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Inequality of opportunity and income inequality in Spain: An analysis over time

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Abstract

The aim of this paper is to contribute both theoretically and empirically to the study of Inequality of Opportunity in Spain. The analysis is carried out using microdata collected by the European Union Statistics on Income and Living Conditions (EU-SILC), which incorporate a wide variety of personal harmonised variables, allowing comparability with other countries. The availability of this database for years 2004 and 2010 is particularly relevant to analyse the impact of the economic crisis, the empirical evidence shows significant increases in both income inequality (17.24%) and, more significantly, inequality of opportunity (62.34%). According to our findings, the effect of circumstances on income distribution has intensified between the two years.

Keywords: circumstances, EU-SILC, income, inequality, opportunity.

JEL Classification: D31, D63, O15.

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1. INTRODUCTION

The analysis of income inequality as well as inequality of opportunity has become increasingly important in recent years and the relevance of research on inequality is even more obvious in scenarios of economic crises. Nevertheless, the analysis and measurement of inequality of opportunity has been carried out from a long term perspective, without consideration of the shocks affecting individuals' welfare through their uneven opportunities or the different effect circumstances may have in different periods of time.

Since the second half of the 20th century the ethical basis of utilitarian paradigm, according to which inequality should be quantified in reference to variables of consumption, income or wages, began to be questioned. As pointed out by numerous scientists and political philosophers (Rawls, 1971; Nozick, 1974; Sen, 1980; Dworkin 1981 a, b; Arneson, 1989; Cohen, 1989) inequality in the distribution of outcome does not denote an adequate ethical approach to assess situations of economic or social disadvantage. All these authors incorporate, from different points of view, the idea that a fair society would be one in which all individuals are not equally rich, but a society in which individuals have the freedom to achieve what they want without being limited by factors or circumstances beyond their responsibility.

Following the formalization by Roemer (1998) to address Inequality of Opportunity it is necessary to distinguish between "circumstances" factors over which individuals have no control (and therefore they cannot be held responsible of) and "efforts" which can be attributed to individuals' performance and commitment. Theoretical work of Roemer (1993) and Van de Gaer (1993) set the basis for the study of inequality of opportunity, expressing their concern about how society should compensate individuals for differences in outcome due to factors beyond its responsibility. Later on, contributions of Fleurbaey (1994) and Bossert (1995) lead to the formulation of the two fundamental ethical principles upon which the concept of Equality of Opportunity rests. The first, already mentioned in Roemer and Van de Gaer studies, was the *principle of compensation* meaning that inequalities attributable to circumstances should be removed. The second principle is called *principle of reward*, and it determines how to compensate efforts within individuals which share the same circumstances.

The concept of Inequality of Opportunity, specifically the idea behind the principle of compensation, is becoming increasingly important when designing public policies. From this perspective, public action should not be aimed at reducing inequalities in income, but at compensating the effect of circumstances in overall inequality. There is experimental evidence (Cappelen et al. 2010) and attitude surveys (Schokkaert and Devooght 2003, Gaertner and Schwettmann 2007) confirming that individuals distinguish between inequality due to the level of effort and due to circumstances, as suggested by the theory of equality of opportunity. This sort of inequality also affects preferences for redistribution, since people who believe that a high level of income or wealth is due to individuals own efforts and not to circumstances tend to prefer less redistributive policies.

Empirical studies in this field are scarce due to the difficulties in measurement since opportunities cannot be observed. As a consequence of the prompt development experienced by the empirical literature in the recent years as well as the difficulties both normative and methodological involved in the measure of inequality of opportunity, the vast majority of the empirical studies have not followed a one-way road. Instead of that, different methodological approaches have been developed in this research area, in which a relationship between normative and theoretical principles is not always observed, as described in Ferreira, Peragine (2015) and Ramos, Van de Gaer (2015). As a result, there is a lack of comparability between different empirical studies, which is a major drawback when interpreting the estimates.

This paper is focused on the study of inequality of opportunity in Spain. More specifically, we develop measures which allow us to estimate inequality of opportunity for years 2004 and 2010 with information from the EU-SILC database. The analysis of these two years is particularly relevant since it allows us to examine the impact of economic crises on inequality of opportunity and its relationship with overall income inequality in a changing scenario.

The rest of the paper is structured as follows. Section 2 provides information of the conceptual framework and different methodological approaches used in the literature to measure inequality of opportunity. Section 3 details the database and the variables used in this paper. Section 4 briefly describes the methodological approaches used in our estimations and the methods to calculate the contribution of the circumstances to inequality of opportunity. Section 5 presents the main empirical results and the paper ends by summarising the conclusions in section 6.

2. CONCEPTUAL FRAMEWORK

The measurement of inequality of opportunity constitutes a great challenge for several reasons. Firstly, opportunities are unobservable since they constitute a set of options that individuals can use in order to achieve their personal goals although they are not always exercised. Given that, they cannot be estimated directly as consumption or income. Secondly, the normative nature of equality of opportunities leads to the existence of numerous approaches when measuring this sort of inequality. Although there is a consensus on the core principles that should be met in measuring inequality of opportunity, the empirical literature is not always consistent with these principles. Thirdly and lastly, measurement can be performed using different methodologies through which we reach different results whose comparability is not guaranteed.

The concept of equality of opportunity was first formalised by John Roemer, who made a distinction between two categories of factors that affect inequality. More specifically, he calls “efforts” those factors over which individuals are held responsible (e.g. how many hours one works, how hard one works or how long one studies) and which produce a “socially acceptable” inequality. On the other hand, “circumstances” are the factors beyond the individual responsibility (e.g. gender, race or familiar background) and, therefore, generate “socially unacceptable” inequality. From this classification and according to Roemer (1998), equality of opportunities would be a situation in which the outcome given as reference (e.g. income or consumption, called variable of “advantage”) was independent of circumstances. Two key concepts were also introduced later: “types” by Roemer (1998), refers to groups of individuals who share the same circumstances and “tranches” by Peragine (2004), which are understood as a groups of individuals who exert the same degree of effort. Both distinctions are used to measure inequality of opportunity.

The distinction between the two principles made by Fleurbaey (1994) and Bossert (1995), the *principle of compensation*, which requires society to compensate individuals for outcome differences due to circumstances and the *reward principle*, which determines how to recompense efforts within individuals with the same circumstances; leads to the development of an extensive literature.

Following Ramos and Van de Gaer (2005) the last principle can be understood in three different ways: *liberal reward*, *utilitarian reward* and *bounded inequality averse reward*. The *liberal reward* according to Bossert and Fleurbaey (1996), implies no income redistribution of the variable used as “advantage” among individuals with the same

circumstances, whereas the *utilitarian reward* (Roemer 1993, Van de Gaer 1993) maintain a neutral position with regard to redistribution between individuals with same circumstances but different efforts. Finally, the *bounded inequality averse reward* says that there should be some redistribution between individuals with similar circumstances but different levels of effort, because the market retribution to efforts originates excessive inequalities.

The theoretical framework based on the principles of compensation and reward contributed to the further development of many empirical studies, which can be classified in several ways depending on the methodological approach used to calculate inequality of opportunity or according to the interpretation given to the core principles. One distinction can be made according to the interpretation given to the principle of compensation which have an ex ante and ex post interpretations. In terms of the ex ante approach, compensation between individuals should be performed prior to the determination of their levels of effort, whereas in accordance with the ex post interpretation compensation should be conducted after knowing their levels of effort, i.e. individuals who exert the same degree of effort would receive the same outcome of advantage.

Table I illustrates the existing compatibilities between the two primary principles of equality of opportunity. Both ex ante and ex post compensation are incompatible with the principle of liberal reward but compatible with the principle of bounded inequality aversion reward. Likewise, the ex post approach has the disadvantage of being incompatible with the principle of utilitarian reward, which is commonly used to estimate inequality of opportunity, if circumstances and efforts are not independently distributed (see Fleurbaey Peragine 2013 and Ramos Van de Gaer 2016) for a further discussion of the topic). Consequently, the ex ante interpretation of the principle of compensation would be sensible when estimating inequality of opportunity following the utilitarian reward approach.

[place TABLE I here]

Additionally, measures of inequality of opportunity can also be classified according to the methodology implemented in their estimation. In this case, measures can be divided into three different types (Table II): the first type of measures are estimated using stochastic dominance analyses of distributions, whereas the estimation of the second

group is based on the concept of fair allocation, and the estimation of the latter type lies in the construction of counterfactual distributions.

The stochastic dominance analysis stems from the ex ante framework and involves tests for first order stochastic dominance (O'Neill et al. 2000 and Lefranc et al. 2008 and 2009) as well as second order dominance (Lefranc et al. 2008 and 2009) in distributions conditioned by circumstances. However, this methodology does not provide a complete classification of inequality of opportunity.

The second approach entails the use of norm based measures. It encompasses the implementation of a redistribution mechanism that assigns each individual an income depending on circumstances and efforts. In this manner, the principles of reward and ex post compensation are satisfied to some extent, as described by Devooght (2008) and Almas et al. (2011). This approach is based on the conditional inequality and egalitarian equivalence criteria introduced by Fleurbaey and Schokkaert (2009).

The third and final approach within this classification, which is the most widely used in the empirical literature, is based on the construction of counterfactual distributions from both ex ante and ex post perspectives. It relies on the isolation of inequality due to circumstances (direct measures based on the criterion of minimum mean, Van de Gaer (1993)), or due to efforts (indirect measures based on the criterion of minimum average Roemer (1993)), and then the comparison between the counterfactual and the initial distribution provides an estimation of the inequality of opportunity. As seen in Table II these measures can be estimated through both parametric and nonparametric techniques.

[place TABLE II here]

In conclusion, given the different normative and methodological approaches, there are many ways to measure inequality of opportunity. However, they all have in common the requirement to define a set of circumstances beyond the individual responsibility and a variable as “advantage” that serves as a benchmark for measuring success (wages, income, wealth...).

3. DATABASE

The database used is the European Survey of Income and Living Conditions (EU-SILC), in particular the surveys conducted in 2005 and 2011, which contain data for years 2004 and 2010 respectively and are the only ones with collected information on characteristics

of the parents of respondents. This survey was first conducted in 2003 and arose from an agreement between six member States of the European Union (Austria, Belgium, Denmark, Greece, Ireland and Luxembourg) and Norway with the main purpose of collecting microdata comparable across countries. Data on income, poverty, social exclusion and living conditions are collected based on the idea of a “common framework” according to which the harmonised variables for each country must be transferred to Eurostat.

To carry out this study the equivalised disposable income¹ of households is adopted as “advantage” variable. This variable is used for EU-SILC in poverty analyses since it takes into account the structure of the households and therefore it is considered a good indicator of living conditions and the quality of life. To perform the proposed analysis the sample is restricted to individuals aged between 25 and 59 years and whose professional situation is dependent worker in order to ensure a level of reliability which cannot be guaranteed by the income declared by self-employed workers.

The selected sample has a remarkable size, 13,299 observations for 2004 and 12,910 for 2010. Variables used as circumstances are shown in Table III as well as the proportion of individuals according to each circumstance and the average level of equivalised disposable income for the two periods analysed. The variables Gender and Immigrant rely on two categories, whereas Maximum parental educational attainment, Density and Regions incorporate three different categories resulting in a maximum of 72 types of individuals.

In Table III it can be seen that changes in shares over time are statistically significant for all variables except for the variable density. The major changes can be observed in the variable *Parental Education* in which the proportion of Low education experienced a slight reduction between 2004 and 2010 due to an increase in the share of individuals whose parents have a Medium level of education. Changes were also observed in the share of immigrants, increasing more than 40% between 2004 and 2010. The other circumstances do not show any major change in their shares between the years analysed.

[place TABLE III here]

¹ The equivalence scale used by EU-SILC is: $e = 1 + 0.5(N_{14+} - 1) + 0.3N_{13-}$ where N_{14+} is the number of household members with 14 years or more and N_{13-} the number of members with 13 years or less.

For a further illustration of the data, Table IV provides the share of individuals within the categories of each circumstance who have an income below the median. In other words, the table shows the percentage of individuals who have an unfavourable situation with respect to the median. As it can be seen in the board, categories within each circumstance show different shares of individuals in a disadvantaged situation. For instance, the circumstance *Parental Education* exhibits a noteworthy increase in the share of disadvantaged individuals as the educational level decreases.

In general, results are fairly intuitive: taking into account the circumstance gender it can be seen that the share of disadvantaged individuals is higher in the category female, and the same occurs with the circumstances *Density* and *Immigrant* in which the categories with a higher proportion of disadvantaged individuals are Low density and Immigrant respectively. In the case of *Regions*, as with *Parental Education*, the share of disadvantaged is higher for the regions representing the low income population. Regarding the rank of categories by the proportion of disadvantaged individuals, no changes are observed between years 2004 and 2010, although the shares vary slightly in some cases.

[place TABLE IV here]

Finally, Figures 1 to 4 illustrate the cumulative distribution functions of income for the circumstances *Immigrant*, *Parental Education*, *Density* and *Regions*² respectively, showing the distributional differences between categories within a circumstance.

As expected, some differences between categories can be noted regarding each circumstance, results that are consistent with the figures shown in Table IV above. Likewise, it can be observed that differences between categories are the same for all levels of effort (income), that is to say, divergence between categories is a continuous effect. The only case in which the continuous effect is not observed corresponds to the circumstance *Regions*, since no differences are found in the upper part of the distribution between the Low and Medium categories.

[place Figure 1 here]

[place Figure 2 here]

² The CDF is not displayed for the variable *Gender* since there is not significant difference between the two categories of individuals observed.

[place Figure 3 here]

[place Figure 4 here]

Tables III and IV and Figures 1-4 have an important descriptive function to understand the composition into categories of each circumstance. However, it is important to bear in mind that they hide a lot of inequality of opportunity, since we are actually interested in the differences between types which are not observed there.

The proposed variables allow us to take into account the main circumstances of individuals. It can be argued that we do not take into account the innate intelligence, which is approached by Björklund et al. (2012) with the IQ coefficient during adolescence and it seems to be a very influential circumstance. However, the EU-SILC database does not provide that information, furthermore, it is questionable if it is a circumstance, since individuals' IQ grows during the childhood and the adolescence due to different stimulus, some of them circumstances (e.g. family background) but also efforts (e.g. time dedicated to study or read).

The construction of the variables and its categorization in no more than three types makes it possible to compare these results with those of other countries contained in the LIS database (foreseen for further research).

Regarding the variables Density and Regions, which can be claimed not to be strictly exogenous since individuals can choose where to live, despite they are not unalterable circumstances we consider that both variables provide significant information about the impact of regional inequalities which conform a large part of overall income inequality. Likewise, it can be argued that the place where individuals live must not be allowed to determine their income. The fact that an individual change its place of residence is indeed dependent of her effort, but the level of effort necessary to change those alterable circumstance is not homogenous between individuals and ultimately clearly depends on unalterable circumstances such as family background or region of birth.

4. METHODOLOGY

This section describes the methodology used to estimate inequality of opportunity for each year. More specifically, the ex ante nonparametric approach proposed by Checchi and Peragine (2010), the ex ante parametric approach used by Ferreira and Gignoux (2011), and the parametric method proposed by Björklund et al. (2012) are described

further on. Likewise, two procedures used to quantify the contribution of each circumstance to overall inequality of opportunity are also discussed.

Equality of opportunity generally requires that the variable of advantage is independent of individual circumstances. To estimate inequality of opportunity we consider N individuals, $i \in \{1, \dots, N\}$ each one characterized by three components: y_i which is the variable of advantage; e , which represents the level of effort exerted and C , the vector of circumstances consisting in K elements where each k is a specific circumstance.

Individuals are divided into T different types, $t \in \{1, \dots, T\}$, and each type comprises all individuals who share the same circumstances. Likewise, each circumstance k can take several values denoted as z_k , and therefore, the number of types is determined by the number of circumstances and the different values each of these circumstances can take. This can be expressed in a more analytical way as follows: $T = \prod_{k=1}^K z_k$.

In order to measure inequality we use the mean logarithmic deviation, MLD, (also known as Theil's L) given by the expression: $GE(0) = \frac{1}{N} \sum_{i=1}^N \ln\left(\frac{\bar{y}}{y_i}\right)$, which belongs to the family of generalized entropy measures³ and satisfies the property of being additively decomposable into subgroups by a *path-independent* decomposition (Foster and Shneyrov 2000).

4.1 Ex ante nonparametric method

Given the distribution of the advantage variable: $y = (y_1, \dots, y_N)$ and considering that there are N individuals divided into T types, a counterfactual distribution $\{\mu_i^t\}$ is generated, in which we assign each individual the type average of the advantage variable. The resulting distribution would be: $\{\mu_i^t\} = (\mu_1^1, \dots, \mu_{n_1}^1; \dots; \mu_i^T, \dots, \mu_N^T)$ and the inequality associated to this distribution would be the absolute inequality of opportunity:

$$IO_A^{NP} = I(\{\mu_i^t\})$$

³ The generalised entropy measures (Cowell 1980 and 2009; Shorrocks 1984) are given by the expression $GE(\beta) = \frac{1}{\beta(\beta-1)} \left[\frac{1}{N} \sum_{i=1}^N \left(\frac{y_i}{\bar{y}}\right)^\beta - 1 \right]$. They conform a family of measures that satisfy the principles of mean independence, population independence, symmetry, the Pigou-Dalton transfer principle and decomposability. The β parameter represents the weight given to the distances between incomes of different parts of the distribution. When β takes low values the measure is more sensitive to what occurs at the bottom of the distribution, whereas for high values of the parameter β the measures would be more sensitive to what occurs on the top. The measure proposed (MLD) entails $\beta=0$.

From the original distribution of the advantage variable and the counterfactual distribution it is possible to estimate the relative inequality of opportunity, which measures inequality of opportunity with respect to overall inequality:

$$IO_R^{NP} = \frac{I(\{\mu_i^t\})}{I(y)}$$

This method is inequality averse to the differences in between type incomes caused by the correlation between effort and circumstance. Therefore, the correlation between efforts and circumstances are treated as a part of circumstances and considered inequality of opportunity.

4.2 Ex ante parametric method of Ferreira and Gignoux (2011)

The parametric method relies on the ordinary least squares estimation of the following equation: $\ln y_i = C_i\beta + u_i$, which is the reduced form of the equation $\ln y_i = C_i\alpha + E_i\delta + v_i$, where α is the direct effect of circumstances on individual outcome, while δ would capture the effect of circumstances through their effect on the level of effort. Hence the β coefficient of the reduced form reflects the impact of both effects in the outcome variable, since efforts E_i depend on circumstances $E(C, e)$

Once the regression is estimated, a counterfactual distribution is constructed to measure inequality of opportunity as follows:

$$\hat{\mu}_i = \exp(C_i\hat{\alpha})$$

Analogous to the nonparametric procedure, absolute and relative inequality of opportunity are obtained from the following expressions:

$$IO_A^P = I(\hat{\mu}_i) \qquad IO_R^P = \frac{I(\hat{\mu}_i)}{I(y)}$$

4.3 Ex ante parametric method of Björklund et al. (2012)

This latter procedure, unlike the previous two, considers the “type-specific variance effect” that we will call indirect inequality of opportunity. It is assumed that each type possesses its own distribution of effort, since the circumstances affect the level of effort exerted. Consequently, the effort would have two components: a type specific component u_i^t with variance σ_t^2 and a pure effort component with homogenous dispersion characterized by the expression: $u_i^t \frac{\sigma}{\sigma_t}$, where u_i^t are the residuals of each type, σ the

overall standard deviation and σ_t the type specific standard deviation (hence, the residuals of the estimated regression are $u_i^t \frac{\sigma}{\sigma_t} = e_i$).

The procedure relies on the estimation of the same model as Ferreira and Gignoux (2011): $\ln y_i = C_i \beta + u_i$ and subsequently uses the residuals of this regression to estimate the type specific variances. Then the estimated variances are regressed on the circumstances and the fitted values are used in order to estimate \tilde{u}_i^t , which is the component that captures the effect of circumstances in the level of effort, that is to say, indirect inequality of opportunity. The regression equation would be written as follows:

$$\ln y_i = C_i \beta + u_i = C_i \beta + \tilde{u}_i^t + e_i$$

4.4. Measurement of the contribution of each circumstance to inequality of opportunity

Once inequality of opportunity has been estimated by the mentioned procedures, we analyse the importance of each circumstance variable in inequality of opportunity. This analysis is carried out for the results of the parametric method, in particular we measure the importance of circumstances in direct inequality. Two different procedures are used: a regression-based inequality decomposition (Fields 2033) and a decomposition based on the marginal effect of circumstances (Shapley value).

The first mentioned method, proposed by Fields (2003) involves performing a regression. This procedure is similar to that proposed by Morduch and Sicular (2003) from the decomposition by factor components of Shorrocks (1982). Nevertheless, in this case the decomposition of inequality cannot only be made by sources of income, it allows us to observe the contribution to inequality of any determinant of income and as well as Shorrocks' method results are independent of the inequality measure chosen and of the level of disaggregation.

This method is implemented regressing the fitted values for the equivalised disposable income $C_i \hat{\alpha}$ on the circumstances. Then, the variance of the dependent variable is decomposed in a way that allows to assign each part of it to the explanatory variables. Hence, the contribution of circumstances to inequality of opportunity can be observed since it is the only sort of inequality existing in the previous estimation of the equivalised disposable income.

The second procedure is the decomposition based on the Shapley value, according to which the marginal effects of circumstances under different sets are computed through an inequality index, in this case GE(0). In order to observe the marginal effect of each circumstances we need to consider all possible sets of circumstances that only differ in the inclusion or omission of the circumstance analysed. Subsequently, the weighted average of the marginal effects of all possible permutations is taken as the contribution of circumstances to inequality of opportunity. This procedure has the advantage of allowing the use of other indexes apart from the variance although its outcome is sensitive to the index chosen and the level of disaggregation.

5. EMPIRICAL ANALYSIS AND RESULTS

This section provides the empirical results obtained with the procedures previously described in section 4. On the one hand, the first subsection contains the estimations of inequality of opportunity through the nonparametric and parametric approaches. With this regard two different sets of circumstances are considered, the first one including all the variables and the second one omitting the circumstance *Regions*, and two cohorts are assumed for the calculations of inequality of opportunity. On the other hand, the second subsection analyses the contribution of each circumstance to inequality of opportunity through the proposed methods.

The analysis of inequality of opportunity in relative terms requires the comparison with overall inequality of the advantage variable. Table V describes the inequality in terms of equivalised disposable income for Spain, showing that inequality experienced a slight increase from 2004 to 2010 (the Gini index increases around a 4%, while the Theil-L index rises 18%). It is interesting to bear in mind that changes in total and relative inequality of opportunity do not necessarily have to coincide in direction, since an increase in inequality of opportunity lower than the increase in overall inequality would lead to a decrease in relative inequality of opportunity). Therefore, it is essential to analyse the indicators both in absolute and relative terms.

[place TABLE V here]

5.1 Estimates of inequality of opportunity through parametric and nonparametric procedures

Tables VI, VII and VIII show the estimated inequality of opportunity according to different procedures: the nonparametric approach, the parametric approach by Ferreira

and Gignoux (2011) and the parametric approach by Björklund et al. (2012). In the first two procedures calculations are made for two sets of circumstances, one which contains 24 different types (since the circumstance referred to regional income is excluded) while the other set (including the variable *Regions*) comprises 72 types of circumstances in order to make a sensitivity analysis of the importance of that variable.

According to the first two procedures an increase in inequality of opportunity is observed between 2004 and 2010 both in absolute and relative terms. The estimated increase in inequality of opportunity is larger according to the parametric procedure. Regarding the impact of the two different sets of circumstances, as expected the inclusion of the Region produces a significant increase in the inequality of opportunity using both procedures. This is due to the fact that the inclusion of a greater number of circumstances results in a better approximation to inequality of opportunity since a wider variety of types are taken into account. Consequently, the component of overall inequality analysed to obtain inequality of opportunity –between groups inequality- is larger.

[place TABLE VI here]

[place TABLE VII here]

Each of the two approaches previously described, parametric and nonparametric, have their advantages and disadvantages, hence, their use may be more or less suitable depending on the situation. Thus, in the nonparametric approach a larger number of circumstances lead to less accurate estimates since there will be few observations for each type of individuals.

In the analysis undertaken, there are some types in which the number of observations are scarce even in the first set of circumstances with 24 types, a problem that increases when the second set of circumstances (72 types) is considered. Consequently the nonparametric estimation of GE(0) index provides a less reliable result than those estimated through the parametric approach. Likewise, as it has been indicated in Section 4 none of these two approaches capture the indirect effect through type-specific variance effect.

Furthermore, the comparison between the two parametric procedures shows that the Björklund et al (2012) approach leads to estimations closer to real inequality of opportunity. This procedure not only provides estimates of the direct effect of circumstances on the mean of individuals income as the two direct methods do, it also

takes into account the indirect type-specific variance effect, meaning individuals should not be held responsible for the differences in effort conditioned to their circumstances and their belonging to a specific type.

Table VIII summarises overall inequality of opportunity calculated by the latter procedure in both absolute and relative terms. This table also shows the part of this overall inequality due to the effect of circumstances in efforts, which is called indirect effect. In this case the inequality of opportunity estimated comprises a 15.21% of overall income inequality in 2004 and almost a 21% in 2010. According to these findings, the indirect component is significantly lower than the direct component, although its importance increases in 2 percentage points from 2004 to 2010.

[place table VIII here]

Table A1 in the Appendix show the results of the least square estimates to the parametric approach for both sets of circumstances, including 24 and 72 types. As it can be seen, the estimated coefficients have the expected signs: the facts of being a woman, living in an urban area with low density, being an immigrant and having progenitors with a low educational level result in a minor equivalised disposable income with regard to their counterparts (being a man, living in an urban area with medium or high population density, being born in Spain or having progenitors with a high educational level). Table A1 also confirms that living in regions which represents the bottom incomes (Low Income category) is negatively correlated with equivalent disposable income. Comparing the estimated coefficients over the two years considered, it can be seen that only two of them have changed substantially: the negative effect of being an immigrant in disposable income has worsened considerably in 2010 and living in a region in the Medium Income category is less bad.

Finally, since the dataset is large enough we can divide the sample into two age cohorts in order to analyse whether or not the effect of circumstances varies over the age. The first cohort comprises the youngest individuals, those between 25 and 40 years, whereas the second cohort contains individuals between 41 and 59 years old. Tables IX and X show the obtained results.

The first finding is that inequality of opportunity increases from 2004 to 2010 for both cohorts, as well as overall income inequality, results which are consistent with the ones from the overall sample. With regard to the differences between the two subgroups, it

seems that the first cohort (individuals between 25 and 40 years old) suffer a greater level of inequality of opportunity than older individuals while the contrary occurs for overall inequality.

These results coincide with our expectations, since in the aged cohort inequality incorporates a larger component of effort (i.e. we assume effort is accumulated over time since an aged person will have had more time to exert effort in a wider set of possibilities along with more time to perceive its results) while in the youngest cohort the effect of circumstances is more noticeable. It is also noteworthy that the indirect component of inequality of opportunity increases more than 3 percentage points for individuals in the second cohort while a modest increase is observed for younger individuals. In short, the obtained results suggest that age plays an important role reducing the effect that circumstances have in inequality of opportunity.

[place TABLE IX here]

[place TABLE X here]

5.2 Contribution of each circumstance to Inequality of Opportunity

Once the inequality of opportunity has been estimated, this subsection analyses the proportion of inequality due to each of the circumstances, computed both for the sets of types with and without the circumstance *Regions*. The analysis is carried out only for direct inequality of opportunity since it is not possible to know what percentage of indirect inequality is due to each of the circumstances and in any case, as we have previously confirmed, direct inequality is considerably more important.

Tables XI and XII show the contribution of each variable in the two years analysed through the regression based procedure by Fields (2003). For both years, the educational level of individuals' progenitors results to be one of the most influential circumstances in direct inequality thus agreeing with the findings of Bourguignon et al (2007) for Brazil. Other influential circumstances are the facts of being an immigrant and living in a region in the Low Income category. Conversely, it is observed that having progenitors with a medium educational level contributes to a lower level of inequality with respect to those with lower educational attainment. The other circumstances analysed (gender and population density) are found non-significant.

With regard to the changes in the contribution of circumstances between 2004 and 2010, the circumstances Gender, Density and Regions reduce their importance in 2010. On the contrary, the importance of being an immigrant and having progenitors with a low educational level increases over time. It is relevant to highlight the outstanding role played by the fact of being an immigrant on inequality of opportunity which doubled its effect between the two years analysed. Lastly, in the case of the medium educational level, its lowering effect increases slightly in 2010.

[place TABLE XI here]

[place TABLE XII here]

Thereupon, it is analysed the contribution of circumstances to inequality of opportunity through the decomposition procedure based on the Shapley value. Table XIII displays the results for the two years considered. This method measures contribution in a general manner (i.e. There is no distinction between the categories include in each circumstances) whereas Fields (2003) takes into account the contribution of the different categories in each circumstances. It can be observed that these results are consistent with the ones from Fields (2003) since they show similar values and the same evolution over time. Nevertheless, results of both procedures cannot be strictly compared since methodologies are different.

[place TABLE XIII here]

Summarizing, the use of these two different procedures allows us to confirm that, within the circumstances analysed, the place of birth (Spain or a foreign country), the region of residence and the educational attainment of progenitors are found to play a significant role in inequality of opportunity. In fact, these three variables contribute more than a half to the estimated inequality of opportunity.

6. CONCLUDING REMARKS

The increase of income inequality in Spain from 2004 to 2010 has been accompanied by an increase in inequality of opportunity both in its direct and indirect components. Overall income inequality measured by GE(0) index, increases between the two years in 17.65%, whereas inequality of opportunity estimated through the Björklund et al. (2012) procedure increases in 60.87%. This implies that the effect of circumstances, factors beyond

individual decisions and responsibility, on income distribution has intensified between the two considered years, arising a serious concern.

At the time of interpreting the obtained results one needs to bear in mind that these estimates depend on the circumstances used in the process. In fact, they only provide a lower bound of the actual inequality of opportunity (Ferreira and Gignoux 2011) since the existence of unobserved circumstances leads to an underestimation of actual inequality of opportunity. According to our empirical findings, the inclusion of further circumstances (the variable Regions) leads to a significant rise in the estimations of inequality of opportunity.

On the other hand, we should avoid the interpretation of the computed measures as the causal effect of the circumstances used (gender, parents' education, population density, place of birth and wealth of the region of residence) on inequality, taking into account the existence of unobserved –omitted- variables, which would lead to a misobservation of the true causal effect of circumstances on disposable income. They can be only considered as the contribution of the circumstances to the estimated inequality of opportunity.

Regarding the procedures we use to estimate inequality of opportunity, calculations are made only for the *ex ante* approach since is not inconsistent with compensation and reward principles, thus providing more meaningful estimates, consistent with the normative basis of this research field.

Comparing the three methodologies implemented to calculate inequality of opportunity, the procedure developed by Björklund et al. (2012) is assumed to be the most reliable and accurate empirical option since it is the only one taking into account indirect inequality. The nonparametric procedure by Checchi and Peragine (2010) should be only used when each type of individuals relies on a considerable number of observations, otherwise it produces more inaccurate results than the other two procedures.

The vast majority of empirical studies analysing inequality of opportunity focus on a specific period, averaging data of several years in order to eliminate transitory variations of income and estimate permanent income. The analysis carried out in this paper includes the comparison between two different years, 2004 and 2010, referred to significantly different economic scenarios, and therefore it provides interesting information about the evolution of inequality of opportunity over time, both in absolute and relative terms.

Likewise, our empirical analysis shows the contribution of a particular circumstance on inequality of opportunity in different moments of time. In fact, the impact of circumstances to inequality changes significantly from 2004 to 2010 (while the circumstances Gender, Density and Regions reduce their importance in 2010, the facts of being an immigrant and having progenitors with a low educational level become more relevant over time). These effects would have been ignored if we had considered the average of information related to both years.

Furthermore, regarding the implementation of public policies to soften or eliminate the effects of the circumstances on income inequality, the consideration of the effects referred to the current period seems to be more sensible than the assumption of an average with past years.

In the end, the present study shows how inequality of opportunity has behaved in a context of economic crisis. It also provides evidence on how the contribution of circumstance has varied in that period, showing that the economic crisis has brought a notorious rise in inequality of opportunity, also increasing the impact of the place of birth and the educational attainment of parents on inequality of opportunity. Lastly, the obtained results in the cohorts analysis suggest that age plays an important role reducing the effect that circumstances have in inequality of opportunity.

REFERENCES

- Alesina, A., & La Ferrara, E., "Preferences for redistribution in the land of opportunities", *Journal of public Economics*, 89(5), 897-931, 2005.
- Almås, I., Cappelen, A.W., Lind, J.T., Sørensen, E.Ø., & Tungodden, B., "Measuring unfair (in) equality", *Journal of Public Economics*, 95(7), 488-499, 2011.
- Arneson, R.J. (1989), "Equality and equal opportunity for welfare", *Philosophical studies*, 56(1), 77-93, 1989.
- Belhaj-Hassine, N., "Inequality of opportunity in Egypt", *The World Bank Economic Review*, 26(2), 265-295, 2012.
- Björklund, A., Jäntti, M., & Roemer, J.E., "Equality of opportunity and the distribution of long-run income in Sweden", *Social choice and welfare*, 39(2-3), 675-696, 2012.
- Bossert, W., "Redistribution mechanisms based on individual characteristics", *Mathematical Social Sciences*, 29(1), 1-17, 1995.
- Bossert, W., & Fleurbaey, M., "Redistribution and compensation", *Social Choice and Welfare*, 13(3), 343-355, 1996.
- Bourguignon, F., Ferreira, F.H., & Menéndez, M., "Inequality of opportunity in Brazil", *Review of income and Wealth*, 53(4), 585-618, 2007.
- Cappelen, A.W., Sørensen, E.Ø., & Tungodden, B., "Responsibility for what? Fairness and individual responsibility", *European Economic Review*, 54(3), 429-441, 2010.
- Checchi, D., & Peragine, V. (2010). "Inequality of opportunity in Italy", *The Journal of Economic Inequality*, 8(4), 429-450, 2010.
- Checchi, D., Peragine, V., & Serlenga, L., "Fair and unfair income inequalities in Europe", *ECINEQ WP 2010 – 174*, 2010.
- Cogneau, D., & Mesplé-Somps, S., "Inequality of opportunity for income in five countries of Africa", *Research on Economic Inequality*, 16, 99-128, 2008.
- Cohen, G.A., "On the currency of egalitarian justice", *Ethics*, 99(4), 906-944, 1989.
- Cowell, F.A., "On the structure of additive inequality measures", *The Review of Economic Studies*, 47(3), 521-531, 1980.
- Cowell, F.A., *Measuring Inequality*, LSE Perspectives in Economic Analysis, Oxford University Press, http://darp.lse.ac.uk/papersDB/Cowell_measuringinequality3.pdf, 2009.
- Devooght, K., "To Each the Same and to Each his Own: A Proposal to Measure Responsibility-Sensitive Income Inequality", *Economica*, 75(298), 280-295, 2008.
- Dworkin, R., "What is equality? Part 1: Equality of welfare", *Philosophy & Public Affairs*, 10, 185-246, 1981a.

- Dworkin, R., "What is equality? Part 2: Equality of resources", *Philosophy & Public Affairs*, 10, 283-345, 1981b.
- Eriksson, K.H., Jäntti, M., & Lindahl, L., "Equality of opportunity and the distribution of long-run income among Swedish men and women", *Unpublished paper*, 2013.
- Ferreira, F.H., & Gignoux, J., "The measurement of inequality of opportunity: Theory and an application to Latin America", *Review of Income and Wealth*, 57(4), 622-657, 2011.
- Ferreira, F.H., & Peragine, V., "Individual responsibility and equality of opportunity", in M. Adler and M. Fleurbaey eds., *Handbook of Well Being and Public Policy*, Oxford University Press, 2015.
- Ferreira, F.H., & Peragine, V., "Equality of opportunity: Theory and evidence", *World Bank Policy Research Working Paper*, 693, 2015.
- Fields, G.S., "Accounting for income inequality and its change: A new method, with application to the distribution of earnings in the United States", *Research in Labor economics*, 22(3), 1-38, 2003.
- Fleurbaey, M., "On fair compensation", *Theory and decision*, 36(3), 277-307, 1994.
- Fleurbaey, M., & Schokkaert, E., "Unfair inequalities in health and health care", *Journal of health economics*, 28(1), 73-90, 2009.
- Fleurbaey, M., & Peragine, V., "Ex ante versus ex post equality of opportunity", *Economica*, 80(317), 118-130, 2013.
- Foster, J.E., & Shneyerov, A.A., "Path independent inequality measures", *Journal of Economic Theory*, 91(2), 199-222, 2000.
- Gaertner, W., & Schwettmann, L., "Equity, responsibility and the cultural dimension", *Economica*, 74, 627-649, 2007.
- Juarez, F. W. C., & Soloaga, I., "iop: Estimating ex-ante inequality of opportunity", *The Stata Journal*, 14(4), 830-846, 2014.
- Lefranc, A., Pistolesi, N., & Trannoy, A., "Inequality of opportunities vs. inequality of outcomes: Are Western societies all alike?"; *Review of Income and Wealth*, 54(4), 513-546, 2008.
- Lefranc, A., Pistolesi, N., & Trannoy, A., "Equality of opportunity and luck: Definitions and testable conditions, with an application to income in France" *Journal of Public Economics*, 93(11-12), 1189-1207, 2009.
- Marrero, G.A., & Rodríguez, J.G., "Inequality of opportunity in Europe", *Review of Income and Wealth*, 58(4), 597-621, 2012.
- Morduc, H.J., & Sicular, T., "Rethinking inequality decomposition, with evidence from rural China", *The Economic Journal*, 112, 93-106, 2002.
- Nozick, R., *Anarchy, state and utopia*. Basic Books, New York, 1997.

- O'Neill, D., Sweetman, O., & Van de Gaer, D., "Equality of opportunity and kernel density estimation: An Application to Intergenerational Mobility", *Advances in Econometrics*, 14, 1999.
- Peragine, V., "Ranking income distributions according to equality of opportunity", *The Journal of Economic Inequality*, 2, 11-30, 2004.
- Piraino, P., "Intergenerational earnings mobility and equality of opportunity in South Africa", *World Development*, 67, 396-405, 2015.
- Pistolesi, N., "Inequality of opportunity in the land of opportunities, 1968–2001", *The Journal of Economic Inequality*, 7(4), 411-433, 2009.
- Ramos, X., & Van de Gaer, D., "Approaches to Inequality of Opportunity: Principles, Measures and Evidence", *Journal of Economic Surveys*, published online, 2015.
- Roemer, J.E., "A pragmatic theory of responsibility for the egalitarian planner", *Philosophy & Public Affairs*, 22(2), 146-166, 1993.
- Roemer, J.E., *Equality of Opportunity*. Harvard University Press, Cambridge, 1998
- Schokkaert, E., & Devooght, K., "Responsibility-sensitive fair compensation in different cultures", *Social Choice and Welfare*, 21(2), 207-242, 2003.
- Sen, A., "Equality of what?" in S. McMurrin ed., *The Tanner Lectures on Human Values*, University of Utah Press, Salt Lake City, 1980.
- Shorrocks, A.F., "Inequality decomposition by factor components", *Econometrica: Journal of the Econometric Society*, 50(1), 193-211, 1982.
- Shorrocks, A.F., "Inequality decomposition by population subgroups", *Econometrica: Journal of the Econometric Society*, 52(6), 1369-1385, 1984.
- Shorrocks, A. F., "Decomposition procedures for distributional analysis: a unified framework based on the Shapley value", *The Journal of Economic Inequality*, 11(1), 1-28, 2013.
- Singh, A., "Inequality of opportunity in earnings and consumption expenditure: The case of Indian men", *Review of Income and Wealth*, 58(1), 79-106, 2012
- Van de Gaer, D., *Equality of opportunity and investment in human capital*, Doctoral dissertation, Leuven: Katholieke Universiteit Leuven, 1993.

APPENDIX

TABLE A1. Regression results by Ferreira Gignoux (2011) approach

Variables\Year	WITHOUT VARIABLE REGION		WITH VARIABLE REGION	
	2004	2010	2004	2010
Female	-0.04*** 0.097	-0.032*** 0.011	-0.042*** 0.096	-0.036*** 0.011
Low density	-0.182*** 0.012	-0.167*** 0.013	-0.105*** 0.012	-0.109*** 0.013
Immigrant	-0.31*** 0.015	-0.435*** 0.015	-0.327*** 0.015	-0.451*** 0.015
Low education	-0.34*** 0.015	-0.367*** 0.018	-0.318*** 0.015	-0.341*** 0.018
Medium education	-0.138*** 0.023	-0.139*** 0.025	-0.130*** 0.023	-0.130*** 0.024
Low Income			-0.303*** 0.014	-0.316*** 0.014
Medium Income			-0.119*** 0.013	-0.06 0.015
Constant	9.778*** 0.015	9.926*** 0.018	9.904*** 0.017	10.047*** 0.019

Notes: Standard deviations are shown in parentheses

TABLES

TABLE I. Compatibility between the interpretations of the principles according to Ramos & Van de Gaer (2015)

Principle of reward	Principle of compensation	
	Ex Ante	Ex Post
Liberal	NO	NO
Utilitarian	YES	NO
Bounded inequality averse reward	YES	YES

Source: Compilation based on Ramos, Van de Gaer (2015)

TABLE II. Measurement of inequality of opportunity according to the implemented methodology

STOCHASTIC DOMINANCE	
O'Neill Sweetman & Van de Gaer (2000)	
Lefranc, Pistolessi & Trannoy (2008)	
FAIR ALLOCATIONS	
Devooght (2008)	
Almas (2011)	
COUNTERFACTUAL DISTRIBUTIONS	
Parametric	Nonparametric
Cogneau & Mesple-Soms (2008)	Checchi & Peragine (2010)
Bourguignon et al. (2007)	Checchi, Peragine & Serlenga (2010)
Pistolessi (2009)	Singh (2011)
Checchi, Peragine & Serlenga (2010)	Belhaj-Hassine (2012)
Ferreira & Gignoux (2011)	Piraino (2015)
Ferreira Gignoux & Aran (2011)	
Singh (2011)	
Belhaj-Hassine (2012)	
Björklund, Jäntti & Roemer (2012)	
Marrero & Rodríguez (2012)	
Eriksson, Jäntti & Lindahl (2013)	
Piraino (2015)	

Source: Compilation elaborated by the authors

TABLE III. Descriptive statistics

VARIABLES/AVERAGE OR PROPORTION	2004	2011	Statistically significance of changes over time
Equivalised disposable income	13,963.93 [7940.631]	15,732.28 [9196.007]	21.248***
Gender			
Female	48.10	49.64	2.4935**
Male	51.90	50.36	2.4935**

Max. parental educational attainment¹			
Low	81.04	79.48	3.1728***
Medium	6.97	9.27	6.8219***
High	11.99	11.26	1.843
Density²			
Low	23.55	24.1	1.045
Medium and high	76.45	75.9	1.045
Immigrant³			
Yes	11.69	16.77	11.7821***
No	88.31	83.23	11.7821***
Regions⁴			
Low	36.58	42.05	9.0655***
Medium	41.85	34.55	12.1570***
High	21.57	23.4	3.5486***

Notes: this table shows the proportion of individuals within each category, except for the equivalised disposable income for which its average in euros (current prices of each year) appears. Differences in shares between categories of the same variable are significant at 1% except for the gender variable in 2010, where no statistical significance is found.

Significant at 5%, *Significant at 1%

¹Parental education: Low, when both or one progenitor has a maximum degree of compulsory education; Medium, if both or one of them has a maximum of secondary education (high school or similar); High, if both or one of them holds a higher education degree.

²The category “Medium and high” includes places with a high degree of urbanization (population density over 500pop./km² and with more than 50,000 inhabitants) and with a medium degree (density over 100pop./km² and more than 50,000 inhabitants or adjacent to a highly populated area), the category “Low” corresponds with a low degree of urbanization, includes areas in which the requirements for a medium degree of urbanization are not satisfied.

³Individuals who were born outside Spain are considered immigrants. EU-SILC distinguishes between persons born in Spain, in the EU-24, in the rest of Europe or other countries. However, further splits in this category would result in few observations on each type, thus affecting negatively the accuracy of the analysis.

⁴The Autonomous Communities (each of the 17 territorial entities in which Spain is divided, corresponding to NUTS 2 category according to the Nomenclature of Territorial Units for Statistics developed by the EU) are divided into three categories according to their relative distribution of the equivalised disposable income, the regions represented the top incomes are in the High category, the middle incomes in the Medium category and the bottom incomes in the Low category.

TABLE IV. Share of individuals with an equivalent disposable income below the median

	2004	2010	Statistically significance changes over time
Gender			
Female	52.81	50.09	1.62
Male	50.85	48.85	3.2375***
Max. Parental educational attainment			
Low	55.96	53.60	3.2539***
Medium	37.68	36.54	1.6718*
High	27.59	28.14	0.00
Population density			
Low	64.06	59.48	8.3182***

Medium and high	47.11	45.58	1.62
Immigrant			
Yes	68.55	73.59	8.9613***
No	50.71	46.77	6.4762***
Regions			
Low	62.89	63.51	1.6811*
Medium	47.95	43.82	3.2537***
High	33.29	35.86	5.1086***

Notes: Differences in shares between categories of the same variable are significant at 1% except for the gender variable in 2010 which has a significance of 5%.

TABLE V. Inequality of equivalised disposable income GE(0) and Gini

	GE(0)	Gini
2004	0.153	0.293
2010	0.180	0.306

TABLE VI. Inequality of Opportunity measured by GE(0).
Nonparametric approach

	WITHOUT REGIONS		WITH REGIONS	
	Absolute	Relative	Absolute	Relative
2004	0.016	10.39%	0.023	14.90%
2010	0.020	10.87%	0.028	15.71%

TABLE VII. Inequality of Opportunity measured by GE(0).
Parametric approach (Ferreira and Gignoux 2011)

	WITHOUTH REGIONS		WITH REGIONS	
	Absolute	Relative	Absolute	Relative
2004	0.015	9.48%	0.021	13.64%
2010	0.022	12.40%	0.032	17.66%

TABLE VIII. Inequality of Opportunity measured by GE(0).
Parametric approach (Björklund et al. 2012)

	TOTAL		INDIRECT	
	Absolute	Relative	Absolute	Relative
2004	0.022	14.07%	0.0007	0.44%
2010	0.035	19.49%	0.0033	1.83%

TABLE IX. GE(0) – 25 to 40 years

	TOTAL		INDIRECT		OVERALL INCOME INEQUALITY
	Absolute	Relative	Absolute	Relative	
2004	0.0252	16.63%	0.0006	0.41%	0.153

2010	0.0414	23.30%	0.0021	1.20%	0.180
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TABLE X. GE(0) – 41 to 59 years

	TOTAL		INDIRECT		OVERALL INCOME INEQUALITY
	Absolute	Relative	Absolute	Relative	
2004	0.0182	11.68%	0.0007	0.48%	0.153
2010	0.0299	16.45%	0.0050	2.77%	0.180

TABLE XI. Proportion of direct inequality of opportunity due to circumstances

(Without regions)

	2004	2010
Female	1.07	0.44
Low density	23.33	12.24
Immigrant	28.88	53.34
Low education	51.57	38.40
Medium education	-4.85	-4.42
Total	100	100

TABLE XII. Proportion of direct inequality of opportunity due to circumstances

(With regions)

	2004	2010
Female	0.80	0.34
Low density	9.37	5.64
Immigrant	21.23	39.10
Low education	33.48	25.19
Medium decuation	-3.19	-2.92
Reg. Low Income	42.97	35.46
Reg Medium Income	-4.67	-2.80
Total	100	100

TABLE XIII. Decomposition based on the Shapley value

Variable	2004		2010	
	Value	Percentage	Value	Percentage
Gender	0.0002	0.86	0.0001	0.39
Density	0.0022	10.31	0.0019	6.08
Immigrant	0.0043	20.67	0.0118	37.2
Parents education	0.0066	31.45	0.0076	23.96
Regions	0.0077	36.71	0.0103	32.37
TOTAL	0.0209	100	0.0318	100

FIGURES

Figure 1

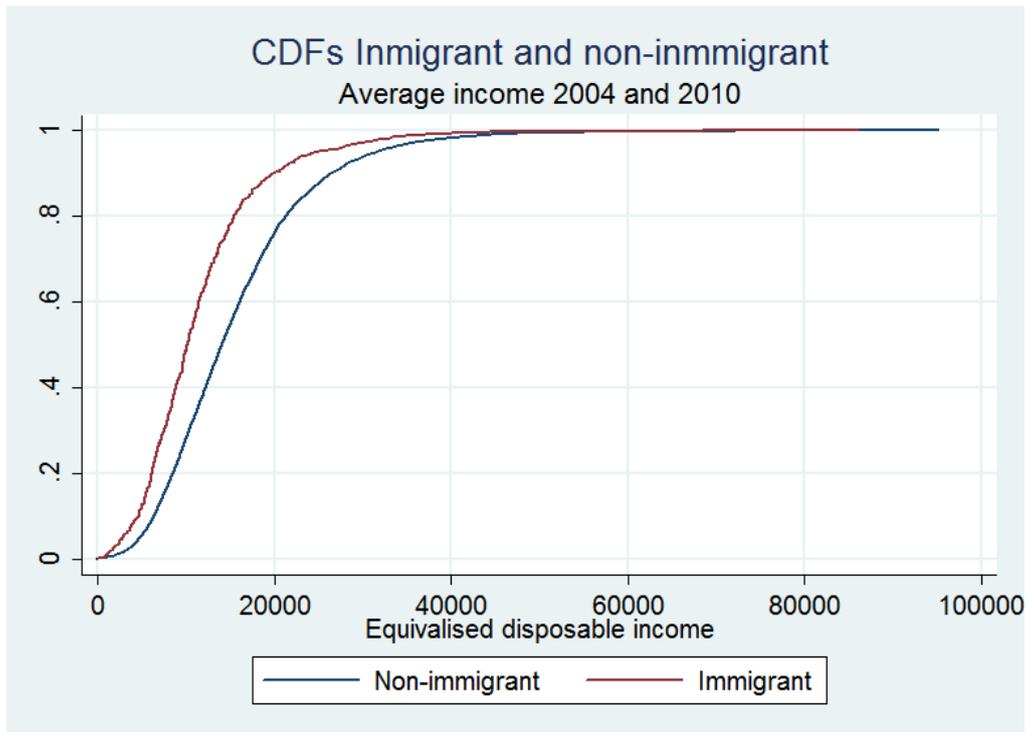


Figure 2

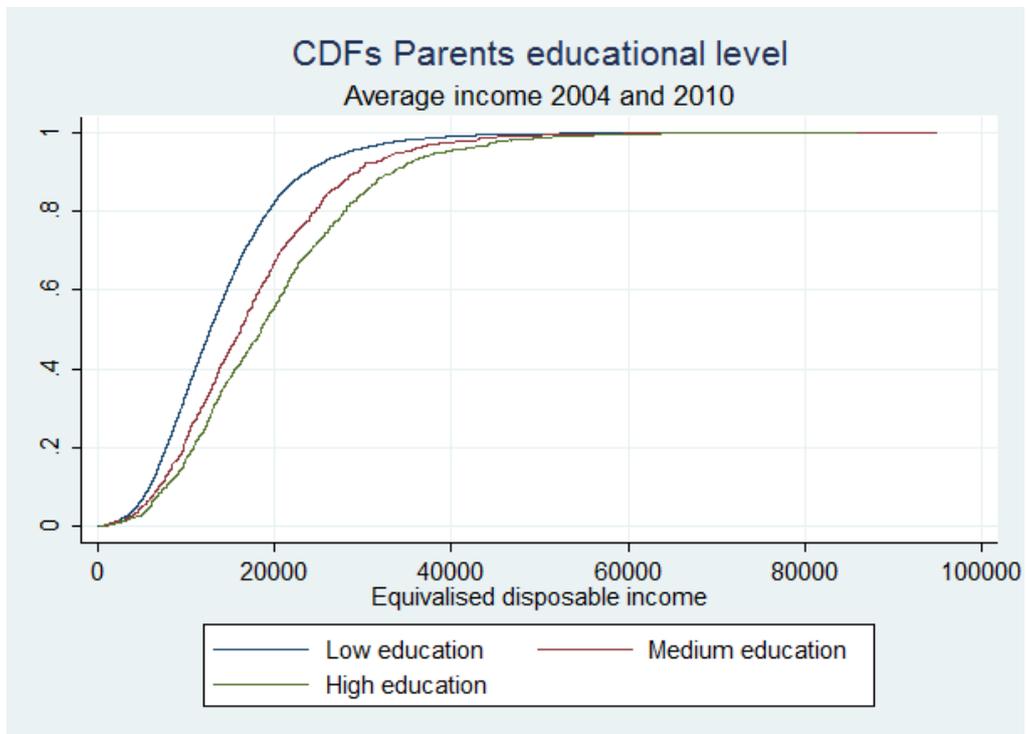


Figure 3

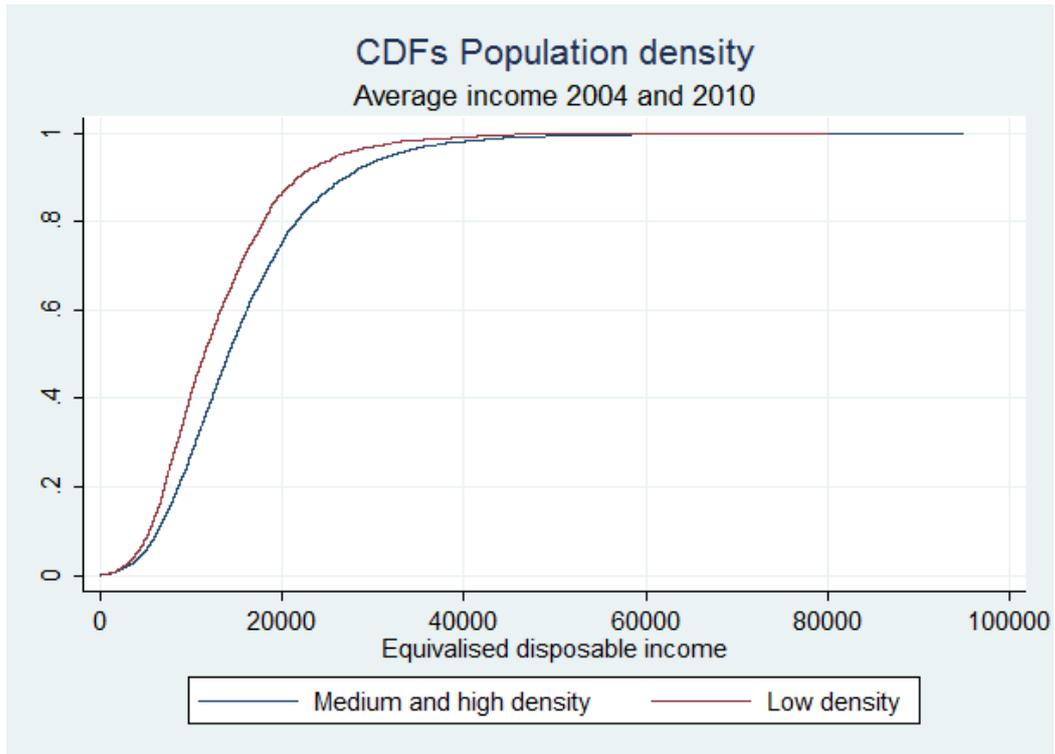


Figure 4

