Inequality of opportunities vs inequality of outcomes: Are Western Societies all alike?

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ABSTRACT

We analyze the extent of inequality of opportunities and inequality of outcome in nine developed countries during the 90's. We define equality of opportunity as the situation where income distributions conditional on social origin cannot be ranked according to stochastic dominance criteria. Stochastic dominance is assessed using non-parametric statistical tests. Our data come from national household surveys and social origin is defined by the respondent's father's education. USA and Italy show up as the most unequal countries both in terms of outcome and opportunity. At the opposite extreme, income distributions conditional on the fathers' education are quite similar in Scandinavian countries even before any redistributive policy. The analysis highlights that inequality of outcomes and inequality of opportunities can sometimes lead to different pictures. For instance, France and Germany experience a similar level of inequality of income while the former country is much more unequal than the latter from the point of view of inequality of opportunity. Differences in rankings according to inequality of outcome and inequality of opportunity underscore the importance of the policymaker's choice of the conception of equality to promote.

NON-TECHNICAL SUMMARY

In the paper, we compare the income distributions conditional on the father's education in nine developed countries in order to measure inequality of opportunity. Moreover, we compare inequality of opporunity with inequality of outcome. We measure income inequality with traditionnal tools. For inequality of outcome, the analysis concludes that income inequality is higher in the US, in Italy and in Great-Britain than in continental European countries (Germany, France, and Netherlands). Northern European countries (Belgium Sweden and Norway) experience a lower relative inequality level. For inequality of opportunities, Italy and the US are still the more inequalitarian, but Great-Britain and Germany are less inequalitarian. The two concepts are clearly positively correlated but the ranking of the countries is not the same.

1 Introduction

As income inequality has risen to the top of the social agenda in many countries, the need for international comparisons has become all the more pressing. Such comparisons provide indications on how different social systems or policies cope with income inequality. Focusing on developed countries, recent studies (Gottschalk and Smeeding (1997; 2000)) have established important differences across countries in the level of income inequality, with the USA and Great-Britain being more unequal than most continental European countries, which in turn are more unequal than the countries of Northern Europe.

Although such evidence is informative, it focuses only on what could be called inequality of *outcome*, that is, final inequality resulting from the economic, demographic and social process which generates the distribution of income. This concept of inequality has been used for decades and is easy to grasp. However, it does not necessarily measure the kind of inequality of concern in the current intellectual and social debate. For instance, influential philosophers such as Dworkin (1981), Arneson (1989) or Cohen (1989) have put the issue of personal responsibility at the forefront of the debate on equality. They stress the idea that economic and social policy should promote equality of opportunity: that it reduces inequality stemming from factors that are beyond the control of the individuals (*circumstances* in the terminology introduced by Roemer), while letting them bear the full consequences of factors for which they can be held responsible. This line of thought was recently introduced in the economics literature by John Roemer in several important theoretical and an empirical contributions ((Roemer, 1998)). It suggests that greater attention should be paid to the relative contribution of circumstances and personal responsibility in

the analysis of inequality.

The purpose of this paper is to offer an international comparison of inequality that echoes more closely the views on inequality held in contemporary societies and that is consistent with modern theories of justice. For this reason, we measure and compare the extent of equality of opportunity for income acquisition in developed economies. This complements results already obtained regarding the comparison of inequality of disposable income. In fact, there is no reason to suspect *a priori* that equality of opportunity is correlated with the degree of equality of outcome. For this reason, we also examine how countries' performance in terms of equality of opportunity relates to their degree of inequality of outcome. Indeed, if some countries favour the concept of equality of opportunity over equality of outcomes, one may observe a somewhat different ranking of countries according to the two criteria. Or it may be that countries that effectively promote equality of outcome are also those which are the most effective in achieving equality of opportunity.

Analyzing the extent of equality of opportunity for income acquisition remains a challenging problem and only few recent analyses have attempted it (See Roemer et al. (2003) and Bourguignon et al. (2003)). In particular, defining the set of relevant circumstances and measuring their contribution to observed inequality is certainly not an easy task; different methods have been suggested in the literature. In this paper, we focus on individual socio-economic family-background, as it is a source of inequality that all authors would agree to be an important dimension of the individuals' circumstances. The definition of inequality of opportunity used here borrows from a companion work (Lefranc et al. (2004a)). This definition rests on the notion of conditional (in)equality. We take the view that studying inequality of opportunity reduces to a comparison of the distributions of income, conditional on

individual social and economic background. Of course the relevant variables needed to describe individual background may vary over place (and time). In India, for instance, conditioning on castes comes to mind. When restricting our comparison to western developed societies, variables such as parental education or social group seem among the most meaningful ones for describing the advantages or deficiencies associated with personal origin.

In this paper, we use a data set gathered by Roemer et al. (2003) specifically designed to convey information on individual income and socio-economic background. This data set is built form national household surveys for nine countries: Belgium, France, Germany, Great-Britain, Italy, Netherlands, Norway, Sweden and United-States. It contains detailed information on most sources of individual income, as well as information, albeit more limited, on the education of the father of the individual respondent.

Since our data differ from those commonly used in international comparisons of income inequality, we first check that they deliver results on inequality of outcome that are comparable to those found in the literature, before turning to the analysis of equality of opportunity. With respect to inequality of disposable income, we also rank countries according to the criterion of Lorenz dominance which is known to be a more robust procedure than ranking by the ordering of inequality indexes. In the comparisons of inequality of outcome and inequality of opportunity we pay particular attention to issues of statistical inference, in contrast to many empirical analyses. To this end, we implement robust non-parametric tests of stochastic dominance that have been developed recently (Davidson and Duclos (2000)).

The rest of the paper is organized as follows. Section 2 presents the definition of equality of opportunity for income acquisition, the statistical procedure and an

index of inequality of opportunity. The data are presented in Section 3. Section 4 includes results about outcome inequality. Section 5 draws inequality-of-opportunity comparisons among the nine countries and offers a picture of each country from both perspectives. The last section concludes.

2 From inequality of outcome to equality of opportunity : definition and measurement

When measuring inequality of outcome in empirical work, a wealth of different approaches and indexes can be used. On the contrary, when departing from the analysis of outcome to examine opportunity, one first requires to provide a definition of equality of opportunity that can be implemented empirically.

In this section we offer a formal definition of equality of opportunity and show how it can be used to assess whether equality of opportunity holds. We also develop a cardinal measure of the extent of opportunity inequality that makes cross-country comparisons possible.

2.1 Definition

Equal-opportunity theories differentiate two fundamental sources of inequality among individuals: on the one hand, factors outside the realm of individual choice, usually referred to as *circumstances*; on the other hand, factors that individuals can be judged responsible for and that can be generically referred to as *effort*. One important principle emphasized by equal-opportunity theories is that differences in circumstances are not a morally acceptable source of inequality. On the other hand, inequality arising

from differences in effort need not be corrected. As a consequence, any level of inequality of outcome can be compatible with equality of opportunity. However, when equality of opportunity prevails, no set of circumstances should provide individuals with an advantage over any other set of circumstances. This allows us to derive a condition for equality of opportunity that can be implemented empirically.[1]

In order to derive this condition, one first needs to be more specific about the definition of the advantage that some circumstances s may provide over some others s'. Consider the situation where individuals would be allowed to choose their circumstances (before knowing the level of effort they will exert). In this context, we say that s provides some advantage over s', if all individuals prefer the opportunity set associated with s to the one associated with s'. Now if $S = \{1, \ldots, \overline{s}\}$ denotes the set of all possible circumstances, we say that equality of opportunity prevails if s is not preferred to s' by all individuals.

In the case of income acquisition, the opportunity offered to an individual with circumstances s can be summarized by the conditional income distribution x conditional on s, denoted $F(x \mid s)$. Choosing among elements of S amounts to choosing among income lotteries summarized by their conditional distribution $F(x \mid s)$. Obviously, the definition of equality of opportunity outlined in the previous paragraph is contingent upon the preferences used to rank the opportunity sets offered by different circumstances. We would like the proposed criterion to hold for a sufficiently broad class of preferences. In this paper we use stochastic dominance theory to rank the opportunity offered by different circumstances. In fact, second-order stochastic dominance is equivalent to Generalized Lorenz (GL) dominance[2]. It offers a powerful

[1] This characterization of equality of opportunity is developed with greater details in Lefranc, Pistolesi, Trannoy (2004a).

[2] The Generalized Lorenz curve plots the average income of individuals below the qth quantile

and quite general criterion for comparing income lotteries.[3] For example, consider two lotteries $F(x \mid s)$ and $F(x \mid s')$. If $F(x \mid s)$ dominates $F(x \mid s')$ according to second-order stochastic dominance, then the lottery associated with s is preferred to the one associated with s' by any individual (a) whose preferences satisfy the axioms of expected utility theory and (b) whose Von-Neuman Morgenstern utility function is increasing and concave. [4]

To summarize, we will say that equality of opportunity is satisfied for the set of circumstances S if and only if :

$$\nexists (s, s') \in S^2 \text{ such that } F(x \mid s) \succ_{SD_2} F(x \mid s')$$

where $\succ_{SD_2}$ denotes second-order stochastic dominance. Defining equality of opportunity as non-dominance with a second order stochastic dominance criterion is equivalent to saying that an individual choosing among these circumstances is unable to rank them.

2.2 Measurement

2.2.1 Stochastic dominance tests

The condition developed in the previous paragraph suggests a natural empirical test to assess whether equality of opportunity prevails: first, estimate the conditional income distributions associated with some given circumstances and then compare

for all quantiles. See for example Cowell (2000).

[3] $F(x \mid s)$ dominates $F(x \mid s')$ according to second-order stochastic dominance, denoted $F(x \mid s) \succ_{SD_2} F(x \mid s')$, iff $\forall x$, $\int_0^x F(y \mid s)dy < \int_0^x F(y \mid s')dy$.

[4] First-order stochastic dominance would provide an even more robust characterization of equality of opportunity, given our definition, since it only requires the Von-Neuman Morgenstern utility function to be increasing.

these distributions using second-order stochastic dominance tools. When drawing the GL curves of two conditional income distributions, three situations can occur: (a) one curve lies above the other, (b) the two curves intersect, (c) the two curves are identical. Our definition implies that equality of opportunity prevail in case (b) or in case (c). It is violated in case (a). Case (c) is an interesting particular case of equality of opportunity[5]. Equality of the conditional distributions may be referred to as strong equality of opportunity and can even be detected with a first-order stochastic dominance test.[6] That is why in practice, we estimate the conditional income distributions and we perform non-parametric stochastic dominance tests at the first and second order. The methodology had been developed in Davidson and Duclos (2000). The details of the test statistics and procedure are presented in the appendix.

We implement the following sequence of tests. Comparing two distributions for sub-populations A and B, we test the null that the two distributions are equal. If we fail to reject the null we conclude to strong equality of opportunity between A and B. Note that rejection of the null can occur either because the two distributions A and B intersect or because of dominance at the first order. Consequently, if we reject the null of equality, we go on testing first-order dominance: we test for the dominance of distribution A over B and vice-versa. If the two tests reject dominance, we go on at the second order by drawing Generalized Lorenz curves. We conclude to equality of opportunity in case of a two-way rejection of dominance.

[5]One can notice that it corresponds to the definition of equality of opportunity developed in Roemer (1998)

[6]$F(x \mid s)$ dominates $F(x \mid s')$ according to first-order stochastic dominance iff $\forall x \; F(x \mid s) < F(x \mid s')$. First-order dominance implies second-order dominance.

2.2.2 Inequality of opportunity index

One drawback of the characterization of equality of opportunity with an ordinal approach is that it does not allow us to rank different situations in which we would reject equality of opportunity. At the cost of a loss of generality, it is also possible to build an index allowing to measure the degree of inequality of opportunity.

Before proceeding further, it is useful to wonder what kind of minimal properties such an index must satisfy. Borrowing from the literature on inequality indexes (see for instance Sen and Foster (1997)), it seems reasonable to require the following properties.

1) *Within-type Anonymity.* The measure must be invariant to any permutation of two individuals of the same type.

2) *Between-type Principle of Transfers of Pigou-Dalton.* Consider two types such that the first one dominates the second one according to the GL test. The measure must decrease if we perform any transfer from some first-type individual to some other second-type individual such that (a) in the ex-ante distribution, the first-type individual is richer than the second-type individual and (b) in the ex-post distribution, the first-type individual is not poorer than the second-type individual, others things being equal. From the Hardy-Littlewood-Polya theorem, it seems clear that the equality of the two distributions may be obtained through a finite sequence of such transfers.

3) *Normalization.* If the CDFs corresponding to all types are identical, then the index must be equal to 0.

4) *Principle of Population.* The measure is invariant to a replication of the population.

5) *Homogeneity of Degree zero.* The measure is invariant to a scale factor applied to all incomes.

This list of properties defines a class of indexes of equality of opportunity. Among it, we favor an index that sounds familiar since it resorts to the most popular index of inequality, the Gini index.

First we ought to agree on a measure of the opportunities offered to individuals of a given type in the space of lotteries. Here we borrow some ideas from the literature about measuring opportunity sets (see Peragine (1999) for a survey). It is natural to see the set under the Generalized Lorenz curve of a given lottery as the feasible opportunity set. Indeed, any lottery dominated according to the GL test belongs to this set. In an influential contribution to the measurement of opportunity, Pattanaik and Xu (1990) axiomatized the cardinal of a discrete set as a measure of opportunity. Among the axioms introduced by the authors, the following monotonicity property reads as follows. Given an opportunity set A and an opportunity y which does not belong to A, $A \cup y$ offers more opportunity than A. When the opportunity set is continuous, counting elements of the opportunity set does not make sense any more. A natural extension is to consider the area below the opportunity set as a cardinal measure of opportunity and, for instance, Bensaid and Fleurbaey (2003) already proposed such a measure when the opportunity set is a budget set. Hence, we use the area under the GL curve of a type as a quantitative assessment of the opportunity of this type.

Let us rank the types according to twice the area under the GL curve, starting from the smallest one. This area for the worst type is equal to $\mu_1(1 - G_1)$ with μ the average and the G the Gini coefficient Yitzhaki (1979) already proposes $\mu(1 - G)$ as a measure of satisfaction of the society, here of the society made of the individuals of

the same type. The Gini-opportunity index obeys to the following formula

$$GO(x) = \frac{1}{\mu} \sum_{i=1}^{k} \sum_{j>i} p_i p_j (\mu_j (1 - G_j) - \mu_i (1 - G_i)). \tag{1}$$

It computes the weighted sum of all the differences between areas of opportunity sets. Dividing by the average income of the population μ allows to get an index which does not depend on the wealth of the society. This index can be viewed as an extension of the Gini coefficient since, when there are as many types as individuals, we are back to it,

$$G(x) = \frac{1}{n^2 \mu} \sum_{i=1}^{n} \sum_{j>i} (x_j - x_i) \tag{2}$$

and therefore the Gini-opportunity index is comprised between 0 and 1. Comparison of formula (1) and (2) allows to establish $GO(x) \leq G(x)$ and that the Gini-opportunity index increases with the number of types.

Even if it is easily established that the Gini-opportunity index satisfies the above properties, distinctive properties of this index deserves more investigation. Here we do not propose an axiomatization of the index, which will be the subject of further research.

3 Data description

Data requirements for comparing inequality of opportunity for income acquisition across countries turn out to be even more stringent than for comparing inequality of outcome. Indeed, the reliability of the empirical analysis calls not only for comparable measures of individual disposable income. It also requires that individual background be measured in a comparable and homogeneous way across countries.

3.1 Data sets and sample selection

The data used in the empirical analysis come from household surveys and micro-economic administrative data from nine different countries: Belgium, France, West-Germany[7], Great-Britain, Italy, Netherlands, Norway, Sweden, and the United States. All data were collected during the first half of the nineties. For each country, the data sets include information on individual and household income, both pre- and post-fisc, as well as information on individual *circumstances*.

Table 1 summarizes the main characteristics of the data sets used for each country. The data used are sub-samples from the original surveys. They were put together by national experts within the context of a previous international comparison of income inequality and equality of opportunity, whose results were presented in Roemer et al. (2003).[8] Although these national data sets were collected independently, much effort was expended to ensure the greatest degree of *ex post* comparability across countries of the different variables used in the analysis.

Needless to say, this represents a challenging task, given the number of countries involved in the present analysis. The comparability of the data across countries remains imperfect and needs to be carefully examined. In fact, one may question the usefulness of such an endeavor given that harmonized micro-economic income data sets, such as the Luxembourg Income Study, the OECD , the ECHP or the World Bank data sets have already been built[9]. However, one unique feature of the

[7]East-Germany has been discarded on the ground that, from an economic point of view, it remained a distinct society from the West-Germany in the mid-nineties.

[8]For providing access to the data, we are grateful to Marx (Belgium data), Wagner (German data), Jenkins (British data) Colombino (Italian data), Pommer (Dutch data), Aaberge (Norwegian data), Fritzell (Swedish data), Page and Roemer (US data).

[9]See Gootschalk et al. (2000) for an analysis of income inequality from the LIS data, OECD (1998) for OECD data, and Deiniger and Squire (1996) for a presentation of the World Bank data. However, these normalized data set are not immune to statistical problem. See Atkinson and

Table 1: Data bases

			Year	Obs.
Belgium	PSBH	Panel survey of Belgian households	1992	933
France	BdF	French Household Survey	1994	2 769
West-Germany	GSOEP	German socio-economic panel	1994	1 143
Great-Britain	BHPS	British household panel survey	1991	991
Italy	SHIW	Italian survey of household income and wealth	1993	1 392
Netherlands	AVO	Dutch facilities use survey	1995	1 758
Norway	SLL	Norwegian survey of level of living	1995	576
Sweden	LNU	Swedish level of living survey	1991	1 469
USA	PSID	Panel study of income dynamics	1991	1 119

data used in this article is that it provides information on individual circumstances (see below), beside information on individual income. Hence, being able to relate individual income to individual circumstances in nine developed economies makes the data set used here extremely valuable. One further advantage of these data is that these data include information on Sweden and the Netherlands, two countries that are often absent form international comparisons of income inequality.

Samples used in the rest of the paper are restricted to households whose head is a man, aged 25 to 40 at the time of the survey (25 to 50 in Germany).

3.2 Main variables

3.2.1 Individual circumstances

Defining the exact set of individual circumstances is a deep and debatable question. Besides, in empirical work, observing this entire set is clearly out of reach. In this

Brandolini (2001) for an assessment.

paper, we examine the dependence of individual opportunity on a narrower set of circumstances, namely circumstances relating to individual social background.[10]

For most countries in our data, individual social background is measured by the level of education of the father. The only two exceptions are France and Great-Britain for which we only observe the occupational group of the father. For each country, we partition our sample in three categories, Ed_1 to Ed_3, where Ed_3 denotes the most advantaged social background. When using father's education, we account for specificities of national educational systems. When using information on father's social group the classification is as follows: for France, (1) farmers and manual workers, (2) clerks and (3) professionals and self-employed workers; for Great-Britain, (1) farmers and unskilled manual workers, (2) clerks and skilled manual workers (3) professionals and self-employed workers[11].

Table 2 provides details about the classification of social background in each country, as well as the number of observations in each category. In the partitioning of our samples, two constraints had to be taken into account. First the need for sub-samples for each type of social background that would be large enough to allow for the estimation of conditional income distributions. Second the requirement of a meaningful partitioning, with respect to each country's educational and social structure. As a consequence of these two constraints, the comparability of our classification across countries remains imperfect. In particular, one should be aware of differences in the relative size of each group across countries. In France, Great-Britain, the Nether-

[10] Of course, social origin may influence individual success through a variety of channels such as economic or genetic inheritance. Our interest solely lies in determining the extent to which circumstances influences individual opportunity sets. Identifying these different channels is not the topic of this paper.

[11] For the French sample it is the occupational group when then individual was 16, In Great-Britain it is the occupational group when he was 14.

Table 2: Samples description

	Observations			Years of education		
	ED_1	ED_2	ED_3	ED_1	ED_2	ED_3
Belgium	425	341	167	< 10	$10 - 12$	>12
France	1274	703	792	—	—	—
G-Britain	402	307	282	—	—	—
W-Germany	857	142	144	< 10	$10 - 13$	>13
Italy	245	706	441	< 5	$5 - 7$	> 7
Netherlands	479	788	491	< 6	$6 - 9$	> 9
Norway	247	170	159	< 9	$9 - 11$	> 11
Sweden	825	414	230	< 8	$8 - 11$	> 11
USA	390	354	375	< 12	12	> 12

Number of observations and number of years of education of the parents for the different sub-samples. —: information about the occupational group of the parents have been used.

lands, Norway and the US, each group represents between 1/4 and 1/2 of the overall population. This does not hold for Belgium, Germany, Italy and Sweden where one group represents less than 1/6 of the overall population. This should be kept in mind when analyzing the extent of equality of opportunity in section 5.

3.2.2 Income

We focus on two measures of individual income: gross pre-fisc annual household income and net disposable annual household income.[12] Analyzing both income measures allows to examine the impact of fiscal redistribution on inequality of outcomes and opportunity.

[12]In most countries, taxes and employee social security contributions are simulated. Differences across countries regarding the share of social security spending financed by means of employer contribution, employee contribution or income tax is likely to reduce the comparability across countries of gross pre-fisc income levels. Comparison of disposable income distributions across countries does not raise similar concerns.

Since household income (both pre- and post-fisc) incorporates a variety of different income sources, similar sources should be taken into account for each country in order to ensure cross-country data comparability. Gross pre-fisc income includes labor income (from both salaried and self-employed workers) and asset income. The only exception is Belgium for which neither self-employment nor capital income is available. This could lead to underestimate inequality in this latter country. Labor income is measured gross of any employee share of social security contributions. Taxes taken into account are income tax as well as housing and property taxes. Transfers include unemployment benefits, all social security benefits (related to sickness, disability, maternity, poverty ...), pensions, child or family allowances and means-tested benefits. Details of income sources taken into account, for each country are provided in table 7. To account for differences in household size, income is normalized using the OECD equivalence scale. It amounts to divide household income by the square root of the number of household members.

4 Inequality of outcome

While several papers have already compared the extent of income inequality across countries, using harmonized data, the analysis undertaken here is interesting for two reasons. First, it can be seen as a test of the validity of the data used in this paper. In fact, our results broadly concur with those of previous analysis, which can be interpreted as an evidence of the validity of our data set for performing cross-country comparisons of inequality. Second, while most comparative papers have concentrated on the analysis of inequality indexes, we also compare relative inequality across countries by using Lorenz dominance criterion. The interest of this latter

criterion lies in its greater generality, since, as shown by Atkinson (1970), Lorenz dominance among two distributions implies that all relative inequality indexes will consistently provide the same ranking of these distributions. We also pay particular attention to issues of statistical inference and implement Lorenz Dominance tests.[13]

We first discuss the ranking of countries which emerges from these tests before performing a comparison with the results of other studies based on inequality indexes.

4.1 Lorenz Dominance tests

One useful way to get a first picture of income inequality in the nine countries is to compare the shape of the income densities. The densities are estimated in logarithm using kernel estimation[14]. Figure 1 gives the densities of the distribution of disposable income centered around their mean. The American distribution is reproduced on each graph to make comparisons easier.

The comparison of these densities reveals important differences across countries in the distribution of income. The contrast between Sweden and the US is striking with a fairly symmetric distribution concentrated around its mean for the first one and a strong right skew for the second one. The differences between other European distributions and America's one are less sharp. Norway shares with Sweden a significant polarization around the mode but it is less concentrated than the Swedish distribution. The case of Belgium seems to be fairly similar to these two Nordic countries. The shape of the distribution in the Netherlands, France and Germany is comparable and lies in an intermediate position between Sweden and the US. The British density is closer to the American one than to the distribution in continental

[13]The methodology of these tests are presented in the appendix.
[14]A Gaussian adaptative bandwidth kernel estimator has been used.

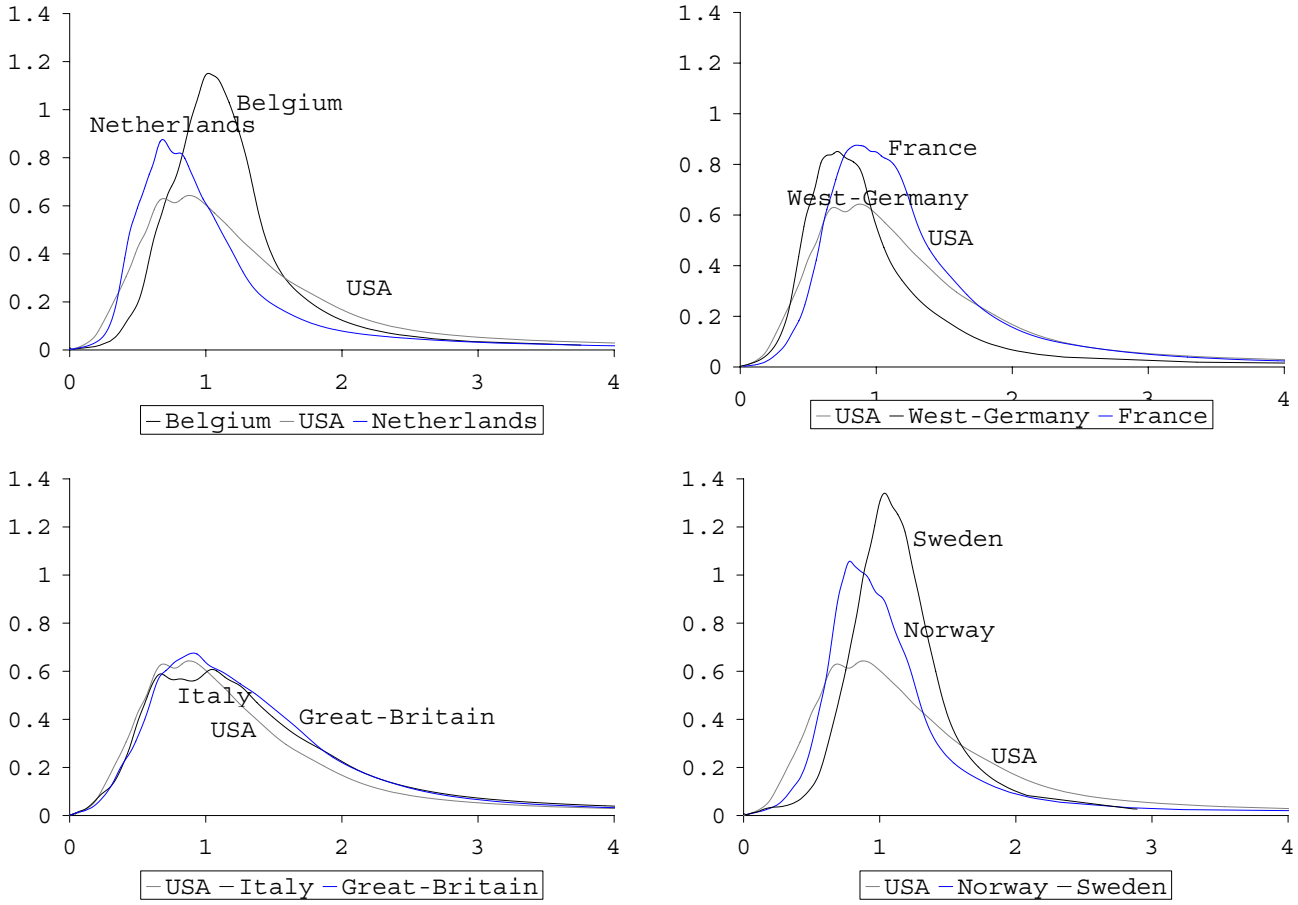

Figure 1: Disposable Income densities estimated by kernel

Europe, with the exception of Italy. This latter country displays a distribution fairly close to the American and British ones.

To obtain a more precise picture of inequality we consider Lorenz curves. Figure 2 shows Lorenz curves for disposable income in each country. As for income densities, the American curve is represented on each graph. Their analysis corroborates our previous comments. On the top-left panel, it is apparent that the Belgian Lorenz curve is above the Dutch curve, which itself dominates the US one. On the top-right panel, one can notice that France and West-Germany have a similar level of inequality.

The bottom-left panel confirms that inequality is pretty much the same in GB, the US and Italy. Finally, on the bottom-right panel, one can notice the significant gap between Scandinavian countries and the United-States.

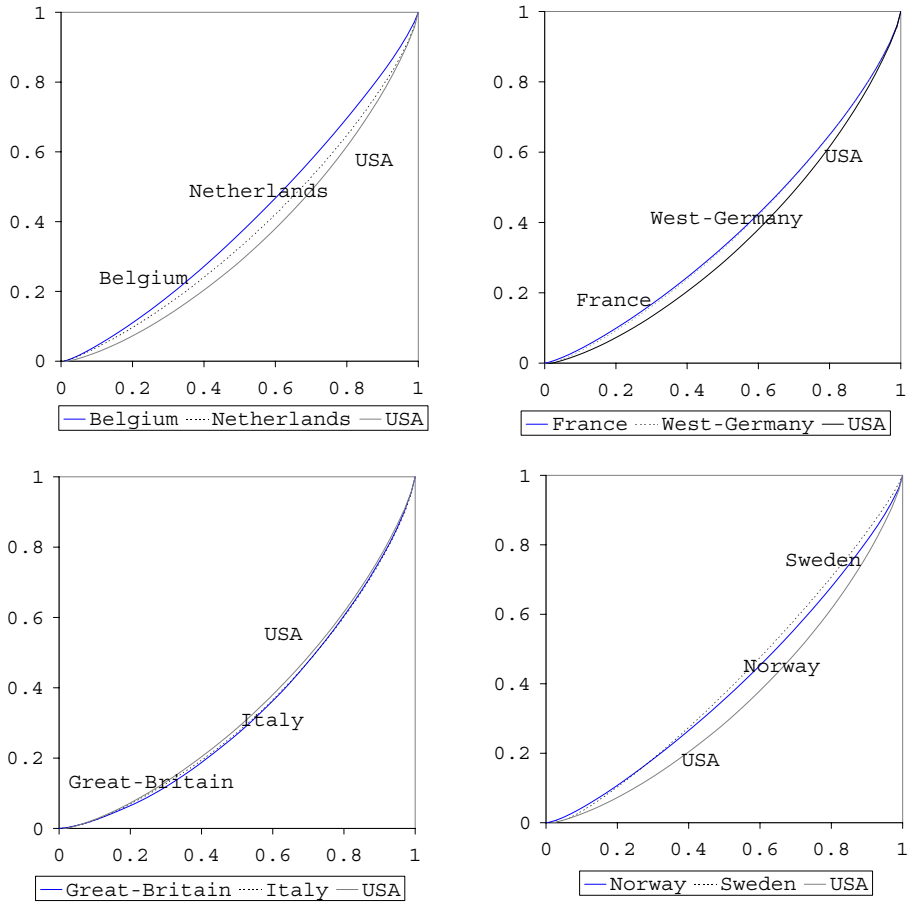

Figure 2: Lorenz curves for disposable income

This visual inspection is confirmed by the results of the Lorenz dominance tests for each pairwise comparison (table 3). These results do not lead to a complete ranking of the countries. However three groups of three countries clearly emerge from those tests. The first group is made of Sweden Norway and Belgium. The second one includes France, Germany and the Netherlands. The third one is composed of GB,

Italy and the US. The hierarchy between the three groups is obvious. All countries in the first group Lorenz-dominate the countries of the second and third group, the countries of the second group Lorenz-dominates the countries of the third one. The within-group ranking is less clear. Within the first group, Sweden dominates Norway but not Belgium; Lorenz curves for Belgium and Norway intersect. This apparently low level of inequality in Belgium may partly be ascribed to the fact that our Belgian data do not take asset income into account. Within the second group and third group, for each pairwise comparison, dominance tests conclude to either equality or crossing of the Lorenz curves.

Table 3: Lorenz dominance tests

	Sweden	Norway	Belgium	France	W-Germ	Nether	G-Britain	Italy	USA
Sweden	-	$>$	?	$>$	$>$	$>$	$>$	$>$	$>$
Norway	-	-	?	$>$	$>$	$>$	$>$	$>$	$>$
Belgium	-	-	-	$>$	$>$	$>$	$>$	$>$	$>$
France	-	-	-	-	?	$=$	$>$	$>$	$>$
W-Germ	-	-	-	-	-	?	$>$	$>$	$>$
Nether	-	-	-	-	-	-	$>$	$>$	$>$
G-Britain	-	-	-	-	-	-	-	$=$	$=$
Italy	-	-	-	-	-	-	-	-	?
USA	-	-	-	-	-	-	-	-	-

The symbols read as follows: $>$: The row dominates the column. $<$: the column dominates the row. $=$: Lorenz curves are identical. ?: Lorenz curves are non comparable.

4.2 Comparison with other studies

In order to assess the reliability of our data, we now compare our results to the ones obtained in other studies, using harmonized income data. In this perspective, we estimate scalar indexes of relative inequality in the nine countries. Estimates are reported in table 8, with bootstrapped standard-errors in brackets. For obvious

reasons, inequality indexes (Gini, CV) and inter-quantile ratios presented in table 8 suggest a ranking of countries that is similar to the one established in the previous section. Within-group differences in inequality indexes are not statistically significant, while between-groups differences are.

One natural benchmark to gauge the reliability of our income data is to compare our results to those obtained in Gottschalk and Smeeding (1997; 2000), using data from the Luxembourg Income Study for the early nineties. Three points should be emphasized. First our relative ranking of countries is to a large extent consistent with the results presented in their studies. Second, for most countries, our estimates of inequality indexes are lower than those reported in their studies. This may largely reflect differences in sample selection rules, and in particular the fact that we have restricted our samples to a narrower age interval[15]. Third, two noteworthy differences appear regarding the level of inequality and the ranking of two countries : France and Italy. In our data the former appears less unequal and the latter more unequal than in Gottschalk and Smeeding (2000), both in absolute and relative terms[16]. Regarding France, the difference in measured inequality can be explained by the fact that we use data from 1994, against 1989 or 1984 in their study. Moreover, Hourriez et al. (2001) demonstrates that disposable income inequality decreases slightly between these dates. Regarding Italy, their data refer to 1991, a year for which measured inequality is markedly lower than in adjacent years, in particular 1993, the year used in our study. For Italy as well as more generally, our results seem close to those of other studies, both in terms of levels of inequality and of ranking of the

[15]For most countries, our samples are restricted to household whose head is aged 25 to 40, while their sample include all non-institutionalized households.

[16]According to the value of Gini coefficients displayed in Gottschalk and Smeeding's study, France ranks third with a Gini of 0.32 after the United-States (0.36) and Great-Britain (0.34). In our data income inequality is larger in Italy and Netherlands than in France. See table 8.

countries: Bertola et al. (2001) find a Gini of 0.348 for disposable income with LIS data in 1994, and rank Italy among the more unequal countries in Europe. The same conclusion emerges from Atkinson (1996), OECD (1998) and Smeeding et al. (2000), who establishes an overall ranking similar to ours. Sastre and Trannoy (2001) find very similar results for Gini indexes using LIS data [17].

Overall, our results closely mimic those obtained in various sources our data, which suggests that we should be reasonably confident in the validity of our income data for international comparisons of inequality. We now turn to the analysis of inequality of opportunity.

5 Equality of opportunity for income acquisition

The above conclusions for inequality of outcomes may not prevail for inequality of opportunity. In fact, in a country with limited inequality of opportunity, there can be important differences in individual success (hence important inequality of outcome) if individuals exert very heterogeneous effort levels. At the opposite, a low level of inequality of outcomes is compatible with important differences according to social origin. This would be the case if the level of effort was negatively correlated with social origin. Results of stochastic dominance tests are first presented. Differences in the return and risk of income lotteries conditional on social background are then analyzed. Lastly, using our index of inequality of opportunity, we examine how countries' performance in terms of equality of opportunity compares to their ranking in terms of overall inequality.

[17] They find a Gini of 0.30 for USA, 0.30 for Great-Britain, 0.23 for Norway, 0.22 for Sweden, 0.26 for Germany, and 0.28 for France. See Sastre and Trannoy (2001) table 2 pp.329.

5.1 Dominance tests

Figure 3 depicts the conditional distributions for primary and disposable income in each country. For each country, income is expressed as a fraction of the country's mean income. It comes as no surprise that having more educated parents is associated with a higher level of income. Indeed in every country but one[18], the CDF for individuals from more privileged origin is always below the CDFs for individuals coming from the two less privileged social backgrounds.

These graphs also reveal important differences between countries in the *magnitude* of the advantage conferred by more privileged backgrounds over less privileged ones. Intuitively, this advantage corresponds to the gap between the CDFs corresponding to the different social backgrounds. As apparent from these graphs, this distance varies strongly from one country to another. For Sweden, the three conditional distributions for Ed_1 to Ed_3 are strikingly close, suggesting that differences in social background translate into very small differences in income. The same holds true, to a lesser extent, in Norway where the gap between the income distributions of the different backgrounds is rather modest.

This stands in marked contrast with the situation in Italy and the US where the gap between the three distributions is important. In Great-Britain, the advantage conferred to the most privileged group is still quite large but the gap between the second most privileged group is less wide than in the US and Italian cases. Moreover, the income distribution of groups Ed_1 and Ed_2 are closer together than in Italy and the US, suggesting more equality of opportunity in this country at the bottom of the social ladder.

[18] In the case of Germany, the graph of the CDF for Ed_3 is above the one for Ed_2 for incomes greater than 1.5 mean income.

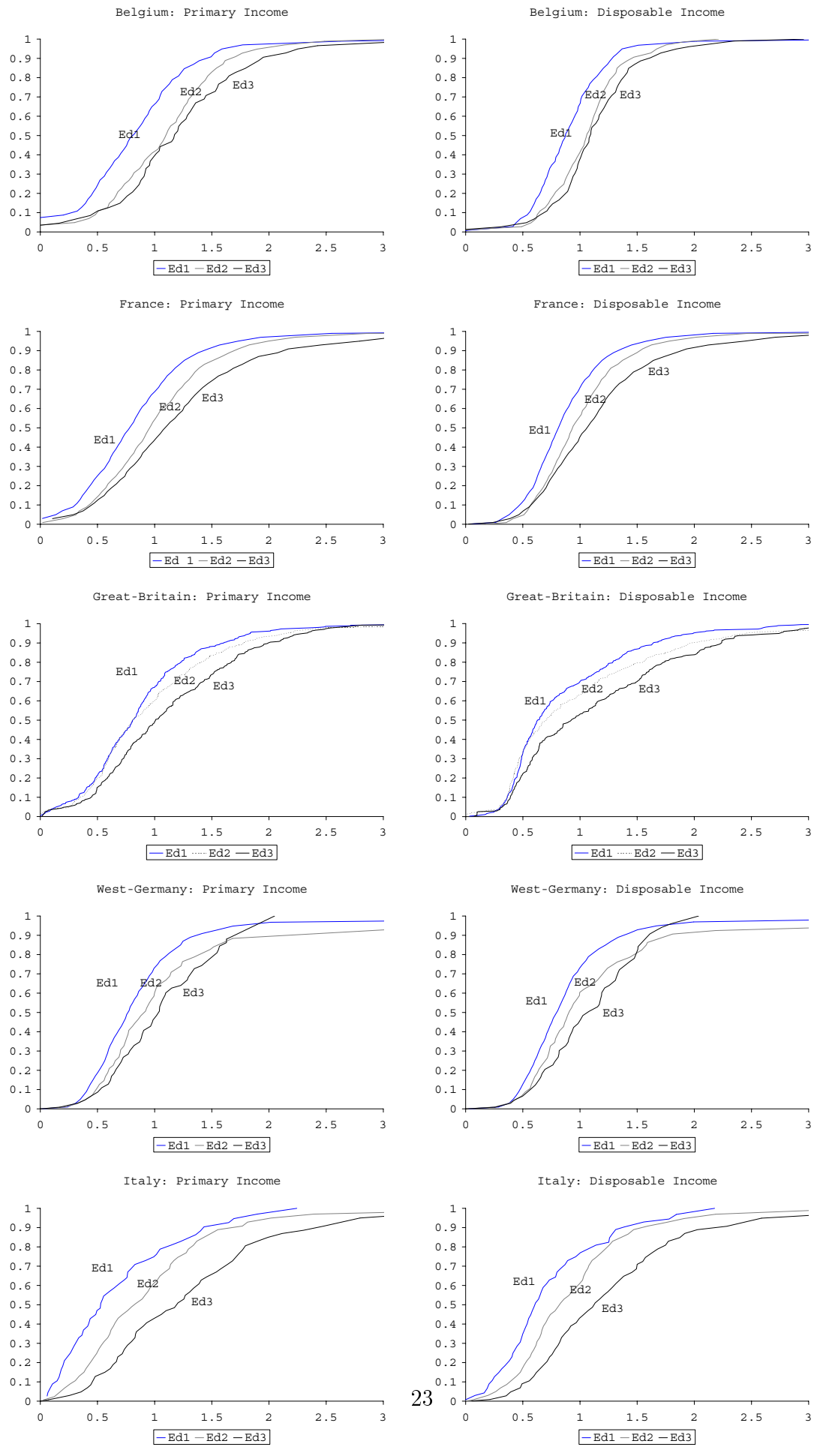

Figure 3: Income distributions conditional on social background

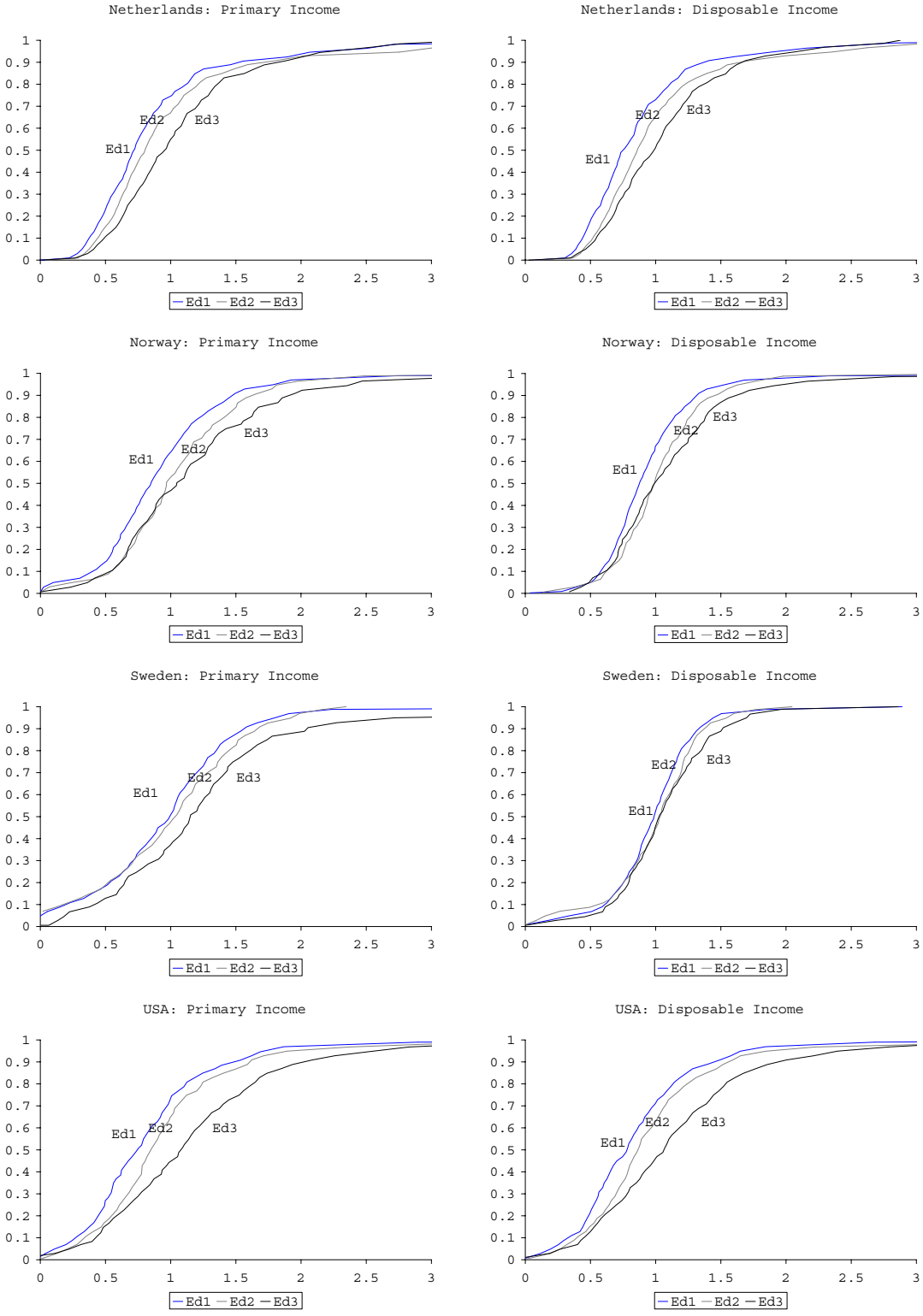

Figure 3: Income distributions conditional on social background (cont.)

The rest of the countries in our data (Belgium, France, Germany and Netherlands) exhibit an intermediate degree of inequality of opportunity. There are significant differences in the income distributions offered to individuals according to their social background. However, the distance between these distributions is smaller than in Italy and the US. It should also be noted that in the former group of countries, especially in Belgium and Germany, inequality of opportunity is more pronounced at the bottom of the social hierarchy, to the extent that the gap between the distributions of groups Ed_1 and Ed_2 is larger than the distance between Ed_2 and Ed_3. This contrasts with the situation in Italy, Great-Britain and the US. However, these differences in the locus of inequality of opportunity may partly reflect differences in the classification used to partition our sample according to social background rather than specific national features.

The extent of inequality of opportunity summarized by these graphs can be formally analyzed with stochastic dominance tests. The results of these tests appear in table 4. The only country in which our equality of opportunity criterion is satisfied for all groups is Sweden. In fact, this country exhibits a situation described previously as strong equality of opportunity, as the pairwise tests conclude to the equality of the three conditional distributions. It should also be stressed that this strong requirement holds for both primary and disposable income. In all other countries, according to our definition, equality of opportunity does not prevail. There exists at least one social background whose income distribution is dominated by that of another group. It is nevertheless possible to rank these countries according to the number of times the statistical tests conclude to dominance in the three pairwise comparisons. In this respect, when focusing on comparisons of disposable income, Norway is the least unequal (in terms of opportunity) since dominance is detected only in one case and

equality prevails in the two other comparisons. Great-Britain and Belgium come next with two cases of dominance and one equality. In the German case, the three tests conclude to dominance, but in two cases, only for second-order stochastic dominance, indicating that the CDFs cross. Lastly, in France, Italy, the Netherlands and the US, the three tests conclude to dominance at the first order, indicating that the hierarchy of social backgrounds apparent on the graphs of the CDF is indeed very robust.

For seven samples out of nine, the results of the dominance tests for primary income are identical to the results for disposable income. This can be interpreted as the weak impact of redistributive policy on equality of opportunity as it is measured here. Hence redistributive policy is not able to fully neutralize the effect of the initial background on the economic success of the next generation. Nevertheless Figure 3 reveals that redistributive policy tends to partially offset the impact of social origin on individual income: in all countries of the CDF for primary income, conditional on social background are always further apart than the CDFs for disposable income.

Table 4: Stochastic dominance tests

Belgium

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<_1$	$<_1$	-	$<_1$	$<_1$
Ed_2	-	-	?	-	-	$=$
Ed_3	-	-	-	-	-	-

France

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<_1$	$<_1$	-	$<_1$	$<_1$
Ed_2	-	-	$<_1$	-	-	$<_1$
Ed_3	-	-	-	-	-	-

Great-Britain

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$=$	$<_1$	-	$=$	$<_1$
Ed_2	-	-	$<_1$	-	-	$<_1$
Ed_3	-	-	-	-	-	-

West-Germany

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<_1$	$<_1$	-	$<_1$	$<_2$
Ed_2	-	-	$=$	-	-	$<_2$
Ed_3	-	-	-	-	-	-

Italy

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<_1$	$<_1$	-	$<_1$	$<_1$
Ed_2	-	-	$<_1$	-	-	$<_1$
Ed_3	-	-	-	-	-	-

Netherlands

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<_1$	$<_1$	-	$<_1$	$<_1$
Ed_2	-	-	$<_1$	-	-	$<_1$
Ed_3	-	-	-	-	-	-

Norway

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$=$	$<_1$	-	$=$	$<_1$
Ed_2	-	-	$=$	-	-	$=$
Ed_3	-	-	-	-	-	-

Sweden

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$=$	$=$	-	$=$	$=$
Ed_2	-	-	$=$	-	-	$=$
Ed_3	-	-	-	-	-	-

U.S.A.

	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<_1$	$<_1$	-	$<_1$	$<_1$
Ed_2	-	-	$<_1$	-	-	$<_1$
Ed_3	-	-	-	-	-	-

The symbols read as follows: $<_1$: The column dominates the row at the first order. $<_2$: The column dominates the row at the second order.=: CdF are identical. ?: CdF curves are non comparable.

5.2 Risk and return of the social lotteries

Using standard tools in risk theory, it is also possible to compare the income lotteries attached to different social background in terms of their return and risk. Since for most countries, the tests conclude to first-order stochastic among social backgrounds, we already know that the expected income (*i.e.* the return) is usually larger for the more favored social background. However, whether the lotteries offered to the more fortunate type are also less risky remains an opened question.[19]

5.2.1 An almost equal risk of conditional lotteries

To focus solely on risk, we examine conditional distributions centered around their means, and we draw Lorenz curves of these centered distributions. Comparing two distributions, if the Lorenz curve of the first distribution is above the Lorenz curve of the other then the first distribution will be considered less risky by all risk-averse individuals, whatever the degree of their risk-aversion. Figure 6 in the appendix presents the Lorenz curves for the conditional distributions. Table 5 contains the results of the Lorenz dominance tests. The testing procedure is similar to the one used for stochastic dominance: we first test for equality of the Lorenz curves, and then test for dominance if equality is rejected.

These results suggest that the degree of risk of the income lotteries associated with social background tend to be rather similar. For most countries, the Lorenz curves of the different types are very close, especially for disposable income. Regarding the tests, there is a surprisingly large proportion of pairwise comparisons for which we conclude to the equality of the Lorenz curves: 19 times out of 27 for primary

[19] This cannot be deduced from our previous empirical evidence since first-order stochastic dominance is consistent with any behavior of the decision-maker toward risk.

income and 17 times out of 27 for disposable income. Even if we exclude all cases in which the uncentered distributions are already equal, we conclude to the equality of the Lorenz curves in about half of the cases. In each country there is at least one pairwise comparison for which equality holds. This is true for both primary and disposable income. All three conditional distributions display the same degree of risk in four countries for primary income (France, West-Germany, Sweden and the US) and two countries for disposable income (Sweden[20] and Belgium). For these countries, the equality of risks suggests that the impact of the family background may only be captured by a scale parameter. As a first approximation, in these countries, the distribution of income conditional on social background, takes the following multiplicative form :

$$x_{is} = E(x \mid s)\epsilon_i \tag{3}$$

where x_{is} denotes the income of individual i with social background s, $E(x \mid s)$ is the expectation of income conditional on s and ϵ_i is a random term independent of social background.[21] It should be stressed that equality in the degree of risk of the different distributions is an interesting special case where the ranking of the distributions can be achieved based solely on a comparison of the returns.

When equality of risks does not hold, the tests conclude to the crossing of the Lorenz curves in one third of the cases. When the conditional Lorenz curves can be ranked, the table indicates that less privileged backgrounds face more risky income lotteries than more privileged ones in all cases for primary income, but only in one

[20]This comes as no surprise regarding Sweden since we had already noted that the conditional distributions are very similar in this country.

[21]For France, this result is robust to a finer partitioning of social background (see Lefranc et al. (2004b) for more details).

third of the cases for disposable income. This indicates that redistributive policies tend to lower the risk of the worst social lotteries. For instance France or West-Germany face a situation of perfect equality of risk in primary income, but after income tax and transfers, the lottery corresponding to the more privileged type is riskier than the other two. Suppose that we are ready to assume, following Roemer's suggestion, that the dispersion of incomes within a type is the result of effort only. Then a policy aimed solely at reducing inequality of opportunity should leave the level of risk unchanged. Under the assumption, which is quite strong admittedly, we conclude that the French and German redistributive policies are not solely motivated by equality of opportunity.

5.2.2 Inequality of Return and inequality of Risk

So far our appraisal of risk relies on ordinal comparisons. Resorting to a cardinal measure allows us to exhibit additional empirical evidence, though at the price of lower robustness. We compute two new indexes that measure respectively inequality of opportunity in terms of returns to social lotteries and in terms of risk across social types. Both indexes derive from the Gini-Opportunity (GO) index described in section 2. Our measure of inequality of opportunity in returns to social lotteries (GO-return) is equal to the value of the GO index when within-social-type inequality has been erased (*i.e.* all individuals in a group have an income equal to the average income of that group). Our measure of inequality of opportunity in risk to social lotteries (GO-risk) is equal to the value of the GO index when between-social-type inequality has been erased (*i.e.* all social types have the same mean income, but

Table 5: Lorenz dominance tests

Belgium							**France**					
	Primary Income			Disposable Income			Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<$	?	-	$=$	$=$	-	$=$	$=$	-	$=$	$>$
Ed_2	-	-	$=$	-	-	$=$	-	-	$=$	-	-	$>$
Ed_3	-	-	-	-	-	-	-	-	-	-	-	-

Great-Britain							**West-Germany**					
	Primary Income			Disposable Income			Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$=$	$=$	-	$>$	$=$	-	$=$	$=$	-	$=$	$>$
Ed_2	-	-	$<$	-	-	$=$	-	-	$=$	-	-	$=$
Ed_3	-	-	-	-	-	-	-	-	-	-	-	-

Italy							**Netherlands**					
	Primary Income			Disposable Income			Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$<$	$<$	-	?	$<$	-	$=$	$<$	-	$=$	?
Ed_2	-	-	$=$	-	-	$=$	-	-	$<$	-	-	$<$
Ed_3	-	-	-	-	-	-	-	-	-	-	-	-

Norway							**Sweden**					
	Primary Income			Disposable Income			Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$=$	?	-	$>$	$=$	-	$=$	$=$	-	$=$	$=$
Ed_2	-	-	$=$	-	-	$=$	-	-	$=$	-	-	$=$
Ed_3	-	-	-	-	-	-	-	-	-	-	-	-

U.S.A.						
	Primary Income			Disposable Income		
	Ed_1	Ed_2	Ed_3	Ed_1	Ed_2	Ed_3
Ed_1	-	$=$	$=$	-	?	$=$
Ed_2	-	-	$=$	-	-	$=$
Ed_3	-	-	-	-	-	-

The symbols read as follows: $<$: The column dominates the row. $=$: Lorenz curves are identical. ?: Lorenz curves are non comparable.

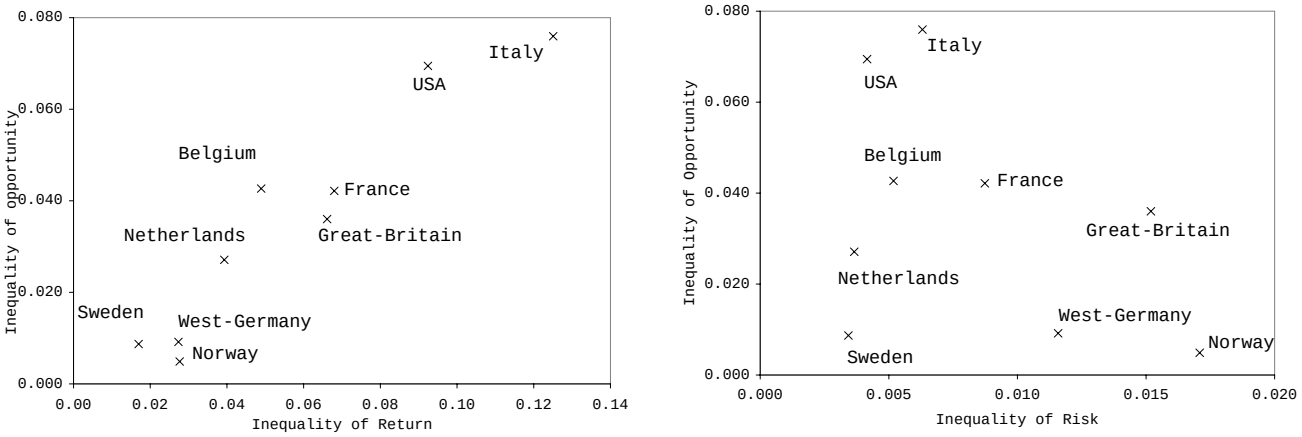

Figure 4: inequality of opportunity inequality of return and inequality of risk

within-type inequality remains [22]). The values of these indexes are presented in figure 4.

It turns out that the dispersion across countries in GO-return is slightly larger than the dispersion in GO-risk. Indeed, the largest value of GO-return is about 7 times greater than the smallest one, while the gap is only 5 times larger for GO-risk. It is instructive to figure out how these two components of inequality of opportunity shape in inequality of opportunity. The two figures illustrate how return inequality and risk inequality are related to inequality of opportunity measured by the Gini-Opportunity index for our sample of countries.

The left panel highlights the positive contribution of inequality of returns to inequality of opportunity. A strong similarity emerges from the comparison of the ranking according to both dimensions. In the making of inequality of opportunity, inequality of returns stands out as the dominant force.

The influence of inequality of risks on the overall result is more complex to figure

[22]More precisely, we equalize between types inequality by a homothetic transformation of the conditional distribution of each type .

out. When interpreting the right panel, we have to take into account the fact that a higher risk inequality is not always detrimental to the least favored background. Indeed, in some countries, for instance France, Great-Britain and Norway, the least advantaged social group is less risky than at least one of the two other groups, while in other countries like the Netherlands and Italy the most privileged type is less risky than some other group (see Table 5). In the former case, risk inequality mitigates return inequality a little bit, while in the latter risk inequality exacerbates return inequality. Let us take some examples to see how this phenomenon matters to shape the ranking of countries. Norway exhibits a larger return inequality than Sweden and yet in terms of inequality of opportunity the ranking is reversed. Indeed Norway displays a large inequality of risks to the detriment of the most privileged type. The same explanation runs for the comparison of France and Belgium, and of Great-Britain and the Netherlands: for France and Great-Britain, inequality of risk mitigates inequality of returns.

5.3 Inequality of opportunity versus inequality of outcomes

We now address the relationship between inequality of opportunity and inequality of outcomes among countries. To do so, we use the Gini index and the Gini-Opportunity index, since resorting to a cardinal measure of inequality makes comparisons easier. The values of these indexes are presented in table 6. Regarding the extent of inequality of opportunity, three groups of country stand out. A first group composed of Sweden, Norway and Germany with the lowest inequality of opportunity. An intermediate group composed of Belgium, France, Great-Britain and the Netherlands. And a group of high inequality of opportunity composed of Italy and the US.

Table 6: Index of inequality of Opportunity (GO) and Inequality of outcome (Gini)

	GO	Gini
Sweden	0.009	0.19
Norway	0.005	0.21
Belgium	0.043	0.20
Nether	0.027	0.26
France	0.042	0.25
West-Germ	0.009	0.26
G-Brit	0.036	0.30
Italy	0.076	0.34
USA	0.069	0.31

Figure 5 reveals a positive correlation between inequality of opportunity and inequality of outcomes. Sweden and Norway are the least unequal countries according to both concepts while the United-States and Italy are the most unequal ones. The correlation between inequality of opportunity and inequality of outcome is of course far from perfect.[23] If we draw a line that joins the two polar cases, two groups of outliers stand out: Belgium and France lay above the line, Netherlands, Great-Britain and Germany are below.

Given the size of our sample of countries, these facts should be interpreted with great caution. However, this pattern of outliers might reflect attitude towards individual responsibility rooted in religious and cultural ethics. European countries of catholic tradition, here Belgium, France and Italy, apparently favor equality of outcome over equality of opportunity: in terms of opportunity, they are the most

[23]If we were to exclude the US and Italy from our graph, very little dependence would have been detected between the extent of inequality of outcome and inequality of opportunity. Of course the omission of these two large countries would have hampered the study. This observation tells us that the positive correlation between the two concepts of inequality may depend on which country is included in the sample.

unequal countries among our sample of European countries. The opposite seems true for European countries with a protestant tradition, here the Netherlands, Germany and Great-Britain. This echoes a well known theme in the sociology of religion. Max Weber (1904-1905) held that the devotion to work that was one of the fundamental elements of capitalism and modernity derived, at least in part, from the Puritan effort to turn work into a spiritual vocation. The respect of effort which lies at the heart of the equality of opportunity doctrine and which leads Dworkin and others philosophers to prescribe the principle of natural reward may take its root in the Protestantism. Consequently the idea of equality of opportunity would be more easily absorbed by countries routinely exposed to the idea of respect of effort that country that are not.

Obviously the poor ranking of the US in terms of inequality of opportunity as well as the preeminent position of Scandinavian countries in terms of equality of outcomes tells us that factors other than religion shape social and economic policy.

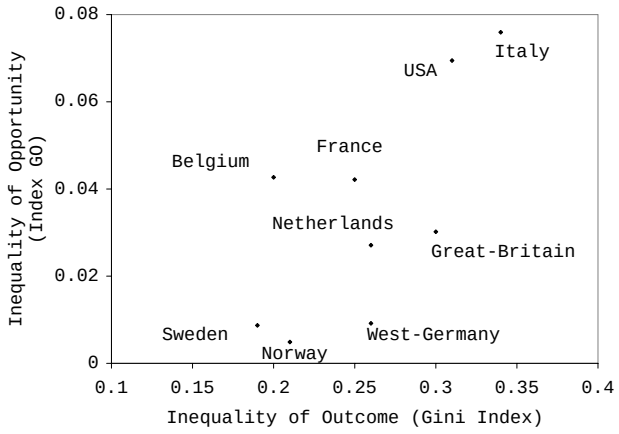

Figure 5: Inequality of outcome and inequality of opportunity

6 Conclusion

We started by claiming that confining analysis to inequality of outcomes is unduly restrictive. If inequality of opportunity were perfectly related to inequality of outcome, the interest of focusing on opportunity would have been greatly reduced, given the considerable amount of results already collected regarding differences across countries in income inequality. Fortunately, our results suggest that inequality of outcome is far from perfectly correlated with inequality of opportunity. On the one hand, countries that exhibit very high (low) levels of inequality of outcome also experience high (low) levels of equality of opportunity. On the other hand, the ranking of countries according to the two criteria are not identical, particularly for countries ranked in the middle of the pack. Obviously, more countries should be analyzed to obtain a more complete and definite picture of the potential contrast or congruence between inequality of outcome and inequality of opportunity among the developed world.

This rather complex picture already suggests two lines for further investigation. First, some policy instrument may achieve reduction in inequality of both outcome and opportunity. For instance, by reducing inequality of opportunity for education, by giving more resources to schools located in poor neighborhoods, equality may be enhanced in the long run on both dimensions. It may explain the achievement of equality of opportunity in Sweden as well as the remoteness of this goal in the US. Analyzing the impact of such policies may help to understand the extent of the correlation between inequality of outcome and inequality of opportunity. This calls for further modeling of the mechanisms through which inequalities of different types have been generated. It is clearly out of the scope of this article but it may be pursued in further research. Then, our results also suggest that the relative emphasis

put on the two objectives of equality may vary across countries. A better knowledge of the political debate about redistributive issues in each country may shed light on international differences in this respect.

Lastly, in view of the rather crude description of the family background adopted here, our results must be taken with a grain of salt. Using a more detailed description of individual social background may affect the results. However, it is hard to guess whether the rankings obtained here are robust or not to such a refinement of the analysis.

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7 Appendix

7.1 Statistical tests

The testing procedure has been developed in Davidson and Duclos (2000). It can be applied to any order of stochastic dominance. In this appendix we illustrate the case of second order stochastic dominance test. First, we estimate the Lorenz or the General Lorenz curves with their non-parametric estimator. From a sample of size N_A, $\mathbf{L}_A$ represents the estimated Lorenz curve of distribution A, and Σ_A its variance-covariance matrix. To compare the Lorenz curves of distributions A and B, we compute the difference of the two estimated vectors, noted $\gamma = \mathbf{L}_A - \mathbf{L}_B$. Insofar as the distributions A and B are independent, the global variance-covariance matrix is given by: $\Sigma = \Sigma_A + \Sigma_B$.

To test the equality of the Lorenz curves: the nul hypothesis is given by $\mathbf{H}_0 : \boldsymbol{\gamma} = 0$. It is then possible to show (see for example Beach and Davidson (1983) and Davidson and Duclos (2000)) that under $\mathbf{H}_0$ the estimated vector $\hat{\gamma}$ is asymptotically normal, then:

$$\hat{\gamma} \sim \mathcal{N}(0, \frac{\mathbf{\Sigma_A}}{\mathbf{N_A}} + \frac{\mathbf{\Sigma_B}}{\mathbf{N_B}})$$

The asymptotic distribution of the statistic T_1, under the nul hypothesis of equality :

$$T_1 = \hat{\gamma}'(\frac{\Sigma_A}{N_A} + \frac{\Sigma_B}{N_B})^{-1}\hat{\gamma} \sim \chi^2_k$$

To test equality of the two Lorenz curves A and B, one only need to compare the value of the statistic T_1 with a χ^2 at five or one percent.

To test relative dominance (ie: L_A dominates L_B), the two hypotheses are $\mathbf{H}_0 : \boldsymbol{\gamma} \in \mathbb{R}^k_+$ against $\mathbf{H}_1 : \boldsymbol{\gamma} \notin \mathbb{R}^k_+$. The Wald test statistic with inequality constraints has been developed by Kodde and Palm (1986) and Wolak (1989). The statistic T_2 defined by :

$$T_2 = \min_{\gamma \in \mathbb{R}^k_+} ||\hat{\gamma} - \gamma||$$

with $||x|| = x'\Sigma^{-1}x$. Kodde and Palm (1986) have demonstrated that T_2 follow a mixture of χ^2 distributions :

$$T_2 \sim \Sigma^k_{j=0} w(k, k-j, \Sigma) Pr(\chi^2_j \geq c)$$

with $w(k, k-j, \Sigma)$ represents the probability that $k-j$ elements of γ be strictly positive. The distribution of this mixture of χ^2 is not tabulated but upper and lower

bounds of critical values are given in Kodde and Palm. It is either possible, if lower and upper bounds do not enable to conclude to estimate critical values of the statistic T_2 by a Monte-Carlo procedure[24].

[24]It is necessary to draw 10,000 normally multivariated vectors with expectation 0 and variance-covariance matrix Σ, then to compute the proportion of vectors that have j positive elements (for $j \in (0, k)$), the proportion is an estimator of the weight $w(k, j, \Sigma)$.

7.2 Data

Table 7: Income variables by country

	Belgium	France	G-Britain	Germany	Italy	Nether.	Norway	Sweden	USA
Activity									
Wages and Salaries	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mandatory employee contrib.	S	S	S	S	S	S	Y	Y	S
Farm/non farm self. emp. income	N	Y	Y	Y	Y	Y	Y	Y	Y
In-kind earnings	N	N	N	N	Y	Y	Y	Y	N
Mand. contrib. for self-emp.	N	S	S	S	S	S	Y	Y	S
Patrimony									
Cash property income (rents, interests, dividends)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Noncash property income (imputed rent from own house)	N	N	Y	Y	Y	Y	Y	Y	N
Market value of residence	N	N	N	N	Y	Y	Y	Y	Y
Taxes									
Income taxes	S	Y	S	S	S	S	Y	Y	S
Property or wealth taxes	S	Y	S	S	S	S	Y	Y	S
Other direct taxes	N	Y	N	N	N	S	Y	Y	S
Transfers									
Sick, accident, disability pay	Y	Y	Y	Y	Y	Y	Y	Y	Y
Social retirement benefits	Y	Y	Y	Y	Y	Y	Y	Y	Y
Child or family allowances	Y	Y	Y	Y	N	Y	Y	Y	Y
Unemployment compensation	Y	Y	Y	Y	N	Y	Y	Y	Y
Maternity allowances	N	Y	Y	Y	N	Y	Y	Y	Y
Military/vet/war benefits	N	Y	Y	Y	Y	Y	Y	Y	Y
Other social insurance	N	Y	Y	N	Y	Y	Y	Y	Y
Means-Tested cash benefits	Y	Y	Y	Y	Y	Y	Y	Y	Y
Private pensions	Y	N	Y	Y	N	Y	Y	Y	N
Alimony or child support	Y	Y	Y	Y	Y	Y	Y	Y	Y

S: Simulated Y: source of income presented in the basis, N: source of income not available in the basis. For the definition of any variable see LIS webpage :http://www.lisproject.org/techdoc/variabdef.htm

7.3 Indexes of inequality of outcome

Table 8: Inequality indexes for disposable income

	Gini	P90/P10	P75/P25	P50/P10	P90/P50	Var. Log.	Theil	Coef. Var.
Belgium	0.20	2.44	1.57	1.63	1.50	0.14	0.06	0.35
	(.007)	(.036)	(.026)	(.032)	(.022)	(.022)	(.004)	(.015)
France	0.25	2.97	1.73	1.72	1.73	0.22	0.11	0.53
	(.005)	(.030)	(.010)	(.014)	(.013)	(.010)	(.006)	(.029)
West-Germany	0.26	3.00	1.75	1.76	1.72	0.37	0.12	0.56
	(.009)	(.052)	(.017)	(.023)	(.021)	(.052)	(.012)	(.048)
Great-Britain	0.30	4.32	2.05	2.20	1.94	0.44	0.16	0.61
	(.008)	(.097)	(.062)	(.045)	(.025)	(.048)	(.011)	(.043)
Italy	0.34	4.66	2.19	2.24	2.08	0.46	0.19	0.67
	(.008)	(.107)	(.074)	(.031)	(.093)	(.033)	(.012)	(.031)
Netherlands	0.26	2.96	1.77	1.73	1.72	0.22	0.11	0.51
	(.005)	(.033)	(.015)	(.015)	(.015)	(.013)	(.006)	(.017)
Norway	0.21	2.40	1.56	1.60	1.50	0.19	0.08	0.45
	(.011)	(.045)	(.017)	(.027)	(.017)	(.027)	(.012)	(.057)
Sweden	0.19	2.26	1.47	1.62	1.38	0.27	0.06	0.34
	(.007)	(.058)	(.013)	(.027)	(.011)	(.039)	(.005)	(.013)
USA	0.31	4.48	2.14	2.24	1.98	0.43	0.16	0.62
	(.008)	(.111)	(.033)	(.048)	(.030)	(.067)	(.011)	(.036)

Var.log.: variance of logarithms. Coef. Var.: coefficient of variation. In brackets: standard-errors estimated by bootstrap (200 replications).

7.4 Conditional Lorenz curves

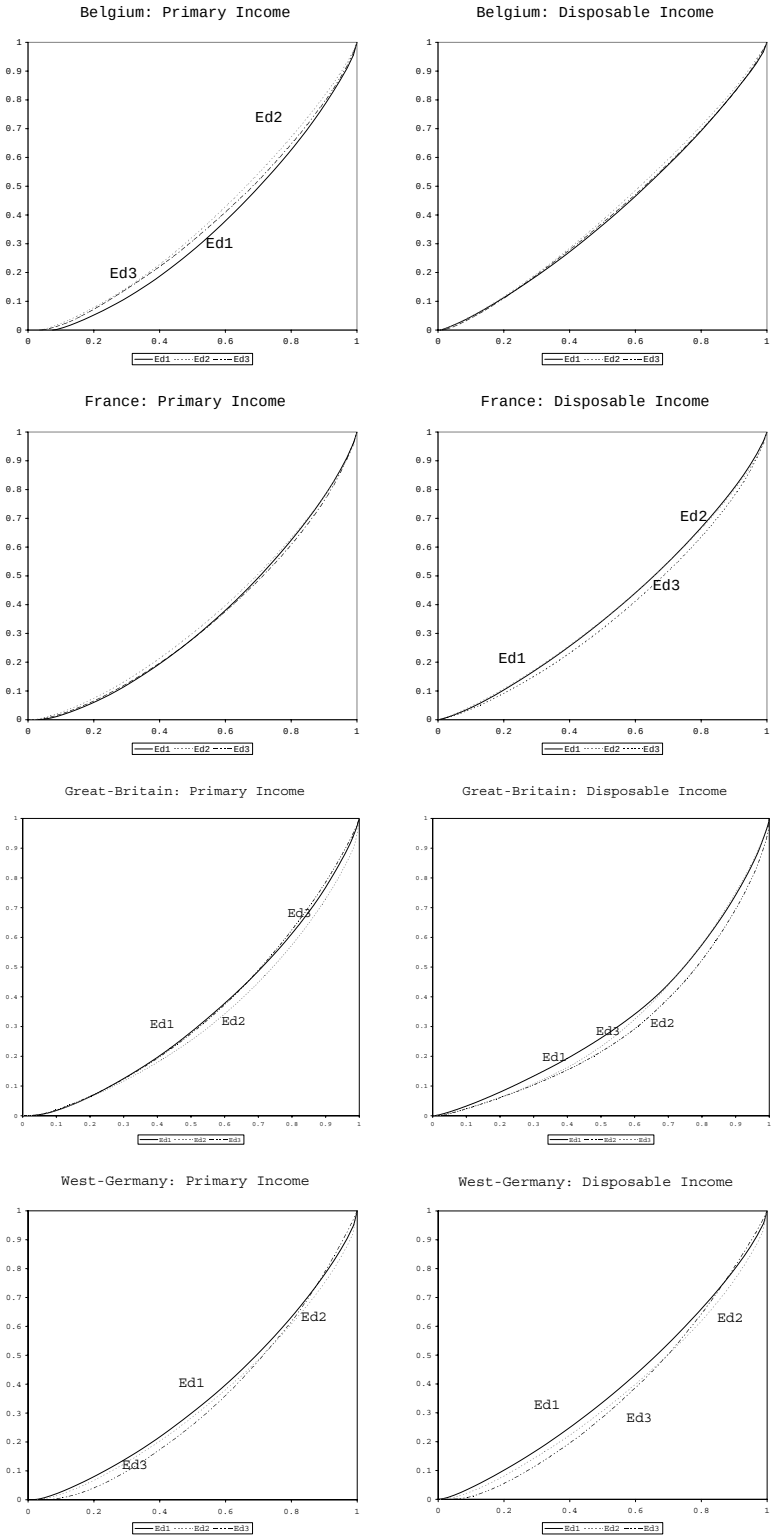

Figure 6: Lorenz curves conditional on social background

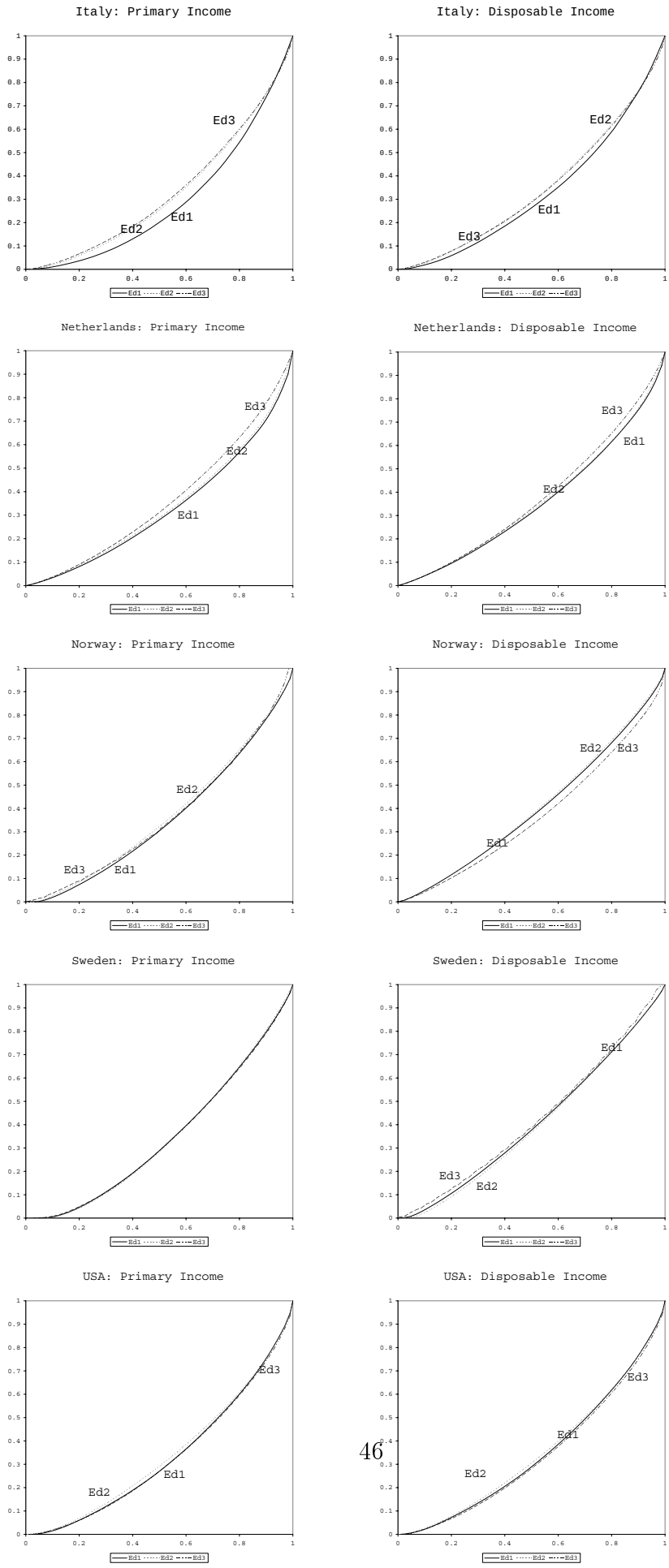

Figure 6: Lorenz curves conditional on social background (cont.)