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Estimation of "Unfair" Inequality in the US

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Abstract: This paper measures unfair inequality in United States between 1990 and 2009. To do so, a novel empirical method developed by Almås et al. (2011) and the generalized proportionality principle of fairness proposed by Cappelen and Tungodden (2007) are employed to evaluate the fairness of pre-tax and post-tax income distributions in the United States during the last two decades in term of fairness. The empirical method makes a differentiation between fair and unfair inequalities and use generalized versions of the most common inequality measures, the Gini index and the Lorenz curve, to measure the unfair inequality. The results of this study show that both pre-tax and post-tax distributions of labor income became less fair during the period considered. However, during the last decade the level of unfairness remain stable, whereas the standard Gini measuring income inequality increased in the same period.

Keywords:Equality of opportunity · Inequality · Unfair inequality

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Contents

List of Figures

List of Tables

1 Introduction and Research Question

The discussion about what is the fair distribution of income in a society is of major concern among normative and empirical economic researchers in the field of income inequality and redistribution of income. Modern egalitarians represented by political philosophers as Arneson and Cohen and by economists as Fleurbaey and Roemer have questioned the idea that the fair distribution of income is represented by the perfect income equality among individuals (Arneson, 1989; Cohen, 1989; Fleurbaey, 1994; Roemer, 1993). For example, how can we consider inequality arising from a situation where all the people have the same opportunities but then some individuals decide to work more than others and therefore have higher income? Or again, should someone that deliberately underachieves be compensated by a redistribution policy? All these and similar questions are the basis of the recent egalitarian theories that take individual responsibility into account. However, several classical inequality indexes assume implicitly that any deviation from the average income is to be considered unfair as they take the equal income distribution as reference point for measurement (Almås, Cappelen, Lind, Sorensen, & Tungodden, 2011). For instance, the most commonly employed index, the Gini coefficient, is graphically represented by the area between the Lorenz curve and the line of equality that corresponds to the situation in which all individuals receive the same share of the total income (Ruiz-Castillo, 2007).

The basic intuition of the different characterizations of the so-called responsibility-sensitive egalitarianism theories is that redistributive policies should compensate inequalities arising from characteristics of individuals that are to be considered not relevant and preserve inequalities that instead are due to relevant characteristics and choices of the individuals (Arneson, 1989; Cohen, 1989). This principle recognize that earnings determinants can be divided into two parts: responsibility variables within the control of individuals(e.g., working hours, occupational choice, and years of education) that represent the "effort" of the individuals and no-responsibility factors beyond the control of individuals (e.g., race, gender and familiar background) that are "circumstances" for which the the individuals can not be held responsible. Inequality arising from circumstances has to be seen as unfair and should be eliminated as much as possible whereas inequality due to different choices and level of efforts is morally acceptable and should be left untouched. It is obviously difficult to discern in the reality which factors are entirely within the control of the individuals and which are not. In general in fact, many responsible factors are indeed affected by no responsibility characteristics. For example decisions regarding the years of education can be influenced by family

background characteristics as parental years of education, and constrained by financial possibilities of the individuals. However, it is clear that some characteristics (education, county of residence) are to an higher extend under the control of individuals than others (race, gender).

Related empirical studies, thus, have developed empirical methods to make a distinction of the inequality arising from responsibility characteristics and the inequality due to no responsible characteristics and to evaluate the redistribution policies according to the concept of fairness or inequality of opportunity. The objective of the present research is to apply one of the most novel method developed by Almås et al. (2011) to estimate the trend of unfair inequality for the distribution of labor income in the US in the last 20 years and compare it with the pattern of inequality measured in the traditional way. The main characteristic of this approach is to use a definition of fair income developed by the normative economic literature and measure to what extent the actual income distribution differs from his counterfactual fair income distribution.

Several empirical studies estimate an increasing labor income inequality in the U.S. since the 80s (see for instance, Pistolesi, 2009; Atkinson, Piketty & Saez, 2011; Autor, Katz & Kearney, 2008). Furthermore, there seems to be an increasing concern about other dimensions of inequality at a political level. For example, the importance of studying the connection between income inequality and intergenerational income mobility has been recognized at a political level by the chairman of the Council of Economic Advisers Alan Krueger. He coined the expression "The great Gatsby curve" to sum the empirical relation between high inequality and low intergenerational mobility found in several empirical studies focusing on the U.S. in the last 10 years (Krueger, 2012). Thus, it seems empirically proved that inequality is passed through generations, result that point toward considering as unfair part of the existing inequality as it depends on parental position in the distribution of income.

Studying inequality of opportunity and unfair inequality it is also important for other reasons. First, understanding how unfair the distribution of income in a given society is can influence the preferences of individuals and politicians about redistributive policy. In fact, in a recent paper, Alesina and La Ferrara (2005), show how individuals' preferences regarding redistribution policies in the U.S. depend in a large part on whether individuals think there is equal opportunity in the income generating process. Second, as explained by World Bank (2006) and Bourguignon, Ferreira and Walton (2007) and related to the relation between income inequality and intergeneration income mobility, high unfair inequality can lead to "inequality traps", a situation in which a homogeneous group in terms of no responsibility characteristics (females, black people) is

excluded from the economic advantages that in general are available to other groups. It is argued that this type of inequality is the one that eventually have a cost in term of the economic performance. For instance, in a patriarchal society, every generation of women face systematically less economic and political opportunities than men. This type of inequality trap can thus restrict the educational and labor market possibility of women and, through this waste of talents, affect the economic performance of the entire society (World Bank, 2006). Bourguignon et al. (2007) suggest that research on the relation between income inequality and economic growth should employ concepts of inequality that discriminate between inequality arising from responsibility and no responsibility characteristics of the individual, because inequality arising from circumstances is the one that may have an adverse impact on the economic growth. Thus, a reliable estimation of the unfair inequality could help to better understand the relation between economic growth and inequality.

One natural question is whether the unfair inequality has followed the same pattern shown by the income inequality and how income labor taxation has affected the trend. The most probable hypothesis is that the unfair inequality has risen in the last decades in U.S.is due to such factors that also negatively affect the standard inequality. The rise of the income share held by top incomes (Atkinson et al., 2011; Burkhauser, Feng, Jenkins & Larrimore, 2012) could in fact raise the portion of inequality that derives from characteristics that are beyond the control of individuals and can be considered irrelevant. The main contribution of this research to the existing literature would be the first attempt to estimate the trend of unfair inequality for the case of the United States using this novel method. Other studies using other empirical strategies and definitions of inequality of opportunity, find that a large percentage of the income inequality is given by unfair inequality (e.g. Pistolesi, 2009). Previous research by Almås (2008) applying a similar approach, estimate the unfair inequality in U.S. only for one year in a cross country comparison with Germany. Using different specifications of the fair distribution of the labor income, the author finds in general that the U.S displays an higher unfair inequality than Germany in 2004.

The rest of the paper is organized as follows. Section 2 revise the relevant normative and empirical literature on inequality of opportunity; Section 3 explain the empirical methodology followed to estimate the fair distribution of labor income and which measure are used to evaluate the distance between it and the actual distribution both for the pre-tax and post-tax situation. Section 4 present the data used for the present analysis and discuss the restriction made to the sample. Section 5 shows and discusses the results of the main analysis and Section 6 of the robustness analysis. Section 7

discusses the main results and concludes.

2 Literature review

2.1 The political philosophic contributions

The economic literature about unfair inequalities and inequalities of opportunities derive from the contributions of political philosophers during the last decades of the twentieth century. Inspired by the seminal works of Rawls and the idea that the "primary social goods" should be equally distributed, Dworkin (1981) develops the notion of equality of resource. According to this theory, people are responsible for the consequences of their choices, but not for exogenous circumstances as natural and social endowments. So in his view initial resources should be equalized. Furthermore the author introduces the distinction between option luck and brute luck. The first one depends on the result of chosen gambles or bets during the lifetime. The latter instead is totally exogenous to individuals and posterior to the initial equal distribution of resources. Thus, the individual suffering of bad brute luck should be compensated by the society with some sort of redistribution of resources.

After Dworkin, other influential political philosophers explicitly state that individuals should be held responsible for their choices Cohen (1989) and Arneson (1989). They argue that providing individuals with equal resources is not an sufficient condition for holding them responsible of the achievements during their life. Instead, they propose to focus on the equality of opportunities ideal. In their frameworks, the individuals should be held responsible only for the choices that are completely within their sphere of control. In particular, Cohen (1989) states that we should "compensate only for those welfare deficits which are not in some way traceable to the individual's choice".

2.2 The normative economic literature

Related economic research has tried to formalize the ethical ideas of the previous philosophical contributions in an economic environment. These theories have later been grouped under the name of liberal egalitarian theories of justice or, alternatively, responsibility-sensitive egalitarian theories (Devooght, 2008; Cappelen & Tungodden, 2004). The common characteristic of these frameworks is to make a distinction between inequality arising from circumstances beyond the individual choice and inequalities arising from characteristics that individuals can be held responsible for. Hence, the two

main intuitions beyond this literature is that difference in income due to responsibility factors should be preserved, whereas inequality due to circumstances should be compensated (Cappelen & Tungodden, 2004).

Initial contributions in this vein are the ones by Bossert (1995) and Fleurbaey and Bossert (1996). They modeled an economy with redistribution where the pre-tax income is a function of both responsible and no responsible variables. They consider a population of individuals $N = \{1, ..., n\}$ with $n \geq 2$ and sets of possible responsible and no responsible variables $\Omega^R = \{R^1, R^2, ...\}$ and $\Omega^{NR} = \{NR^1, NR^2, ...\}$ respectively, with $\Omega^{NR}, \Omega^R \in \mathbb{R}$. Individul i is characterized by a vector of responsible variables and a vector no responsible variables, x_i^R and x_i^{NR}, denoted as $x_i = (x_i^R, x_i^{NR}) \in \Omega = \Omega^R \times \Omega^{NR}$. The entire population is similarly represented by a vector $x = (x_1, x_2, ..., x_n) \in \Omega^N = \Omega \times \Omega ... \times \Omega$. The levels of responsible and no responsible characteristics in a society are represented by $\Omega^R(x)$ and $\Omega^{NR}(x)$ and the distribution of effort in population it is defined as $E(x)$. It is assumed that pre-tax income is a function of the responsibility and non responsibility characteristics of the individual,

$$y_i = f(x_i^R, x_i^{NR}). \tag{1}$$

They also define a redistribution mechanism that for any distribution of pre-tax income assign a post-tax income to each individual. The redistribution of income F is assumed such as $\sum_{i=1}^{n} F_i = \sum_{i=1}^{n} y_i$, i.e. the total pre-tax income is equal to the total post tax income.

Bossert (1995) try to characterized the ideas of philosophers as Cohen and Arneson with two different principles. They argue that any responsible-sensitive egalitarian or egalitarian liberal redistribution scheme should at least satisfy two different principles. The first principle reflects the egalitarian approach and it is called "equal income for equal responsibility" (EIER). This principle states that there should be no differences in income between individuals that show the same responsibility characteristics:

$$x_i^R = x_j^R \Rightarrow F_j = F_i. \tag{2}$$

Thus, if two individuals differs only with regards their no responsibility characteristics, this principle precludes any difference in the post-tax income. This principle it is also seen to represent the equalitarian ideal and it is commonly called the compensation principle.

The second principle instead is related with the idea of responsibility and is the "Equal Treatment for Equal Circumstance "(ETEC), sometimes called the libertarian

or the reward ideal. This principle states that two individuals with the same non responsibility factors should be equally treated by the distribution mechanism:

$$x_i^{NR} = x_j^{NR} \Rightarrow F_j - y_j = F_i - y_i. \tag{3}$$

That means that individuals with the same vector of no responsibility factors are characterized by differences in pre-tax income that derive only from differences in the responsibility factors. Thus, the post-tax income should preserve these difference and taxes (or assigns a transfer) by the same amount these two individual.

The main finding of Bossert (1995) is that in general, for populations with $N \geq 2$ and for no additive separable income functions, the two principles can not be jointly satisfied by any distributional mechanism. In a subsequent contribution Fleurbaey and Bossert (1996) show that instead there exists a series of distributional mechanisms that can satisfy alternatively one of the principles and a weaker formulation of the other one. The characterization of these requirements lead to the formulation of principles that define what is to be considered a fair distribution of income. For example, one the families of principle that the authors develop and it is used by a subsequent empirical work (Devooght, 2008) and employed in the robustness analysis of the present research, is the Egalitarian equivalent mechanisms, defined as:

$$F_i^{EE} = y_i = f(x_i^R, \tilde{x}^{NR}) - \frac{1}{N}\sum_j^n [f(x_j^R, \tilde{x}^{NR}) - y_j] \tag{4}$$

where $\tilde{x}^{NR}$ is any vector of no responsibility factors freely chosen. The authors show that this mechanism satisfy the egalitarian ideal of compensation but only a weaker definition of the libertarian ideal of reward.

More recently, Cappelen and Tungodden (2007) criticized the ETEC and the EIER as the best way to characterize a responsible-sensitive egalitarian ideal. The authors states that a stronger characterization of the ETEC and a weaker definition of the EIER better captures the two ideals embodied in the responsible-sensitive egalitarian ideal. Regarding the ETEC they make the example of two populations represented by the vectors of characteristics x and $\bar{x}$ where $\bar{x}$ derived by permuting the vector of responsibility of two individuals i and j. Thus, x and $\bar{x}$ have the same distribution of responsible and no responsible vectors. In a situation like that the ETEC is consistent with distribution mechanisms that assign different post-tax incomes to i in A and j in B, even if the responsibility vectors are the same. Thus, the authors propose to strengthen the ETEC imposing that if the responsibility vectors are the same for two

different populations, individuals with the same responsibility vector should receive the same share of total post-tax income. They call this principle the Equalization for Equal Effort (EEE) principle. Formally we can write:

$$E(\bar{x}) = E(x) \text{ and } \bar{x}_i^R = x_j^R \Rightarrow \frac{F_i(\bar{x})}{\sum y(\bar{x})} = \frac{F_i(x)}{\sum y(x)}, \tag{5}$$

Regarding the EIER instead the authors notices that it is too restrictive. For istance it does not allow any redistribution for those situations in which there are differences in the no responsibility vectors among individuals characterized by any average responsibility vector. In the authors' opinion, a better definition of the liberal ideal should specify when the redistribution is not admissible, but not restrict the redistribution in other cases.

They author propose another specification of the liberal ideal, the *no equalization for uniform class circumstances* (NEUAT), that requires there is no redistribution if individuals have different level of responsible characteristics levels and the average no responsible characteristics are equal for at all responsibility levels.

Having proposed these two requirements the authors define a principle that respects both of them and identify the fair income of individuals. It is called the generalized proportionality principle and according to it the individual demand for redistribution is equal to the average income of a contrafactual situation in which all individual share the responsibility vector that individual actually has. So, it depends on the distribution of no responsible factor in the society but only in its actual level of responsibility factor. Every individual i is thus characterized by a request of redistribution, $g(x_i^R, \cdot)$, equal to:

$$g(x_i^R, \cdot) = \frac{1}{n} \sum_j f(x_i^R, x_j^{NR}) \tag{6}$$

They show that if all individuals show the same preference the generalized proportionality principle implies that the fair income z for individual i is given by:

$$z_i = \frac{g(x_i^R, \cdot)}{\sum_j^n g(x_j^R, \cdot)} Y, \tag{7}$$

where Y is the total actual labor income. According to this principle, the fair income for any individual is represented by the share of the total income that the individual would have earned in a contrafactual situation where everybody have the actual level of responsible variables, but where everyone has the same reference level of no responsible

variables as defined before.

The authors show that the generalized proportionality principle respects the minimal liberal equalitarian requirements of *equalization for equal effort* and of *no equalization for uniform class circumstances*. In particular, this principle identify a fair income for each individual eliminating those inequality that arise from non responsibility factors, but only holding individuals responsible for their responsibility factors. Thus, individuals with equal responsibility factors have equal fair income, and if all individuals in a distribution share the same no responsibility factors, fair incomes are equal to the actual incomes.

2.3 Empirical economic literature

In general and until recently, the empirical studies that tried to estimate the unfair inequalities or the inequality of opportunity for a given society, consider only one of the two ideals initially proposed by Fleurbaey and Bossert (1996). On the one hand, part of the authors considers that there is inequality of opportunity if there is inequality of income between individuals that have the same level of responsibility characteristics. They thus consider the compensation principle (EIEER). The empirical strategy consists in grouping together individuals with the same level of responsibility characteristics (same years of education, same numbers of hours worked, etc) and estimating the inequality of opportunity as the inequality of income within the groups created. Using inequality measures that allow for the decomposition of the total inequality in the between and the within groups inequality, they thus can evaluate which share of the overall inequality is due to inequality of opportunity. This approach is also known with the name of ex-post approach as the groups are made looking at responsible characteristics that individuals choice over time.

On the other hand, part of the researches focuses on the ETEC requirement. Thus, after dividing the population in homogenous groups according to the level of no-responsibility factors (ethnicity, gender, region of birth, etc), ETEC states that within each group, as the individuals have the same no responsibility factors, inequality is fair. Instead, assuming that the conditional distribution of responsibility variables is independent of the no responsibility factors, inequality of opportunity is represented by the inequality between groups. This approach is also known with the name of ex-ante approach because the individuals are grouped according to their no responsible characteristics that in general are fixed over time and are determined before the income generation process (gender, race, ethnicity).

For both types of views a non-parametric and a parametric methods can be used. The main difference is whether to impose a functional form in order to estimate the relation between responsible or no responsible variables and the incomes. There are two main problems that affect both ex-post and ex-ante approaches. First, the non-parametric estimations is highly data-intensive. For instance with four no-responsible characteristics that all assume 3 possible values, the population can be partitioned into 81 different groups. As groups size declines, the variance for the estimation of the inequality index becomes problematically large. Thus, this approach needs big sample or to restrict the analysis to only few responsible or no responsible characteristics (Bourguignon & Ferreira, 2007). Alternatively, a non-parametric method can be used, but in this case an arbitrary functional form has to be chosen (Checchi, Peragine & Serlenga, 2010). Second and perhaps more importantly the ex-post and the ex-ante approaches in general give no comparable results. Checchi and Peragine (2009) show with a simple numeric example as the results are in general different. The same incompatibility that was present in the normative characterization of the ETEC and the EIEER is still at work in the empirical.

These methodological issues are clear for the case of the United States thanks to the research by Marrero and Rodríguez (2011). The authors estimate the inequality of opportunity for the period between 1969 and 2007 using the same data source of the present study. They employ different parametric procedures and a non-parametric method to study the ex-ante inequality of opportunity. In general, the different procedures lead to both different levels and trends of the estimated inequality of opportunity during the period. The only robust result is a significant drop of inequality of opportunity during the last sub period, from 2005 and 2007. Furthermore, the different approaches yield also to consider differently the relative importance that the no responsible characteristics have on the overall inequality of opportunity. In fact, with the non-parametric approach, the most important circumstances affecting the inequality of opportunity seems to be the parental education, whereas in the parametric approach the most important no responsibility characteristic seems to be the race of the individuals. Using the same data set, Pistolesi (2009), compare the results of the ex-ante and ex-post approaches for the period between 1968 and 2001 using in both cases a semi-parametric estimation. Also in this case, the trend presents some different characteristics, with the ex-ante inequality of opportunity showing more variability during the period and a steadily decrease from 1992 to 1997, while the ex-post approach leads to a stable and constant inequality of opportunity trend during all the period considered.

More recently, empirical studies have try to measure the unfair inequality in a more

comprehensive way. In fact, the principles that derives both from the characterization made by Fleurbaey and Bossert (1996) and by Cappelen and Tungodden (2007) have been applied by some authors to study which is the fair distribution of income in a given society. The advantage of using these principle is that they already take into account the egalitarian as well as the libertarian ideals. The principles developed by Fleurbaey and Bossert (1996) and by Cappelen and Tungodden (2007) suggest which is the fair income for each individual. For instance, Devooght (2008) estimate a contrafactual fair income distributions for every pre-tax and post-tax income distribution using one of the principle developed by Fleurbaey and Bossert (1996). Instead, Almås et al. (2011), whose method has been followed in the present analysis, decide to consider the reference incomes defined by the generalized proportional principle of Cappelen and Tungodden (2007) as the fair incomes for each individual . In the next section, the empirical method will be explained.

3 Empirical Methodology

3.1 The difference based Lorenz curve and the Unfairness Gini coefficient

The empirical methodology employed by the present analysis in order to estimate the trend of the unfair inequality in the US follow the empirical strategy developed by Almås et al. (2011). As explained in the previous section, the authors identify the fair distribution of incomes using the generalized proportionality principle developed by Cappelen and Tungodden (2007) and then evaluate to what extent the actual distributions of pre-tax and post-tax incomes deviate from the fair incomes' distribution using a generalized version of some traditional inequality measures.

Thus, In order to asses the unfairness of an actual distribution, new inequality measurements are needed. In fact, traditional inequality indexes consider the perfectly equal income distribution as the reference distribution for measurement and they do not allow considering an individual specific fair income such the one defined in equation 7. For example, the Lorenz curve is a measure of strict inequality. In fact, after ranking the individual from lowest to highest income y_i, the curve is calculated as:

$$L(s;A) = \frac{\sum_{i=1}^{ns} y_i}{n\mu(A)}, \quad 0 \leq s \leq 1. \tag{8}$$

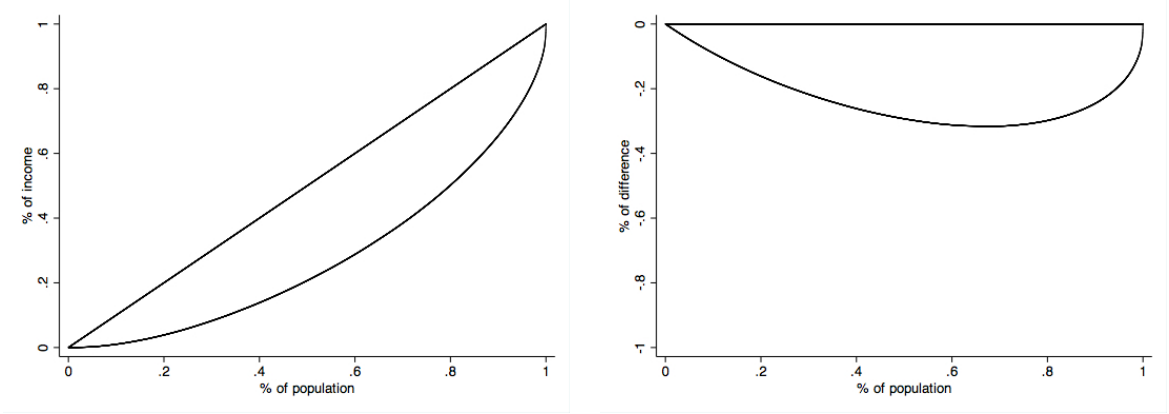
Recognizing that the fair income in this framework is the mean income, Almås et al. (2011) propose a generalized and equivalent version of the lorenz curve called the difference based lorenz curve. In this case, the incomes are ranked from the lowest (and negative) to highest (and positive) difference between the actual income and the reference income (in the traditional case it is the mean) $d_1 = y_1 - \mu \leq d_2 = y_2 - \mu \leq \quad ... \quad \leq d_n = y_n - \mu$ and the lorenz curve is now defined as:

$$L(s; A) = \frac{\sum_{i=1}^{ns} d_i}{n\mu(A)}, \quad 0 \leq s \leq 1. \tag{9}$$

Figure 1 reports the graphical representation of the standard Lorenz curve and the difference based Lorenz curve for the same distribution of pre-tax labor income. The areas between the curves and the straight lines are the same.

Figure 1: Traditional Lorenz curve and Difference based Lorenz Curve

(a) *Lorenz Curve.* (b) *Difference based Lorenz curve.*



Note: Traditional Lorenz curve and Difference based Lorenz curve ($z_i = \mu$) for the distribution of labour income among male individuals in US, year 2010. The areas are equivalent and thus the gini coefficient is the same
Source: PSID

The differenced based approach can be applied to fairness principles other than the strict equality, thus considering reference incomes z_i that differs for each individual. For instance in the case we want to hold individuals responsible for all the responsible and no-responsible characteristics that affect the labor income we have $z_i = y_i \quad \forall i$ leading to $d_i = 0 \ \forall i$. In this case, no unfair inequality would be recognized in any real distribution of income.

The difference based Lorenz curve leads to the specification of the so called unfairness

Gini coefficient. In the standard specification the Gini coefficient is defined as:

$$G = \frac{1}{2n(n-1)\mu} \sum_{i=1} \sum_{j=1} |y_i - y_j|, \tag{10}$$

the difference approach instead is:

$$G = \frac{1}{2n(n-1)\mu} \sum_{i=1} \sum_{j=1} |d_i - d_j|. \tag{11}$$

In the traditional case, $z_i = \mu \; \forall i$, we have $d_i - d_j = y_i - y_j + \mu - \mu = y_i - y_j$ and the two specifications are equivalent. The unfairness Gini coefficient allows us to evaluate income distribution applying different principle of fairness as the actual income can be now compared to a reference fair incomes. In order to do so, a definition of fair income for each individual is needed.

3.2 The fair income

Applying the generalized proportionality principle described above, we can now get an estimation of the fair pre tax income for each individual. Assuming a linear labor earnings function, we can estimate the following equation by OLS:

$$log\ y_i = \beta x_i^R + \gamma x_i^{NR} + \epsilon_i, \tag{12}$$

and use the estimated betas in order to calculate the fair income for each individual. The income function can be rewritten as $y_i = f(x_i^R, x_i^{NR}, \epsilon_i) = \exp(\beta x_i^R) \exp(\gamma x_i^{NR} + \epsilon_i)$. Substituting equation 6 in 7 we get:

$$z_i = \frac{g(x_i^R, \cdot)}{\sum_j^n g(x_j^R, \cdot)} Y = \frac{\frac{1}{n} \sum_j \exp(\beta x_i^R) \exp(\gamma x_j^{NR} + \epsilon_j)}{\sum_h \frac{1}{n} \sum_j \exp(\beta x_h^R) \exp(\gamma x_j^{NR} + \epsilon_j)} Y = \frac{\exp(\beta x_i^R) \sum_j \exp(\gamma x_j^{NR} + \epsilon_j)}{\sum_h \exp(\beta x_h^R) \sum_j \exp(\gamma x_j^{NR} + \epsilon_j)} Y, \tag{13}$$

eliminating $\sum_j \exp(\gamma x_i^{NR} + \epsilon_i)$ in the numerator and denominator leads to the definition of the empirical counterpart of the generalized proportional principle:

$$z_i = \frac{\exp(\beta x_i^R)}{\sum_j \exp(\beta x_j^R)} Y, \tag{14}$$

that identifies the estimated fair income for individual i. This principle is used in the main analysis to estimate the reference fair distribution for pre-tax and post-tax incomes and the unfairness Gini coefficient is then employed to estimated the unfairness in the United States. As mentioned in the literature review section, one of the advantages of this novel method is that it takes into account both the compensation and the rewards ideals embodied in the responsible liberal egalitarian theories, whereas the previous empirical analyses can just consider one of them. Furthermore, it is possible to check the relative importance of the different responsible characteristics in determining the differences between the traditional Gini and the unfairness Gini by varying the variables included in the responsibility set. However, one of the possible shortcoming of this method, relative to the previous ex-ante approach, is that it is not possible to discern the relative importance of the no responsibility characteristics on determining the level of unfairness in the society. This lack is due to the fact that the fair income is calculated only considering the responsible characteristics of the individuals, and thus is not possible to check which are the main circumstances that affect the unfairness.

4 Data

4.1 Data source

The data used for the present analysis is the The Panel Study of Income Dynamics (PSID). The PSID is a nationally representative sample of U.S. individuals and the family units in which they reside. It began in 1968 and since that time it has continued to follow PSID families and the offspring of the original families every year from 1968-1997 and every two years since 1997. The waves from 1990 to 2009 are considered. The sample was composed of 5,000 households in 1968 but the number has increased over time. For the analysis and due to its longitudinal design sample family weights are needed in order to ensure that the PSID data is nationally representative (Gouskova, Heeringa, McGonagle, & Schoeni, 2008). However, this study does not exploit the longitudinal dimension of the data, treating every year considered as a cross sectional data set. As reported above the PSID has been widely used for researches focusing on income inequality, inequality of opportunity and intergenerational mobility. However, the use of surveys to study income inequality has been criticized because of the under coverage of top-incomes that are seen to be the main causes of the rising inequality in the U.S. (Atkinson et al., 2011). Several studies have then used taxation data but also this type of data is not without problems and furthermore it is not suitable for

studies concerning inequality of opportunity, as information on personal characteristics is missing (for a discussion on the limitations of survey and taxation data in the case of U.S see Burkhauser et al., 2012)

4.2 Sample Restriction and Main Variables

4.2.1 Pre-tax Labor income

Following previous studies on unfair inequality (Almås et al., 2011; Devooght, 2008) the measure of labor income of individuals are annual labor wages and salaries earned in the previous year from employment and self employment. They also include bonuses, overtime and commissions. Only individuals, aged 20 to 60 with a positive labor income are considered in the analysis. Researches on income inequality suggest to use 3 or more years averages of the labor incomes in order to avoid temporary fluctuations of short-run labor earnings. However, as pointed out by Pistolesi (2009), averaging annual the vectors responsible variables would lead to a underestimation of responsibility differences among individuals. Furthermore, the author shows that the income inequality, measured by the Theil index and calculated using the PSID and similar specification of the labor income, displays similar trend for the averaged and no averaged income. Thus, in the present study only annual labor income is used for the empirical analysis.

4.2.2 Post-tax Labor income

It has been necessary to restrict the data further more in order to study the fairness of the post tax distribution of income. The PSID reports the pre tax income, and an estimation of the post tax income was made using the TAXSIM. The TAXSIM is an tax liability calculator developed by researchers at the NBER that estimates the federal and state income taxes in the United States and it has been usually used with the PSID data (Butrica & Burkhauser, 1997). The taxation system in the US is based on different marginal tax rates for different type of tax units. There are four different type of tax units: single, married filing jointly, married filing separately, head of household (Butrica & Burkhauser, 1997) and for example in 2013 the first marginal tax rate change for singles was at roughly 9000 dollars and for a married couple that fill the taxes jointly is at 18,000. Thus, estimating the federal and state taxes without distinguishing between married and not married individual will lead to a biased estimation if for example, married individuals decide to work less than singles.

A better procedure for the estimation of post tax incomes would be to consider the

whole family income, as explained in Butrica and Burkhauser (1997). However, as explained before, the empirical analysis needs individual characteristics for the estimation of the fair pre and post tax fair income and imputing the individual characteristics of the head to all the family income is not a feasible solution. Almås (2008) and Almås et al. (2011) make two different choices. In the first case, the author decides to consider only single households, with the individual characteristics being the same as the household characteristics, and tax units are represented only by single individuals that fill the income tax forms alone. In the other paper instead, the authors consider all individuals (singles and married) and estimate the taxes in Norway using a tax calculator similar to TAXSIM that consider all the individuals to be individual tax unit[1].

In this analysis the strategy employed by Almås (2008) is followed. Hence the analysis is restricted to single households. This choice will of course leads to results that can be hardly generalized to the whole society but they can still can give useful insights on the fairness of the pre-tax and post tax income distribution. Using only those individuals, TAXSIM needs information about state of residence, taxation year, labor income and it returns estimated federal and state tax liabilities. It is difficult to assess the reliability of these estimations but Butrica and Burkhauser (1997) after comparing the estimations with the estimation of post-tax income included in the PSID until 1990 concludes that the differences are trivial.

4.2.3 No-responsibility characteristics

Furthermore, we need information on responsible and no responsible characteristics for the individuals in order to estimate the individual fair income. The set of circumstances exogenous to the individuals choice instead comprises age, the gender and the race of individual.

A shortcoming of the analysis due to data availability is that it can not include a variable capturing the nationality of individuals. In 1990 a sample of households consisting of families originally from Mexico, Puerto Rico, and Cuba was added to the main sample. However, as this sub sample does not consider all major groups of immigrants the, it was dropped from 1995. From 1997, instead a sample of post 1968 immigrant families was included in the sample (PSID, 2000). Due to difficult comparability among years and the fact that for 1996 no immigrants were included, a decision has made of not including a variable capturing the immigrant status among

[1]The webpage of the tax model used by the author, `http://thomas.nhh.no/stata/norsk_skatt.html` explains that the program estimate post tax income only for tax-class 1 (single men without children)

the circumstances variables.

4.2.4 Responsibility characteristics

The main responsibility characteristics that are found by previous researches to influence the labor income are the human capital formation and the labor offer decisions for each individuals (Marrero & Rodríguez, 2011). These characteristics are proxied in the analysis by years of education and average working hours during the week. Other responsibility variables are, following Almås et al. (2011) a dummy variable indicating if the individual work in the public sector and another categorical variable capturing the fact that the individual decides to migrate to another state if the individual reports to live in a different state than the one where he born and grew up.

The main analysis assumes that these variables are entirely within the control of the individuals and thus the individuals are held responsible for the consequences of the choice regarding these characteristics. However, it is possibles that the decision regarding the main responsibility variables is affected by no responsibility characteristics of the individual (Checchi & Peragine, 2009). Regarding the human capital formation the decision can be partially determined by financial constraints and individuals born in rural area can have different perception regarding the beneficial effect of education on labor earnings than individuals born in urban areas. Furthermore the decision of weekly working hours can be narrowed by medical reason or by the type of working agreement (part time contracts) (Marrero & Rodríguez, 2011). As a preliminary analysis it is worth checking if there are important differences in the responsibility characteristics among the main groups of individuals divided accordingly their no responsible variables. Table 1 reports the descriptive statistics for the main variables in the responsibility set conditional to the gender and race of individuals. Indeed there are some important differences among races and gender with respect the responsible characteristics. An higher proportion black and female individuals work in the public sector in both 1990 and 2010. Furthermore white individuals have on average 1 year more of education than black individuals and there is an higher proportion of white and male individuals that decide to work more than 40 hours per week in both 1990 and 2009. Overall, these differences are in line with the ones found by Almås et al. (2011) for the case of Norway.

Table 1: Responsibility characteristics by gender and race

	Male		Female	
	1990	2009	1990	2009
Proportion in public sector	0.15	0.12	0.23	0.19
Mean years of Education	13.3	13.3	13.3	13.5
working hours				
Proportion working hours:≤30	0.07	0.13	0.13	0.17
Proportion Working hours: 30-40	0.46	0.45	0.62	0.54
Proportion Working hours: more than 40	0.47	0.42	0.25	0.29
Proportion Internal Migration	0.32	0.33	0.32	0.32
	White		Black	
	1990	2009	1990	2009
Proportion in public sector	0.16	0.14	0.32	0.19
Mean years of Education	13.5	13.7	12.7	12.8
working hours				
Proportion working hours:≤30	0.11	0.15	0.12	0.12
Proportion Working hours: 30-40	0.50	0.46	0.70	0.62
Proportion Working hours: more than 40	0.39	0.39	0.18	0.26
Proportion Internal Migration	0.32	0.34	0.27	0.25

Note: Proportion mean values estimated using sample weights.
Source: PSID

In order to partially take into account the possible correlation between responsible and no responsible variables a simple method developed by Almås et al. (2011) is applied in the robustness analysis. This approach tries to control for family background and the State where individuals grew up when holding individuals responsible for the educational and working decisions. Thus information on parental educational level and State of born is also needed. This will restrict the data further as only the subsample with full information has been considered.

Table 2: Descriptive statistics

	1990	2009
Proportion female	0.55	0.52
Proportion in public sector	0.20	0.16
Age		
Proportion aged 20-29	0.32	0.32
Proportion aged 30-39	0.32	0.23
Proportion aged 40-49	0.24	0.22
Proportion aged 50-59	0.12	0.23
Mean years of Education	13.30	13.42
working hours		
Proportion working hours:$\leq$30	0.12	0.15
Proportion Working hours: 30-40	0.61	0.50
Proportion Working hours: more than 40	0.26	0.35
Proportion Internal Migration	0.32	0.32
Race		
White	0.77	0.70
Black	0.20	0.24
Other	0.03	0.06
Mean income, 2005 constant Dollars	32821	35040
Observation	2,161	2,991

Note: Proportions and mean values estimated using sample weights. Income is deflated using the CPI index (2005=100).
Source: PSID

The restrictions made leads to samples of on average 2000 single head of households for every year considered. Table 2 reports the descriptive statistics for the first year and the last year of the analysis. Between these two years some trends can be described. first there has been a decreasing share of workers in the public sector. There is also a process of aging of the working population and an higher proportion of working hours per week higher than 40. Regarding the race, there is a under representation of other races than white and black, mainly because of the problem regarding migration described above.

5 Results: Unfairness in the US

In this section the main results about the estimation of the trend of unfairness inequality in the US will be analyzed.

5.1 Labor earnings equation

The first step in the empirical analysis is represented by estimating a regression for each year in order to get the coefficients that will be used in order to calculate the pre-tax and post-tax fair income for each individual. Equation 12 is estimated using

the standard log-level specification:

$$lny_i = \beta x_i^R + \gamma x_i^{NR} + \epsilon_i, \tag{15}$$

where y represents income, x_i^R and x_i^{NR} are the vectors of responsible and no responsible variables and ϵ_i represents the error term. The dependent variable used is the log labor income, whereas the independent variables as described above are: dummy variables indicating the gender and the race of individuals, if individual works in the public sector and if he has migrated to another US state, the years of education, the average working hours and the age.

Table 3 reports the estimation result of the labor income equation 15 just for the first year and the last year of the analysis. The coefficients have the expected signs and are in general statistically significant, women are found to earn less than men in both years by roughly the same magnitude. Having more education is correlated with higher earnings and the educational premium is increased in the last 20 years. Black and individuals of other races earn less than white individuals and working in the public sector has a positive correlation with earnings and the coefficient increase over the twenty years considered. Results for the other years are similar (all regressions results are reported in table 7 in the appendix).

Table 3: Labor Income Equation

VARIABLES	log(income) 1990	log(income) 2009
Internal mobility	0.0364	0.0720**
	(0.03)	(0.03)
Education	0.0792***	0.1256***
	(0.01)	(0.01)
Working hours: 30-40	1.2161***	1.2079***
	(0.09)	(0.06)
Working hours: more than 40	1.4616***	1.5894***
	(0.09)	(0.06)
Age: 30-39	0.2426***	0.2382***
	(0.04)	(0.04)
Age: 40-49	0.3292***	0.2439***
	(0.05)	(0.04)
Age: 50-59	0.4073***	0.3543***
	(0.05)	(0.04)
Black	-0.2732***	-0.2356***
	(0.03)	(0.03)
Other races	-0.1979**	-0.0264
	(0.08)	(0.09)
Female	-0.1483***	-0.1532***
	(0.04)	(0.03)
Public sector	0.1440***	0.1794***
	(0.04)	(0.04)
R-squared	0.350	0.389
Sample size	2161.00	2991.00

Note: Estimation of the labor equation. The dependent variable is the logarithm of labor income. Omitted categories are: working hours:≤30, age: 20-29, white. Robust standard errors are reported in parentheses.*** significant at 1% level, ** significant at 5% level, * significant at 10% level. Source: PSID

5.2 Pre-tax and Post tax fair income distribution

After the labor regression the pre-tax and post tax fair incomes for every individuals in each year can be estimated. Applying the generalized proportionality principle defined in equation 14 the formula is:

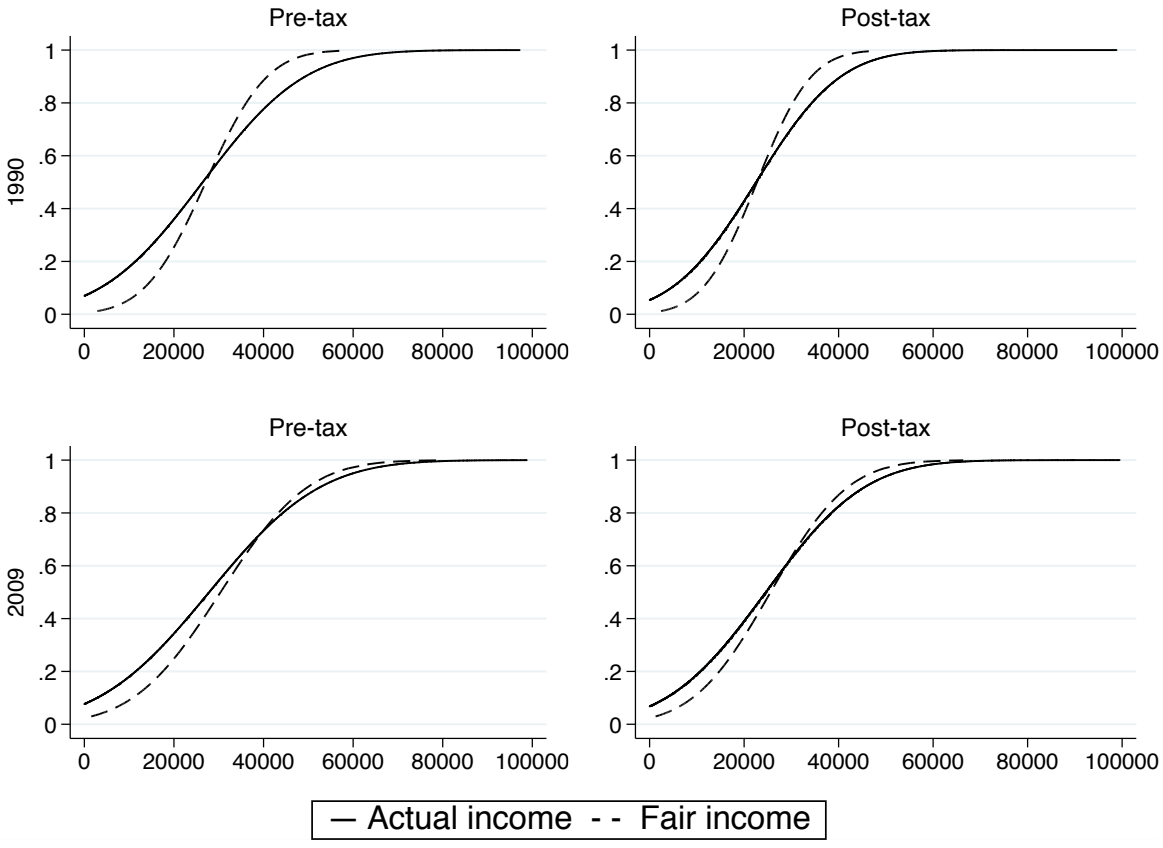
$$z_i = \frac{exp(\hat{\beta} x_i^R)}{\sum_{j=1} exp(\hat{\beta} x_j^R)} Y, \tag{16}$$

where the beta coefficients are obtained from equation 15. For the pre-tax fair income, Y will be equal to the summation of all pre tax incomes. Instead for calculation of the post-tax fair income, Y is the summation of all post tax incomes.

The fair pre-tax and post-tax incomes are estimated considering years of education, working hours, migration and working in the public sector as individual responsibility characteristics included in the vector x_i^R. The inclusion of these variables follows previous studies but it is discretional and the results using different responsibility sets will be presented in the following sections.

As a preliminary analysis, Figure 2 reports the cumulative distribution functions of both the fair incomes and the actual incomes for both pre tax and post tax distribution and for 1990 and 2009. In each year and both before and after taxes, the cumulative distributions of actual incomes have a less steep slope than the relative cumulative distribution of fair income. Furthermore, the distributions of actual incomes are less compressed than the distributions of fair income. Thus, it seems that the distributions of actual income show more inequality than the distributions of the contrafactual fair incomes.

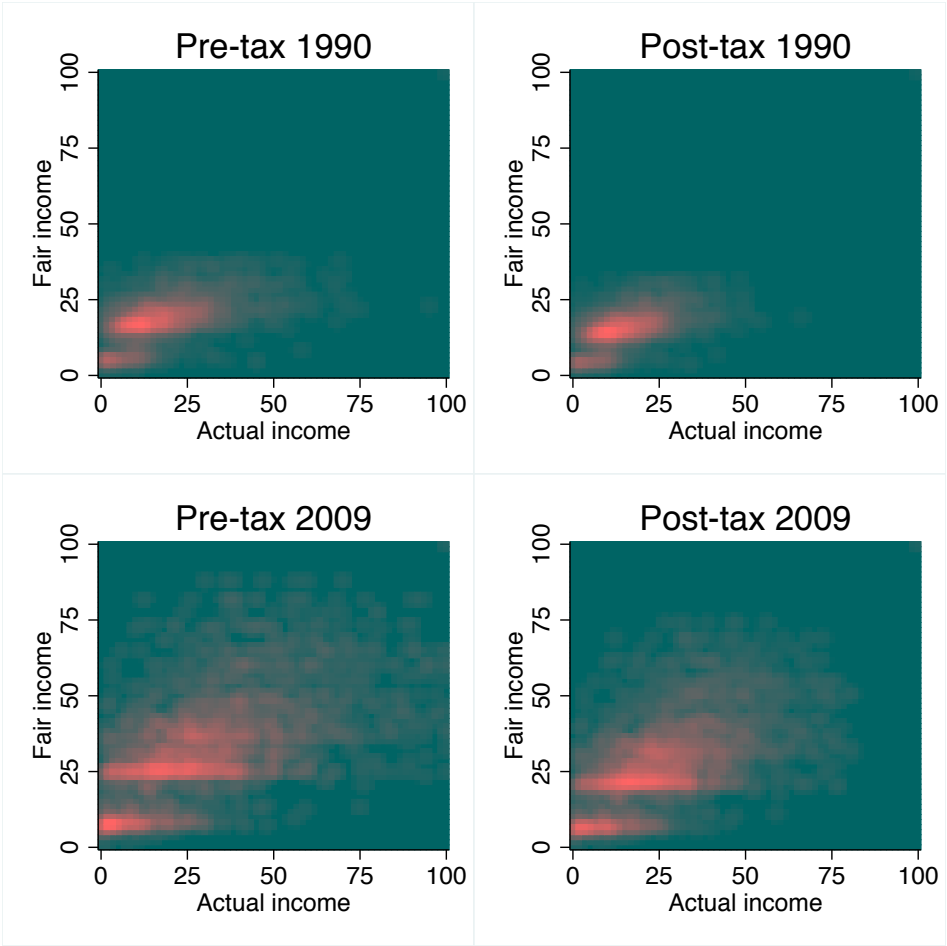
Figure 2: Cumulative distribution functions



Source: PSID

Looking at the differences between 1990 and 2009, we can see that the cumulative distribution of pre-tax and post-tax actual incomes are closer to the corresponding distribution of fair incomes in 2009 than in 1990. This fact would imply than the distribution in 2009 is less unfair than distribution in 1990. However, the fair incomes are individual specific, i.e. they differ from individual to individual. Thus, the ranking of individuals according to their actual incomes can be different when ranking individuals according to their fair income. For example, in a case in which $y_i > y_j$ but, other things being equal, i has less years of education than individual j, we will have that $z_j > z_i$. For this reason the cumulative distributions of actual and fair incomes order individuals in different ways and so using them to do a fairness comparison in a situation where the fair income is individual specific can be misleading.

Figure 3: Bivariate distribution of actual and fair income



Note: The figure shows joint distributions of fair income and actual income in 1990 and 2009 for both pre-tax and post-tax. The maps link each individual's actual income to his fair income. The fair income is calculated considering a responsibility set that includes years of education, working hours, internal mobility and working in the public sector
Source: PSID

A better graphical interpretation is, following Almås et al. (2011), reported in figure 3. Each graph reports the bivariate distribution of fair and actual incomes for both pre-tax and post-tax situation in 1990 and 2009. Each individual's actual income is thus linked to his or her fair income. The graphical representation implies that if for all individuals the actual income is equal to the fair income the points lay on the 45 degree line. Points above the diagonal line means that the fair income is higher than the actual income, whereas points below the line identifies individuals with higher actual income that the fair income. The more intense the shade of red, the higher the concentration of observation in the region is.

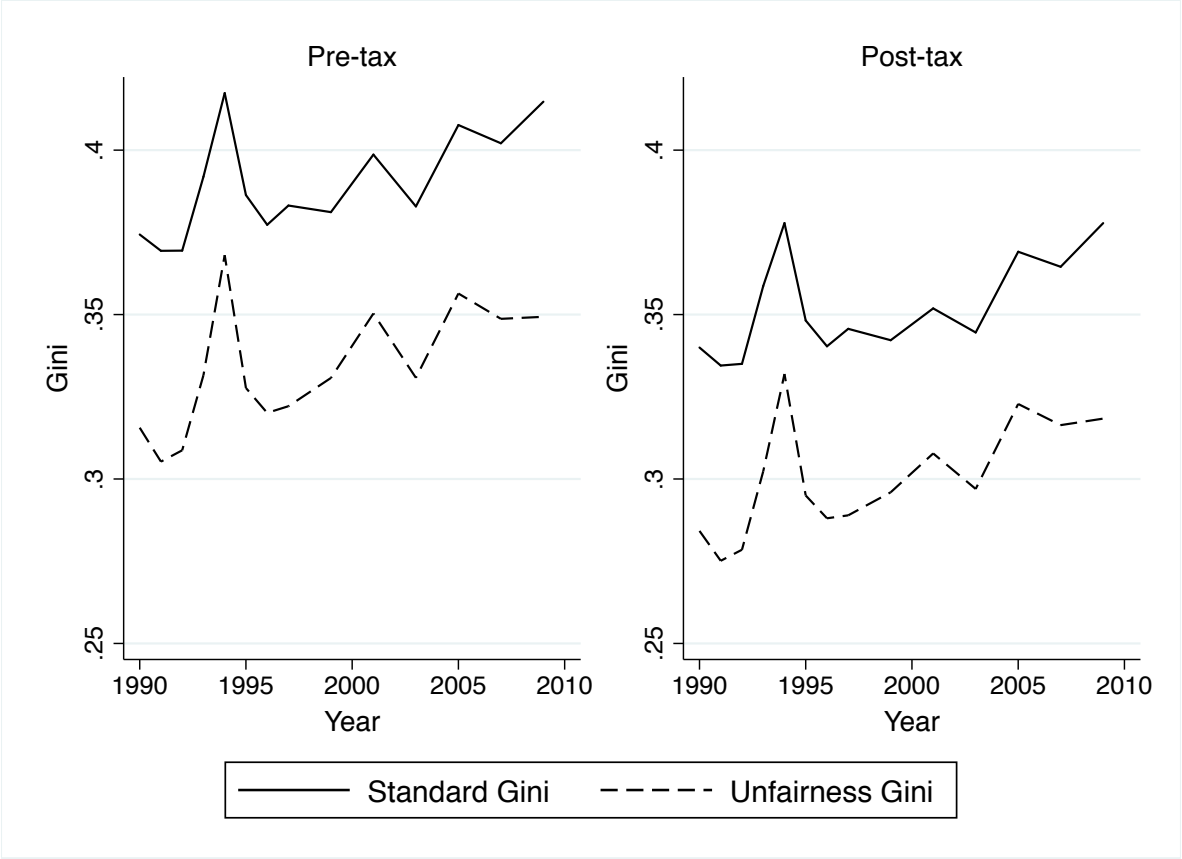
From this graphical representation different observations can be made. First, for both 1990 and 2009, the bivariate distribution of post tax incomes seems to be less spaced out than the corresponding distribution for pre tax incomes, meaning that indeed taxation in both years helps to decrease the difference between fair and actual incomes, thus decreasing the unfair inequality. From another point of view and in contrast to the observation made for the cumulative distribution, the shade red areas in 2009 for both pre tax and post tax income are larger than in 1990.

From this graphical and preliminary analysis, it seems that the unfair inequality is higher in 2009 than in 1990 even if the taxation helps to decrease by some extent the deviation between the actual incomes and the fair incomes.

5.3 Unfairness Gini: Pre-tax income distribution

Now we turn to analyze the trend of the unfair Gini both for the pre-tax incomes and for the post tax incomes. The unfair Gini is calculated using equation 11 considering hours worked, years of education, working for government and internal mobility as the characteristics for which individuals are held responsible. The first graph on the left in figure 4 reports the estimated trend of the traditional Gini and the unfair Gini coefficients for the pre-tax incomes. Regarding the traditional Gini coefficient (i.e. the one with empty responsibility set), we can see that beside some fluctuation during the 20 years considered, overall theinequality increased considerably from 1990 to 2009. The estimation of pre-tax Gini coefficient is in line with the existing literature on the rising of economic inequality in the United States since the 80s (Krueger, 2012; Autor et al., 2008). In particular, after a first period of substantial increase in the first part of the 90s reaching the highest level in 1995, the Gini coefficient decreases until the end of the decade. However, an upward trend started in the first years of the new century. Finally, with the advent of the financial crisis, the Gini coefficient returns to the level of 1995. Overall there is a 10% increase (from 0.374 to 0.415 as reported in table 8 of the appendix), in line with the increase of the Gini estimated by U.S. Census Bureau (2012)(Table A-2) using a different type of data.

Figure 4: Standard Gini and Unfairness Gini: 1990 and 2009



Note: The graphics reports the trends of standard Gini and Unfairness Gini for the period 1990-2009 both for pretax and post tax incomes. Unfair Gini derives from the estimation of fair pre-tax and post-tax income give in equation 16. The responsibility set includes: hours worked, years education, work for government and internal mobility.
Source: PSID

Regarding the unfair pre-tax Gini, that can be seen as an unfairness measure of the income generating process in the United States, some features characterize his trend in contraposition with the traditional Gini. First of all, in the first half of the period, from 1990 to 2001 the traditional and unfair Gins show a similar growth rate. The first measure shows a 7 percent increase between 1990 and 2001 whereas the percentage change of the traditional Gini is around 10. In the following period, the changes in the unfair Gini coefficient are more compressed than the fluctuation of the traditional Gini. The value of unfair Gini in 2009 is roughly the same as the value in 2001, whereas the traditional gini keeps increasing (see the second and sixth columns of table 8). It seems from this analysis that a qualitative change of fairness in the income generating process took place in the United States at the beginning of the new millennium.

5.4 Unfairness Gini: Post-tax income distribution

The second half of the Figure 4 represents the estimated trends of the traditional and unfair post-tax gini. Regarding the traditional Gini, the taxation system in general helped to decrease the level of inequality in every year and to compress the rate of growth along the period. However, it seems that in the last years, taxation partially failed to contrast the rise in inequality. In fact, from 2001 to 2009 the rate of growth of the post-tax Gini is higher than the rate of growth of the pre-tax Gini, roughly a 7 percent increase in the whole period against the 4 percent of the pre-tax Gini. This finding corroborates the results by Bargai, Dolls, Immervoll, Neumann, Peichl, Pestel, and Siegloch (2013), who, estimating the post-tax income with the TAXSIM calculator, suggested that tax reforms in the early 90s helped to decrease the income inequality growth, whereas tax reforms in the early 2000s have the opposite effects.

Regarding the unfair post-tax Gini, the same observations as in the pre-tax case can be made. First of all, in the first period the unfair Gini growth in a similar way as the traditional Gini. Instead in the second sub period, the increase of the unfair Gini is more modest than the increase of the traditional Gini. Comparing the pre-tax and post-tax unfair Gini, seems it seems that taxation help to decrease the unfairness of the income distribution in every years.

Looking instead at the whole period, we can conclude that the unfair Gini coefficient gives a qualitative similar picture to the traditional Gini. In fact, both for the pre-tax and post-tax situation, the unfair Gini and the traditional Gini coefficients experienced an increase of roughly 11%.

5.5 Different responsibility sets

In the previous section, a responsibility set including, hours worked, education, working for the public sect and internal migration, has been proposed. Of course, the decision of which characteristics the individual should be held responsible for is discretionally. Thus, in this sub section we consider other responsibility sets that can alternatively be used. We consider the possibility of including in the responsibility set: no variables (the resulting Gini is the traditional Gini that consider the average income to be the fair income for all the individuals); only the working hours; the working hours and years of education; working hours, years of education and working in the public sector; working hours, years of education, working in the public sector and internal migration; the last one will include also the error term in the labor equation, that mean

the unobservable factors that explain variation between the incomes. Variables that are not included in any case in the responsibility sets are the gender, the race and the age of the individuals as they are unequivocally beyond the control of individuals. Doing so, we can also check which are the responsible variables that, when included in the responsibility set, decrease in a relevant way the amount of unfairness in the distribution of income.

Table 4: Unfairness Gini for different responsibility cuts.

Responsibility set	G^u pre-tax		G^u post-tax	
	1990	2009	1990	2009
$\emptyset$ (Standard Gini)	0.374	0.415	0.340	0.378
$\{H\}$	0.344	0.371	0.310	0.336
$\{H, E\}$	0.318	0.348	0.286	0.317
$\{H, E, G\}$	0.316	0.350	0.284	0.319
$\{H, E, G, M\}$	0.316	0.349	0.284	0.318
$\{H, E, G, M, \epsilon_i\}$	0.133	0.122	0.120	0.113

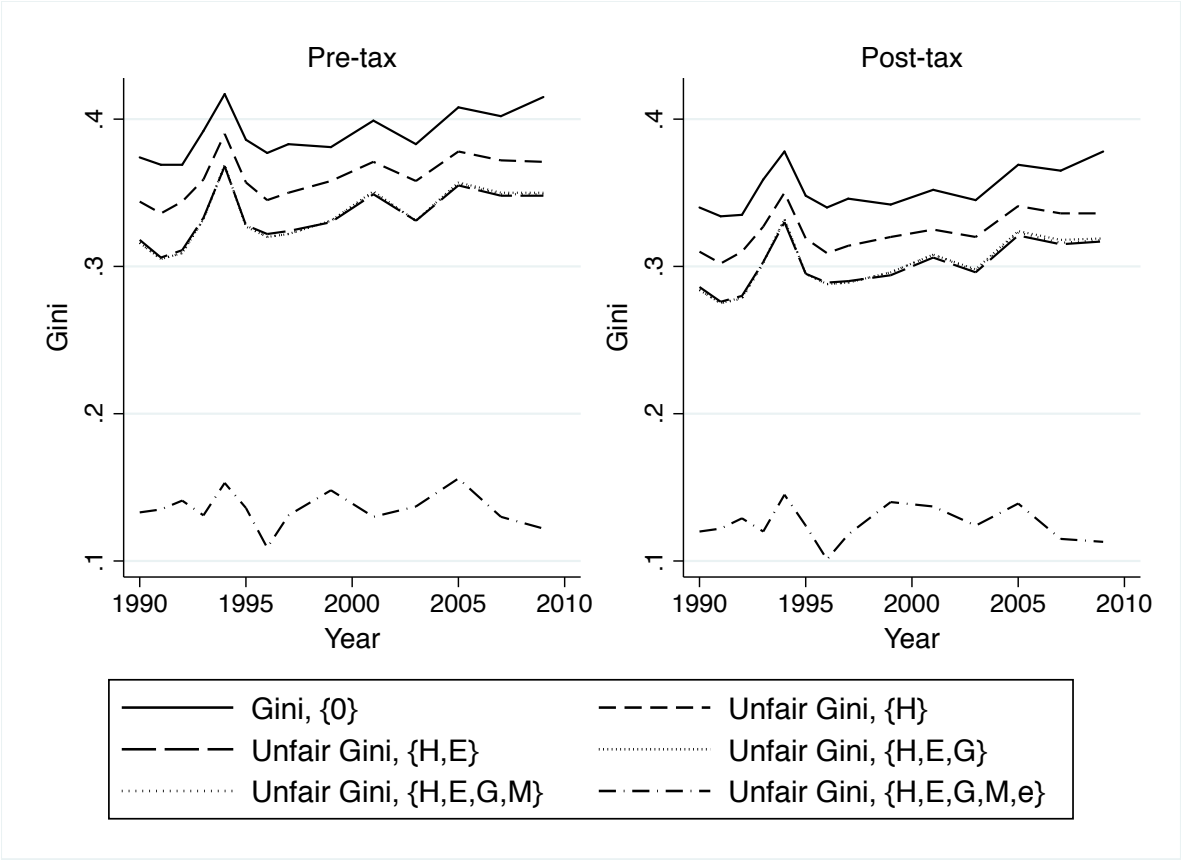
Note: Responsibility sets x^R can included in the different specifications: no variables $\emptyset$, estimation leads to the standard Gini; average week working hours H; years of education E; working for the government G; internal mobility M and the error terms ϵ_i that represent the part variation among income that we can not explain. The remaining variables are included in the no responsebility set x^{NR}. Source: PSID

Table 4 reports the values of the unfair Gini for the beginning and the end of the period of the different specifications. First, adding variables to the responsible set in general decreases the value of unfair inequality measured by the Gini. In the extreme case of holding the individuals responsible for all the observable and unobservable characteristics, there would be no unfair inequality and the unfair Gini would be equal to zero. When considering only the observable characteristics, the major changes in the level of Unfair Gini are registered when the responsibility set pass from including no variables to including only the hours of work and when we add also the years of education.

However, no matter which observable variables are included in the responsibility set, the increase of both pre-tax and post-tax unfair gini is around 10% over the whole period. Adding also the unobservable characteristics to the responsible factors implies both a huge drop in estimation of the Unfair gini in all the years and a slightly decrease over the whole period. However, including the unobservable factors in the responsibility set seems not to be a reasonable choice as among them there are many characteristics beyond the control of the individual (the nationality, having born in a rural area) that

are not captures by the data used in the analysis.

Figure 5: Unfair Gini with different responsibility sets



Note: The graphics reports the trends of standard Gini and Unfairness Gini for the period 1990-2009 both for pretax and post tax incomes. Unfair Gini derives from the estimation of fair pre-tax and post-tax income give in equation 16 for different The responsibility sets. Source: PSID

Figure 5 reports the trends of the pre-tax and post-tax unfair Gini for all different responsibility sets. It is evident that all the specifications follow the same pattern. As noticed before only the unfair gini for the responsibility set including the unobservable factors follows a different path especially during the last years of 2000s, where a steep decrease in the unfair Gini can be seen. However, we can conclude that overall, the choice of the responsibility characteristics does not change the qualitative results discussed in the previous section. Also in this case, it is worth mentioning that The traditional Gini (represented by the higher line in both graphs) follows different trend than the unfair ginis in the second period.

It can be also noticed that the most noticeable drop in unfairness is the result of adding to the responsibility set the working hours and years of education. The further

additions of working for government and internal migration have not important effect on the unfairness. From the figure we can see that only four lines are distinguishable, the traditional Gini, that always remain higher than others; the unfair Gini related to the responsible set including only working hours; the unfair Gini adding also years of education to the responsible set (and the almost overlapping Ginis including also the public sector and internal migration dummy); and finally the unfair Gini for the responsible set including all observable and unobservable characteristics.

6 Robustness Analysis

In this section, we consider several robustness checks in order to corroborate the results found in the previous section. First, a subsample of individuals for which parental information is available is used to apply an alternative method that try to take into account the possible correlation between responsible characteristics and circumstances. Finally, the other measure of unfairness, the difference based Lorenz curve, developed by Almås et al. (2011) will be used to check the results found in the previous section.

6.1 Control for correlation between responsibility and no responsibility characteristics

A possible problem in the correct estimation of the fair income is the possibility that the responsibility factors are affected by the no responsibility characteristics. As formalized by Checchi and Peragine (2009) it is possible to think that the non responsibility characteristics can have both a direct and an undirect effect on the labor income. The indirect effect of no responsibility factors works through the impact of no responsibility factors on the responsibility characteristics. We can write thus:

$$y_i = f(x_i^R(x_i^{NR}, r_i), x_i^{NR}), \tag{17}$$

where the responsibility factors are considered now to be a function of no responsibility factors and the responsible and individual choice of the individuals r_i. In this context we allow the responsible variables to be directly affected by the circumstances beyond the individual control. Table 1 indeed shows that there are some differences in the mean values for some responsibility variables between gender and races. For example, on average white individuals are more educated that black individuals and there is an higher percentage among men than among women working more than 40 hours.

To take account of this possible correlation the simple method outlined in Almås et al. (2011) is followed. For this robustness analysis I consider the sub sample of individuals with information about parental years of education. This restriction leads to a subsample that contains in general around the 80% of the observations of the sample considered in the main exercise. For example for 1990 the sample drop from 2262 to 1941 individuals.

First, we regress the main responsibility variables, years education and hours worked on years of education of father and mother and state where individuals grew up for each year considered as specified in the following equation:

$$x_i^R = \alpha + \beta_1 Fe_i + \beta_2 Me_i + \beta_4 B_i + \epsilon_i, \tag{18}$$

where Fe_i, Me_i, FMe_i represent father's education level, mother's education level and the interaction of the two measures for individual i and B_i is the country where individual i grew up. For the hours worked regression, almost all coefficient are statistical insignificant, so the analysis for this responsibility variable was not carried on. First panel of table 5 reports the results for 1990 and 2009 (regressions results for all years are reported in table 11 in the appendix).

Instead, the second panel of the table reports the results for 1990 and 2009 for the regressions with years of education as the dependent variable.The regression results shows a significant correlation with the background variables. In order to capture the educational decision that can be imputed to the individuals' responsibility, the years of educational variable is thus replaced by a variable capturing the difference between actual years of education and the years of education predicted by using the parameters in equation 18. The intuition behind this method is that the difference between the actual value and the predicted value represents the decision of individuals that is not influenced by circumstances and no-responsibility variables that are beyond the individual control. With the new educational variable, the procedure to estimate the fair income is replicated.

Table 6 reports the Gini coefficients for the pre-tax situation in 1990 and 2009 for the sub sample of individuals with parental information, using both the standard method and the modified approach with the new education variable. First we can notice that the Standard Gini is very similar to the pre-tax standard Gini in 1990 and 2008 for the full sample reported in table 4. As any variation in the standard Gini should depend only in the observations chosen, the stability of the measure gives some support for the fact that the additional sample restriction made for this robust analysis haven't change

Table 5: Parental education regressions

Dependent Variable:	**Hours Worked**	
	1990	2009
Education of Father	0.1761	0.0827
	(0.16)	(0.16)
Education of Mother	0.1438	0.2461
	(0.18)	(0.18)
State grew up	0.0312**	-0.0072
	(0.02)	(0.02)
R-squared	0.005	0.002
Sample size	1860.00	2320.00
Dependent Variable:	**Years of Education**	
	1990	2009
Education of Father	0.3813***	0.2683***
	(0.04)	(0.02)
Education of Mother	0.2912***	0.3018***
	(0.04)	(0.03)
State grew up	0.0148***	0.0064**
	(0.00)	(0.00)
R-squared	0.202	0.185
Sample size	1860.00	2320.00

Note: *** significant at 1% level,** significant at 5% level, * significant at 10% level. Robust standard errors reported in parenthesis.
Source: PSID

the representativeness of the sample. The same conclusion can be reached looking at figure 6 that in the upper part reports the trend of the traditional Gini of for the full sample and for the sub sample.

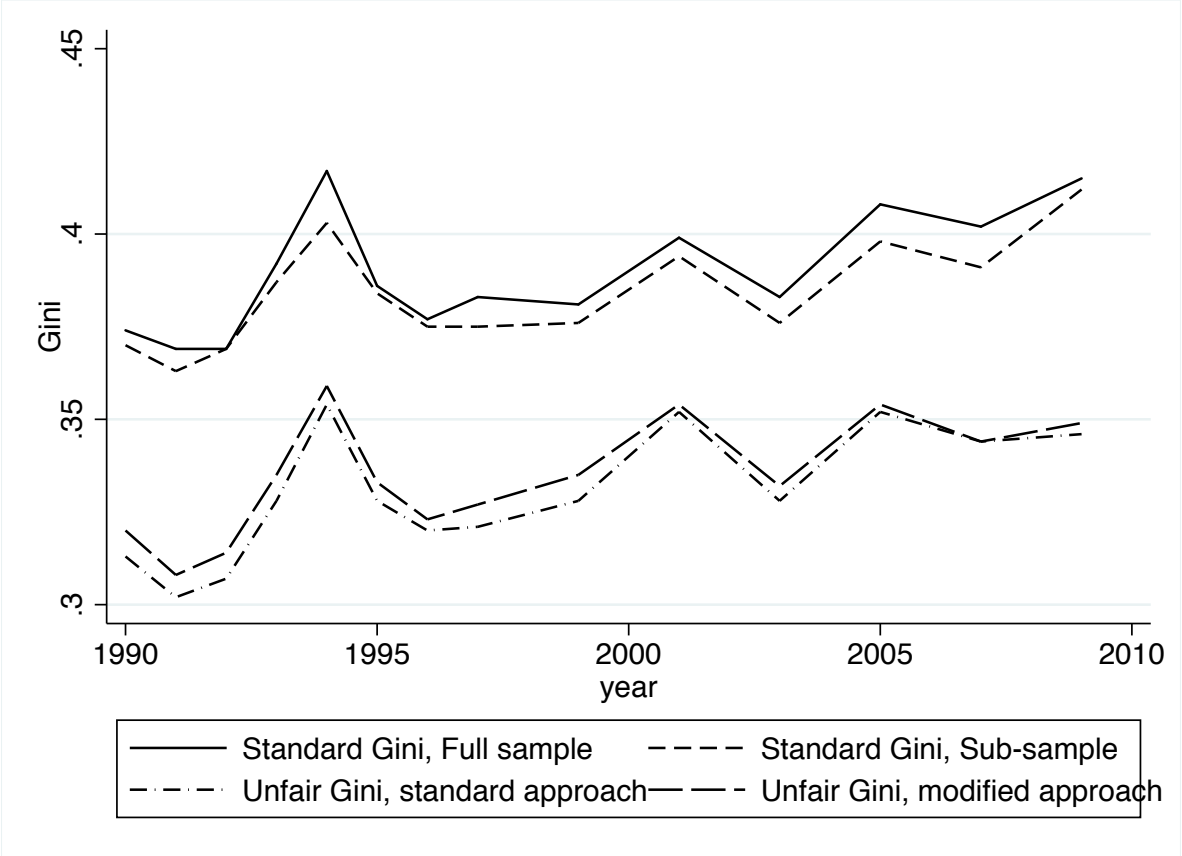
The remaining rows of table 6 reports the unfair Ginis. The values remains stable when the modified approach is used. Some differences can be found but they have in all the cases the same direction and magnitude for every years. Thus, using either the standard or the modified approach in the study of unfair Gini seems not to matter and the qualitative results remaisn the same. This can be understood also by looking at Figure 6 where the unfair Ginis for the preferred responsibility set (the one including years of education, hours worked, public sector and internal migration) are reported for the standard and the modified approach. Both measures follows the same trend and the distances between the values in each years remain quite stable. Also in this case, the unfairness seems to increase for the first period, until 2001, and then remain stable.

Table 6: Unfairness Gini for subsample with parental information.

Responsibility set	G^u pre-tax, standard approach		G^u pre-tax, modified approach	
	1990	2009	1990	2009
$\emptyset$ (Standard Gini)	0.370	0.412	0.370	0.412
$\{H\}$	0.339	0.366	0.339	0.366
$\{H, E\}$	0.314	0.345	0.320	0.349
$\{H, E, G\}$	0.313	0.347	0.319	0.350
$\{H, E, G, M\}$	0.313	0.346	0.319	0.349

Note: The table presents estimation of Gini's for the subsamples of individuals with parental information. In the modified approach the education variable is replaced by a variable that capture the difference between the actual years of education and the predicted education. Responsibility sets x^R can included in the different specifications: no variables $\emptyset$, estimation leads to the standard Gini; average week working hours H; years of education E; working for the government G; internal mobility M and the error terms ϵ_i that represent the part variation among income that we can not explain. The remaining variables are included in the no responsibility set x^{NR}.
Source: PSID

Figure 6: Unfairness Ginis for subsample with parental information



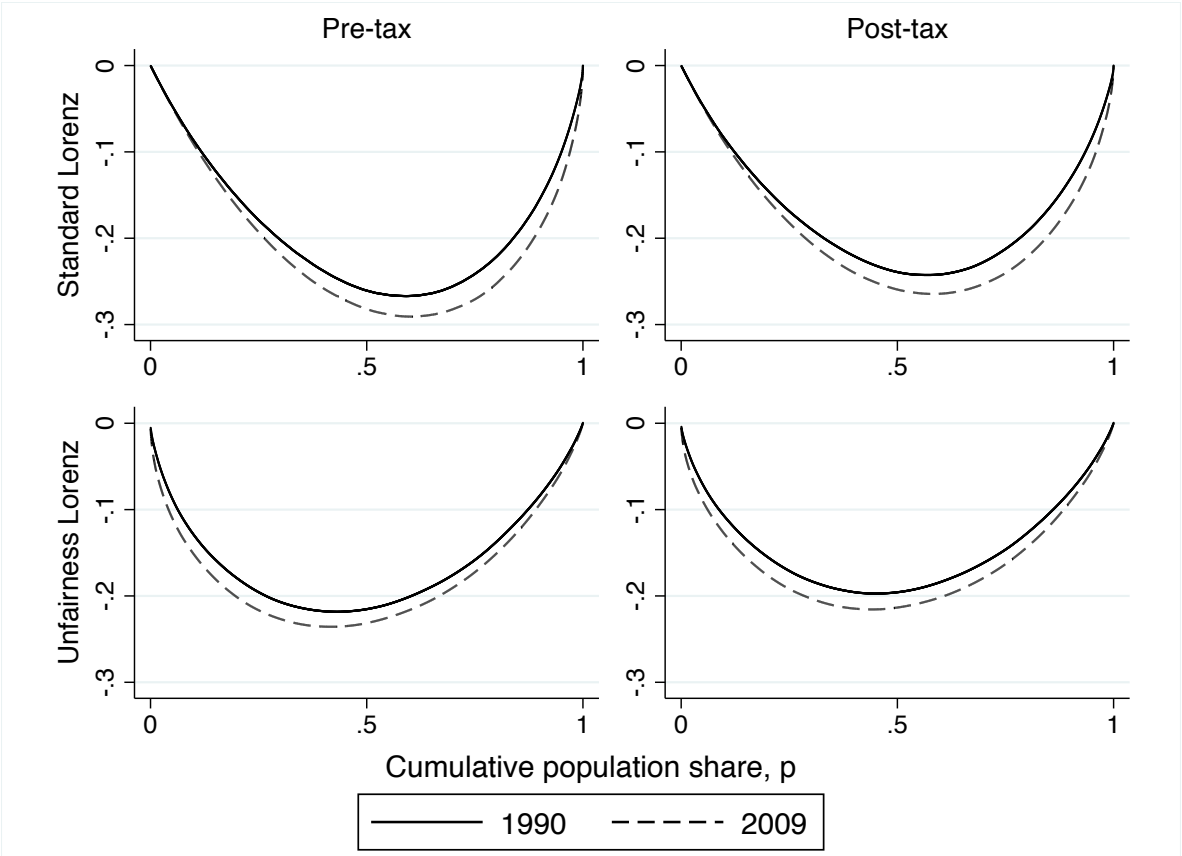
Note: The graphics reports the trends of standard Gini and Unfairness Gini for the period 1990-2009 for pretax incomes for the subsamples of individuals with parental information. For comparison also the standard Gini for the full sample is reported. The figure also compares the standard approach and the modified approach with correction for education.
Source: PSID

6.2 Unfairness Lorenz Curves

Another useful sensitivity analysis is to use different inequality measures and check whether the main results found in the previous section are confirmed. In fact, different inequality indexes could lead to different conclusion than the ones implied by the based on the Gini coefficient. The difference based Lorenz curve developed by Almås et al. (2011) can be used for this purpose. In particular, it is straightforward to check if an income distribution displays more inequality than another one accordingly to the class of inequality indexes that follows the desirable conditions of transfers, scale invariance and the principle of population comparing the related Lorenz curves (Ruiz-Castillo, 2007).

Regarding the traditional specification of the Lorenz curve, the concept of Lorenz dominance of income distribution A over income distribution B occurs when the curve relative to distribution A is above curve of income distribution B for any given cumulative proportion of population. In this case, income distribution A Lorenz-dominates income distribution B and this means that there is less inequality in A than in B. It also means that the qualitative results regarding inequality obtained comparing the Ginis corresponding to distribution A and B is robust to the results that can be obtained using any other relative inequality index (Moyes, 1987). Almås et al. (2011) show that the differenced based Lorenz curve follows the same properties and also in this case the unfairness Lorenz dominance imply the same considerations.

Figure 7: Difference based Lorenz curves



Note: The graphs report the differenced based Lorenz curves for 1990 and 2009 in the cases of empty responsibility set (equivalent to the Standard Lorenz Curve) and of the responsibility set including hours worked, years of education, internal mobility, and working in the public sector.
Source: PSID

Following equation 9, The difference based lorenz curves for the case of empty responsibility set (this curves are equivalent to the standards Lorenz curve), and for responsibility set including working hours, years of education, working in the public sector and internal migration have been calculated for both pre-tax and post-tax distributions in some of the years considered.

Figure 7 compare the first and the last years of the period. Regarding the standard Lorenz curve, for both the pre-tax and post-tax labor income distribution, 1990 distributions lorenz-dominates the 2009 distribution. This means that in 1990 there was more inequality than in 2009 and the results are robust to choice of any of relative inequality indexes

Also for the unfairness analysis, 1990 distribution Lorenz-dominates the 2009 distribution for both pre-tax and post-tax distribution. This means that in 2009 the

distribution of labor income was more unfair that in 1990 and that the use of other indexes different from the the unfair Gini, would have given the same qualitative result.

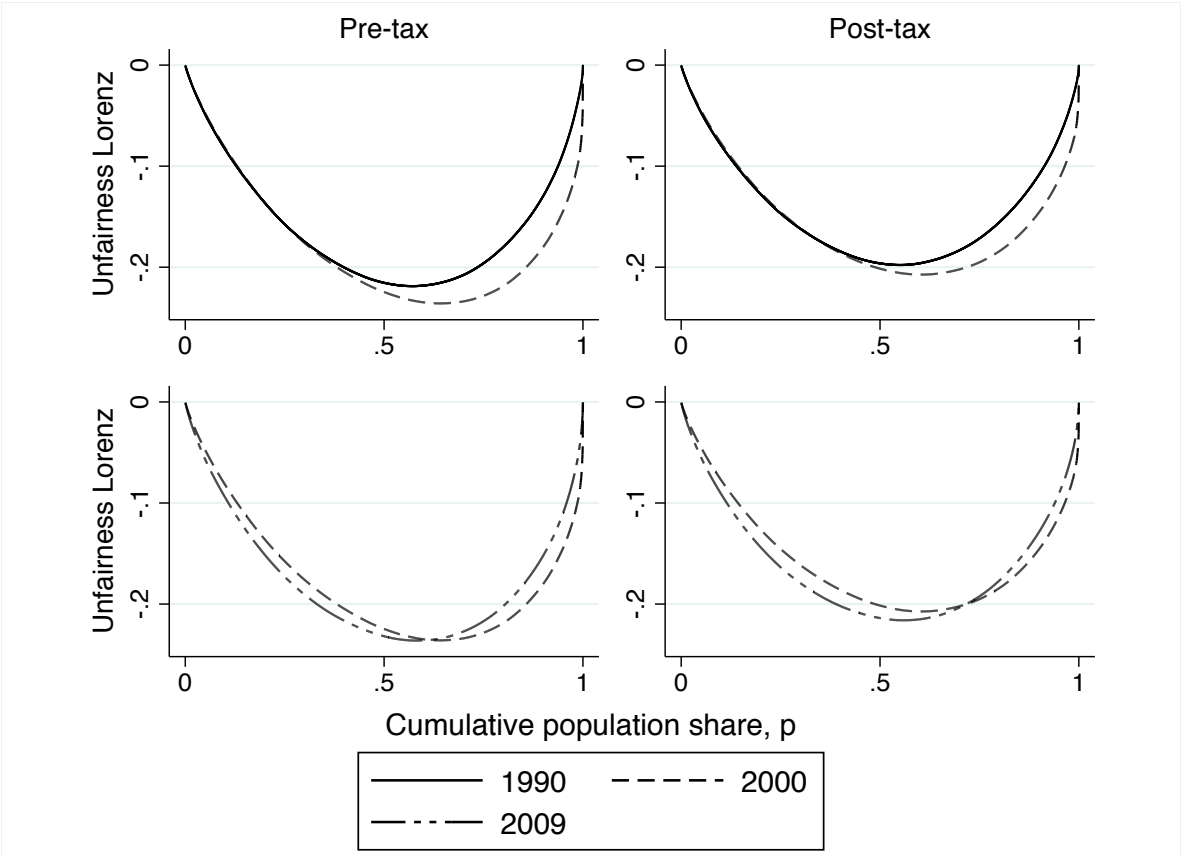
In the main analysis, one of the observations was that in a first sub-period (1990-2001) the unfair Gini was growing in the same way as the traditional Gini, whereas in the final sub-period (2001-2009) the unfairness remains stable. Thus, it is interesting also to compare for these two sub period the pre-tax and post- tax unfairness lorenz curves.

In the upper part of figure 8 there are reported the unfairness lorenz curves in 1990 and 2001 for pre-tax and post-tax distribution. Even if in both cases there is one intersection between the curves, the curves almost overlap for the lower tail of the distribution and a diverge substantially from the cumulative 50% percent of the population. Thus, it seems that the increase of unfairness estimated using the Gini coefficient is robust to the use of other inequality indexes.

The third and fourth graphs in the figure 8 compare instead the situation in 2001 with the situation in 2009. In this case the intersection between the curves is more visible in both the pre-tax and post-tax income meaning that it is more likely that different inequality indexes belong to the class of the relative inequality indexes give different ranking of the two distributions depending on the weights the index gives to the different part of the distributions.

Overall, also this sensitivity check confirmed the results found in the main exercise. First, it seems that the increase in the unfairness between 1990 and 2009 is indisputable. Second, it is also confirmed that the increase in unfair inequality is more clear from 1990 to 2001, whereas in the second period the increase, if any, was modest and not consistent to the use of alternative inequality measures than the Gini coefficient.

Figure 8: Alternative principles.



Note: The graphs report the differenced based Lorenz curves for 1990,2001 and 2009 in the cases of the responsibility set that includes hours worked, years of education, internal mobility, and working in the public sector.
Source: PSID

6.3 Other sensitivity principle

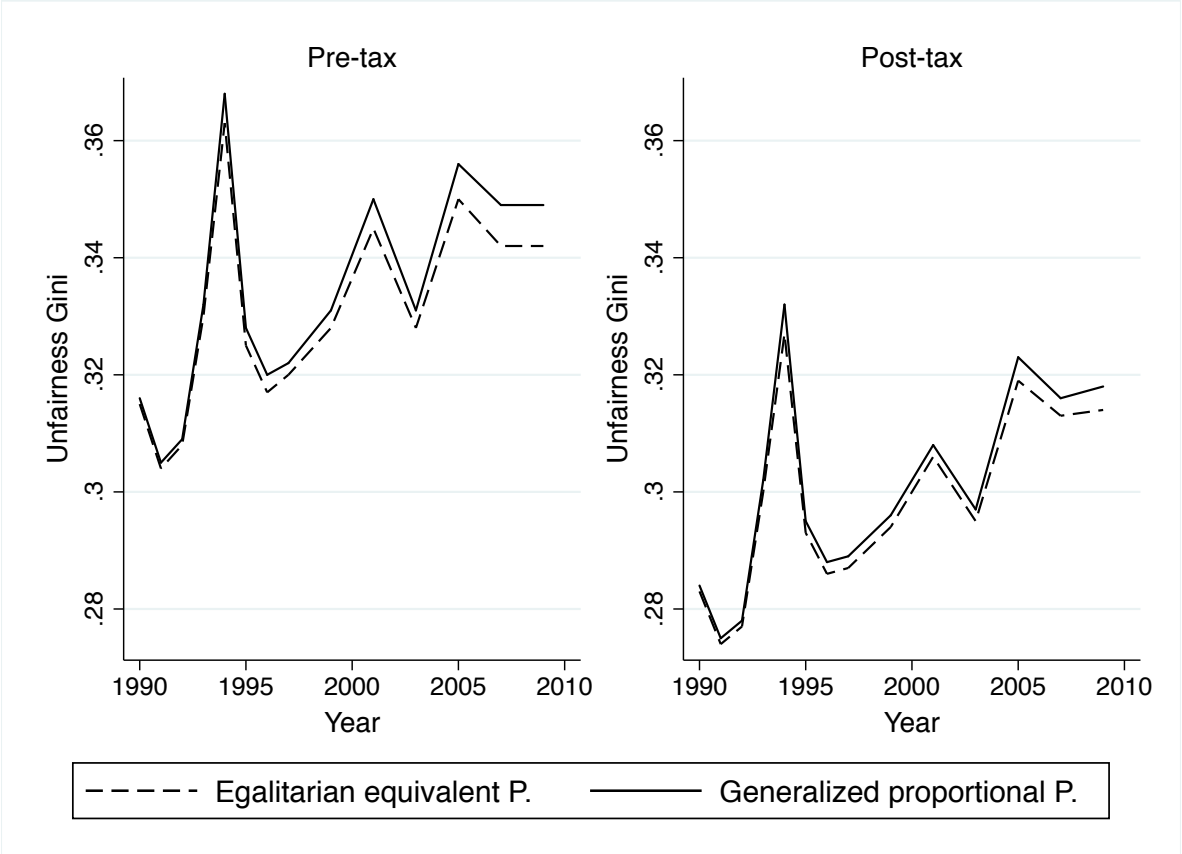
The analysis so far is based on the estimation of unfair inequality using as reference income distribution the distribution of fair incomes constructed using the empirical counterpart of the generalized responsibility principle. The choice of this principle was made because it is considered the one that better captures the responsible-sensitive ideal (Almås et al., 2011). However, as described in the literature review section, other principles can identify the fair redistribution policy and thus be used to construct the reference income distribution and in this section one of them will be used to check whether the results of the previous section are robust to the choice of fairness principle. In particular the Egalitarian equivalent principle developed by Fleurbaey and Bossert (1996) and employed in the empirical analysis of Devooght (2008) for the case of Belgium will be used.

Given the labor income regression estimated by equation 15, the empirical counterpart of the principle defined by equation 4 is:

$$z_i^{EE} = \exp(\beta x_i^R + \gamma \tilde{x}^{NR}) - \frac{1}{N}\sum_{j=1}^{n}(\exp(\beta x_j^R + \gamma \tilde{x}^{NR}) - y_j), \tag{19}$$

where $\tilde{x}^{NR}$ is now the vector of averages of the no responsibility variables and y is the pre-tax or post-tax income depending on the case studied. The specification of the responsibility set of the main analysis is used.

Figure 9: Unfairness Gini, Egalitarin Equivalent and Generalized proportional principle



Note: The graphics reports the trends of the unfairness Gini for the period 1990-2009 both for pretax and post tax incomes with different principles used to estimate the fair income, the Generalized Proportional and the Egalitarian Equivalent principles. The responsibility set includes: hours worked, years education, work for government and internal mobility. Source: PSID

Figure 9 reports the trend of the unfairness Gini in the case the fair incomes are calculated using the Generalized proportional principle and in the case the fair incomes are calculated using this last one definition of fair income. In general, the trend followed

by the unfairness Ginis are similar for both pre-tax and post-tax distributions. The lines almost overlap for the first part of the period and, even if diverge in the 2000s, the qualitative results outlines in the main analysis do not changes.

7 Discussion and Concluding Remarks

The research presents the first attempt to study the trend of unfair inequality in the U.S. using the novel approach proposed by Almås et al. (2011). Using data from the PSID for the period between 1990 and 2009 the paper proposed an estimation of the unfair inequality both or the pre-tax and post-tax labor income distribution for single households in the United States using a modified version of the Gini index and a reference contrafactual distribution of fair income estimated using the generalized proportional principle proposed by Cappelen and Tungodden (2007).

The results related to both the main analysis and following robustness check point toward considering the distribution of labor income in the United States to be more unequal in 2009 than in 1990, both for the pre-tax income and the post-tax income. In particular, the 1990 distribution of pre-tax and post-tax incomes Lorenz dominate the corresponding distribution in 2009. Furthermore, the Gini coefficient registers and increase of approximately a 10% for both the pre-tax and post-tax income distributions. This is a result in line with previous empirical analysis of the inequality in the United States (U.S. Census Bureau, 2012). As found by Bargain et al. (2013), the taxation in the last decade failed to decrease the growth rate of the inequality.

The main contribution to the existing empirical literature it is that overall the distribution of income in the United States has became more unfair in the last 20 years. The unfair pre-tax Gini coefficient increased of about 10 percent during the whole period and the rate of growth of the unfair post-tax Gini is a slightly higher, meaning that taxation does not contrast the upward trend of unfairness in the distribution of income. Using the preferred responsibility set, the unfairness Gini increased from 0.316 in 1990 to 0.349 in 2009 for the pre-tax income distribution and from 0.284 to 0.318. This result is robust to the choice of other responsibility sets, to the definition of fair income and to the use of other inequality indexes. The rise during this period can be caused by some of the factors that also lead to the rise in the overall inequality. For example the rise in the share of total income held by the top percentiles of the distribution increased in the U.S. since the 80s and it is likely that this increase is not motivated by an increase of effort that those individuals have exerted. An increasing share of

women in the labour force can also have lead to an increase in the unfair inequality. In fact, as estimated by the labor regression women earn on average less than men, and an higher proportion of working women could have raise the inequality that depend on the irrelevant characteristic represented by the gender of individuals.

Two different sub period trends can be recognized. First, during the 90s, the unfair Gini and the traditional Gini show a similar growth rate. Instead from 2001 the the pre-tax and post-tax unfair Gini coefficients remain stables. This trend is in contrast with the trend displayed by the traditional Gini, that increased also in the last decade. These results are in general robust to other specifications of the responsibility set, to other inequality measurements and to an other principle used to identify the fair income distribution. This finding is someway in line with the findings by Pistolesi (2009) and Marrero and Rodríguez (2011). They also find that in the last period of their analysis, the share of the total inequality due to the inequality of opportunity decreased. One of the possible explanation given by the authors is that the earning return to the responsible variables has increased in this period. This possibility is consistent with the coefficient estimated for the labor regression in table 3. In fact, the education premium for every additional year of education increase from 1990 to 2009 and also the individuals working more than 40 hours earn more in 2009 relatively more than individuals working less than 30 hours than in 1990. Another possible explanation is that the financial crisis, even if has had a worsening effect on the overall inequality, has produced a fairer distribution.

It seems thus, that in the last decade, even if the income inequality increase in the United States both for pre-tax and post-tax income distributions, the unfairness remains stable. The recognition of this discrepancy between the trends of the unfairness Gini and the standard Gini can be derived from the increasing importance of responsible characteristics in determining the labor income (e.g. the increase educational premia). However, the purpose of this paper was only to give reliable estimation of the unfairness in the United States, and only hypothesis can be make. Further research could be conducted to determine the causes of the different trends. As pointed out in the introduction, recognizing the determinants of these different trends could be important also in the study of the relation between inequality and the redistribution policies and the relation between inequality and economic performance.

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8 Appendix

Table 7: Labor regressions, all years

Table . Name

	1990	1991	1992	1993	1994	1995	1996	1997	1999	2001	2003	2005	2007	2009
Internal mobility	0.036	0.011	0.060*	0.050	0.091*	-0.018	0.001	-0.017	0.086**	0.068*	0.087**	0.051	0.097**	0.072**
	(0.034)	(0.037)	(0.035)	(0.042)	(0.052)	(0.054)	(0.047)	(0.046)	(0.041)	(0.037)	(0.039)	(0.043)	(0.042)	(0.034)
Education	0.079***	0.099***	0.099***	0.099***	0.112***	0.123***	0.109***	0.092***	0.107***	0.110***	0.110***	0.123***	0.132***	0.126***
	(0.007)	(0.007)	(0.007)	(0.009)	(0.013)	(0.012)	(0.011)	(0.011)	(0.010)	(0.008)	(0.008)	(0.009)	(0.008)	(0.008)
W. hours: 30-40	1.216***	0.989***	0.962***	0.990***	1.070***	1.120***	1.074***	1.167***	0.844***	0.977***	1.011***	1.022***	1.110***	1.208***
	(0.087)	(0.078)	(0.078)	(0.073)	(0.086)	(0.090)	(0.085)	(0.112)	(0.086)	(0.083)	(0.080)	(0.082)	(0.076)	(0.064)
W. hours: $\geq$ 40	1.462***	1.289***	1.193***	1.265***	1.301***	1.369***	1.348***	1.489***	1.105***	1.234***	1.217***	1.259***	1.334***	1.589***
	(0.090)	(0.082)	(0.083)	(0.077)	(0.091)	(0.093)	(0.089)	(0.118)	(0.089)	(0.085)	(0.085)	(0.086)	(0.079)	(0.064)
Age: 30-39	0.243***	0.268***	0.254***	0.235***	0.183***	0.314***	0.290***	0.251***	0.307***	0.205***	0.384***	0.398***	0.297***	0.238***
	(0.040)	(0.044)	(0.045)	(0.049)	(0.060)	(0.053)	(0.048)	(0.051)	(0.050)	(0.043)	(0.046)	(0.049)	(0.046)	(0.039)
Age: 40-49	0.329***	0.414***	0.419***	0.384***	0.287***	0.455***	0.321***	0.290***	0.344***	0.340***	0.339***	0.389***	0.271***	0.244***
	(0.048)	(0.048)	(0.047)	(0.054)	(0.068)	(0.055)	(0.060)	(0.058)	(0.055)	(0.044)	(0.050)	(0.053)	(0.049)	(0.044)
Age: 50-59	0.407***	0.461***	0.495***	0.405***	0.403***	0.253**	0.399***	0.378***	0.503***	0.374***	0.411***	0.424***	0.323***	0.354***
	(0.055)	(0.056)	(0.053)	(0.062)	(0.081)	(0.106)	(0.067)	(0.084)	(0.065)	(0.055)	(0.059)	(0.057)	(0.052)	(0.043)
Black	-0.273***	-0.239***	-0.272***	-0.246***	-0.369***	-0.265***	-0.179***	-0.311***	-0.256***	-0.199***	-0.235***	-0.254***	-0.224***	-0.236***
	(0.035)	(0.037)	(0.038)	(0.041)	(0.051)	(0.044)	(0.041)	(0.055)	(0.041)	(0.035)	(0.040)	(0.038)	(0.038)	(0.031)
Other races	-0.198**	-0.161**	-0.061	-0.169*	-0.077	0.037	-0.009	-0.177*	-0.113	-0.156**	-0.048	-0.014	0.132*	-0.026
	(0.078)	(0.079)	(0.060)	(0.087)	(0.167)	(0.144)	(0.115)	(0.092)	(0.070)	(0.064)	(0.063)	(0.105)	(0.080)	(0.088)
Female	-0.148***	-0.118***	-0.128***	-0.151***	-0.173***	-0.104**	-0.119***	-0.104**	-0.244***	-0.193***	-0.200***	-0.193***	-0.175***	-0.153***
	(0.036)	(0.037)	(0.037)	(0.041)	(0.052)	(0.043)	(0.043)	(0.051)	(0.039)	(0.034)	(0.039)	(0.041)	(0.038)	(0.032)
Public sector	0.144***	0.122***	0.110**	0.132***	0.243***	0.126**	0.151***	0.168***	0.198***	0.190***	0.201***	0.210***	0.187***	0.179***
	(0.045)	(0.043)	(0.045)	(0.046)	(0.063)	(0.055)	(0.053)	(0.058)	(0.044)	(0.035)	(0.045)	(0.042)	(0.040)	(0.036)
R-squared	0.350	0.369	0.329	0.308	0.251	0.313	0.286	0.327	0.304	0.397	0.328	0.357	0.368	0.389
Sample size	2161	1753	1968	2072	1724	1799	1873	1662	1693	1783	1974	1983	2139	2991

Note: Estimation of the labor equation for all years. The dependent variable is the logarithm of labor income. Omitted categories are: working hours:$\leq$30, age: 20-29, white. Robust standard errors are reported in parentheses*** significant at 1% level, ** significant at 5% level, * significant at 10% level.
Source: PSID

Table 8: Unfairness Gini,pre-tax, post-tax, all responsibility sets.

Pre-tax						
year	$\emptyset$ (Standard Gini)	$\{H\}$	$\{H, E\}$	$\{H, E, G\}$	$\{H, E, G, M\}$	$\{H, E, G, M, \epsilon_i\}$
1990	0.374	0.344	0.318	0.316	0.316	0.133
1991	0.369	0.336	0.306	0.305	0.305	0.135
1992	0.369	0.344	0.311	0.309	0.309	0.141
1993	0.392	0.359	0.333	0.332	0.332	0.131
1994	0.417	0.390	0.368	0.369	0.368	0.153
1995	0.386	0.357	0.328	0.327	0.328	0.136
1996	0.377	0.345	0.322	0.320	0.320	0.109
1997	0.383	0.350	0.324	0.322	0.322	0.131
1999	0.381	0.358	0.330	0.331	0.331	0.148
2001	0.399	0.371	0.349	0.351	0.350	0.130
2003	0.383	0.358	0.331	0.331	0.331	0.137
2005	0.408	0.378	0.355	0.357	0.356	0.156
2007	0.402	0.372	0.348	0.350	0.349	0.130
2009	0.415	0.371	0.348	0.350	0.349	0.122
Post tax						
year	$\emptyset$ (Standard Gini)	$\{H\}$	$\{H, E\}$	$\{H, E, G\}$	$\{H, E, G, M\}$	$\{H, E, G, M, \epsilon_i\}$
1990	0.340	0.310	0.286	0.284	0.284	0.120
1991	0.334	0.302	0.276	0.275	0.275	0.122
1992	0.335	0.310	0.280	0.279	0.278	0.129
1993	0.359	0.327	0.303	0.303	0.302	0.120
1994	0.378	0.350	0.330	0.332	0.332	0.145
1995	0.348	0.319	0.295	0.295	0.295	0.124
1996	0.340	0.309	0.289	0.288	0.288	0.101
1997	0.346	0.314	0.290	0.289	0.289	0.118
1999	0.342	0.320	0.294	0.296	0.296	0.140
2001	0.352	0.325	0.306	0.308	0.308	0.137
2003	0.345	0.320	0.296	0.298	0.297	0.124
2005	0.369	0.341	0.321	0.324	0.323	0.139
2007	0.365	0.336	0.315	0.318	0.316	0.115
2009	0.378	0.336	0.317	0.319	0.318	0.113

Note: The table presents estimation of Gini's for all responsibility sets. Responsibility sets x^R can included in the different specifications: no variables $\emptyset$, estimation leads to the standard Gini; average week working hours H; years of education E; working for the government G; internal mobility M and the error terms ϵ_i that represent the part variation among income that we can not explain. The remaining variables are included in the no responsibility set x^{NR}.

Table 9: Unfairness Gini,pre-tax, all responsibility sets for the subsamples with parental information

Standard approach					
year	$\emptyset$ (Standard Gini)	$\{H\}$	$\{H, E\}$	$\{H, E, G\}$	$\{H, E, G, M\}$
1990	0.370	0.339	0.314	0.313	0.313
1991	0.363	0.329	0.303	0.302	0.302
1992	0.369	0.343	0.309	0.308	0.307
1993	0.387	0.355	0.329	0.329	0.328
1994	0.403	0.376	0.354	0.354	0.354
1995	0.384	0.356	0.329	0.328	0.328
1996	0.375	0.343	0.321	0.320	0.320
1997	0.375	0.343	0.321	0.320	0.321
1999	0.376	0.353	0.326	0.329	0.328
2001	0.394	0.367	0.350	0.352	0.352
2003	0.376	0.351	0.328	0.328	0.328
2005	0.398	0.369	0.350	0.353	0.352
2007	0.391	0.361	0.341	0.344	0.344
2009	0.412	0.366	0.345	0.347	0.346
Modified approach					
year	$\emptyset$ (Standard Gini)	$\{H\}$	$\{H, E\}$	$\{H, E, G\}$	$\{H, E, G, M\}$
1990	0.370	0.339	0.321	0.320	0.320
1991	0.363	0.329	0.309	0.309	0.308
1992	0.369	0.343	0.315	0.314	0.314
1993	0.387	0.355	0.336	0.336	0.335
1994	0.403	0.376	0.359	0.360	0.359
1995	0.384	0.355	0.333	0.333	0.333
1996	0.375	0.343	0.325	0.323	0.323
1997	0.375	0.343	0.326	0.326	0.327
1999	0.376	0.353	0.332	0.336	0.335
2001	0.394	0.367	0.353	0.356	0.354
2003	0.376	0.351	0.332	0.333	0.332
2005	0.398	0.369	0.352	0.356	0.354
2007	0.391	0.361	0.341	0.345	0.344
2009	0.412	0.366	0.349	0.350	0.349

Note: The table presents estimation of Gini's for the subsamples of individuals with parental information. In the modified approach the education variable is replaced by a variable that capture the difference between the actual years of education and the predicted education. Responsibility sets x^R can included in the different specifications: no variables $\emptyset$, estimation leads to the standard Gini; average week working hours H; years of education E; working for the government G; internal mobility M. The remaining variables are included in the no responsibility set x^{NR}.

Table 10: Unfairness Gini,pre-tax, post-tax for the Egalitarian equivalent principle

pre-tax		
year	Pre-tax Gini	Post-tax Gini
1990	0.315	0.283
1991	0.304	0.274
1992	0.308	0.277
1993	0.330	0.300
1994	0.363	0.327
1995	0.325	0.293
1996	0.317	0.286
1997	0.320	0.287
1999	0.328	0.294
2001	0.345	0.306
2003	0.328	0.295
2005	0.350	0.319
2007	0.342	0.313
2009	0.342	0.314

Note: The table presents estimation of unfairness Ginis using the Egalitarian equivalent principle in order to identify the fair distribution of incomes. Responsibility sets x^R includes: average working hours H; years of education E; working for the government G; internal mobility M. The remaining variables are included in the no responsibility set x^{NR}.

Table 11: Working hours and years of education regressions, all years

Dependent Variable:	**Working hours**													
	1990	1991	1992	1993	1994	1995	1996	1997	1999	2001	2003	2005	2007	2009
Education of Father	0.176	0.184	0.205	-0.005	0.188	0.170	0.261	0.362**	0.085	0.093	0.189	0.232	0.151	0.083
	(0.155)	(0.162)	(0.154)	(0.175)	(0.201)	(0.176)	(0.164)	(0.178)	(0.182)	(0.173)	(0.189)	(0.197)	(0.195)	(0.164)
Education of Mother	0.144	0.622***	0.163	0.535***	0.439*	0.127	0.195	0.186	0.015	0.727***	0.120	0.172	0.183	0.246
	(0.180)	(0.184)	(0.178)	(0.198)	(0.232)	(0.202)	(0.187)	(0.209)	(0.208)	(0.201)	(0.216)	(0.219)	(0.212)	(0.178)
State grew up	0.031**	0.001	0.002	0.000	-0.000	-0.002	0.023	0.027	0.001	0.001	0.026	-0.005	-0.008	-0.007
	(0.016)	(0.017)	(0.016)	(0.019)	(0.022)	(0.019)	(0.018)	(0.017)	(0.019)	(0.018)	(0.020)	(0.021)	(0.021)	(0.017)
R-squared	0.005	0.019	0.004	0.007	0.007	0.002	0.006	0.009	0.000	0.017	0.003	0.003	0.002	0.002
Sample size	1860	1519	1687	1790	1518	1580	1648	1302	1314	1374	1498	1517	1633	2320
Dependent Variable:	**Years of Education**													
	1990	1991	1992	1993	1994	1995	1996	1997	1999	2001	2003	2005	2007	2009
Education of Father	0.381***	0.357***	0.338***	0.311***	0.263***	0.288***	0.244***	0.253***	0.231***	0.228***	0.252***	0.257***	0.272***	0.268***
	(0.036)	(0.038)	(0.035)	(0.033)	(0.035)	(0.034)	(0.035)	(0.033)	(0.035)	(0.032)	(0.031)	(0.030)	(0.030)	(0.025)
Education of Mother	0.291***	0.295***	0.297***	0.289***	0.201***	0.201***	0.267***	0.269***	0.293***	0.267***	0.249***	0.257***	0.264***	0.302***
	(0.042)	(0.043)	(0.041)	(0.038)	(0.041)	(0.039)	(0.040)	(0.039)	(0.040)	(0.038)	(0.035)	(0.034)	(0.033)	(0.027)
State grew up	0.015***	0.010**	0.013***	0.013***	-0.002	-0.000	-0.001	0.002	-0.000	0.000	-0.002	0.003	0.006*	0.006**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
R-squared	0.202	0.198	0.198	0.189	0.121	0.138	0.133	0.152	0.156	0.147	0.152	0.157	0.167	0.185
Sample size	1860	1519	1687	1790	1518	1580	1648	1302	1314	1374	1498	1517	1633	2320

Note: Estimation of the labor equation for all years. The dependent variable is the logarithm of labor income. Omitted categories are: working hours:≤30, age: 20-29, white. Robust standard errors are reported in parentheses.*** significant at 1% level, ** significant at 5% level, * significant at 10% level.
Source: PSID