) + \theta_c^n I(x) \leq I(y) + \theta_c^n I(y),$$

which implies $1 + \theta_c^n \geq 0$. Hence, $\theta_c^n \geq -1$. Further, since $I(x) \leq I(y)$, then by definition of $\succsim_P$, we have $(x^*, \{x^*, y\}) \succsim (x^*, \{x^*, x\})$. Since $I(x^*) \geq I(y) \geq I(x)$, we have

$$I(x^*) + \theta_c^n I(x) \geq I(x^*) + \theta_c^n I(y),$$

which implies that $\theta_c^n \leq 0$.

For $(x, A) \in \mathbb{D}_c$, define

$$J(x, A) = J(\tilde{x}, \tilde{A}).$$

We show that J represents $\succsim$ on $\mathbb{D}_c$. Take any $(x, A), (y, B) \in \mathbb{D}_c$ such that $(x, A) \succsim (y, B)$. By Axiom 3, we know $(x, A) \sim (\tilde{x}, \tilde{A})$ and $(y, B) \sim (\tilde{y}, \tilde{B})$. Also, $I(x) = I(\tilde{x})$. Therefore,

$$\begin{aligned}(x, A) \succsim (y, B) &\Leftrightarrow (\tilde{x}, \tilde{A}) \succsim (\tilde{y}, \tilde{B}) \\ &\Leftrightarrow J(x, A) \leq J(y, B).\end{aligned}$$

□

Now, we know for any $n \geq 2$ and any $c > 0$, there exists a Gini index of social perception of inequality that represents $\precsim$ on $\mathbb{D}_c^n$. Furthermore, due to the Axiom 3, there exists a θ such that $0 \leq \theta \leq 1$ such that $\theta = -\theta_c^n$ for all $n \geq 2$ and $c > 0$. We consider $\precsim$ on the set $\mathbb{D}_c = \bigcup_{n \geq 2} \mathbb{D}_c^n$.

Lemma 6. *The function J defined on eq (1) and (2) represents $\precsim$ on $\mathbb{D}$.*

Proof. Take any $(x^m, A) \in \mathbb{D}_c^m$ and $(y^k, B) \in \mathbb{D}_c^k$. Suppose that $(x^m, A) \precsim (y^k, B)$. Let $x_A = \arg\min_{x \in A} I(x)$ and $y_B = \arg\min_{y \in B} I(y)$. By Axiom dominance, we have

$$(x^m, A) \sim (x^m, \{x^m, x_A\}) \quad \text{and} \quad (y^k, B) \sim (y^k, \{y^k, y_B\}).$$

Let $n = m \times k$ be the common product of m and k. Define

$$x^n = \underbrace{(x^m, \cdots, x^m)}_{k\text{th } x^m} \quad \text{and} \quad x_A^n = \underbrace{(x_A, \cdots, x_A)}_{k\text{th } x_A}.$$

Therefore, x^m, x^n and x_A, x_A^n have the same Lorenz measures, respectively. So, Axiom 3 implies that

$$(x^m, A) \sim (x^n, \{x^n, x_A^n\}).$$

Similarly, we define

$$y^n = \underbrace{(y^k, \cdots, y^k)}_{m\text{th } y^k} \quad \text{and} \quad y_B^n = \underbrace{(y_B, \cdots, y_B)}_{m\text{th } y_B}.$$

Again, Axiom 3 implies that

$$(y^k, B) \sim (y^n, \{y^n, y_B^n\}).$$

Therefore, $(x^n, \{x^n, x_A^n\}), (y^n, \{y^n, y_B^n\}) \in \mathbb{D}_c^n$. By assumption that $(x^n, \{x^n, x_A^n\}) \precsim (y^n, \{y^n, y_B^n\})$, we must have

$$J((x^n, \{x^n, x_A^n\}) \leq J(y^n, \{y^n, y_B^n\}),$$

which is

$$I(x^n) - \theta \min\{I(x^n), I(x_A^n)\} \leq I(y^n) - \theta \min\{I(y^n), I(y_B^n)\}.$$

Since x^n is a k replicate of x^m, we have

$$\begin{aligned} I(x^n) &= \frac{\sum_{1\le i<j\le n}|x_i - x_j|}{n^2 c} \\ &= \frac{k^2 \cdot \sum_{1\le i<j\le m}|x_i - x_j|}{(mk)^2 c} \\ &= I(x^m) \end{aligned}$$

Similarly, $I(x_A^n) = I(x_A)$, $I(y^n) = I(y^k)$ and $I(y_B^n) = I(y_B)$. Hence,

$$(x^m, A) \succsim (y^k, B) \Longleftrightarrow J(x^m, A) \le J(y^k, B).$$

Now consider $\succsim$ on $\mathbb{D}^n = \bigcup_{c>0} \mathbb{D}_c^n$. We show that J restricted on $\mathbb{D}^n$ represents $\succsim$ on $\mathbb{D}^n$. Take any $(x, A) \in \mathbb{D}_c^n$ and $(y, B) \in \mathbb{D}_e^n$ such that $(x, A) \succsim (y, B)$. Let $\alpha = c/e$. Then $\mu(\alpha y) = \mu(z) = c$ for any $z \in \alpha B$. So $(\alpha y, \alpha B) \in \mathbb{D}_c^n$. It is immediate to see that y and αy have the same Lorenz measure and so are B and αB. By Axiom 3, $(y, B) \sim (\alpha y, \alpha B)$. Transitivity implies that $(x, A) \succsim (\alpha y, \alpha B)$, which is

$$I(x) - \theta \min_{x' \in A} I(x') \le I(\alpha y) - \theta \min_{y' \in \alpha B} I(y').$$

Note that

$$\begin{aligned} I(y) &= \frac{\sum_{1\le i<j\le n}|y_i - y_j|}{n^2 e} \\ &= \frac{\sum_{1\le i<j\le n}|\alpha y_i - \alpha y_j|}{\alpha n^2 c/\alpha} \\ &= I(\alpha y). \end{aligned}$$

Then, it implies that

$$(x, A) \succsim (y, B) \Leftrightarrow I(x) - \theta \min_{x' \in A} I(x') \le I(y) - \theta \min_{y' \in B} I(y').$$

Finally, we extend $\succsim$ to $\mathbb{D}$. Take any (x, A) and (y, B) in $\mathbb{D}$ such that $(x, A) \succsim (y, B)$. Let $x_A = \arg\min_{x' \in A} I(x')$ and $y_B = \arg\min_{y' \in B} I(y')$. Clearly,

$$(x, A) \sim (x, \{x, x_A\}) \succsim (y, \{y, y_B\}) \sim (y, B).$$

Let n be the least common multiple of the dimensions of x, x_A, y, y_B. Let x^n, x_A^n, y^n, y_B^n be the replicates of x, x_A, y, y_B, respectively. Therefore,

$$(x, \{x, x_A\}) \sim (x^n, \{x^n, x_A^n\}) \succsim (y^n, \{y^n, y_B^n\}) \sim (y, \{y, y_B\}).$$

Let $\mu(x^n) = c_x$, $\mu(x_A^n) = c_A$, $\mu(y^n) = c_y$ and $\mu(y_B^n) = c_B$. Then, we have

$$\Big(x^n, \{x^n, \frac{c_x}{c_A}x_A\}\Big) \sim (x^n, \{x^n, x_A^n\}) \succsim (y^n, \{y^n, y_B^n\}) \sim \Big(\frac{c_x}{c_y}y^n, \{\frac{c_x}{c_y}y^n, \frac{c_x}{c_B}y_B\}\Big).$$

Therefore,

$$\begin{aligned}(x, A) \succsim (y, B) &\Leftrightarrow \Big(x^n, \{x^n, \frac{c_x}{c_A}x_A\}\Big) \succsim \Big(\frac{c_x}{c_y}y^n, \{\frac{c_x}{c_y}y^n, \frac{c_x}{c_B}y_B\}\Big) \\ &\Leftrightarrow I(x^n) - \theta \min\{I(x^n), I(\frac{c_x}{c_A}x_A)\} \leq I(y^n) - \theta \min\{I(y^n), I(\frac{c_x}{c_B}y_B)\} \\ &\Leftrightarrow I(x) - \theta \min\{I(x), I(x_A)\} \leq I(y) - \theta \min\{I(y), I(y_B)\}.\end{aligned}$$

□

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