Who Are The Worst-Off When Preferences Matter*

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Abstract

Fleurbaey and Maniquet have proposed the criteria conditional equality and egalitarian equivalenc [16] and [17] to assess the equity among individuals in an ordinal framework. They have not been applied as often as the criteria proposed by Roemer or Van de gaer [30] and [33] that adopt a cardinal approach. This paper proposes a model that is consistent with these ordinal criteria and enables to compare them with the cardinal criteria. We estimate a utility function that incorporates heterogeneity in groups' preferences from which we approximate individuals' preferences. We obtain ordinal measures of well-being, apply conditional equality and egalitarian equivalence and propose two cardinal measures of well-being that are comparable with the ordinal model to compute Roemer's and Van de gaer's criteria. Finally we compare the characteristics of the worst-off displayed by each criterion. We apply this model to a sample from US data and obtain that only 10% of the worst-off belong to all criteria.

Keywords: Random utility, Preference Heterogeneity, Welfare Measures, Inequality of Opportunity

1 Introduction

Usually, inequality of opportunity is measured by selecting a particular outcome and decomposing it into two kinds of determinants: the factors beyond the individuals' responsibility, often called circumstances, and the factors for which the individual can be held responsible, the responsibility-factors. Equality of opportunity requires erasing unfair inequalities due to circumstances but maintaining

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fair inequalities due to responsibility-factors. As a result, outcomes should be a function of responsibility-factors only.

If one takes a cardinal measure for the outcome, interpersonal comparisons are straightforward since everybody is assumed to value equally the outcome. In such a case, we can easily make social orderings based on the concept of equality of opportunity. Two main criteria rely on cardinal measures of outcomes. Firstly, Roemer's criterion requires that individuals who exert the same effort (being the responsibility-factor) obtain the same outcome. If this is not the case, an equality of opportunity policy would consist in maximizing the outcome of those who obtain the lowest outcome at each level of effort. A second criterion proposed by Van de gaer's states there is equality of opportunity if the mean outcome conditional to circumstances are equal. As people who share the same circumstance are called a type, the target of a policy aiming at reducing inequality of opportunity should give the priority to the type with the lowest average outcome.

In both cases, as these criteria require comparing and aggregating individuals' outcomes, they implicitely assume that individuals have homogeneous preferences over the outcome. If we take the income for instance, it means that two individuals a and b value equally the same amount of income. But it may not be the case. If the individual a values more leisure than the individual b, a lower income for the individual a may give him an equal well-being as a higher income for individual b because the individual a prefers to earn less in order to have more free time. This illustrates the fact that cardinal measures cannot account for the heterogeneity in preferences.

Even though it is difficult to identify empirically heterogeneous preferences, it is a noble objective as fairness could aim to respect heterogeneous preferences in case policies should not aim to distort preferences. Representing heterogeneous preferences implies working in an ordinal setting in which the way individuals rank situations would reveal their preferences.

However, because it it is impossible to obtain a social orderings that respect fully heterogeneous preferences, it is only possible to rank individuals' situations by making normative choices that enable interpersonal comparisons. This is the proposal made by Fleurbaey and Maniquet [15] [16] [17] [18]. It presents the advantage of accounting for heterogeneous preferences when defining criteria of fairness and make explicit the normative choices on which rely fair orderings.

Their work in the field of welfare economics is strongly related to the concept of equality of opportunity [20] because the social rankings they propose are based on equity criteria very similar to the definition of equality of opportunity. Indeed, they consider that individuals' well being is the relevant outcome on which should be based social rankings and the observed choices made by the individual permit to identify their preferences. Secondly, given individual's well-being is a function of preferences and non-responsibility factors, policies should erase inequalities due to non-responsibility factors and be neutral [1] with respect

[1]Here neutral means that policies should not aim to distort preferences, in such a case, inequalitites between individuals having distinct preferences do not give room to redistribution

to preferences. In particular, fair policies should rely on two principles that derive from the non-envy principle.

The first principle corresponds to the compensation principle: compensation means we should compensate for factors for which the individual is not responsible. Therefore, people with the same preferences should achieve the same well-being. This is very similar to Roemer's criterion that requires people with the same responsibility factors should end up with an equal outcome.

The second principle corresponds to the neutrality principle: neutrality refers to the neutral treatment of individuals with respect to their preferences. This neutrality principle means that individuals should be treated equally with respect to their preferences[2]. As a result, redistribution mechanisms should be designed in such a way that individuals with equal circumstances will pay/receive the same taxes/transfers. This principle is closer to Van de gaer's criterion that recommends people to have equal opportunities whatever their non-responsibility factors. Because people should have the same opportunities before deciding on their responsibility factor, this principle encapsulates the idea of neutrality according to which the treatment of the individuals should be independent from their responsibility factors.

The compensation and natural reward principles, probably equally appealing, cannot be both satisfied when individuals have heterogeneous preferences [18, 6]. That is why, Fleurbaey and Maniquet measure unfairness through two criteria, each one giving the priority to one principle and fulfilling only partially the second one. The criterion of conditional equality fulfills the natural reward principle and compensates partially inequalities due to non-responsibility factors. The criterion of egalitarian equivalence gives priority to the compensation principle but does not satisfy neutrality with respect to all preferences.

Given the existence of these four criteria, the aim of the paper is twofold:

Firstly, we propose a model in an ordinal set-up that approximates individuals' preferences through the observable choices made by the individuals. This enables us to apply Fleurbaey and Maniquet by respecting their theoretical approach. In fact, previous empirical applications of Fleurbeay and Maniquet's criteria have been adapted in a cardinal framework: Almas [3] and Devooght[9] have used the definition of conditional equality and egalitarian equivalence to measure unfair inequalities for income, therefore, they did not explicitely account for preferences. Then, Decoster and Haan [10] have proposed the first application that follows the key points of the approach, especially the identification of heterogeneous preferences and the use of an ordinal framework [10] but preferences are not individualistic, they are common to groups of people depending on their socio-demographic variables. Moreover, they estimate a discrete choice model to identify groups' preferences but then they translate it into a continous model when making the social orderings.

In this paper, we propose a extension of Decoster and Haan's model such as to (1) approximate the individualistic component of preferences and (2) apply in

[2]This idea could be questioned if we consider that some goals or preferences should be avoided according to some prevalent values but this discussion falls outside the scope of this paper

a discrete framework the two criteria to be consistent with the original discrete model on which relies our estimates of preferences.

Our second objective is to use the same model to apply Roemer's and Van de gaer's criteria. To our best knowledge, it exists only a theoretical comparison of the four criteria [14] To this end, we have to solve two issues. Firstly, we need a cardinal measure of well-being. To obtain it, we use two distinct strategies. On the one hand, we erase heterogeneity in preferences such as to obtain a cross-individual comparable measure of well-being. This corresponds to the assumption made to apply conditional equality. On the second hand, we take a money metric for utility that is used for implementing the egalitarian equivalence criterion. In both cases, this is a way to rely on assumptions that make comparable the four criteria. Secondly, we have to split between effort and non responsibility factors instead of the split preference/non responsibility factors used on the ordinal model. We take the same non responsibility factors as the one used for conditional equality and egalitarian equivalence. Concerning effort, because here it is not observable direcly, we use the Roemer's Identification Axiom: assuming the outcome is a monotonous increasing function of effort, individuals who sit at the same percentile of the outcome's distribution function of their type have exerted the same effort.

This model is finally applied to a sample of US singles from the 2005 CNEF data set. We identify who are the worst-off according to each criterion such as to know if there is any worst-off regardless of the criterion used. For each criterion, we build a distribution by ranking the individuals (or groups of individuals) from the worst-off to the better-off and the worst-off refer to the individuals who belong to the first decile of the relevent distribution. This comparison across criteria informs us about the impact of the normative choices that enable interpersonal comparisons on the measures of fairness.

The rest of this paper is organized as follows: Section 2 presents the model. Section 3 details the empirical estimation. In Section 4 are presented the data and main results. Finally, Section 6 provides a conclusion.

2 The Four Criteria

2.1 Conditional Equality and Egalitarian Equivalence

2.1.1 A simplified budget set

In a population of N agents, we have a profile of skills s_N equal to the set of wage rates w and a set of utility functions u_N, that depend on consumption and leisure. An economy is $e = (s_N, u_N)$ where every agent maximizes his utility u_i over consumption and leisure $(C_i, L_i) \in X = (0, 1)$

In brief, well-being is assumed to depend on disposable income, C and leisure L and can be represented through an utility function $u(C, L)$. The way people value leisure will affect their well-being such that if two individuals have heterogeneous preferences for leisure, a same bunle (C,L) does not mean an equal well-being.

Every individual maximizes his utility subject to a budget constraint $B \subseteq X$. The budget represents the level of consumption accessible to the individual. It varies for each individual because it depends on (1) the individual's wage rate w that is assumed to be constant whatever the individual's labour time, (2) the amount of labour time $l = 1 - L$ and (3) the tax rate t applied to the gross labour earnings.

This budget is actually not linear since t varies along with $w * l$. But when implementing conditional equality and egalitarian equivalence criteria, we aim to preserve as far as possible the neutrality principle. This states that the treatment of individuals should be neutral with respect to preferences and this is incompatible with the actual non linear budget sets. Instead, we could compute the redistribution rules that fulfill the criteria in a neutral setting if we worked with nested budget sets, and rank the budget sets in an unequivocal way when defining who the worst-off are.

This is why, before implementing the conditional equality and egalitarian equivalence criteria, a preliminary transformation of the actual budget set into a simplified budget set is necessary. The simplified budget set is composed by the lump sum transfer that, with his observed wage rate and free to choose the bundle (C,L) according to his preferences and this transfer, would make the individual just as well-off as he is in his current situation. We obtain nested budget sets by replacing the actual budget set by a lump-sum transfer in the following way:

Given every individual maximizes his utility subject to a budget constraint $B \subseteq X$, the utility function derived from any subset B is:

$$u_i(B) = \{\max u_i(c, l) | (c, l) \in B\} \tag{1}$$

The simplified budget set $B^* \subseteq X$, is determined by the gross income and a lump-sum transfer $\hat{t}$ such that:

$$B^*(w_i, \hat{t}) = \left\{(c, l) \in X | c \leq w \times l + \hat{t}\right\} \tag{2}$$

and:

$$u_i(c, l) = u_i(B^*(w_i, \hat{t})) \tag{3}$$

2.1.2 Responsibility versus non responsibility factors

Before defining the equity criteria, we need to define the split between responsibility and non-responsibility factors.

In Fleurbaey and Maniquet setting, the non-responsibility factor is the wage-rate. The wage-rate is likely to represent skills that are mostly the product of genetics, family background, luck but also effort. Despite this choice appears to be quite controversial, as we aim to implement the criteria following the spirit of their authors, we take the same hypothesis. The responsibility factors are individuals' preferences and correspond to the preferences for leisure and

consumption as preferences affect well-being through consumption and leisure. [3] Once identified the wage-rate, the individual's preferences and the implicit budget set, we can explain in further detail the equity criteria.

2.1.3 Conditional equality

Conditional equality permtis to fulfill completely the neutrality principle and achieve partially the compensation for circumstances. Formally, defined in Fleurbaey [15] conditional equality can be computed as follows:

> "Define a reference value for responsibility characteristics and give priority (according to the leximin criterion) to individuals, who, with their current resources and circumstances and this reference value of responsibility characteristics, would be the worst-off."

In a nutshell, the idea enclosed in this principle is the following: in a fair economy, if individuals had the same preferences, they would end up with the same well-being. Thus, the individuals who would obtain the lowest well being when fixing a reference value for preferences for all are those whose non responsibility factors impact negatively on their well being. These are the worst-off. Then, a conditional equality rule consists in fully neutralizing the effect of circumstance for the people having the reference value for preferences and partially neutralizing the effect of non-responsibility factors for others because of the restriction according to which this principle always imposes a same treatment for individuals having the same circumstances.

In the framework defined above, implementing conditional equality requires defining a reference value for preferences. This is done by fixing a reference utility function. Then, when we suppose that individuals have the same preferences, according to the fairness principles, they should obtain the same well-being. This turns to have equal simplified budget sets because individuals with equal preferences obtain the same well-being if they have the same budget sets. Therefore, when ranking in ascendent order the simplified budget sets, we obtain the rankings of individuals from the worst-off to the well-off:

Formally, individuals are ranked according to:

$$\widetilde{u}(B(w_i, \hat{t_i})) \tag{4}$$

where $\hat{t_i}$ is the lump-sum transfer corresponding to the simplified budget set such that:

$$u_i(C_i, L_i) = u_i(B(w_i, \hat{t_i})) \tag{5}$$

and $\widetilde{u}$ is the reference utility function that results from fixing a reference value for preferences.

Instead of fixing a reference value for the form of the utility function, we could also fix a reference value for labour time. It is equivalent with stating that

[3] In the estimation, we only estimate heterogeneity in preferences for a question of simplicity given it does not change the results.

all individuals have preferences such that they decide to work the same amount of worked hours. In this case, implementing conditional equality consists in ranking the individuals' well-being when all individuals work the same amount of hours.

2.1.4 Egalitarian Equivalence

The second equity criterion, called egalitarian equivalence, fulfills completely the compensation principle and partially the neutrality principle. As defined by Fleurbaey [15], it requires the following:

> "Define a reference type of circumstances and give priority (leximin) to individuals whose current level of well-being would be obtained with the least resources if their circumstances were of the reference type"

This method permits to mimic a situation where inequalities would be due to responsibility characteristics only. In consequence, the redistribution rule that emerges from this principle will fully fulfill the compensation principle but it may treat unequally individuals with the same circumstance.

Concerning the application of this criterion, Fleurbaey proposes to use different reference value for the wage rate as the reference value affects people ranking. As the ranking depends on the apportion between preferences and income, the higher is the reference wage rate, the more priority will be given to the people having lower preferences for leisure, that is to say the hard-working people.

If the reference wage rate is equal to zero, we obtain the zero egalitarian equivalence. To this end, we rank $\hat{t_i}$ in ascending order as defined by :

$$u_i(x_i) = u_i(B(0, \hat{t_i})) \tag{6}$$

If the reference wage rate is equal to the minimum wage rate, we will obtain the min egalitarian equivalence: It consists in ranking in ascending order the $\hat{t_i}$ as defined by

$$u_i(x_i) = u_i(B(min_{j \in N} s_j, \hat{t_i})) \tag{7}$$

Lastly, the wage egalitarian equivalence or equivalent wage is defined in Fleurbaey [15] as:

> "For each individual, compute the counterfactual wage rate (with no transfer) that would make the individual as happy as in his current situation, and give priority (leximin) who are the worst-off in these terms."

Formally, it is equivalent to rank the individuals in ascending order according to $\hat{w_i}$ that satisfies:

$$u_i(x_i) = u_i(B(\hat{w_i}, 0)) \tag{8}$$

2.2 Roemer's and Van de gaer's criteria

2.2.1 Methodological questions

For the application of conditional equality and egalitarian equivalence, the form of the utility function itself does not matter, we only need to know the way people rank the bundles (C, L) according to their preferences in order to make orderings. Instead, Roemer's and Van de gaer's criteria use a cardinal measure of well being such as to make the interpersonal comparisons. Taking the observed earnings is not an appropriate solution as the first two ones would account for another dimension of well-being and the last two ones would not. A possible solution is to take a measure of well-being. This is consistent with the hypothesis made above about individuals' behavior.

Then, the question is to select an appropriate cardinal measure of well-being. On the one hand, to implement the conditional equality criterion, we need to choose a reference utility function for everybody in order to remove heterogeneity in preferences. It means that the value of $\widetilde{u}(B(w_i, \hat{t_i}))$ that is obtained for conditional equality is (1) comparable across individuals because the same utility function is used for everybody, and is (2) an approximation of the current individual's well-being. In fact, we erased the impact of heterogeneous preferences on well-being, but this limitation is imposed by the Roemer's and Van de gaer's criteria. In consequence, this measure can be used to implement Roemer's and Van de gaer's criteria and will be easily comparable with the results given by the conditional equality criterion.

On the other hand, the egalitarian equivalence consists in obtaining the amount of resources that should be given to an individual such that he obtains his current level of well-being if all individuals had the same circumstance. In consequence, this amount of resources reflect the current well-being of the individuals and it respects individual's preferences. This is a money metric for individual's well-being. For example, if we take the zero equivalance criteria, we obtain the resources that an individuals needs to be as well off as he is in his current situation if he did not work. One limit is that this money metric corresponds to a virtual situation that may not occur ever. Still, this measure enable us to implement Roemer's and Van de gaer's criteria and is directly comparable with the results given by the egalitarian equivalence criterion.

The second problem we face is the fact that Roemer's and Van de gaer's criteria make a distinction between effort and circumstance, instead Fleurbaey and Maniquet distinguish between preferences and non responsibility factors.

To make the comparison more reliable among the four criteria, it is natural to define the circumstance in the same way as the non responsibility factors because both term reflect the factors that are beyond individual's responsibility. Thus, the circumstance is unique and corresponds to the wage rate [4].

Regarding effort, from the previous framework, effort is multidimensional, it

[4] More complex specifications could be of main interest but are left to other studies since here the puropose is to offer a consistent comparison among several criteria and not a detailed implementation of one specific criterion.

is made of the preferences for leisure and consumption but also the amount of leisure chosen and the form of the utility function, so it is impossible to find one single continous value for effort. A way out is to use Roemer's Identification Axiom to determine one index of responsibility: firstly, the population is partitionned into types according to the wage rate. Then, we draw the outcome's distribution function of each type, the outcome being the well-being as defined above. And we assume that the individuals belonging to the same percentile of their outcome's distribution function have exerted the same effort. In this way, we obtain an index of individual's effort. Moreover, this method is coherent with Roemer's definition of effort and allows us to compute Roemer's and Van de gaer's criteria consistelntly with their original framework.

2.2.2 Implementating Roemer's and Van de gaer's criteria

There is equality of opportunity according to Roemer when people exerting the same effort obtain the same outcome. Measuring the fairness of any distribution consists in comparing individuals' well-being at each level of effort across types, and improving equality of opportunity would require maximising the mean outcome of the individuals who have the lowest well-being at each level of effort.

With such a criterion, the worst-off may be defined as the individuals with the lowest well-being at each level of effort in the extent that an increase in their well-being would improve the fairness of the distribution.

To implement it, we firstly divide the population into types. Then we take our cardinalization of well-being and apply Roemer's Identification Axiom to obtain an indirect measure of effort. Lastly, we take the individuals with the lowest well-being for each value of effort and obtain who the worst-off are according to Roermer's criterion.

Equality of opportunity defined by Van de gaer's is characterized by an economy where the average well-being of each type is equal. With such a definition, the worst-off cannot be identified individually. Instead they can be defined as the type with the lowest average well-being.

To identify them, we use the cardinalization of the well-being detailed above. Then, we measure the nverage well-being conditional of the type and the worst-off are the individuals who belong to the type with the lowest average well-being.

3 A discrete choice model to apply the criteria

3.1 Estimation of groups' preferences

The first objective is to identify heterogeneous preferences in an ordinal frawework where individual's well-being depend on consumption and leisure. To this end, we start with Aaberge et al. [1, 2] model:

We assume that individual's well-being is representable through a utility function that depends on disposable income C, leisure L, socio-demographic variables X and a random error term ϵ_{ij} that varies independently among indi-

viduals and alternatives. It is not observed but affects individuals' choices. The utility function can be written as follows:

$$V_{ij}(C, L) = U(C_{ij}, L_{ij}, X_i) + \epsilon_{ij} \tag{9}$$

The two sub-indices may appear redundant. They aim to show that utility differs across individuals i and across alternatives over the worked hours j [5]. Indeed, the earnings C depend on the wage rate that varies across the individuals i and depend on the amount of worked hours. Also, the amount of leisure L depend on preferences for leisure, defined individually, and the worked hours. Finally, ϵ_{ij} is also assumed to vary across individuals and alternatives.

The individual i maximizes his utility by choosing his amount of worked hours ($l = 1 - L$) from a set of the alternatives on worked hours $j \in J$. Empirically, as we use a dicrete choice model, we restrict the individual's choices such that the individual is free to select his labour time among 12 alternatives:

$$j \in J = (0, 5, 10, 15, .., 55) \tag{10}$$

The individual is subjected to a budget constraint that depends on the wage rate received by the individual, the amount of labour time and the taxes he pays on his gross earnings. The wage rate is supposed to be constant whatever the amount of labor time picked by the individual. As the actual taxes are not linear, we use information on income taxes given by the OCDE such that to reproduce the actual individual's budget constraint, that is to say, to calculate the net earnings an individual would receive for each of the 12 alternatives.

The budget constraint can be writtten as:

$$C = w \times l - t(w, l) \tag{11}$$

Where $t(w, l)$ is the tax function that transforms gross earnings into net earnings.

Regarding the deteriministic part of the utility function, we use the same specification as Aaberge et al. [1, 2] and Decoster and Haan [10]:

$$U(C, L) = \beta_C \frac{C^{\alpha_C} - 1}{\alpha_C} + \beta_L \frac{L^{\alpha_L} - 1}{\alpha_L} \tag{12}$$

The parameters β_C, α_C, β_L and α_L indicate preferences for consumption and leisure.

β_C, α_C and α_L are common to all individuals. But heterogeneity among groups of individuals is introduced through β_L that depend on socio-demographic variables:

$$\beta_L = \beta_{L_0} + \beta_{L_1} X_i \tag{13}$$

Where X_i are gender, age, education and ethnic group.

[5] j and l both represent the working hours. Nevertheless we use both to maintain the intuitive meaning of l being the labor time, and j the discrete alternative.

The variables that expain the differences in the preference for leisure have been widely used in the literature to explain the determinants for labour supply. They are not really under the individual's control but they are expected to explain differences in preferences for leisure. In fact, Dworkin, Rawls, Fleurbaey and Maniquet share the view according to which as long as people identify with their preferences, no matter what explains these preferences, we should be neutral with respect to them. The aim of the paper is to implement the criteria according to the view of their respective authors, therefore β_L will represent individuals' preferences and we do not want to compensate for them.

To obtain the parameters of the deterministic part of the utility function, the estimation relies on a rationality assumption that states that if the ith individual makes the choice j in particular, it means that V_{ij} is the maximum among the j alternatives. In other words, the probability that the the ith individual makes the choice j is:

$$Prob(y_i = j) = Prob(V_{ij} > V_{ik}) \forall k \neq j \tag{14}$$

We replace V_{ij} and V_{ik} by its expression and obtain:

$$Prob(y_i = j) = Prob(\epsilon_{ik} - \epsilon_{ij} < -(U_{ik} - U_{ij})) \forall k \neq j \tag{15}$$

The resulting multinomial model is treatable if we assume that ϵ_{ij} is $i.i.d$ random value with type I extreme value distribution, then differences in epsilon follow a standard logistic distribution [8]. In this case, we estimate the parameters of the utility function by maximum likelihood as a conditional logit model where:

$$Prob(y_i = j) = \frac{\exp U(C_{ij}, L_{ij})}{\sum_{k=0}^{n} \exp U(C_{ik}, L_{ik})} \forall k \neq j \tag{16}$$

We obtain as many utility functions as numbers of groups having the same socio-demographic characteristics. Formally, we have:

$$V_{ij}(C, L) = \beta_C \frac{C^{\alpha_C} - 1}{\alpha_C} + (\beta_{L_0} + (\beta_{L_1} X_i)) \frac{L^{\alpha_L} - 1}{\alpha_L} + \epsilon_{ij} \tag{17}$$

It means that individuals who have the same leisure and the same consumption may obtain a distinct well-being if they have a disctinct β_L. That is to say that the form of the utility function will vary accross individuals that have a different age or gender or education or ethnic group.

In the end, with this estimation proposed by Aaberge et al. [1, 2] and Decoster and Haan [10], we estimated groups' preferences for leisure. However, Fleurbaey and Maniquet would recommend to identify individuals' preferences as the criteria they propose allow us to establish individuals' rankings. Instead, if we identify groups preferences, it is not really coherent to establish individuals' rankings. This is why, we propose a extension of this model to approximate individuals' preferences.

3.2 Approximation of individual's preferences

β_L does not include information specific to the individuals. On the contrary, ϵ_{ij} is specific to the individual and the alternative and impact on the well-being V_i. As a result, it is reasonable to assume that the error term, ϵ_{ij}, may capture the individualistic component of preferences not explained by β_L.

After estimating the parameters of $U(C, L)$, we can compute the utility an individual would obtain for each alternative $j \in J$. It may occur that the individual maximises his utility for the amount of labor time he actually chose. In this case, we assume the individual has the same preferences as his group to which he belongs.

But, we may also obtain that the individual maximises his utility for an amount of labour time he did not pick. Formally, we can observe $U(C_{ij}, L_{ij}) < U(C_{ik}, L_{ik})$ where j is the amount of labor time the individual has actually chosen and k is one or some other possible alternatives. However following the assumption of our model according to which the individual is rational, we should have $V(C_{ij}, L_{ij}) > V(C_{ik}, L_{ik})$ for all the other possible alternatives k.

Assuming there is no problem of specification of our model and using the expression of V_{ij} we deduce that ϵ_{ij} may explain why, at the same time, the individual does not maximise his utility U_{ij} for his actual labour time j, whereas he actually maximizes his utility V_{ij} when picking a labour time j. In such a case, ϵ_{ij} captures the individualistic component of preferences not explained by β_L. Still, ϵ_{ij} is not observable after the estimation. In this sense, we cannot capture the individual's preferences. Nevertheless, we can use the assumptions of the model to get a proxy for differences in epsilon:

(1) if the individual has picked the alternative j it means that the utility he obtains with this option is superior to any other alternative. Formally, it means that:

$$\epsilon_{ik} - \epsilon_{ij} < -(U_{ik} - U_{ij}) \forall k \neq j \tag{18}$$

Omitting indexes, we can say that because individuals are rational, we have to satisfy:

$$\Delta\epsilon < -\Delta U \tag{19}$$

(2) The hypothesis of the estimation according to which differences in epsilon follow a standard logistic distribution means that the density function is:

$$f(\Delta\epsilon) = \frac{\exp \Delta\epsilon}{1 + \exp \Delta\epsilon^2} \tag{20}$$

Using (1) and (2) permits us to rescale the density function of $\Delta\epsilon$ so that:

$$f(\Delta\epsilon|\Delta\epsilon < \Delta U) = \frac{f(\Delta\epsilon)}{Prob(\Delta\epsilon < \Delta U)} = \frac{f(\Delta\epsilon)}{P} \qquad \forall\epsilon < -\Delta U \tag{21}$$

$$f(\Delta\epsilon|\Delta\epsilon < \Delta U) = 0 \qquad \forall\epsilon \geq -\Delta U \tag{22}$$

where P is:

$$P = 1 - \frac{\exp \Delta U}{1 + \exp \Delta U} \tag{23}$$

This rescaling matters for our purpose because it allows us to better identify the form of the indifference set for every individual and this is the starting point for the application of the conditional equality and egalitarian equivalence criteria. Indeed, with our estimation we can compute the utility received by an individual for the bundle (C,L) he actually chose. With this information, we can compute the level of consumption an individual would need to obtain the same utility if he had chosen another labor time. That is to say we can compute 12 points of the indifference set given we have supposed an individual has 12 alternatives of labor time.

Given the points of an indifference set are such that $V_{ik} = V_{ij}\ \forall k \neq j$. By replacing V_{ik} and V_{ij} by their expressions and omitting the index i, each point of the indifference set is as follows: :

$$IC_k = [C_j^{\alpha_c} + \frac{\alpha_c}{\beta_c}(\Delta\epsilon + \frac{\beta_l}{\alpha_l}(L_j^{\alpha_l} - L_k^{\alpha_l}))]^{\frac{1}{\alpha_c}} \tag{24}$$

We observe we need a value for $\Delta\epsilon$. This is when the rescaling appears to be crucial. Given the unconditional density function of $\Delta\epsilon$, we generate one million drawings of a random variable that follows a standard logistic distribution so as to obtain one million possible values for $\Delta\epsilon$. Then, for each alternative and each individual, we measure ΔU. From each of these values, we compute the expected value of our generated random variable given equation 19.

To summarize, what we have done is simply to use the assumptions about the distribution of $\Delta\epsilon$ and the rationality hypothesis to define the conditional distribution $\Delta\epsilon$. This allows us to better approximate the indifference set of every individual as the form of the indifference set is specific to the individual when $E(\Delta\epsilon)$ is different from zero. Still, two individuals who share the same socio-demographic characteristics and who maximize U for their chosen labor time will have the same indifference set.

3.3 Conditional Equality

First of all, afer using the actual budget set to estimate the deterministic part of the utility function, we need to determine the simplified budget set to implement both criteria. Given the definition given above and our discrete choice model, we take the observed individual's wage rate and the points of the indifference set to compute $\hat{t}$ such that:

$$\hat{t} = IC_k - w_i \times k \tag{25}$$

The minimum value of $\hat{t}$ among the twelve k is $\bar{t}$. It is the minimal lump sum transfer that makes individual as well off as he is in his current situation with his observed wage rate and free to choose his labour time. It permits to compute the simplified budget set BC_k defined as:

$$BC_k = w_i \times k + \bar{t} \tag{26}$$

With the simplified budget set, we can turn to the application of the conditional equality criteria: we fix a reference value for β_L and ϵ, and obtain for each individual what would be his utility for each alternative of labor time given the simplified budget constraint.

The maximum value for utility we obtain for each individual is labelled $\bar{U}_i$ and these values are now comparable across individuals since all individuals share the same utility function form. Ranking $\breve{U}_i$ gives us the ranking of individuals according to the conditional equality criterion. The worst-off are the persons with the 10% lowest value for $\breve{U}_i$.

As the results may change depending on the reference value for β_L and ϵ, we vary the reference values. We use four different technics for fixing reference values for the utility function. When selecting a utility function form common to all individuals, well-being varies across alternatives only, this can be done directly through β_l, thus, we assume epsilon is equal to zero for every indivudal and every alternative. In fact, Firstly, we fix two distinct values for β_L in order to know by how much the characteristics of the worst-off vary when we take a low or a high reference value for the preference for leisure. Secondly, we fix l=20 and alternatively l=40 and compute the utility of every individual if they opted for this labor time given their observed wage rate and their own preferences.

3.4 Egalitarian Equivalence

Departing from the indifference set IC_k, egalitarian equivalence requires fixing a reference value for the wage rate and compute the minimum lump-sum transfer that gives to the individual his actual level well-being with this reference value for the wage rate. To do this, we compute $\forall k$:

$$EE_k = IC_k - \tilde{w} \times k \tag{27}$$

where $\tilde{w}$ is the reference wage rate. It is equal to 0 in the case of the zero egalitarian equivalence criterion and $\tilde{w}$ is equal to the minimum wage rate (fixed to 5 dollars per hour) when computing the min egalitarian equivalence criterion.

We select the minimum EE called $\bar{EE}$ among the twelve EE for every individual and rank $\bar{EE}$ in ascending order. The worst-off are the persons with the 10% lowest value for $\bar{EE}$.

For the computation of the wage egalitarian equivalence, we find which wage rate the individual should receive to achieve the lowest point of his actual indifference set if there were no tax.

For each point of the indifference set IC_k, except for $k = 0$, we generate:

$$WEE_k = \frac{IC_k}{k} \tag{28}$$

We take the minimum WEE_k among the eleven values for k, it is labelled $\bar{WEE}$, and the worst-off are the individuals with the 10% lowest value for $\bar{WEE}$.

3.5 Roemer's and Van de gaer's criteria

We first have to use a cardinalization of the utility function. As explained above, we propose two technics to obtain a cardinal measure of the actual well-being.

The first one is point of the indifference set when $k = 0$. It is the consumption level that would give to the individual his actual level of well-being if he did not work, called CI_0. It is a money metric of the actual well-being, it is directly comparable with the egalitarian equivalence and it is also related to a special case of conditional equality when individual have enough preference for leisure so as to choose not working. The second method consists in imposing to all individuals the reference value of β_L and ϵ we have used for the conditional equality criterion. These two cardinalizations will make the cardinal criteria more comparable alternatively with the egalitarian equivalence and with the conditional equality criteria.

Regarding the split effort/circumstance: types are defined according to the wage rate. Precisely, we build ten types according to the value of each decile of the distribution function. Effort is measured indirectly by using Roemer's Identification Axiom: people who sit at the same percentile of the utility distribution function of his type have exerted the same effort. Given the value of each decile, we build ten levels of effort. The worst-off are the individuals with the 10% lowest utility at each level of effort. Given our decomposition betwen types and effort, we obtain the same number of worst-off for this criterion and for the other ones.

To implement Van de gaer's criterion, we simply compute the mean utility conditional to the type. The worst-off is the type with the lowest average well-being.

4 Data and Results

4.1 Data

The empirical analysis is based on US data from the Panel Study of Income Dynamics (PSID) for 2005 that provides information on incomes in 2004. It includes detailed information on socio-demographic variables. Given we do not have at our disposal a microsimulation model describing the exact model of tax and transfers the individuals face, we focus on singles without children as the OECD report on income taxes gives detailed information on taxes for this population. As a result, our measures are restricted to this specific sample and the results cannot be generalized to the whole population. In addition, we restrict our sample to people who work at least twenty hours a week [6]. We also restrict our sample to individuals aged between 25 and 65 years old who are not self-employed, retired or fully engaged in education. This gives us a sample of 597 individuals.

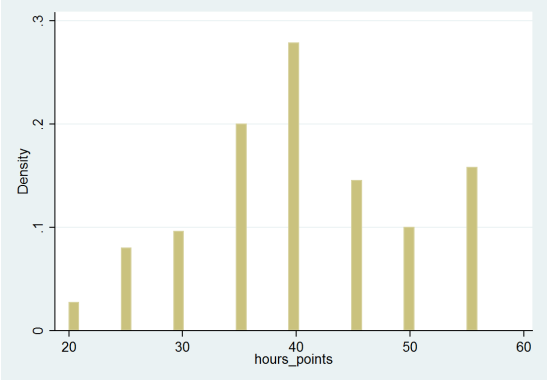
[6] As we have poor information on transfers given to people who do not work, we are not able to well explain the decision of not working. To avoid mis-specification, we exclude this population that represent 8% of the sample

Table 1: Descriptive Statistics

Characteristics	Frequence	mean labor time	mean monthly net income
Education: less than high school	9.73%	40.26	1680.53
Education: high school	37.75%	39.73	2080.68
Education: more than high school	52.52%	40.78	2738.07
White	51.93%	40.31	2581.76
Black	42.71%	40.41	2185.45
Other	5.37%	40.47	2120.07
Women	43.34%	38.70	2307.40
Men	56.66%	41.62	2449.29
Sample	100%	40.36	2387.73

Even though we restrict our sample to individuals who work at least 20 hours, we estimate our model by assuming that individuals can choose freely among twelve alternatives on worked hours [7] . The wage rate is assumed to be constant whatever the number of worked hours, this is in line with Decoster and Haan model [1, 2]. Distribution of working hours is given in Figure 1.

Figure 1: Working hours



To build the budget constraint, we use the 2004 OECD report for the US to derive the net income for each possible working hours. Precisely, we first calculate the gross wage rate by dividing the individual gross labour earnings by the annual working hours. Then, we make discrete the labor time such as to vary between 0 and 55. For each discrete alternative, we compute the corresponding gross total earnings and we use the report on tax income to simulate the corresponding net earnings. For every individual, we fix a maximal amount of time endowment T=80, and leisure is T minus the amount of weekly working hours. Then, in the empirical estimation, leisure is normalized to one

[7] This does not affect in a large extent our estimates since individuals are found to maximize their utility when working between 30 et 55 hours a week

and net income is expressed in units of 10000 dollars per year.

We do not include capital income in the estimation. The gross amount of capital income the individual receives is available but there is no desaggregation by type of capital income and no data on net capital income. As taxes depend on the sources of this income, net capital income cannot be properly computed[8].

Figure 1 indicates the distribution of the sample in terms of education, gender and ethnicity, these characteristics are used to describe who the worst-off are according to each criterion. We also indicate the mean labor time and mean net income.

4.2 Estimation Results

Table 2 presents the estimates of the parameters of the utility function. We find individuals have positive preferences for consumption (α_c is positive and significantly different from zero) and leisure because β_l is found to be positive for every individual. On the other hand, despite the parameters α_c and α_l are not both inferior to one (but significantly different from zero), the utility function is still concave because the value for labor time is never bigger than 11/16.

Regarding the components of β_l, we find that being a women, and having a low education level have a significant positive impact on preference for leisure, which is also found in Decoster and Haan study for Germany.

There is no significant heterogeneity among individuals explained by the other observable characteristics. This may be explained econometrically by the small sample size (597 individuals). Moreover, this may be due to the fact we have restricted our sample to individuals without any children. Within this particular sample, most individuals tend to work full-time, so it is likely that this sample lacks of heterogeneity in preferences. In this context, it appears even more appropriate to correct groups' preferences with our approximation of the differences in epsilon.

In addition, we propose an additional test: we check how much our model fits well with our data in the following sense: our model will be satisfactory if our estimation results display that the individual obtained a maximum value for U_i for his chosen labor time. It would mean that our model explain well individuals' preferences with the socio-demographic variables. To this end, we compute the value for U_{ik} for each labor time and check if $U_{ij} > U_{ik}$, j being the amount of worked hours the individual chose and k the other possibilities. Given we identify groups' preferences and have a discrete choice model, it is unlikely to find a 100% fit. Therefore, we also extend our comparison: if the individual does not maximize U_{ik} for the labor time j, we check if the maximum value for U_{ik} corresponds to a "close" alternative. For instance, if the individual works 40 hours a week, in case U_{ik} is not maximum for $k = 40$, we check if it is maximum for $k = 35$ or $k = 45$.

[8] Capital income would affect the level of the budget constraint and probably the decision of working or not. Therefore, not taking into account capital income should affect the slope of the utility function for low level of working hours. As most individuals of the sample work full time, our estimates should not be affected by the fact we exclude capital income.

Table 2: Parameters of the Utility Function

	Coefficient	z
Preference for Consumption		
β_c	16.21	4.61
α_c	0.017	0.79
Preference for leisure		
β_l :		
Age	-32.22	-0.90
Age squared	37.59	0.87
Women	3.50	3.39
Education (ref: more than high school degree)		
Less than high school	1.85	1.09
High school	2.02	1.92
Ethnicity (ref:white)		
Black	-0.08	-0.09
Other	0.93	0.45
Intercept	41.84	2.62
α_l	1.33	6.45

We find that our estimation results display that the individual obtained a maximum value for his chosen labor time in 1/3 of the sample. More satisfactory is the fact that in 60% of the sample, U_{ik} is maximum for the chosen labor time or the "close" alternative.

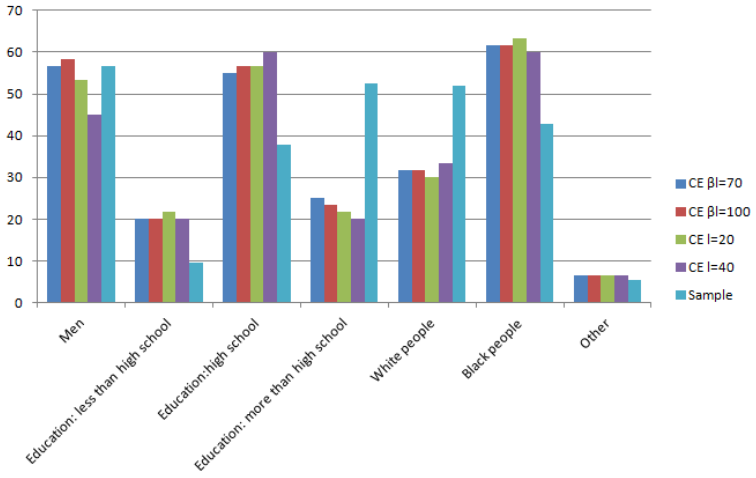
4.3 Who are the worst-off?

Firstly, we fix two different reference values for β_l. The first one is 70, the second one is 300. The mean of β_l among individuals in the sample is around 37, but we decide to take a larger value because ϵ is assumed to be equal to 0. Indeed, with our estimation, we underestimate the quantity of people who maximize their utility for a labor time inferior to 40 hours a week. This means that our value of β_l is underestimated. With the computation of the expected value of the differences in ϵ , we can correct this. In order to take it into account for the computation of the conditional equality criterion, we take a value of β_l that is bigger than the estimated value.

Intuitiveley, when increasing the value of β_l the worst-off should turn to be individuals with higher wage-rate. That is concordant with our results. As we increase the reference value for β_l the results change significatively. If we assume strong preferences for leisure, the worst-off turn to be men, individuals with high education and the white people. Instead, when we took a reference value of 70, the worst-off tend to be people with a rather low educational level (high school or less), the women and the black people.

When we fix an amount of labor time equal to 20 or 40, the results are quite similar with the conditoonal equality criterion when β_l is equal to 70. This is

Figure 2: Conditional equality



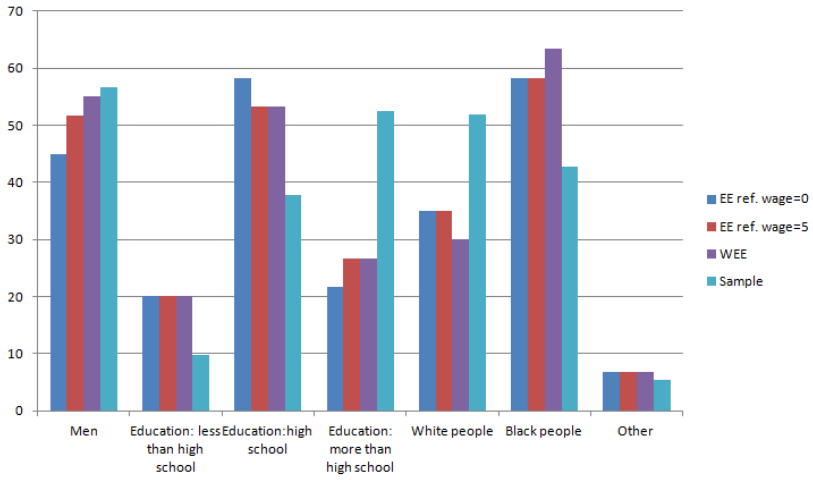
explained by the fact that determining a positive amount of labor time means the individuals do not have very high preference for leisure. If this were the case, they would not choose working half time or more.

Regarding the egalitarian equivalence criteria, results change slightly depending on the reference value for the wage rate. When the reference value is equal to zero, the worst-off tend to be people with high distate for working, so that they need low transfer to be as happy as they would be if they did not work. Here, in comparison with the composition of the sample, the worst-off are composed by more women and people with a degree equal to high school who are those with high preference for leisure.

On the other side, results given by the wage egalitarian equivelence criterion and by the egalitarian equivalence when the reference value for the wage rate is equal to 5 dollars per hour are quite similar. The proportion of men increase slightly as well as the proportion of white people. We could expect bigger differences but given our restricted sample, we fail to obtain significant differences when we vary the reference value.

Regarding Roemer's criterion, the result vary significantly depending on the cardinal measure of well-being we select. When we fix $\beta_l = 70$ and $\epsilon = 0$, we make the results more comparable with the conditional equality criterion. However, the worst-off according to Roemer's criterion are not comparable with the ones identified by the different conditional equality criterion. In comparison with conditional equality, there are more men, individuals with high educational level and more white people among the worst-off using Roemer's criterion. The reason why we obtain more people with high net observed income could be found in the definition of the worst-off. Given they are the people with the lowest outcome at each level of effort, we have automatically some worst-off among people exerting a high level of effort. In consequence, within the group

Figure 3: Egalitarian Equivalence



at the top level of effort, the worst-off have a relatively low outcome but still they have a higher outcome than the individuals exerting a low level of effort given the assumption implied by RIA.

The worst-off according to the min egalitarian equivalence criterion are also different from the worst-off according to Roemer's criterion when the outcome is the min egalitarian equivalence. We can give the same explanation as provided above. This shows that not only the normative choice induced by the cardinalization modifies the identification of the worst-off but also the split between preference/circumstance versus effort/circumstance lead to distinct results.

Figure 4: Roemer's criterion

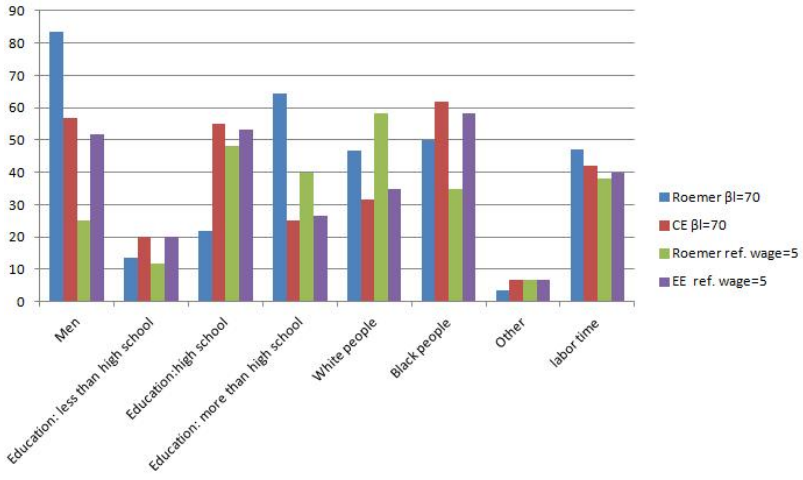
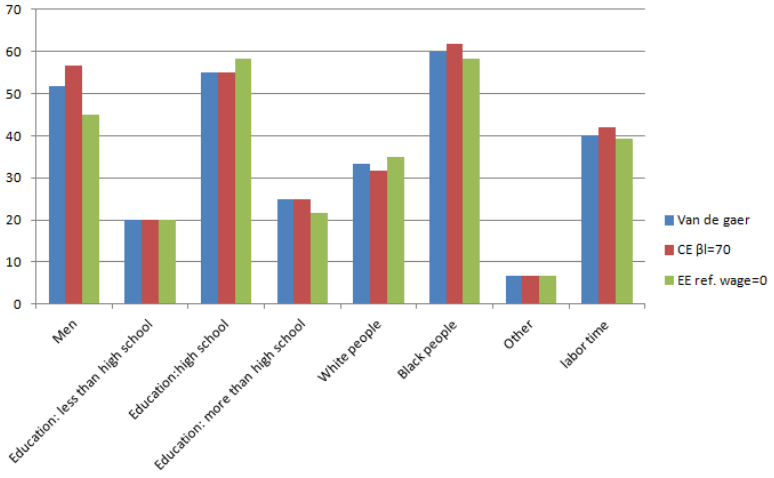


Figure 5: Van de gaer's criterion



When turning to Van de gaer's criterion, we find that the worst-off according to this criterion are the same regardless the cardinalization. In any case, they are the individuals who belong to the type with the lowest wage-rate. The composition of the worst-off are depicted in the Figure 5 and we observe that the composition of the worst-off coincides in a larger extent with the one depicted by the conditional equality, reflecting the theoretical similarity between both criteria. Also, we obtain that if we took the mean observed net income, the individuals with the lowest wage rate would still be the worst-off.

4.4 Differences and Similarities among the criteria

The final question we raise here is the following: Is there any worst-off common to all the criteria? In other words, can we raise an unique conclusion about the persons who suffer more unfairness regardless the criteria of inequality of opportunity and the cardinalization we use?

To this end, we take the four criteria and for each criterion, we take one particular version of it. We compare the zero egalitarian equivalence with the conditional equality when is equal to 70, with Van de gaer's criterion and with Roemer's criterion when the cardinal outcome is obtained by fixing a common preference for leisure equal to 70. In fact, the results do not vary significantly when we change the version of each criterion [9]. Then, we identify the worst-off according to each criterion and we compare how many individuals are common to the four criteria and/or to some of them.

To summarize the results, Figure 6 shows the characteristics of the worst-off across criteria and the Figure 7 displays the percentage of individuals who

[9] robustness checks are available upon request.

Figure 6: Characteristics of the worst-off across criteria

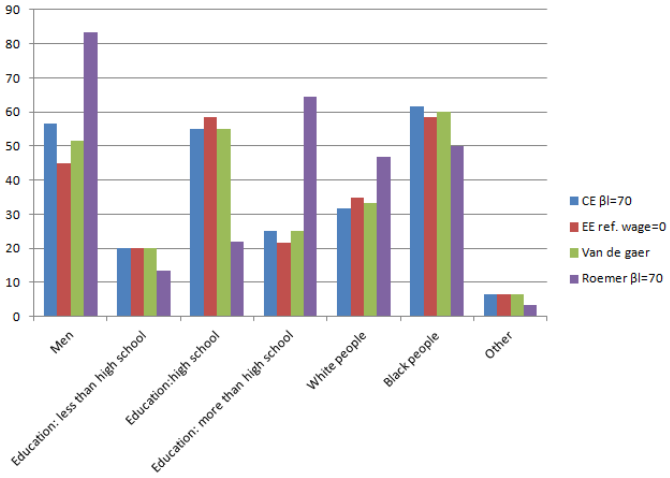
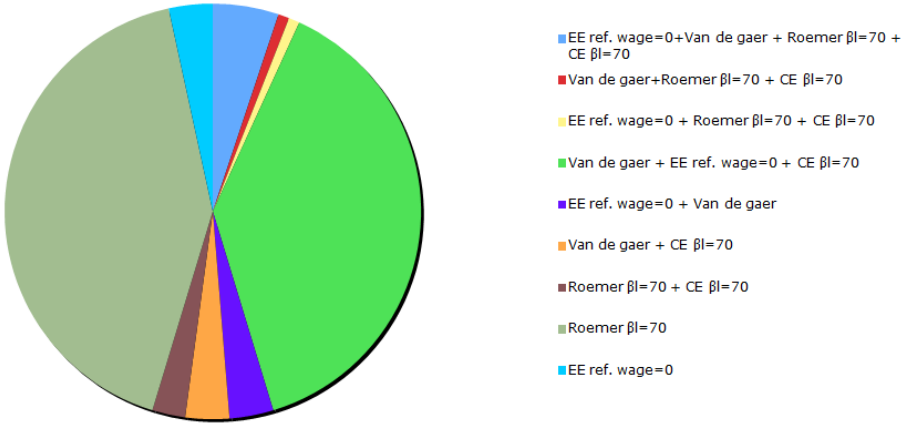


Figure 7: The worst-off according to each criterion



belongs to multiple criteria simultaneously. We obtain that only 10% of the individuals are a worst-off according to all the criteria.

This exercise confirms previous results on the difference between Van de gaer's and Roemers's criteria [32]. Here, the two criteria differ substantially even when we use the same cardinalization. This means that the distribution function of well-being by type crosses so that the individuals with the lowest wage rate are not always the worst-off when we use Roemer's criterion.

Regarding the difference between the two ordinal criteria, most of the worst-

off are common to the conditional equality and egalitarian equivalence criteria. In fact, both criteria qualify unfair inequalities as due to the wage rate. This is why we obtain that the worst-off tend to be the individuals with low wage rate and this explains also why Van de gaer and the ordinal criteria coincide in a large extent. Indeed, the two ordinal criteria rely will exhibit more differences regarding the redistribution policy they recommend because each of them focus on a distinct principle (compensation versus neutrality). Their difference is less obvious when we identify the worst-off.

Nevertheless, this exercise is instructive in order to evidence the impact of the normative choice we make when enabling interpersonal comparisons. Firstly, the fact that only 10% of the individuals are worst-off regardless the criteria show that the hypothesis that allows us to make interpersonal comparisons have a large impact on the identification of the proper target of any redistribution policy aiming at reducing unfairness. Secondly, the fact that the worst-off according to Roemer's criterion are so distinct from the ones identified by the other criteria show how much the definition of equality of opportunity matter. In fact, stating that equality of opportunity consists in erasing inequalities due to factors for which the individual is not responsible is not a precise enough definition. This confirms the difference between the conception ex-post and ex-ante of equality of opportunity.

5 Conclusion

This paper proposes an empirical application of distinct criteria of equity. Our contribution is twofold: Firstly, we define a model that allows us to better approximate individuals' preferences such as to apply the criteria of conditional equality and egalitarian equivalence. Secondly, we propose to compare these criteria with the criterion proposed by Roemer and the one proposed by Van de gaer. In this way, we propose two methods for translating the ordinal model into a cardinal model. Each method derives from the normative choices raised by the criteria of conditional equality and egalitarian equivalence in order to make the comparisons as reliable as possible.

We apply our model to a sample of singles from the PSID data set and identify who are the worst-off according to each criterion. We find that our model makes possible refining groups' preferences to better approximate individuals' preferences. Then, we find that only 10% of the individuals are worst-off regardless of the criterion used.

We conclude (1) our model for identifying individuals' preferences may be improved but still offers a valuable method for better applying the ordinal criteria of equality of opportunity and (2) the discrepancy between the criteria in terms of the worst-off identified shows how important are the normative choices on which rely interpersonal comparisons.

This first application lead to results of limited scope as we restrict our analysis to singles without children. A micro-simulation model would permit to enlarge our conclusions. Nevertheless, our results provide a first insight on the

divergence between the criteria of fairness from an empirical perspective.

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