A DEPRIVATION APPROACH TO INEQUALITY OF OPPORTUNITY: EVIDENCE FROM THE PSID

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Abstract

In line with Roemer's (1993) pragmatic theory (i) a disjoint and exhaustive partition rule is assumed by which individuals within the same population can be grouped depending on the sole circumstances, and (ii) rank-based responsibility orderings are assumed in order to compare individuals within and across subgroups. In this framework I show that the Gini's between-group inequality component (Dagum, 1997) can be additionally decomposed in such a way to measure both opportunity inequality and its contribution to outcome inequality. Given six circumstance variables (gender, health, economic condition of parents in the early years, ethnicity, IQ test-score in the early years and unemployment rate in the place of origin in the early years), opportunity inequality is found between 5.8% and 6.3% of outcome inequality from 1999 to 2007 with gender and health playing the major role among circumstance variables. In addition it is shown that the increasing pattern of outcome inequality from 1999 to 2007 cannot be ascribed to opportunity inequality.

Keywords: *inequality, opportunity, measurement*
JEL: D63, D31

1 Introduction

Within the egalitarian tradition a separating line has to be drawn between egalitarianism of outcomes and egalitarianism of opportunity. By the former, rich-to-poor redistribution is generally socially desirable since, it is said, every individual should be allowed to achieve equal respect, equal social status and equal participation in democratic arenas, and, mostly, preserved from humiliation, exploitation and subordination (Anderson, 1989). By the latter, instead, rich-to-poor redistribution is socially desirable whenever aimed at the compensation of outcome disparities due to circumstances, which, by definition,

can be more or less favorable independently of individual responsible choices. As a result opportunity egalitarianism strongly relies on the identification of circumstances and responsible choices which is not straightforward at all: even effort - the icon of responsible choices for economists - is somehow and partially influenced by circumstances like family education and social environment (Rawls, 1971).

Even if the existing literature on the measurement of outcome inequality is overwhelming, in the last two decades there has been an increasing interest in opportunity inequality (Kranick, 1996; Ok, 1997; Fleurbaey, 2001; Peragine, 2004; Abatemarco, 2010). In addition, following Roemer's idea (Roemer, 1998) by which inequality of opportunity is attained if the distribution of earnings is independent of circumstances, several practical applications have been recently produced in this field (Bourguignon et al., 2007; Ferreira et al., 2008; Lefranc et al., 2008; Checchi et al., 2010).

Given a set of circumstance variables (father and mother's education, father's occupation, race, and region of birth), Bourguignon et al. (2007) suggest to estimate (parametric approach) the contribution of circumstance variables within the income generation process. Then the estimated reduction in earnings inequality which would attain if differences in these circumstance variables were eliminated is interpreted as a measure of opportunity inequality. In this framework circumstances are found to account for between 10% and 37% of the outcome inequality in Brazil. Given a similar set of circumstance variables (gender, race, place of birth, parental education and occupation), Ferreira et al. (2008) and Checchi et al. (2010) measure opportunity inequality in terms of between-group inequality using both the parametrical and the non-parametrical approach. Here counterfactual income distributions are estimated assuming null within/between-group inequality and the mean log deviation index is preferred because of the path-independency of the decomposition procedure (Foster et al., 2000). As a result circumstances are found to account for between 35% and 50% of the outcome inequality in Latin America (Ferreira et al., 2008) and between 20% and 40% of the outcome inequality in Europe (Checchi et al., 2010). Lefranc et al. (2008) use the Gini-opportunity index in order to capture welfare improvements (abbreviated social welfare function) due to improvements in the set of circumstances. Given the partition of the population with respect to parental education, it is shown that US and Italy are the most unequal Western countries both in terms of outcome and opportunity.

The contribute of this paper intends to be both methodological and empirical. From a methodological point of view a deprivation approach is proposed for the measurement of opportunity inequality within Roemer's pragmatic theory (Roemer, 1993). By the latter theory (i) a disjoint and exhaustive partition rule is assumed to exist by which individuals within the same population can be grouped depending on the sole circumstances, and (ii) rank-based responsibility orderings are assumed in order to compare individuals within and across subgroups. On the one hand, in line with the existing literature, the

pragmatic theory implies a complete rank-based responsibility ordering among members of the same subgroup and, as a result, the legitimacy of pairwise income gaps among individuals sharing equal circumstances. On the other hand, in contrast with the existing literature, the pragmatic theory also assumes a rank-based responsibility ordering among members of different subgroups by which between-group income disparities are not necessarily illegitimate. In a sense Roemer's pragmatic theory places more stringent and risky assumptions on responsibility orderings which may seriously affect empirical evidences on inequality of opportunity.

Given Roemer's pragmatic theory I show that the Gini's between-group inequality component from Dagum's decomposition (Dagum, 1997) can be additionally decomposed in such a way to measure both opportunity inequality and its contribution to outcome inequality. This approach extends previous findings in Abatemarco (2010) where Dagum's between-group inequality component is shown to be non-increasing with respect to non re-ranking rich-to-poor transfers that are not increasing any of the income gaps among *non-responsibility comparable* income units (opportunity fair transfers).

From an empirical point of view, US income distributions are compared over time from 1999 to 2007 in terms of both opportunity inequality and its contribution to outcome inequality. Compatibly with the PSID resources, 64 subgroups are defined as a result of the combination of six binary circumstances: male/female, perfect/non-perfect health status, well-off/non-well-off economic situations of parents in the early years, propitious/non-propitious ethnicity, high/low IQ test in the early years, and high/low unemployment rate in the place of origin in the early years. Given such a partition of the population, the sole income units observed (i) in 1999 (resp. 2003, 2005, 2007) and (ii) in the early years (IQ word-test in the 1968 or 1972) are considered. Within this framework opportunity inequality accounts for between 5.8% and 6.3% of outcome inequality. In addition gender and health status are found to be the major sources of opportunity inequality for all waves.

The paper is organized as follows. In section 2 opportunity inequality is defined and the methodology for opportunity inequality comparisons outlined. The dataset and the results from the empirical computation are discussed in section 3. Section 4 concludes.

2 Inequality of opportunity

In contrast with inequality of outcomes, the measurement of opportunity inequality strongly relies on the definition of responsibility orderings. Basically in the case of outcomes inequality any non re-ranking rich-to-poor transfer is equity improving, but this is not enough for social justice in terms of opportunity inequality. Within the latter approach, in order to be equity improving, a

non re-ranking rich-to-poor transfer is additionally required to be *opportunity fair*, that is, it shouldn't be increasing any of the pairwise income gaps that cannot be legitimated invoking responsible choices. In this sense responsibility orderings represent the starting-gate for opportunity egalitarianism.

2.1 Responsibility ordering

In the existing literature a pragmatical approach to responsibility orderings is proposed by Roemer (1993). Here (i) a disjoint and exhaustive partition rule is assumed by which individuals within the same population can be grouped depending on the sole circumstances, and (ii) rank-based responsibility orderings are assumed in order to compare individuals within and across subgroups. In this context the income gap among two members of different subgroups is *opportunity unfair* whenever individuals are equally ranked in the respective subgroups, ie. the income gap is unequivocally determined by circumstances. Differently, income gaps among members of the same subgroup are *opportunity fair* since individuals within the same subgroup share the same circumstances but different responsibility, ie. the income gap is unequivocally determined by responsible choices.

Let $\Theta := \{\theta_1, ..., \theta_\varrho\}$ be the finite set of possible circumstances. Given the increasingly ordered subgroup income vector $\bar{x}_\gamma = \{x_{1\gamma}, ..., x_{n_\gamma,\gamma}\} \in \Re_+^{n_\gamma} \backslash \{0^{n_\gamma}\}$ with $\gamma \in [1, \varrho]$, the income distribution for the entire population can be rewritten as $\mathbf{x} := \{\bar{x}_1, ..., \bar{x}_\varrho\}$. Also, given a monotone transformation $\phi(\cdot)$ and the γth subgroup cumulative frequency distribution $F_\gamma(\cdot)$, let $e_{i\gamma} = \phi[F_\gamma(x_{i\gamma})] \in \Xi \subseteq \Re_+$ be a scalar variable indicating the ith responsibility type in subgroup γ. Within Roemer's pragmatic theory, $e_{i\gamma} \gtreqless e_{j\kappa} \Leftrightarrow F_\gamma(x_{i\gamma}) \gtreqless F_\kappa(x_{j\kappa})$, so that, if $e_{i\gamma} < e_{j\kappa}$, then the jth individual in subgroup κ is more *deserving* than the ith individual in subgroup γ. Also, given the γth increasingly ordered subgroup income vector, it must be the case that $e_{1\gamma} < e_{2\gamma} < ... < e_{n_\gamma\gamma}$.

In the presence of equally sized subgroups this framework is particularly convenient for the measurement of opportunity inequality. Indeed, given two increasingly ordered subgroup income vectors $x := \{x_1, ..., x_n\}$ and $y := \{y_1, ..., y_n\}$, since $e(x_i) = e(y_i)\ \forall\, i$, the income gaps $|x_i - y_i|\ \forall\ i$ fully reveal the contribution of heterogeneous circumstances within the income generation process at every responsibility level. However, as observed in Abatemarco (2010), in the presence of non equally sized subgroups the responsibility ordering above is no longer fully revealing about the impact of heterogeneous circumstances at every responsibility level. Then a generalization of Roemer's *complete* responsibility ordering may be preferred by which the original $e_{i\gamma} = \phi[F_\gamma(x_{i\gamma})]$ is replaced by $\phi[F_\gamma(x_{i-1,\gamma})] < e_{i\gamma} \leq \phi[F_\gamma(x_{i\gamma})]$ where $\phi(\cdot)$ is once again a monotone function. As a result, a partial responsibility ordering is obtained by which (a) if $F_\gamma(x_{i-1,\gamma}) \geq F_\kappa(x_{j\kappa})$ then $e_{i\gamma} > e_{j\kappa}$, (b) if $F_\gamma(x_{i\gamma}) \leq F_\kappa(x_{j-1,\kappa})$ then $e_{i\gamma} < e_{j\kappa}$, and (c) the income units are non-responsibility comparable oth-

erwise. For instance, given two increasingly ordered subgroup income vectors, $x := \{x_1, x_2\}$ and $y := \{y_1, y_2, y_3\}$, then $e(x_2) > e(x_1)$, $e(y_3) > e(y_2) > e(y_1)$, $e(y_3) > e(x_1)$ and $e(x_2) > e(y_1)$, while the couples (x_1, y_1), (x_1, y_2), (x_2, y_2) and (x_2, y_3) identify the set of non-responsibility comparable income units, i.e., the income gaps that cannot be legitimated invoking responsible choices. [1]

Evidently this generalization automatically implies consistent responsibility orderings: the complete responsibility orderings obtained under the assumption $e_{i\gamma} = \phi[F_\gamma(x_{i\gamma})]$ cannot contradict the partial responsibility orderings obtained from this generalization.

2.2 Inequality of opportunity

Given the partial responsibility ordering above, the definition of opportunity inequality strongly relies on the identification of opportunity fair/unfair outcome inequalities. In order to define opportunity fairness two different ethical value judgements are usually considered: the *principle of compensation* and the *principle of reward*. By the former outcome inequalities due to differences in circumstances are inequitable and so compensation deserving. By the latter outcome inequalities due to responsible choices are equitable and not compensation deserving. By virtue of the two principles above some individuals may be entitled to compensation/reward and some others asked to compensate/reward. Unfortunately, the two principles above do not automatically generate a compensation/reward scheme for all income units since income disparities cannot be generally ascribed to the sole circumstances or responsible choices. In this sense the basic ethical value judgements do not allow for an exhaustive identification of opportunity fair/unfair outcome disparities and, as a result, different approaches to the measurement of opportunity inequality may be proposed consistently with the two principles above. [2]

Here a deprivation approach to opportunity inequality is proposed. Following Runciman (1966), an individual is relatively deprived of income x when (i) she does not have income x, (ii) she sees some other person or persons having income x, (iii) she wants income x, and (iv) she sees it as feasible that she should have income x. Basically in the field of opportunity egalitarianism it is the latter condition (iv) that really matters. Here I assume that *she sees it as feasible that she should have income* x *if and only if the corresponding income gap cannot be legitimated invoking responsible choices*. As a result, given the partial responsibility ordering above, pairwise income gaps are opportunity fair if (i) the income units belong to the same subgroup, or (ii) the income

[1] Obviously in the presence of equally sized subgroups the set of equally responsible income units (original definition) necessarily coincides with the set of non-comparable income units (generalized definition).

[2] On the different approaches to inequality of opportunity see Fleurbaey (2001).

units belong to different subgroups with the richer income unit being the more deserving one. On the contrary, pairwise income gaps are unfair if (iii) the income units belong to different subgroups and they are non-responsibility comparable, or (iv) the income units are responsibility comparable across subgroups with the richer income unit being the less deserving one.[3] Recalling the example above, given the increasingly ordered subgroup income vectors $x := \{x_1, x_2\}$ and $y := \{y_1, y_2, y_3\}$ with $x_1 > y_3$ and $x_2 > y_1$, (i) $|y_3 - y_2|$, $|y_3 - y_1|$, $|y_2 - y_1|$, $|x_2 - x_1|$ are opportunity fair within-group income gaps, (ii) $|x_2 - y_1|$ is the opportunity fair between-group income gap, (iii) $|x_1 - y_1|$, $|x_1 - y_2|$, $|x_2 - y_2|$, $|x_2 - y_3|$ are the opportunity unfair income gaps among non responsibility comparable income units, and (iv) $|x_1 - y_3|$ is the opportunity unfair between-group income gap.

2.3 The measurement of opportunity inequality

Given the definition of opportunity inequality, any non re-ranking transfer (rich-to-poor or poor-to-rich) is opportunity fair whenever it does not increase any of the opportunity unfair income gaps. Then the Pigou-Dalton principle of transfer can be reformulated for opportunity egalitarianism as follows.

Axiom 2.1 (Opportunity fair Pigou-Dalton principle of transfer) *Given a generic opportunity inequality index $I(\cdot)$, let $\mathbf{x^A} := \{\bar{x}_1^A, ..., \bar{x}_\varrho^A\}$ be the income distribution of population A partitioned with respect to circumstances $\Theta := \{\theta_1, ..., \theta_\varrho\}$, if $\mathbf{x^B} := \{\bar{x}_1^B, ..., \bar{x}_\varrho^B\}$ is obtained from population A through a non re-ranking (i) rich-to-poor and (ii) opportunity fair transfer, then $I(\mathbf{x^A}) \geq I(\mathbf{x^B})$.*

Following Abatemarco (2010) it can be shown that between-group inequality indices comparing subgroup average incomes (generalized entropy measures and three-components Gini's decomposition) or subgroup equally distributed equivalent incomes (welfaristic inequality measures) do not satisfy axiom (2.1).[4] On the contrary, deprivation based inequality measures are definitely more convenient in this framework. More specifically, given the responsibility ordering above and the opportunity fair principle of transfer, the between-group inequality component from Dagum's decomposition of the Gini index (Dagum, 1997) can be additionally decomposed in such a way to satisfy

[3] Alternatively, given a desirability ordering among the possible sets of circumstances, one may assume that she sees it as feasible that she should have income x if and only if the income disparity can be legitimated invoking heterogeneous circumstances.

[4] In Abatemarco (2010) opportunity unfair income gaps are restricted to the sole income disparities among non-responsibility comparable income units, but the same argumentations apply here.

axiom (2.1) by construction.

Given the set of circumstances $\Theta := \{\theta_1, ..., \theta_\varrho\}$, let G^W and G^B be the within- and between-group inequality components as obtained from Dagum's decomposition

$$\begin{aligned} G^W &= \sum_{\kappa=1}^{\varrho} \frac{n_\kappa^2 \mu_\kappa}{n^2 \mu} G_\kappa \\ G^B &= \frac{1}{2n^2\mu} \sum_{\kappa=1}^{\varrho} \sum_{\gamma=1}^{\varrho} \sum_{i=1}^{n_\kappa} \sum_{j=1}^{n_\gamma} |x_{i\gamma} - x_{j\kappa}| \ \forall \ \kappa \neq \gamma \end{aligned} \tag{1}$$

where $x_{i\gamma}$, μ and n indicate, respectively, the income of the ith income unit in the γth subgroup, average income and the size of the population. Let's now consider the following partition of the pairwise income gaps in G^B [5]

$$g_{ij\kappa\gamma}^{NC} = \begin{cases} |x_{i\kappa} - x_{j\gamma}| & if \quad e_{i\kappa} \| e_{j\gamma}, \\ 0 & otherwise \end{cases}$$

$$g_{ij\kappa\gamma}^{OF} = \begin{cases} |x_{i\kappa} - x_{j\gamma}| & if \quad (e_{i\kappa} > e_{j\gamma},\, x_{i\kappa} > x_{j\gamma}) \, or \, (e_{i\kappa} < e_{j\gamma},\, x_{i\kappa} < x_{j\gamma}) \\ 0 & otherwise \end{cases}$$

$$g_{ij\kappa\gamma}^{OU} = \begin{cases} |x_{i\kappa} - x_{j\gamma}| & if \quad (e_{i\kappa} > e_{j\gamma},\, x_{i\kappa} < x_{j\gamma}) \, or \, (e_{i\kappa} < e_{j\gamma},\, x_{i\kappa} > x_{j\gamma}) \\ 0 & otherwise \end{cases}$$

These three groups identify the pairwise income gaps among, respectively, non-responsibility comparable income units, responsibility comparable income units with opportunity fair income gaps, and responsibility comparable income units with opportunity unfair income gaps. Then G^B can be additionally decomposed as $G^B = G_{NC}^B + G_{OF}^B + G_{OU}^B$ where

$$G_{NC}^B = \frac{1}{2n^2\mu} \sum_{\kappa=1}^{\varrho} \sum_{\gamma=1}^{\varrho} \sum_{i=1}^{n_\kappa} \sum_{j=1}^{n_\gamma} g_{ij\kappa\gamma}^{NC} \ \forall \ \kappa \neq \gamma \tag{2}$$

$$G_{OF}^B = \frac{1}{2n^2\mu} \sum_{\kappa=1}^{\varrho} \sum_{\gamma=1}^{\varrho} \sum_{i=1}^{n_\kappa} \sum_{j=1}^{n_\gamma} g_{ij\kappa\gamma}^{OF} \ \forall \ \kappa \neq \gamma \tag{3}$$

$$G_{OU}^B = \frac{1}{2n^2\mu} \sum_{\kappa=1}^{\varrho} \sum_{\gamma=1}^{\varrho} \sum_{i=1}^{n_\kappa} \sum_{j=1}^{n_\gamma} g_{ij\kappa\gamma}^{OU} \ \forall \ \kappa \neq \gamma \tag{4}$$

As a result, compatibly with the responsibility ordering above, the Gini index can be decomposed as follows

$$G = (G^W + G_{OF}^B) + (G_{NC}^B + G_{OU}^B) \tag{5}$$

with the last term in brackets, $G_{EO} = G_{NC}^B + G_{OU}^B$, measuring opportunity inequality and $G_{EO}^c = \frac{G_{EO}}{G}$ measuring the contribution of opportunity inequality to outcome inequality.

[5] The symbol $\|$ indicates non-comparability.

Evidently G_{EO} is non-increasing with respect to non re-ranking rich-to-poor opportunity fair transfers. In addition it is (i) scale invariant, (ii) partially symmetric (Cowell, 1980), (iii) replication invariant, and (iv) $G_{EO} \in [0, 1[$. More specifically, in the presence of equally sized subgroups $G_{EO} = 0$ if and only if (i) $x_{i\gamma} = x_{i\kappa} \, \forall \, i, \gamma, \kappa$, or, (ii) income is equally distributed across the whole population. In the case of non-equally sized subgroups $G_{EO} = 0$ if and only if (i) any subgroup is some k-fold replication of the others, or (ii) income is equally distributed across the whole population. $G_{EO} \to 1$ if (i) $\varrho \to +\infty$ and the income ordering for the entire population can be replicated joining non-intersecting subgroup income orderings, ie. $x_{1\gamma} < x_{2\gamma} < ... < x_{n_\gamma \gamma} < x_{1\kappa} < x_{2\kappa} < ... < x_{n_\kappa \kappa} < ...$, or (ii) $n \to +\infty$ and there exists one income unit sized subgroup holding the whole income. [6]

3 An application to the PSID

3.1 Data

The PSID [7] is used in order to compare US income distributions over time in terms of opportunity inequality. This database has been preferred due to the available information on "typical" circumstance variables and the number of records. From a methodological point of view, the former aspect is crucial since, if a relevant circumstance variable is omitted within Roemer's framework, then some of the unfair income gaps are automatically neglected and opportunity inequality underestimated. From a practical point of view, the latter aspect is crucial as well: in the absence of a sufficient number of observations, additional assumptions are required in order to estimate parametrically the counterfactual income distributions (Ferreira et al., 2008).

Four waves are considered from 1999 to 2007 (1999, 2003, 2005, 2007). Prior waves are not considered due to missing or partial information on ethnicity. In addition the 2001 wave hasn't been considered because of missing information on taxable income. [8] Disposable income is defined as the total income

[6] It is worth observing that if $G^B_{OU} \neq 0$, then it must be the case that $G^B_{OF} \neq 0$ as well (not vice versa). This is an arguable implication of the rank-based responsibility ordering in Roemer's pragmatic theory.

[7] Panel Study of Income Dynamics, public use dataset. Produced and distributed by the Institute for Social Research, Survey Research Center, University of Michigan, Ann Arbor, MI (2009).

[8] Income data in the 1999, 2003, 2005 and the 2007 wave refer respectively to the 1998, 2002, 2004 and 2006 chronological year.

(transfer income included) minus taxes on taxable income. [9]

In order to capture the impact of opportunity inequality on inequality of outcomes, six circumstances variables are considered: gender, health, economic situations of parents in the early years, ethnicity, IQ score-test in the early years and unemployment rate in the place of origin in the early years. With respect to previous works in this field (Bourguignon et al., 2007; Ferreira et al., 2008; Checchi et al., 2010), two new circumstance variables are introduced: health status and IQ score in the early years. Evidently health status cannot be fully addressed in terms of non responsible choices, but one may agree that the major threats to individuals' health come from genetical transmission and responsible choices of the others. Similarly, cognitive abilities may be regarded as effort variable, but one may agree that the IQ score-test in the early years is mostly determined by social environment and genetical transmission. [10]

Even if the set of circumstance variables is extended with respect to previous works in this field, it is still the case that other relevant variables are omitted (eg. luck). In this sense the results of this work must be still intended as a lower bound estimation of opportunity inequality.

In order to preserve a sufficient number of observations, binary circumstances are defined, even if, except for gender, more than two alternatives are available from the PSID. Evidently the definition of binary variables is an arbitrary choice which is not irrelevant for the empirical application. [11]

The health variable has been used in order to distinguish individuals reporting "excellent", "very good" with respect to the rest of the population answering "good", or "fair", or "poor health". This definition of the binary variable is mostly expected to identify the individuals with no health problems at all. For the economic situation of parents in the early years the population has been partitioned drawing a separating line among individuals reporting "pretty well off" and the rest of the population answering "poor" or "average". This definition is mostly aimed at the identification of true benefits in the in-

[9] In order to account for the Federal Income Tax, brackets and tax rates from 1998 to 2006 have been considered.

[10] The introduction of a proxy for cognitive abilities (IQ test) within the set of circumstance variables is not straightforward from a philosophical point of view since a trade-off may occur between different social and ethical objectives, that is, as observed in Lefranc et al. (2008), the "*above notion of equality of opportunity may contradict other ethical principles such as self-ownership and freedom*".

[11] Mostly the definition of binary variables is expected to reflect the *discriminating power* of each circumstance variable, that is, the shares of the advantaged/disadvantaged income units. If the definition of the binary circumstance variable implies a fifty-fifty chance to be advantaged/disadvantaged then the discriminating power is maximum. On the contrary, the discriminating power is minimum whenever all income units are advantaged or disadvantaged. This aspect is not irrelevant for measurement purposes within the deprivation approach because the number of between-group pairwise income gaps is automatically increasing with the discriminating power.

come generation process due to family origins. With respect to ethnicity a separating line is drawn between income units reporting "American" or "national origin" (e.g., French, German) or "religious" (e.g., Jewish, Catholic) and the others reporting "hyphenated American" or "nonspecific Hispanic identify" or "racial" or "other".[12] For the IQ-test records, scores available for existing individuals in the 1968 and/or the 1972 wave (available for two years only from the PSID) are used. The IQ test-score is assumed to be low whenever (i) the individual has been interviewed in both waves obtaining a score that is below the median score in both waves, or (ii) the individual has been interviewed in one of the two waves only positioning below the median score.[13] Finally the unemployment rate in the place of origin in the early years is assumed to be low under 5.9%, and viceversa (available ranges are "under 2%", "2 - 3.9%", "4 - 5.9%", "6 - 10%", "over 10%").

Compatibly with the PSID resources, 64 subgroups are generated as a result of the combination of six binary circumstances: gender (male $[M]$, female $[F]$), health (perfect $[H]$, non-perfect $[\bar{H}]$), economic situation of parents in the early years (pretty well off $[W]$, non-pretty well off $[\bar{W}]$), ethnicity (propitious $[E]$, non-propitious $[\bar{E}]$), IQ score (high $[I]$, low $[\bar{I}]$), and unemployment rate in the place of origin in the early years (low $[U]$, high $[\bar{U}]$).[14] Since most of the required information are not available for non-head income units, the analysis has been restricted to the sole head income units, respectively, in the 1999, 2003, 2005 and 2007 wave.[15] In order to drop outliers, income units belonging to the first and to the latter centile of the population have been dropped. In addition subgroups with less than three observations are disregarded. Missing

[12] This partition is supported by empirical evidences on average disposable incomes for each group. For instance in the 1999 wave the average disposable incomes for "American", "national origin" and "religious" are respectively 27.796 USD, 28.265 USD and 30.811 USD. Differently, average disposable incomes for "hyphenated American", "nonspecific Hispanic identify", "racial" and "other" are respectively 19.457 USD, 21.248 USD, 22.907 USD and 18.417 USD.

[13] For the 1968 wave the PSID database report information on Ammons' Quick Test (Mednick, 1965). For the 1972 wave, instead, a standard IQ word-test has been used.

[14] In order to define each of the subgroups both the PSID family and the PSID individual data files have been used. Specifically, longitudinal sample weights have been extracted from the individual data files from the 1999 to the 2007 wave respectively. Income information, gender, health status, ethnicity and economic conditions of parents in the early years have been extracted from the family data file for 1999, 2003, 2005 and 2007 respectively. IQ-test records and the unemployment rate in the place of origin in the early years are obtained from the family data file for the 1968 and the 1972 wave. The latter variables have been associated to the corresponding income units from the 1999 to the 2007 wave using control variables (family identifier, person number and age of individual).

[15] In addition available IQ scores mostly refers to head income units since, even if the result is assigned to each member of the family, the head income unit was expected to administer the test both in the 1968 and in the 1972.

income values are replaced with zeros or average values depending on the nature of each variable. [16] As a result, the population consists of 3392 records in the 1999, 3233 records in the 2003, 3149 records in the 2005 and 2991 records in the 2007. Empty or non statistically significant subgroups are 17 in the 1999, one in the 2003 and zero in the 2005 and 2007 waves (Tab. A.1). [17]

Since the sole head income units born before 1972 were considered, the population consists of individuals aged, on average, between 49 (1999 wave) and 55 (2007 wave) years old. The average disposable income is found between 27.542 USD in the 1999 wave and 34.422 USD in the 2007 with an average increase of 7.74% every two years. With respect to each single circumstance variable, the population consists of 61-62% male, 48-51% perfect health, 3-23% well-off economic conditions of parents, [18] 47-50% propitious ethnicity, 56-58% high IQ-scores, and 66-67% low unemployment rate. Finally, if subgroups are grouped depending on the number of "*favorable*" circumstances (Tab. A.2), then the increase of disposable income due to a marginal improvement in the number of favorable circumstances is found, on average, between 4.208 USD and 5.545 USD (13-19% of disposable income).

3.2 Results

When considering the whole population, the US Gini for the distribution of disposable incomes is usually found between 0.36 and 0.38 from the 1998 to 2004 (Gottschalk et al., 2000; Heathcote et al., 2009). Given the distribution of disposable incomes for (i) head income units (ii) aged, on average, between 49 (1999 wave) and 55 (2007 wave) years old, the Gini index is found, respectively, 0.412 in the 1999, 0.419 in the 2003, 0.421 in the 2005 and 0.424 in the 2007. This is consistent with previous findings in Heathcote et al. (2009),

[16] Zero values have been replaced for rental income, dividends, trust funds, interest and property tax (104-113 substitutions in each wave). Average values are used for health status, unemployment rate, and economic conditions of parents (19-24 substitutions in each wave). Finally "other" has been assigned to non-respondents with respect to ethnicity (12-21 substitutions in each wave).

[17] It is worth observing that income units observed in one wave are not necessarily respondents in the other waves. In particular both ethnicity and economic conditions of parents for 1999 (and 2001) have not been brought forward for same heads and wives. In addition a new codification of ethnicity responses has been introduced in 2001. These changes are likely to be the main sources of the abrupt change in the subgroup composition when comparing the 1999 wave with the others.

[18] The very large range with respect to the economic conditions of parents is due to the 1999 wave. The shares from 1999 to 2007 are respectively 3%, 23%, 24%, and 15%.

where inequality is found sensibly larger in the population of singles [19] (income pooling within married households reduces inequality) and increasing with the age of the sample (early retirements and the experience wage premium usually increase inequality).

	1999	**2003**	**2005**	**2007**
G	0.412	0.419	0.421	0.424
G^W	0.020	0.012	0.012	0.015
G^B	0.392	0.407	0.409	0.409
G^B_{OF}	0.367	0.381	0.384	0.384
G^B_{NC}	0.007	0.008	0.008	0.008
G^B_{OU}	0.017	0.018	0.017	0.016
G_{EO}	**0.025**	**0.027**	**0.025**	**0.025**
G^c_{EO}	**6.0%**	**6.3%**	**6.0%**	**5.8%**

Tab.1. Gini's decomposition from (5). Source: author's computation on PSID data.

Outcome inequality is found increasing over time from 1999 to 2007, but this is not the case of opportunity inequality. The latter is 0.025 in the 1999, 0.027 in the 2003, 0.025 in the 2005 and 0.025 in the 2007, corresponding to a contribution to outcome inequality of 6.0% in the 1999, 6.3% in the 2003, 6.0% in the 2005 and 5.8% in the 2007 (Tab.1). The latter results automatically imply that the 5.8-6.3% of the overall pairwise income disparities cannot be legitimated invoking responsible choices. Due to methodological differences (deprivation approach), this result is sensibly lower than previous empirical findings for Brazil (10-37%), Latin America (35-50%) and Europe (20-40%).

The incidence of each single circumstance variable on overall inequality of opportunity is reported in Tab.2. The latter value is defined as the G_{EO} reduction due to the suppression of each single circumstance variable from the original set of circumstances. [20] For all waves gender and health status represent the most relevant sources of opportunity inequality (respectively 2.1-2.4 and 2.2-2.5 percentage points), but these results may be driven by the age profile of the population (pre-1972 cohorts). In addition, as it may be expected, the incidence of the health status is found increasing over time due to the years passing by for the population. The economic conditions of parents in the early years and the unemployment rate in the place of origin in the early years are found the less relevant circumstance variables for all waves (0.9-1.4%). In addition the two latter variables are dominated by the IQ-score in the early years (1.3-1.7%) for all waves. Finally the joint contribution of

[19] Evidently the population of singles is not the same as the population of head income units, but the latter definitely accentuates the share of singles.

[20] It is worth observing that this procedure does not allow for a path-independent decomposition of G_{EO} since the contribution of each circumstance depends on the other circumstance variables.

	1999					
	Gender	**Health**	**Parents**	**Ethnic.**	**IQ score**	**Unemp.**
G_{EO}	0.016	0.016	0.021	0.019	0.019	0.021
G^c_{EO}	3.9%	3.8%	5.1%	4.7%	4.5%	5.1%
Contrib.	**2.1%**	**2.2%**	**0.9%**	**1.3%**	**1.5%**	**0.9%**
	2003					
	Gender	**Health**	**Parents**	**Ethnicity**	**IQ score**	**Unemp.**
G_{EO}	0.017	0.017	0.021	0.021	0.021	0.021
G^c_{EO}	4.0%	4.0%	5.1%	5.0%	5.0%	5.0%
Contrib.	**2.3%**	**2.3%**	**1.3%**	**1.3%**	**1.4%**	**1.3%**
	2005					
	Gender	**Health**	**Parents**	**Ethnicity**	**IQ score**	**Unemp.**
G_{EO}	0.017	0.015	0.020	0.020	0.020	0.020
G^c_{EO}	3.9%	3.5%	4.7%	4.8%	4.7%	4.8%
Contrib.	**2.1%**	**2.4%**	**1.2%**	**1.2%**	**1.3%**	**1.2%**
	2007					
	Gender	**Health**	**Parents**	**Ethnicity**	**IQ score**	**Unemp.**
G_{EO}	0.014	0.015	0.020	0.019	0.018	0.020
G^c_{EO}	3.4%	3.5%	4.6%	4.5%	4.3%	4.6%
Contrib.	**2.4%**	**2.5%**	**1.4%**	**1.5%**	**1.7%**	**1.4%**

Tab.2. Contribution of each circumstance variable to inequality of opportunity. Each column refers to the partition of the population obtained dropping one single circumstance variable from the original set. For each partition rule three values are indicated for each wave: the opportunity inequality index, the contribution of opportunity inequality to outcome inequality and the reduction of the latter with respect to the original partition. Source: author's computation on PSID data.

health status and IQ-score is found between 3.2% and 3.5%.[21] This result highlight the impact of the two new circumstance variables introduced in this paper with respect to the existing literature.

4 Concluding remarks

In this paper, given the responsibility orderings derived from Roemer's pragmatic theory, a deprivation approach to the measurement of opportunity inequality is proposed. Within this approach it is shown that the Gini's between-group inequality component can be additionally decomposed in order to measure opportunity inequality and its contribution to outcome inequality. Given six binary circumstances (gender, health, economic situation of parents in the early years, ethnicity, IQ-score in the early years, and unemployment rate in the place of origin in the early years) and the population of individ-

[21] By construction, the reduction of G^c_{EO} due to suppressing two circumstance variables simultaneously must be larger than the aggregation of the two effects on G^c_{EO} taken singularly.

uals born before 1972, the contribution of opportunity inequality to outcome inequality is found between 5.8% and 6.3%. In addition, even if outcome inequality is found increasing over time (from 1999 to 2007), empirical evidences suggest that such an increase cannot be explained in terms of opportunity inequality. Finally gender and health status are indicated as the major sources of opportunity inequality, while the economic conditions of parents in the early years seems to be the least relevant circumstance variable.

Tab. A.1: Subgroups composition and average disposable incomes.

		1999		**2003**		**2005**		**2007**	
ID	Subgroup	(%)	μ(USD)	(%)	μ(USD)	(%)	μ(USD)	(%)	μ(USD)
1	MHWEIU	-	-	0.034	42161	0.031	43066	0.016	45384
2	FHWEIU	-	-	0.011	39480	0.010	35146	0.007	35316
3	M$\bar{H}$WEIU	-	-	0.018	26567	0.022	33735	0.007	31431
4	MH$\bar{W}$EIU	0.113	37684	0.075	39167	0.074	40279	0.093	46749
5	MHW$\bar{E}$IU	0.001	41372	0.022	46208	0.021	45623	0.010	54960
6	MHWE$\bar{I}$U	-	-	0.009	42427	0.010	42768	0.008	40599
7	MHWEI$\bar{U}$	0.002	29671	0.030	50785	0.025	52244	0.009	58356
8	F$\bar{H}$WEIU	0.003	23729	0.008	19977	0.008	25254	0.009	30935
9	FH$\bar{W}$EIU	0.046	28180	0.038	26593	0.032	26479	0.038	29822
10	FHW$\bar{E}$IU	0.000	32179	0.004	31103	0.002	47742	0.001	27434
11	FHWE$\bar{I}$U	-	-	-	-	0.002	28554	0.002	33047
12	M$\bar{H}\bar{W}$EIU	0.077	27242	0.057	27499	0.068	25270	0.072	32243
13	M$\bar{H}$W$\bar{E}$IU	0.001	22380	0.010	38969	0.010	45865	0.006	52975
14	M$\bar{H}$WE$\bar{I}$U	-	-	0.004	22376	0.006	36533	0.002	32322
15	MH$\bar{W}\bar{E}$IU	0.060	35959	0.039	34420	0.033	41322	0.043	42139
16	MH$\bar{W}$E$\bar{I}$U	0.040	30475	0.028	33637	0.029	40610	0.032	40616
17	MHW$\bar{E}\bar{I}$U	0.000	14157	0.008	34684	0.009	36954	0.006	33312
18	FHWEI$\bar{U}$	0.002	19205	0.004	23175	0.004	33925	0.004	53033
19	M$\bar{H}$WEI$\bar{U}$	-	-	0.009	42947	0.014	43709	0.006	26977
20	MH$\bar{W}$EI$\bar{U}$	0.078	40824	0.056	40193	0.045	41083	0.066	50385
21	MHW$\bar{E}$I$\bar{U}$	-	-	0.008	34715	0.008	41758	0.007	34931
22	MHWE$\bar{I}\bar{U}$	-	-	0.005	33361	0.005	44918	0.002	22766
23	F$\bar{H}\bar{W}$EIU	0.039	16969	0.035	15059	0.038	20837	0.036	25442
24	F$\bar{H}$W$\bar{E}$IU	0.002	11335	0.008	23465	0.006	18386	0.002	31934
25	F$\bar{H}$WE$\bar{I}$U	0.001	8334	0.004	23030	0.003	13584	0.003	31924
26	FH$\bar{W}\bar{E}$IU	0.020	24780	0.017	28325	0.013	31023	0.012	38179
27	FHW$\bar{E}\bar{I}$U	0.002	12058	0.005	21556	0.002	25002	0.004	23511
28	FH$\bar{W}$E$\bar{I}$U	0.011	15569	0.010	20872	0.008	33254	0.011	28921
29	M$\bar{H}\bar{W}\bar{E}$IU	0.039	26189	0.031	25763	0.033	28119	0.040	39541
30	M$\bar{H}\bar{W}$E$\bar{I}$U	0.027	25750	0.023	27514	0.024	22561	0.026	28799
31	M$\bar{H}$W$\bar{E}\bar{I}$U	-	-	0.009	25677	0.008	31521	0.007	34483
32	MH$\bar{W}\bar{E}\bar{I}$U	0.040	28187	0.028	30665	0.028	33778	0.034	37902
33	F$\bar{H}$WEI$\bar{U}$	-	-	0.002	18493	0.003	16540	0.003	35731
34	FH$\bar{W}$EI$\bar{U}$	0.019	27043	0.018	24116	0.019	31923	0.015	27601
35	FHW$\bar{E}$I$\bar{U}$	-	-	0.002	18706	0.002	23303	0.002	43990
36	FHWE$\bar{I}\bar{U}$	0.001	16370	0.002	23243	0.003	28121	0.002	20441
37	M$\bar{H}\bar{W}$EI$\bar{U}$	0.041	32628	0.030	35220	0.040	33811	0.045	35379
38	M$\bar{H}$W$\bar{E}$I$\bar{U}$	-	-	0.005	32054	0.005	29540	0.004	29894
39	M$\bar{H}$WE$\bar{I}\bar{U}$	-	-	0.003	25937	0.003	23139	0.003	31757
40	MH$\bar{W}\bar{E}$I$\bar{U}$	0.023	37083	0.024	42409	0.023	42960	0.019	42285

		1999		2003		2005		2007	
ID	Subgroup	(%)	μ(USD)	(%)	μ(USD)	(%)	μ(USD)	(%)	μ(USD)
41	MH$\bar{W}$E$\bar{I}\bar{U}$	0.022	32307	0.014	35839	0.014	39442	0.018	44604
42	MHW$\bar{E}\bar{I}\bar{U}$	-	-	0.004	22970	0.002	34548	0.002	34689
43	M$\bar{H}\bar{W}\bar{E}\bar{I}$U	0.036	19306	0.029	22665	0.031	25406	0.030	26890
44	FH$\bar{W}\bar{E}\bar{I}$U	0.020	20238	0.014	23556	0.013	26981	0.014	28464
45	F$\bar{H}$W$\bar{E}\bar{I}$U	0.001	13143	0.005	13890	0.008	18938	0.002	13455
46	F$\bar{H}\bar{W}$E$\bar{I}$U	0.020	12904	0.020	16003	0.022	14977	0.023	15905
47	F$\bar{H}\bar{W}\bar{E}$IU	0.024	17595	0.015	16284	0.018	17729	0.022	18114
48	F$\bar{H}\bar{W}$EI$\bar{U}$	0.024	18469	0.022	20002	0.022	19137	0.024	21124
49	F$\bar{H}$W$\bar{E}$I$\bar{U}$	-	-	0.002	9478	0.002	8223	0.001	9826
50	F$\bar{H}$WE$\bar{I}\bar{U}$	0.001	16748	0.004	19165	0.003	21048	0.001	10581
51	FH$\bar{W}\bar{E}$I$\bar{U}$	0.007	24915	0.004	31689	0.005	22654	0.005	25208
52	FHW$\bar{E}\bar{I}\bar{U}$	0.001	18982	0.002	29272	0.001	37399	0.001	25170
53	FH$\bar{W}$E$\bar{I}\bar{U}$	0.008	20509	0.006	21523	0.005	15721	0.009	19937
54	M$\bar{H}\bar{W}\bar{E}$I$\bar{U}$	0.022	24618	0.011	26509	0.011	34773	0.017	38519
55	M$\bar{H}\bar{W}$E$\bar{I}\bar{U}$	0.018	21572	0.015	22280	0.018	21141	0.019	23099
56	M$\bar{H}$W$\bar{E}\bar{I}\bar{U}$	0.000	31181	0.004	12738	0.006	18403	0.002	12347
57	MH$\bar{W}\bar{E}\bar{I}\bar{U}$	0.019	24462	0.015	26785	0.010	31524	0.015	36608
58	F$\bar{H}\bar{W}\bar{E}\bar{I}$U	0.032	16149	0.030	16274	0.028	18176	0.029	20374
59	M$\bar{H}\bar{W}\bar{E}\bar{I}\bar{U}$	0.017	16540	0.013	22209	0.015	20858	0.015	23234
60	FH$\bar{W}\bar{E}\bar{I}\bar{U}$	0.004	15481	0.004	17306	0.003	16042	0.003	29811
61	F$\bar{H}$W$\bar{E}\bar{I}\bar{U}$	-	-	0.001	12467	0.002	13588	0.001	13378
62	F$\bar{H}\bar{W}$E$\bar{I}\bar{U}$	0.009	12934	0.009	20305	0.014	17571	0.013	15898
63	F$\bar{H}\bar{W}\bar{E}$I$\bar{U}$	0.012	18739	0.012	16513	0.009	16892	0.010	16060
64	F$\bar{H}\bar{W}\bar{E}\bar{I}\bar{U}$	0.012	14900	0.010	13884	0.011	17815	0.009	12116

Tab.A.1. Average disposable incomes and frequencies (%) are reported for each wave and subgroup. Each subgroup is indicated by six letters referring to each circumstance variable. Source: author's computation on PSID data.

Tab. A.2: Groups of subgroups average disposable incomes.

		1999		2003		2005		2007	
Subgroups	No.F.	(%)	μ(USD)	(%)	μ(USD)	(%)	μ(USD)	(%)	μ(USD)
1	6	-	-	0.034	42161	0.031	43066	0.016	45384
2-7	5	0.117	37416	0.166	41090	0.161	41790	0.133	46312
8-22	4	0.307	32835	0.278	32730	0.275	35015	0.295	38882
23-42	3	0.289	26613	0.273	27723	0.276	29954	0.289	34469
43-57	2	0.200	19935	0.169	21126	0.176	22107	0.186	24470
58-63	1	0.075	16214	0.069	17986	0.070	18255	0.071	19890
64	0	0.012	14900	0.010	13884	0.011	17815	0.009	12116

Tab.A.2. Each group of subgroups is characterized by the same number of favorable circumstances (No.F.). Average disposable incomes and frequencies (%) are reported for each group and wave. Source: author's computation on PSID data.

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