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Abstract

If we define equity as the cake-sharing or distribution problem, then, unlike economic efficiency, equity lies largely in the eyes of the beholder. No wonder it has been given short shrift by traditional economic analysis. It is however possible to go further and take this context dependence as a starting point, rather than as an end point. Using both survey and experimental data, I will demonstrate that equity's context dependence is not random, but highly structured and thus predictable. Given a finite set of equity norms, both the socio-economic 'situation' (age, income, profession...) and the policy 'context' (nature of constituency and resource or burden to be distributed) determine to a large degree which people support or oppose which equity norms. This information can be used to construct an equity metric that reflects the diversity of equity preferences for any given policy context – an approach I call 'empirical normativism'. More precisely, one can use lab experiments to construct two inequity metrics, one based on the self-serving equity-norm preferences of direct stakeholders, and one based on the preferences of non-incentivized non-stakeholders. These metrics can be used to trade-off with efficiency criteria in prioritizing projects or policies competing for limited funds.

Keywords: Equity; equity-efficiency trade-offs; experimental economics; resource allocation policy

JEL classification: D31, D63, P16, H24, C91

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1. Introduction

Consider an age-old problem: between two projects or policies A and B, how do you decide which is 'fairer' or 'more equitable' if different stakeholders hold different views about what is fair or equitable? How do you make this judgment with potentially conflicting equity norms? More specifically, let us focus on the 'pie-sharing' or distributional equity problem, where a given amount, which can be a resource or a burden, a benefit or a cost, must be distributed to a given constituency. This problem is perhaps most acute in the field of natural resource management and environmental policy, where different people, often with different backgrounds, tend to be affected in different ways. This is partly due to the fact that the environment is mostly a public good. A good example is given by the Kyoto negotiations on how the total amount of greenhouse gas abatement effort (a burden) must be distributed across different nations of the world (e.g. Cazorla & Toman, 2001). Such equity concerns come in addition to other concerns, such as economic efficiency and ecological effectiveness (see e.g. Halpern et al., 2013).

A straightforward solution, though perhaps politically dangerous, is to resort to a dictator. One individual, or a group of individuals, decide unilaterally what is meant by fair or equitable and compare projects A and B accordingly. But what if a majority of stakeholders think otherwise? Clearly, at least in a democratic system, we have a real problem that warrants some kind of solution. In this paper, we propose one such solution which, to our knowledge, has not yet been examined.

Previous analyses of distributional equity typically consider a single equity criterion, principle, rule or norm (these terms can be considered interchangeable for now; we shall use the term 'equity norm' in this paper). Some consider two or three, rarely more (see references below). More importantly for our problem, most pie-sharing analyses study equity directly, in terms of percentage shares to be allocated, for instance a 50-50 or a 67-33% split. This is possible as long as the distribution problem is simple and the number of individuals involved remains small; with large numbers, the information burden relating to individual characteristics necessary for equity judgments becomes overwhelming. This is why in real life equity judgments are most often made by appealing to some equity norm. This introduces an important distinction for our study.

As also explained by Ubeda (2014), we must distinguish between ‘selfishness’ and ‘self-serving bias’, or SSB. In the present context, a selfish decision is one that does not consider any equity aspect at all, but only seeks to maximize one’s own benefits. In contrast, a SSB decision is one that does consider the equity issue but chooses, in the family of equity norms, that which best seems to serve one’s own interests. Clearly, political and economic negotiations are rife with SSB proposals. As a result it is not always clear whether ‘fair’ means what it is meant to mean. What is clear is that the choice of equity norm, and the degree to which SSB is present, are heavily context dependent. The present study hopes to shed some light on this too.

This paper builds on and extends recent work by Favarelli (2007), Cappelen et al. (2007), Durante et al. (2013) and Ubeda (2014) and is also an offshoot from Konow (2001) and Frohlich & Oppenheimer (1992). We also build on the set of quasi-universal equity norms used by Cazorla & Toman (2001), Ringius et al. (1998, 2002) and Rose & others (1998a, 1998b, 2002) in the context of international environmental negotiations. Like the more recent studies, this paper presents results from an experimental study, carried out in controlled lab conditions. The experiments were designed with more than one purpose in mind (see Schilizzi & Black, 2009), one of them being the construction of an equity metric that could solve the multi-norm decision problem outlined at the start of this paper: how can we decide how equitable is a distributional proposal when stakeholders hold potentially conflicting views about what is equitable? We call our solution to this problem the multi-norm “weighted equity metric”, or WEM.

Section 2 of this paper describes our experimental setup; section 3 describes the construction of the multi-norm equity metric; section 4 shows how the metric can be used to gain insights into context-dependence and what influences the degree of SSB; and section 5 concludes.

2. Experimental design

The reason for choosing an experimental approach is that it alone allows for systematic control of contextual factors and precise knowledge of individuals’ salient characteristics and equity preferences. Two sets of variables affect these preferences: the socio-economic position in society of each individual (e.g. their income, education level, location, etc.), and the nature of the context defining the equity problem (e.g. the resource or burden being distributed, the amounts at stake; who is involved; the information available, the presence and strength of trade-offs with equity). Both dimensions can be quite complex in the field, but can be clearly delineated in the lab in order to focus on the core problem.

From the literature cited above, we defined and operationalized 13 different equity norms: egalitarian (Egal), Rawlsian maxmin (Mm), 'interests of the future' (a form of intergenerational equity) (IGE), ability to pay (AtP), vertical equity (HE), horizontal equity (VE), market justice (Mkt), Pareto compensation (Par), exclusions rule (Exc) and sovereignty (Sov); three more norms were also included, but they are not relevant for the present paper[1]. We designed our experiments using University students organized in 'distribution groups' of 10 participants each. The group size of 10 was a compromise that included the ability to distinguish without ambiguity the effects of each equity norm (with too small a group two or more norms could lead to the same allocation). 10 such groups had been organized but only 9 were formed in the end (a total of 90 participants). Each group was organized identically, as shown in Table 1.

Table 1: Group composition (9 such)

Player ID	Name of Participants	Wealth Endowment	Dep'ts parameter	Productivity factor	*Effort input*
1	**A (**poorest)	**5**	**0**	**1.00**	***1***
2	**B**	**7**	**1**	**1.11**	***1***
3	**C**	**9**	**2**	**1.22**	***1***
4	**D**	**12**	**0**	**1.33**	***1***
5	**E**	**14**	**1**	**1.44**	***1***
6	**F**	**16**	**2**	**1.56**	***1***
7	**G**	**18**	**0**	**1.67**	***1***
8	**H**	**21**	**1**	**1.78**	***1***
9	**I**	**23**	**2**	**1.89**	***1***
10	**J (**richest)	**25**	**1**	**2.00**	***1***

For an equity problem to have meaning, stakeholders must differ in some way, usually in more than one. Cake-sharing is an equity problem to the extent that different parts of the cake differ: in taste, in composition, in the nature and amount of topping, in the degree of baking,

[1] These are three 'process equity' norms, as opposed to 'outcome equity'. This study focuses only on the latter kind and, until further notice, a multi-norm equity metric is only applicable to outcome-related equity norms.

etc. All 10 individuals in the group differed in some scenarios by two salient parameters and in others by three. Wealth endowments reflected initial distributions of money, real or hypothetical. Number of dependents simulated ‘need size’, such as family size or population size. The individual productivity factor (IPF) was included in scenarios where, as explained below, equity must be traded-off with efficiency. An IPF of 1.33 means that $1 allocated to a participant (#4 here) translates into $1.33 available for distribution. More money given to the richer participants means a bigger cake to share, and vice versa. This creates a tension between equity and efficiency concerns. The last column is a place-holder to remind us that real effort was not included in this study, either as a ‘production’ phase prior to distribution (which could avert a potential endowment effect) or as a determinant for the choice of equity norm (e.g. principle of proportionality). For each group, an equal sum of money was available for distribution to the 10 participants. How it was distributed would depend on which equity norm was most preferred by the group as a whole. How this was done we turn to now.

A simple task would have been to ask each participant to choose, among the list of equity norms, the one most preferred, that is, the one that would lead to the fairest or most equitable distribution as seen by him or her. But this would have yielded a rather poor data set, and one that was not adequate for studying the context-dependence of individual choices. Instead, participants were asked to rate on a Likert scale of [-10, +10] each of the 13 equity norms, and this in each different experimental context or scenario. This yields, in addition to the most preferred norm (of which there may be more than one), the degree of intensity with which each norm is supported or opposed. A rating of 0 reflects indifference or hesitation about a specific norm in the given context. Later, in the statistical analysis, one can control for individual trends to under- or over-rate all equity norms (i.e. whether one tends to be supportive or antagonistic overall). An example of such a rating scale is given below:

Please give your degree of AGREEMENT or DISAGREEMENT with the following allocation rules:

2. *Payments are distributed, equally, only to the poorest* ***5****. With $50 and 10 people, each of the poorest 5 receives $10 and the richest 5 receive $0.*

–10 –8 –6 –4 –2 0 +2 +4 +6 +8 +10

which represents the second in a list of 13. The one shown represents a specific parameterization of the Rawlsian ‘maxmin’ norm. Before participants started any rating, each norm was explained and illustrated using Powerpoint examples for each. A Q&A session checked for any misunderstandings.

In a given group, the ratings by all 10 participants of all 13 norms are aggregated to compute the total sum score of each norm; the one that receives the highest total score is chosen to allocate the money across the group. Participants know this in advance and can use this information in their ratings. This allows for SSB to be expressed.

Once the most preferred norm is identified for the group, it must translate into payments for each individual. Payments derive from the definition of the equity norms, as shown in Table 2 for a total amount to be distributed of $100.

Table 2: Share of $100 to each individual according to each equity norm

Position **Norm**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
AtP	23.49	16.27	12.44	10.07	8.46	7.29	6.41	5.71	5.16	4.70
Egal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Exc	2.74	5.00	18.46	1.46	11.75	15.61	12.74	6.63	13.95	11.67
HE	5.00	10.00	15.00	5.00	10.00	15.00	5.00	10.00	15.00	10.00
IGE	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Mkt*	5.94	11.54	11.49	7.28	11.42	8.00	18.94	2.72	11.34	11.33
Mm	20.00	20.00	20.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00
Par	7.90	7.90	15.09	7.90	9.53	12.66	10.33	7.90	11.32	9.47
Sov	3.33	4.81	6.30	7.78	9.26	10.74	12.22	13.70	15.19	16.67
VE	35.46	21.82	14.60	10.13	7.09	4.89	3.22	1.92	0.86	0.00
IPFs	**1.00**	**1.11**	**1.22**	**1.33**	**1.44**	**1.56**	**1.67**	**1.78**	**1.89**	**2.00**

*) Payments for the ‘market justice’ (Mkt) norm represent one particular realization of this rule, the results of which depend on market outcomes. Participants knew this in advance.

As will be explained below, a pre-determined fixed amount of $50 was actually allocated in 4 of the scenarios; in the other 4, the individual allocations above were multiplied by their IPF values shown in the bottom row of Table 2, and the total could be around $75 for example.

We defined 8 scenarios, meaning that each individual had to provide 8 x 13 = 104 ratings, done in two consecutive sessions. Total duration for both sessions was a little over two hours. Three key parameters define 8 scenarios in a full factorial:

- the presence or absence of incentivization with real money;
- the presence or absence of equity-efficiency trade-offs; and
- the presence or absence of Rawls’ veil of ignorance.

In 4 scenarios, participants had to allocate to their own group a certain amount of money ($50), while in 4 others no money was involved and this was public knowledge at the outset. By comparison with the real money formulation, the maxmin norm in the non-incentivized scenarios simply read as: "*Payments are distributed, equally, only to the poorest (for example, the poorest half)*", with no reference to any specific sum. The non-incentivized scenarios were played before the incentivized ones.

In 4 scenarios with no equity-efficiency trade-offs, the way the initial budget of $50 was distributed did not affect the final amount the participants received, while in 4 other scenarios the final amount available depended on how the money was distributed (either for real or hypothetically). To create tension between equity and efficiency, money distributed to more richly endowed participants augmented the total final amount available for distribution more than if the money was distributed to the less richly endowed. This can be understood as reflecting a greater capacity of the rich to invest. The no trade-off scenarios were played before the trade-off ones.

In 4 scenarios participants knew who they were in the group, e.g. if they started off richly endowed or poorly endowed, while in 4 other scenarios they only discovered who they were after their rating of equity norms had been done, thereby implementing Rawls' veil of ignorance strategy. The known position scenarios were played before the unknown position ones. This was to allow comparability of results between scenarios: it was important for participants to have first played the full-information scenario so that they knew how to play the no-information one. Results suggest this strategy worked as intended.

The above combination of context factors results in the following schema (Table 3):

Table 3 : Experimental scenario definitions

Scenario	Definitional code	Incentivization (Y/N)	Equity-Efficiency trade-off (Y/N)	Veil of ignorance (Y/N)
S 1	TEK	N	N	N
S 2	MEK	Y	N	N
S 3	TPK	N	Y	N
S 4	MPK	Y	Y	N
S 5	TEU	N	N	Y
S 6	MEU	Y	N	Y
S 7	TPU	N	Y	Y
S 8	MPU	Y	Y	Y

Note on code: T = (cheap) talk; M = (real) money; E = (pure) equity; P = productivity; K = known position; U = unknown position. The code indicates the definition of the scenario.

The purpose of this setup was to focus on comparisons and differences between scenarios. None of the scenarios should be examined by themselves, in isolation; only differences between them are of interest. The above design means we can carry out comparisons in several dimensions.

3. Construction of the metric

The preceding design results in a one-column vector of individual ratings for each equity norm in every scenario. Each individual rates 13 norms (except in scenario 1 where only 12 are rated) in 8 different scenarios. With 90 individuals, this gives 9270 observations. The first four rows out of the 9270 look as follows (Table 4):

Table 4: First four data points (out of 9270)

Individual	Group	Wealth	Deps	Prodty	Scen	T	M	E	P	K	U	Ei	**Likert ratings**
1	1	5	0	1.00	1	1	0	1	0	1	0	1	**3**
1	1	5	0	1.00	1	1	0	1	0	1	0	2	**-10**
1	1	5	0	1.00	1	1	0	1	0	1	0	3	**5**
1	1	5	0	1.00	1	1	0	1	0	1	0	4	**8**

and represent (in the last column to the right) the ratings by individual 1 for the first 4 equity norms (Ei) in scenario 1, defined as TEK or “non-incentivized, no equity-efficiency trade-off, and known position”. Other individual characteristics are given by group number (in which the allocation was made), initial wealth endowment, number of dependents, and individual productivity parameter (only for scenarios with equity-efficiency trade-offs). Thus individual 1 rated the first norm (egalitarian distribution) on the [–10,+10] scale at +3 (mild support) while rating the second norm (maxmin rule) at –10 (strongest opposition). And so on down. Though adequate for statistical analyses, this layout of the data is not appropriate for constructing an equity metric.

Grouping individuals by allocation group and by scenario brings out the concrete conditions of resource allocation, necessary for an equity metric. The data layout then takes on the following format (Table 5):

Table 5: Complete ratings for group 1 in scenario 1

	Equity	**Group 1**									
Scen 1	**Norms**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Egal	**3**	2	-5	-5	-3	-4	-3.5	3	5	-5
	Mm	**-10**	4	-2	-3	-10	4	-6.5	5	2	-10
	IGE	**5**	-2	4	2	8	8	5	8	10	6
	AtP	**8**	-4	6	5	0	10	-4.5	6	0	8
	VE	-6	4	2	5.5	-10	-6	-5.5	8	-8	-9
	HE	-6	6	4	4	10	-8	5	5	6	6
	SB	-3	-2	-6	-2	-2	2	5	-1	5	1
	Cons	7	-2	-6	-1.5	2	6	-0.5	-2	5	-6
	Mkt	9	-6	2	-2	-4	4	6	0	-2	4
	Par	7	2	6	3.5	6	9	5	3	0	-10
	Exc	4	1	6	5	10	10	3	9	8	10
	Sov	-5	-4	-4	-1	6	4	2.5	-5	2	-10
	GF										

The four values in the box are the same as the four values in the previous Table (4). In scenario 1 (only), the ‘grand-fathering’ (or ‘acquired rights’) equity norm is not applicable, as it refers to a previous outcome. The rows are given by the 13 equity norms, and the columns by the 10 participants in a given group. There are 8 more such matrices below and 9 more to the right, to a total of 72 such matrices, creating an overall 104 by 90 matrix of 9360 cells. As will become clear below, this structure for the data is necessary for designing an equity metric in the presence of multiple equity norms.

One way to do so is to consider in the given scenario the relative importance of each equity norm by all ‘stakeholders’ (in this case, group participants). That is, the relative importance for the constituency (the group) of the egalitarian norm (Egal) is computed as the sum of its ratings as shown in row 1 divided by the sum of all ratings for all norms. In the process, however, one must first transform the matrix into purely positive numbers by adding 10 to each rating, so that the values appear on the interval [0, 20]. Thus, in this example, after having added 10 to each rating, the ratio of the first line to the total is 88/1350 = 6.5%. Across all 10 participants of this group, the egalitarian norm has a relative weight of 6.5%. By contrast, the ‘Exclusion’ norm (‘Exc’, row 11), the most highly rated in this group, is nearly twice as important at 12.3%. The lowest rated in this scenario (1) is the Maxmin rule (‘Mm’, row 2), at 5.5%. Of course, the relative importance of all 13 equity norms should add up to 100%. So for each of the 72 matrices like the one above, one obtains a vector of relative weightings for each group in each scenario.

Bringing together all 9 such vectors for each of the 9 groups of 10 generates the following matrix for scenario 1 (based on the re-scaled [0 to 20] ratings):

Table 6: Group % weights as a function of individual ratings (Scenario 1)

Equity Norms	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**	**G7**	**G8**	**G9**
Egal	6.5	8.5	10.9	8.9	9.7	9.5	9.7	8.7	9.6
Mm	5.5	6.3	3.5	5.4	8.3	5.0	8.4	7.6	5.3
IGE	11.4	11.3	8.4	8.8	9.6	8.3	9.1	9.9	9.2
AtP	9.9	7.3	10.2	10.6	8.0	8.0	9.7	9.1	9.1
VE	5.6	7.1	5.2	4.3	7.0	6.4	7.3	8.4	4.8
HE	9.7	9.3	10.9	12.4	8.5	10.6	9.3	10.3	10.2
SB									
Cons									
Mkt	8.2	7.5	5.0	6.2	5.7	5.2	5.9	3.3	5.8
Par	9.8	9.9	9.8	8.7	8.9	9.1	9.2	11.3	9.8
Exc	12.3	9.6	10.9	12.6	10.7	11.5	9.8	11.9	11.0
Sov	6.4	7.2	7.8	6.9	7.6	9.1	7.1	5.0	9.1
GF									

In the process, one must drop the 'process equity' norms of 'sovereign bargaining' (SB), 'consensus' (Cons) and grandfathering (GF); one would also usually drop the 'market justice' norm (Mkt)[2]. Our equity metric is solely based on 'outcome equity' norms, given that one cannot predict ex ante the outcomes of process-based allocations. As will be discussed below, it is in general not helpful to mix together the two types of equity norms. In Table 6 above, the corresponding three rows are left empty. The fact that rows and columns no longer add to 100% is of no concern for the next step.

The next step consists in transforming relative weightings into actual payments. This is done using Table 2 presented earlier, where each equity norm, if implemented, distributes the available quantity across all (10) participants in a predefined manner. The actual allocation to a given individual *j* is then the weighted sum of the quantity x_j allocated under equity norm E_i multiplied by its relative importance w_i as per Table 6, thus $x_j(E_i)*w_i(E_i)$. For example, for individual 1 of group 1 in scenario 1 the egalitarian allocation is \$5.00 (one tenth of \$50) multiplied by the 6.5% equity-specific weight; this results in a payment of \$0.325 (rounded to 0.33 in Table 7 below).

[2] Except in this case we ran a model simulating a market among participants which generated equilibrium prices and quantities and, as outcomes, net gains from transactions for each group participant.

Table 7: Payments as a function of the Weighted Equity Metric

	Group 1,		Scenario 1								Renorm-
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	alization
Egal	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	3.26
Mm	0.55	0.55	0.55	0.55	0.55	0.00	0.00	0.00	0.00	0.00	2.74
IGE	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	4.55
AtP	1.17	0.81	0.62	0.50	0.42	0.36	0.32	0.28	0.26	0.23	4.96
VE	0.99	0.61	0.41	0.28	0.20	0.14	0.09	0.05	0.02	0.00	2.80
HE	0.24	0.49	0.73	0.24	0.49	0.73	0.24	0.49	0.73	0.49	4.87
(SB)											
(Cons)											
Mkt	0.24	0.47	0.47	0.30	0.47	0.33	0.78	0.11	0.46	0.46	4.09
Par	0.39	0.39	0.74	0.39	0.47	0.62	0.51	0.39	0.55	0.46	4.89
Exc	0.17	0.31	1.13	0.09	0.72	0.96	0.78	0.41	0.86	0.72	6.13
Sov	0.11	0.15	0.20	0.25	0.30	0.34	0.39	0.44	0.48	0.53	3.19
50.00	5.59	5.49	6.78	4.07	5.28	5.13	4.68	3.55	5.00	4.43	41.49
%	**11.2**	**11.0**	**13.6**	**8.1**	**10.6**	**10.3**	**9.4**	**7.1**	**10.0**	**8.9**	

Every one of the 10 ‘outcome equity’ norms thus contributes to each individual a specific amount, the sum of which appears in the bottom line. However, when added up over all the participants in the group, the sum total does not add up to the available $50, given that we dropped the ratings for the ‘process equity’ norms. Each participant’s allocation must therefore be renormalized to add up to the $50. The bottom line is thus the result of each individual sum (over the 10 equity norms) multiplied by (in this case) 50/41.49 = 1.205 (for individual 1 we obtain 4.63 × 1.205 = 5.59, as shown). The sums in the right-most column of the table are for carrying out the renormalization.

In the 4 scenarios (3, 4, 7 and 8) involving equity-efficiency trade-offs, the total amount allocated is not equal to $50 and depends on how much each group participant receives. These amounts varied between $70 and $80 depending on scenarios. This final amount is obtained by multiplying each of the 10 individual amounts by the individual’s productivity factor, which ranges from 1.0 to 2.0 from the poorest individual #1 to the richest individual #10, as explained earlier. $1 allocated to individual #10 thus contributes $2 to the total amount distributed.

The bottom line in Table 7 above represents, for Group 1 in Scenario 1, the “equitable” group allocation of the available $50 in a way that reflects each individual’s distinct equity preferences. It can be called the Weighted Equity Allocation, and the procedure just described defines what can be called the Weighted Equity Metric, or WEM.

4. Use of the Weighted Equity Metric (WEM)

4.1 Comparing different projects or policies

The WEM provides an allocation of resources (or burdens) as a function of the ratings by all concerned. But what are we to do with it, and how can it be used in a policy context?

The WEM being a collective construct, it is unlikely to reflect each individual's own personal views as to which policy is most equitable. We need to compare the WEM construct to each individual's equity preferences. In a given equity context, individuals will have a most preferred equity norm that, for one reason or another, they would like to see implemented. It is natural then to identify what the resource allocation would be based on each individual's independent choice and compare it to the one resulting from application of the WEM. The further the WEM-based allocation is from the individually most preferred allocation, the less 'equitable' will the allocation appear to the individual. The difference, or distance, between the two measures the individual's equity-related dissatisfaction or perception of inequity – the "it's not fair!" reaction.

For each individual *j*, one can define an allocation based on the WEM as *WEMj* and the allocation based on her most preferred equity norm as *Rj* (based on the individual ratings). The perceived inequity is then defined by (*WEMj – Rj*). If it is negative, the allocation will appear as inequitable or unfair according to the individual's most preferred equity norm in that context; if it is zero or positive, the allocation will appear as equitable or even, if large enough, as selfishly beneficial.

A policy maker having to choose between two or more projects A and B may be interested in choosing the one that will appear most equitable to his constituency. It is not the WEM itself that will allow him to decide whether A⮚B or B⮚A, where the symbol '⮚' means "*perceived as more equitable than*", but the difference *D* = (*WEM – R*). Then

$$\text{A} \succ \text{B if, and only if, } D_A < D_B$$

$$\text{or } \text{A} \succ \text{B} \Leftrightarrow D_A < D_B$$

Computation of the *WEMj* metric was described in the previous section.

Rj measures the allocation to individual *j* resulting, in the given context, from his most preferred equity norm as given by his highest Likert rating. If two (or more) equity norms have received equal ratings, then the arithmetic mean of the allocations resulting from the two (or more) norms is used. This reflects indifference between any of these single allocations. For each j, the difference *Dj* = (*WEMj – Rj*) is computed and then the sum (or the mean) over all *j*.

To illustrate, consider Table 5 again (shown as 5-bis below) where individual ratings for various equity norms have been collected (Group 1 in Scenario 1 of our experiment).

Table 5-bis : Most preferred equity norms in group 1, scenario 1
(read vertically under each individual)

Individuals NORMS	1	2	3	4	5	6	7	8	9	10
Egal	3	2	-5	-5	-3	-4	-3.5	3	5	-5
Mm	-10	4	-2	-3	-10	4	-6.5	5	2	-10
IGE	5	-2	4	2	8	8	5	8	**10**	6
AtP	8	-4	**6**	5	0	**10**	-4.5	6	0	8
VE	-6	4	2	**5.5**	-10	-6	-5.5	8	-8	-9
HE	-6	**6**	4	4	**10**	-8	5	5	6	6
Mkt	**9**	-6	2	-2	-4	4	**6**	0	-2	4
Par	7	2	**6**	3.5	6	9	5	3	0	-10
Exc	4	1	**6**	5	**10**	**10**	3	**9**	8	**10**
Sov	-5	-4	-4	-1	6	4	2.5	-5	2	-10

Note: Ratings on a Likert scale of [–10,+10] with 0 = indifference.

Some individuals have clear preferences, with a single most preferred equity norm (e.g. #1 clearly prefers 'market justice' in the given context), while others hesitate between two or more; for example, individual #3 hesitates between, or has equal preferences for, norms AtP, Par and Exc, each with the same maximum rating of +6. The following Table 8 translates these ratings into (here, dollar) allocations to each individual.

Table 8 : Individual $ allocations for group 1, scenario 1

Individuals NORMS	1	2	3	4	5	6	7	8	9	10
Egal										
Mm										
IGE									4.00	
AtP			6.22			3.65				
VE				5.07						
HE		5.00			5.00					
Mkt	2.97						9.47			
Par			7.54							
Exc			9.23		5.88	7.80		3.31		5.43
Sov										
Payment	2.97	5.00	7.66	5.07	5.44	5.72	9.47	3.31	4.00	5.43

For individual #3, the payment of $7.66 is the mean of the three payments (6.22; 7.54; 9.23), as the corresponding equity norms all received an equal highest rating of 6 (Table 5-bis).

Importantly, note that the sum of the payments made as per the bottom line to not add up to the available $50, but instead to $54.48, which exceeds the available amount. This is to be expected, as individuals from their own point of view do not, and have no reason to, factor in the collective budget constraint in their choice of equity norm, assuming they were able to do so (this would be computationally demanding). In choosing their most preferred norm, each individual implicitly assumes the rest of the world should adjust to his choice; and of course everyone else assumes the same.

In Table 9 below the allocations for each individual in the group have been averaged out over all 9 groups, and thus represent average earnings specific to one of the ten positions in the group. The first row gives the WEM allocations whereas the second row gives the allocations as per individuals' most preferred equity norm(s). The difference between the two, as per the bottom row, gives the perceived losses created by imposition of the WEM allocation instead of the individually most preferred one. In the example below, individuals in position 6 in the group perceive, on average, having incurred the greatest loss (–$1.88), while those in position 5 actually perceive having obtained a 'good deal', since they obtain, on average, $0.31 more than they believed should be their fair share. (Note that this scenario did not involve any real money and was focused on 'judgments of principle'.)

Table 9: Measuring 'perceived inequity' in scenario 1

Individuals	1	2	3	4	5	6	7	8	9	10	Mean
WEM_j ($)	5.75	5.53	6.74	4.18	5.28	5.08	4.48	3.64	4.94	4.38	5.00
R_j ($)	6.30	5.86	7.07	5.59	4.98	6.97	5.51	4.24	5.85	5.52	5.79
Differences D_j ($)	-0.55	-0.33	-0.33	-1.41	0.31	-1.88	-1.03	-0.60	-0.91	-1.14	-0.79

In Table 9 above, it appears from these experimental data that in scenario 1 application of a WEM allocation would be, in aggregate, considered to be rather equitable. The measured 'inequity', which represents an overall perceived loss compared to each individual's most preferred allocation norm, is –$0.79 and represents a deviation of 16% from the equal allocation of $5.00. In scenario 2, this mean difference is more than twice as high: –$1.95, or 39% of $5.00. This accounts for the fact that the WEM allocation, unlike that based on the *Rj*, obeys the budget constraint of $50. In principle then, any project whose mean difference *D* (for the same budget) had a greater negative value than -0.79 would be rejected in favour of this one. Note that by definition Pareto-optimality is irrelevant in this context. The problem here is how to move along the Pareto-optimal frontier, all points of which, from an efficiency point of view, are all equivalent. The fact that some individuals perceive a loss while others may perceive a gain is to be expected, and will always be the case.

4.2 Predictions for different scenarios

In this section, we would like to test whether this approach yields useful insights to the equity problem with heterogeneous preferences. To do this, we report experimental results carried out using different equity scenarios which, by way of principle, should affect the choice of the most preferred equity norm by participants. One reason, among others, for such context-dependence is the phenomenon of self-serving bias (SSB); that is, the choice of a supposedly equitable norm as a function of its perceived benefits to the chooser (see Favarelli, 2007; Cappelen et al., 2007; Ubeda, 2014; Durante *et al*., 2014).

Our experimental design combined three contextual factors into a full factorial, as explained in section 2 above:

1) Incentivization or not (with real money)
2) Equity-efficiency trade-off or not
3) Veil of ignorance or not (using John Rawls' scenario)

From the literature cited above, we can formulate a number of hypotheses regarding the degree to which individuals will bias their equity norm ratings in a self-serving manner. In the context of our study, the greater the degree of self-serving bias, the greater the (average or total) difference *D* between the *WEM* allocation and the *R* allocation. But now we have as many such measures as there are scenarios, which we can index by their number: $D_k = (WEM_k – R_k)$.

Two such hypotheses can be formulated following the existing literature, as per Table 10.

Table 10 : Hypotheses to test the significance of the WEM metric

Hypotheses	**Testable condition**	**Explanation**
Hyp. 1a *1b*	S1➢S2 or $D_1 < D_2$ and S3➢S4 or $D_3 < D_4$ but	This reflects the expectation a) That the presence of real monetary stakes will 'activate' self-serving bias more than in their absence; and b) That this relationship holds even in the presence of equity-efficiency trade-offs; but c) That under the veil of ignorance, real stakes no longer

1c	S5 ≈ S6 or $D_5 = D_6$	matter in terms of self-serving bias.
Hyp. 2	S2➤S4 or $D_2 < D_4$	Introducing an equity-efficiency trade-off exacerbates self-serving bias

Note: No ex-ante predictions can easily be made involving scenarios 7 and 8.

Following the procedure described above, the values of the different *Dj*'s were computed for each scenario *k* (7 and 8 omitted here) using our experimental data, and are summarized in Table 11 below. The numbers in the Table give the D_{jk}, the differences for each individual $j\in\{1, 90\}$ (averaged out over the 9 groups) for each scenario $k\in\{1, 8\}$ and represent dollar values.

Table 11 : 'Perceived inequity' for selected scenarios, by individual position ($ values)

Individual positions	1	2	3	4	5	6	7	8	9	10	Mean	$Sig(D_k)$ *	Nb/10 $D_j > 0$
D_1	-0.55	-0.33	-0.33	-1.41	+0.31	-1.88	-1.03	-0.60	-0.91	-1.14	-0.79	p=0.002	3
D_2	-6.06	-1.71	-0.03	-0.55	-1.29	-2.31	-1.18	-1.29	-2.58	-2.50	-1.95	p<0.001	0
D_3	-0.79	+0.35	-0.44	-1.00	+0.36	-3.13	-0.89	-2.12	-3.56	-2.33	-1.36	p<0.001	1
D_4	-3.18	-2.68	-1.50	-0.75	-0.68	-3.92	-2.04	-2.26	-4.04	-5.10	-2.62	p<0.001	0
D_5	+1.43	+1.20	-0.97	+0.90	+0.18	+0.56	+0.03	-0.89	-0.09	-0.88	-0.11	p=0.703	7
D_6	+1.26	+0.64	-0.08	+0.89	+0.36	-0.02	-0.32	-0.69	-0.62	-1.04	-0.04	p=0.978	7

*) Significance of the difference between the average WEM_k and R_k measures using a Wilcoxon Signed Ranks Test, with *k* being the scenario number. Scenarios 7 and 8 are not shown here.

We can check how well the data confirms or not the hypotheses formulated above based on the mean D_k for each scenario.

Hyp. 1a : $D_1 < D_2$ Confirmed: Table 11 yields |0.79| < |1.95| in absolute values, significant at the 1% confidence level (Wilcoxon Signed Ranks Test, Z = –3.48 , p < 0.001).

Hyp. 1b : $D_3 < D_4$ Confirmed: Table 11 yields |1.36| < |2.62| in absolute values, significant at the 1% confidence level (Wilcoxon Signed Ranks Test, Z = –4.27 , p < 0.001).

Hyp. 1c : $D_5 = D_6$ Confirmed: Table 11 yields |0.11| and |0.04| in absolute values, non-statistically significant (Wilcoxon Signed Ranks Test, Z = –0.395 , p = 0.693).

Hyp. 2 : $D_2 < D_4$ Confirmed: Table 11 yields |1.95| < |2.62| in absolute values, with significant at the 1% confidence level (Wilcoxon Signed Ranks Test, Z = –3.50 , p < 0.001).

In the second to last column of Table 11, the statistical significance for each scenario selected of the difference between the average WEM_k and R_k measures is given. As predicted, the differences between WEM_5 and R_5 and between WEM_6 and R_6 are not statistically different from each other: in both these scenarios the WEM allocation is not collectively seen as ‘unfair’ by the whole ‘constituency’ of all 90 participants. The last column provides another angle by counting the number of individuals per group, on average, which do not perceive any loss from the application of the WEM allocation. In this case, the higher this number, the more equitable the WEM procedure is perceived. This is a crude measure, but it is easily understood by policy makers and we can check that the relative values (this time with the reverse inequality) still hold.

4.3 From lab to field

There at least three aspects in extending these ideas from the lab to the field: operationalizing equity norms outside the lab; working with potentially large populations as opposed to a small group of individuals; and deciding which scenario is most relevant.

Operationalizing equity norms. In our experiments, the final quantity to be distributed, whether dependent on the distribution itself or not, was known. In the real world, this is not always immediate, and, accordingly, equity principles as voiced by stakeholders may not be in a form that will allow an equitable solution. If we take the example of water restrictions, a maxmin (Rawlsian) distribution may at first be formulated simply as an abstract principle: “*Only the highest water users incur restrictions*”. But if we wish to implement our experimental procedure, we need to be more specific, and formulate the maxmin norm as: “*The total amount of 10 GL of water restrictions are to be allocated to the N % highest water users*”.

Note that first of all the quantity to be distributed has to be clearly defined and quantified. This is true for every distribution rule. Secondly, the maxmin rule, to be implemented, requires a parameter to be specified: who is included in the “highest water users”. This could be the top 50%, or the top 20%. The resulting pattern of water restrictions could differ greatly. The maxmin rule is an example of a 1-parameter equity norm. Other norms, like equality or sovereignty, are parameter-independent. Yet others, like the exceptions rule or inter-generational equity, require up to 3 parameters to be made operational (which explains why they are implemented in so many different ways).

Equity preferences in large populations. Experimental results reflect ratings by clearly identified individuals in tightly controlled lab conditions. The socio-economic position of each individual in their group and each individual’s ratings for each equity norm are perfectly well known. But out in the field, with a potentially large population, such knowledge may not come easy. To start with, it would be impractical to measure every single individual's equity preferences, unless the constituency was small enough. Instead, a representative sample of the population needs to be constructed; it can then be surveyed or asked to participate in so-called 'artefactual' field experiments (to use John List's terminology). Representativeness here is a key concern. Preliminary focus groups will have identified the key parameters that are considered relevant for consideration of equity issues, such as household wealth or income, size of family, etc. Data on these parameters need to be collected from the sample population and then related to equity ratings.

In previous studies, equity preferences have most often been studied directly, in terms of a quantitative pie-sharing exercise. This approach is well suited to the lab but impractical for field work. Our approach studies equity preferences indirectly, via ratings of equity norms that have previously been identified as relevant (they have actually been shown to be universal[3]). This is how equity preferences are usually expressed in real-world situations. Our lab methodology can therefore be transferred out to the field, with some adjustments; for example, work with a representative sample instead of the whole population. This is why it is important here to control for representativeness in relation to all stakeholders concerned[4].

Reference scenarios. The other issue is the linking of equity preferences as expressed in an experimental setting to field conditions. Out of the eight scenarios defined in the previous section, it would appear that scenarios 2 and 4 would typically reflect most real-world situations, depending on whether equity-efficiency trade-offs were perceived as relevant or not: they involve real stakes and participants know their socio-economic position in the community. But we know that these scenarios involve heavy self-serving biases in the choice of equity norms. Comparing the equitability of two or more projects on this basis may or may not be appropriate.

If the policy maker's concern is to minimize dissatisfaction in his constituency, basing his policy choices on the grounds of self-serving biased measures of equity would seem appropriate: the project with the lowest D measure ($D = WEM - R$), as defined above, will respond best to his concern. If however the goal is to define a most equitable policy irrespective of current political pressures, perhaps because it targets the future or extends well beyond the current constituency, then use of scenarios other than S2 or S4 are more appropriate; which ones exactly would depend on the scope of the projects or policies. If they

[3] See e.g. Cazorla & Toman (2001); Ringius et al. (1998, 2002) and work by A. Rose (several publications).

[4] Note the use of a sample may be seen as implicitly appealing to a 'sovereign bargaining' equity norm over and above any other norm, to the extent that the sample will 'represent' the preferences of the whole constituency. Ideally, the composition of the sample should be agreed upon by most of the constituency.

concern the future with no immediate link to the present, e.g. with a start in a number of years' time, then the veil-of-ignorance scenarios would seem appropriate.

More importantly, the use of self-serving versus non- or less self-serving scenarios may ultimately depend on whether stakeholders are asked to participate in the design or choice of the policy or not. If not, they are likely to behave in a self-serving manner; if they are also 'law-givers', they may adopt a more general attitude and search for genuinely equitable solutions. In that case, projects with the lowest $D = WEM - R$ as defined from low self-serving biased experimental scenarios are most appropriate.

5. Conclusions and further perspectives

To the motivating question of this study, we have answered with the affirmative: yes, it is possible to design an equity metric when stakeholders hold conflicting views about equity. This metric extends and generalizes the approach by Ringius et al. (1998), and innovates by endogenizing the equity criteria used for equity evaluations. We have described a procedure to build such a multi-norm "weighted equity metric" (or WEM) and have shown it can be used by decision makers. They can use it to compare whether a project or policy is 'fairer' or 'more equitable' than another in the presence of a heterogeneous community; they can use it to measure the degree of perceived inequity from applying this metric; and they can use it to identify who in the community will see greater inequity and who will see lesser inequity, if at all. This disparity among stakeholders is inevitable and is a fundamental aspect of the tensions between potentially unlimited individual aspirations and the interaction of many such aspirations, constrained by resource limitations; this disparity is also parallel to, but totally distinct from, the concept of Pareto compensation, which itself constitutes only one of the possible equity norms (Le Grand, 1990). We have shown that the use of this WEM metric can provide insights into the nature of context-dependence that determines the degree of self-serving bias (SSB) affecting the choice of the most preferred equity norm. The predictions one can make based on the existing literature are borne out by the use of this metric.

To construct this metric we have had to design an appropriate experimental protocol allowing for systematic variations in context parameters. The implementation of equity norms in experimental conditions, together with real payments made to participants, has forced us to more clearly identify the nature of different equity norms, in particular to realize that while some are parameter-independent, others require up to three parameters in order to lead to an unambiguous allocation. Although not the purpose of this study, a literature review of field data could use this insight to shed some light on how and when different parameterizations of equity norms have been used, whether by decision makers or by analysts. We have also clarified the main conditions for extending the construction of the equity metric from controlled lab conditions to real world conditions. The next step would naturally be to provide the proof of the pudding and carry out such a field application.

The work carried out to date is far from finished. Using the same data set, a number of other questions can be, and are being, answered, namely: which individual characteristics and context factors most determine the equity ratings and the degree of self-serving bias? Does Rawls' 'veil of ignorance' condition swamp the effects of the other factors, as the current results seem to suggest? To what extent is the context dependence of different equity ratings predictable, and what factors affect the degree of predictability? The experimental protocol must also be extended to include, in particular, scenarios where real money is allocated to another, anonymous group, rather than to one's own group, and the results compared to the non-incentivized scenarios where no real money is at stake: this could shed some light on the rationale of choices in non-incentivized conditions.

The construction and use of an equity metric such as the one proposed in this paper could help provide an equal playing field with other concerns, such as economic efficiency or ecological impact. To the extent that the metric provides a one-dimensional scalar measure, all sorts of comparisons and trade-offs are allowed, and work such as that by Halpern et al. (2013) can acquire a whole new dimension, both in theory and in practice.

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