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## **On the Meaning and Measurement of Redistribution in Cross-Country Comparisons**

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# On the meaning and measurement of redistribution in cross-country comparisons\*

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## Abstract

There is confusion in the literature concerning the relationship between income inequality and redistribution in a cross-country perspective. The reason for this is that different contributions in the literature are not referring to the same characteristic. This is shown by addressing information about redistribution in an international context from a number of angles: the size measures, such as tax revenue and government spending, the progressivity and redistributive effect with which the size is financed on the tax side, and the redistributive effects of government spending. By employing micro data from the Luxembourg Income Study database in combination with more aggregated information from the OECD for 15 countries, we show that the answer to the question “does more income inequality generate more redistribution?” depends on how the concept of redistribution is operationalized. Moreover, we argue that closer attention should be given to the common-base version of redistribution, which uses the “transplant-and-compare” procedure of Dardanoni and Lambert (2002). This conceptualization of redistribution is in fact what many authors actually may have in mind when discussing the relationship between income inequality and redistribution.

**Keywords:** Redistributive effect; Personal income tax; Cross-country comparison

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# 1. Introduction

What is the relationship between income inequality and redistribution in a cross-country perspective? A large number of articles discuss the relationship between income inequality and redistribution among countries. Despite recent empirical evidence suggesting that there is more redistribution when pre-tax income inequality is high, see Milanovic (2000), it is claimed by other authors that societies with low pre-tax income inequality redistribute more than less equal societies, see e.g., Persson (1995) and Bénabou (2000). In this paper we argue that a main reason for the confusion stems from differences in measurement strategies. The various authors are not all discussing the same thing. Redistribution refers to a whole range of different policy attributes, and different contributions in the literature are not all referring to the same characteristic. Another reason for the contrasting results is that studies apply different estimators for identification of the relationship between redistribution and initial dispersion. Whether one uses information about the same countries over time (“within estimator”), as Milanovic (2000) does, or addresses “between countries” data for identification of the relationship, as for instance done by Wagstaff et al. (1999), is highly relevant for the interpretation of results. Given the widespread attention this issue has attracted in the economics literature, it is of significant importance to spell out the implications of using alternative methods.

Ideally, one would like to have a measure of redistribution which captures the overall effect of both transfer and tax policies, but because of deficient information from data one often sees that contributions focus on more limited patches of the broader picture. We shall show that the answer to the question “does more income inequality generate more redistribution?” depends on how the concept of redistribution is operationalized and the choice of method for identification of the relationship. The operationalization issue refers both to the selection of a measure to quantify redistribution and to the choice of information used. By using definitions of redistribution employed in previous discussions of this topic in the literature, and also adding in some other alternatives, and by employing micro data from the Luxembourg Income Study (henceforth LIS) database in combination with more aggregated information from the OECD for 15 countries, we shall be able to examine the extent to which country-level pre-tax and transfer income inequality rankings accord with rankings of redistribution for different approaches.

We address the term “redistribution” from a number of angles. Redistribution from a tax perspective may refer to both the size of the revenue (or the size of the government) and the progressivity or redistributive effect with which the size is financed. Further, it may refer to different tax bases, such as the personal income tax and indirect taxes. Indirect taxation is often seen as a “blunt instrument” for redistribution (Stern, 1990; Creedy, 2003), and we shall limit the focus to the personal income tax here. The expenditure side may similarly be characterized in terms of the size of the government and various measures of the redistributive effects of government spending, and with respect to effects of specific support schedules on the expenditure side.

In particular, we shall argue that closer attention should be given to a measure of redistribution not seen in this field of the literature until very recently, namely the common-base method of the “transplant-and-compare” version of redistribution (Dardanoni and Lambert, 2002). According to this perspective and methodology, redistributive effect is measured in terms of a common base where measures of redistribution for each country are adjusted for pre-tax income inequality differences between countries in terms of two parameters for location and spread. By eliminating all pre-tax income inequality differences other than those due to differences in location and spread, this procedure identifies each

country's "redistributional efforts" according to a common-base. The common-base estimator we present is an alternative to the "within" and "between" estimators already used in the literature. We believe that this conceptualization of redistribution is in fact what many authors actually have in mind when discussing the relationship between income inequality and redistribution.

## **2. Conflicting evidence from the literature**

Intuitively one would expect that countries with the highest pre-tax income inequality are most redistributive, simply because the potential for redistribution is highest. This may follow from standard social welfare reasoning (based upon an additive social welfare function) with individual utility functions exhibiting diminishing marginal utility of income. However, it is often claimed that redistribution from rich to poor is least present when and where it seems most needed; a finding that Lindert (2004) calls "the Robin Hood paradox". Both across the globe and over time Lindert sees a general tendency that anti-poverty policy is positively related to average income and negatively related to income inequality.

The interest in the relationship between income inequality and redistribution has been spurred by the analyses of income distribution and economic development (or economic growth); early contributions are Kuznets (1955) and Kaldor (1956) (with opposite causal links, however). Because more redistribution leads to more distortionary taxation, which in turn influences economic growth, one subsequent line of research has focused on the median-voter hypothesis to explain the link between income distribution and growth, see Alesina and Rodrik (1994) and Persson and Tabellini (1994).

The median-voter model (Romer, 1975; Roberts, 1977; Meltzer and Richard, 1981) proposes a relationship between inequality and redistribution following from the median voter demanding more redistribution the greater is the distance between the median income and the mean income, and this would generate a positive relationship between income inequality and redistribution across countries. Thus, the median-voter hypothesis forms a theoretical framework with clear testable implications for discussions of the link between income inequality and redistribution. Empirical support for the association is mixed, however, and moreover, as is important for the point of departure of the present study, the relationship is discussed empirically with respect to a range of different measures. For instance, Perotti (1996) lets the marginal rates of tax and expenditure be explained by a measure of inequality defined by the "middle-class share"; that is, by the income share of the third and fourth quintiles when households are ranked according to disposable (post-tax) income. The tax regression generates an insignificant parameter estimate for inequality, whereas the expenditure specification gives the expected positive sign: greater inequality leads to higher expenditures. However, Bassett et al. (1999) retest the link between inequality and transfers and find either an opposite sign or insignificant estimates.

Milanovic (2000) criticizes the study by Perotti for using post-tax income and not pre-tax income when defining inequality. He uses factor income, with and without pension transfers, to do this, and measures redistribution by the income share gain of the lower half of the income distribution, of the bottom quintile and of the middle class (fifth and sixth deciles) in the transition to disposable income. These results show strong support for the redistribution hypothesis, i.e., that greater redistribution is likely to happen in more market-unequal environments, whereas support for the median-voter model as the pivotal explanation is considerably weaker. The identification is based on a fixed effect estimation (and therefore no use of inter-country differences), which influences the interpretation of results. See also Milanovic (2010): the identification of a positive "within country" relationship means that one

will observe more redistribution *in each country* for increasing income inequality. In order to clarify this further, let us for simplicity assume that we employ data for the US and Norway only. Then the “within country” estimator describes the expected change in US and Norwegian redistribution from a marginal change in income inequality, in contrast to the “between countries” estimator,<sup>1</sup> which depicts the expected difference between US and Norwegian redistribution for a marginal difference in income inequality between them. As it cannot be ruled out that the results from the two different estimations would differ, the choice of method for econometric identification may be important and may have contributed to the mixed results in the literature.<sup>2</sup>

In contrast to Milanovic (2000), many other contributions within the field discuss the redistribution hypothesis in a “between countries” fashion. For instance, Wagstaff et al. (1999) is a comprehensive analysis of redistributive effects and tax progressivity effects of the personal income tax for twelve OECD countries. They find that there is no link between pre-tax income inequality and the degree of redistribution brought about by the personal income tax. Ireland, Spain, the UK and the US are the countries with the most unequal pre-tax income distributions, and they are found to be more redistributive than many other countries, but less redistributive than Sweden and Finland, which have very low levels of pre-tax income inequality. As noted in the Introduction, the present paper introduces a third estimator for discussions of the redistribution hypothesis: the common-base estimator of the “transplant-and-compare” procedure (Dardanoni and Lambert, 2002), see Section 5.2. In terms of the terminology applied, we may call our suggestion a “normalized between countries” estimator.

The conflicting results from these various studies have not escaped attention: “redistribution is often correlated with income inequality in just the opposite way than predicted by standard politico-economic theory: among industrial democracies the more unequal ones tend to redistribute less, not more.” (Bénabou, 2000, p. 96), and alternative theories have been developed, for instance emphasizing the role of insurance in redistributive policies; see e.g., Bénabou (2000) and Moene and Wallerstein (2001). Bénabou (2000) finds that the “rate of fiscal progressivity”, measured by the elasticity of post-tax income with respect to pre-tax income, is U-shaped with respect to inequality in pre-tax income across countries, whereas Moene and Wallerstein (2001) focus on links between inequality, measured by the ratio of pre-tax earnings at the 90<sup>th</sup> and the 10<sup>th</sup> percentiles, and social expenditures as a share of GDP, and find support for voters having both redistributive and insurance motives.

Other studies emphasize different social assessments of inequality. Alesina and Angeletos (2005) suggest that differences in redistributive efforts reflect differences between societies in social perceptions regarding the fairness of market outcomes, whereas Lambert et al. (2003) argue that societies which are less averse to inequality have higher objective inequality, and that different attitudes to what are socially acceptable levels of inequality in different countries can account for differing redistributive policies.

The inequality and redistribution relationship is also at the centre of attention in other lines of research. For instance, Slemrod and Kopczuk (2002) suggest that the development of tax administration and enforcement influence the behavioral response to a tax rate change, and that low income countries (measured in GDP) will not have the administrative ability to dampen the elasticity of taxable income, and will therefore restrain both the size of government and the progressivity with which the size is financed.

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<sup>1</sup> In terms of the panel data of Milanovic (2000), OLS estimation on the time averages of the panel units will generate a “between country” regression.

<sup>2</sup> Another econometric challenge is that there may be simultaneity problems; see Milanovic (2010) for further details.

### **3. On the relationship between income inequality and redistribution**

#### **3.1 Different approaches to the measurement of redistribution**

We shall not consider, in this paper, mechanisms by which inequality and redistribution might be linked. Rather, we shall investigate links between outcome measures of inequality and of redistribution for different definitions of redistribution. A central strand of the measurement literature associates redistribution with tax level (for a formal definition of this, see ahead) and tax progressivity. Global (summary) progressivity measures contain a contribution from the pre-tax income distribution, and also contain a contribution from either the distribution of the tax burden or the distribution of post-tax incomes. Measures involving the latter are referred to as redistributive effect measures; measures involving the former are referred to as disproportionality measures. In either case, overall progressivity results from the interrelationship between taxes and the pre-tax income distribution, a characteristic which from a public policy point of view makes tax progressivity measurement often more interesting than pure inequality measurement: it establishes relationships between initial conditions (pre-tax income distributions), policy tools (taxes) and outcomes (post-tax income distributions).

However, with three distributions involved (pre-tax income, post-tax income, and tax burden), and as there exist different inequality measures to sum up these distributions, not surprisingly the literature offers a plethora of progressivity measures. We shall briefly review the main ones here, beginning with Gini-based measures, which are by far the most prevalent. Technicalities are deferred until Section 3.2 of the paper.

The works of Kakwani (1977), Reynolds and Smolensky (1976) and Aronson et al. (1994) typify this strand of the measurement literature. Bourguignon and Morrison (1980) prove that the Reynolds-Smolensky index is the only conventional measure of the redistributive effect of an income tax which is determined jointly by tax level and the inequality impact of an identically-distributed one dollar tax. Aronson et al.'s (1994) decomposition of the Reynolds-Smolensky index shows how to isolate vertical, horizontal and reranking contributions from this measure, and subsumes the earlier Kakwani (1977, 1984) approaches. The Aronson et al. methodology has recently been considerably refined; see Urban and Lambert (2008). Going back in time, Musgrave and Thin (1948) and Pechman and Okner (1974) offered precursor measures to the Reynolds-Smolensky index which can (now) be seen as normalizations of the achieved inequality reduction, in which the normalization is by the equality or inequality level prevailing before the tax was applied. Fellman et al.'s (1999) "optimal yardstick" approach measures the redistributive property of an in-place income tax relative to the redistribution that could have been achieved had the tax been designed to have maximal inequality impact given the tax level. This approach uses the extended Gini coefficient of Yitzhaki (1983), providing the analyst with an opportunity to input a distributional judgment parameter, which conditions the results.

An important non-Gini strand of the progressivity literature uses the welfare-function-based Atkinson (1970) index of inequality, for a chosen degree of inequality aversion, to quantify redistributive effect. The Blackorby and Donaldson (1984) and Kiefer (1984) progressivity indices each adopt this approach, which, like that of Fellman et al., requires an assumption about the degree of inequality aversion of the social observer. Lambert and Thoresen (2009) found, when applying the Blackorby-Donaldson index, that the Norwegian tax system is not very redistributive. This might seem surprising given the perception of

Scandinavian economies being very redistributive, but it is intuitive given the “cost of proportional taxation” concept underpinning the Blackorby-Donaldson index.<sup>3</sup> When the inequality of the pre-tax income distribution is low, the social decision maker will pay less in order to avoid a proportional tax. Therefore, when such a measure is used as an indicator of the degree of tax progressivity, we find small redistributive effects, e.g. for the Norwegian tax system. Duclos and Lambert (2000) contains evidence of much higher values for Canada.

All of these approaches result in progressivity measures which conflate tax system differences with pre-tax distributional differences. When used to make cross-country comparisons of redistributive effect, this tangled, twofold informational content prevents pre-tax inequality and what we might call “redistributional effort” from being explored as distinct phenomena. In Dardanoni and Lambert (2002) a methodology is proposed which fixes this problem, rendering a common-base estimator for cross-country comparisons of redistribution. Post-tax income distributions are adjusted on the basis of differences between the pre-tax distributions they are derived from by controlling for location and spread differences. By eliminating all other pre-tax income inequality differences, for whatever reason they happened (behavioral incentive differences or demographic variations, for instance), we get closer to identifying the effect of tax policies or “redistributional ambitions” across countries. Redistributive properties are measured and compared (using any or all of the conventional methodologies) for the “transplanted” income distributions, now for a common baseline. Comparisons after such transplantation are guaranteed invariant to the choice of baseline if candidate distributions are isoelastic transformations of one another (i.e. if the pre-tax income distributions only differ in logarithms by location and scale, thus not exhibiting major shape dissimilarities). In a series of transplant-and-compare exercises undertaken for the Norwegian income tax system over the period 1992-2004, Lambert and Thoresen (2009) reported that the transplant-and-compare procedure yielded “cogent and seemingly robust results, which are also intuitively satisfying”.

Progressivity measurement can readily be extended to the benefits flowing from government expenditure programs, if attributed to individuals or households in cash-equivalent terms,<sup>4</sup> and to a combined tax and benefit system. See Kim and Lambert (2009) for the extension of the Gini-based measures to a combined tax and benefit system, and Duclos and Lambert (2000) in respect of the Atkinson-index-based measures. Horizontal and reranking effects are considered in these papers. It is typically found that the tax and benefit components of a combined system contribute to overall horizontal inequity in different income ranges; see Dardanoni and Lambert (2001, p. 814) and Duclos and Lambert (2000, pp. 106-109) on this. Fellman et al’s (1999) “optimal yardstick” methodology is articulated for both benefits and a combined tax and benefit system. The transplant-and-compare procedure can be invoked to ensure that redistributive properties are measured and compared after having controlled for the differences which exist between pre-tax and pre-benefit income distributions.

### 3.2 More details about the measures of redistribution used in this study

Let  $x$  be individual or household pre-tax income, let  $n$  be post-tax income and let the aggregates of these across the population be  $X$  and  $N$ . Denote the Gini coefficient for an

<sup>3</sup> This index measures the proportion of after-tax income the social observer would hypothetically pay to convert a flat tax system with the same yield into the given one.

<sup>4</sup> Government expenditures fund not only low-income support, but also programs in education, health, defence, justice, diplomacy, etc, as well as providing for general administration. Expenditures on some of these operations may be poorly measured in available statistics. Also, there is no uncontroversial and operational principle which can be used to guide such an attribution exercise.

attribute  $u = u(x)$  by  $G_U$ , and denote the Atkinson inequality index with parameter  $e$  by  $I_U(e)$ . Principally, we shall encounter  $G_X$  and  $G_N$  and  $I_X(e)$  and  $I_N(e)$  in what follows. The concentration coefficient for  $u$  when income units are ranked by  $x$  will be denoted  $C_U$ . We shall encounter  $C_N$  and  $C_T$  here, where  $t = x - n$  is the individual tax payment and  $T$  is the total tax. Let the total tax ratio (or overall average tax rate) be  $g = T/X$ . The factor  $[(1-g)/g]$  is often called *tax level*: it measures total taxes relative to the total remaining (post-tax) income. This notation, along with all of what follows, is exactly as in Kim and Lambert (2009).

We first enumerate the Gini-based measures that will feature in our empirical investigations. The Reynolds-Smolensky (1976) index of redistributive effect is  $RE = G_X - G_N$  and the Kakwani (1977) index of disproportionality is  $P^K = C_T - G_X = [(1-g)/g] V^K$  where  $V^K = [G_X - C_N]$  quantifies the “vertical” redistributive characteristic of the income tax, namely, its inequality-reducing impact *on average*, from which additional terms need netting out in order to obtain  $RE$ . A negative ‘horizontal’ contribution arises in case there is unequal tax treatment of pre-tax equals (introducing inequality where there was none before). Kakwani did not allow for this feature of a typical tax system in his 1977 paper, but in his 1984 paper introduced the decomposition  $RE = V^K - R^K$ , where  $R^K = G_N - C_N$  is an index of the reranking which occurs when income units which were better-off than others before tax end up worse-off, because of differential tax treatments. In Urban and Lambert (2008) it is shown how to properly adapt this decomposition when, as is common, there is a sparsity or complete lack of exact pre-tax equals in one’s data. The final decomposition is of the form  $RE = V^{UL} - H - R^K$ , where  $H$  is a term measuring the effect of the unequal treatment of exact equals, which is effectively netted out of Kakwani’s  $V^K$ ; his reranking measure stands. An algorithm for computing  $V^{UL}$  (or  $H$ ) is given in Urban and Lambert (2008).<sup>5</sup>

The earlier Gini-based indices of redistributive effect are those of Musgrave and Thin,  $RE^{MT} = \frac{1 - G_N}{1 - G_X}$ , and Pechman and Okner,  $RE^{PO} = \frac{G_X - G_N}{G_X}$ . The “optimal yardstick”

version, due to Fellman et al., takes the form  $RE^F(v) = \frac{G_X(v) - G_N(v)}{G_X(v) - G_0(v)}$  where  $G_X(v)$  and

$G_N(v)$  are extended Gini coefficients with parameter  $v > 1$ , and  $G_0(v)$  is the (counterfactual) post-tax Gini which would pertain if the same tax revenue were raised by a 100% tax on all income above a certain pre-tax threshold, with no tax lower down the distribution.<sup>6</sup> The

Blackorby-Donaldson (1984) index of redistributive effect is  $RE^{BD} = \frac{I_X(e) - I_N(e)}{1 - I_X(e)}$  and the

Kiefer index is  $RE^{KI} = I_X(e) - I_N(e)$ . The last of these measures redistributive effect as inequality reduction, without normalization; the others normalize by either pre-tax inequality ( $RE^{PO}$ ) or pre-tax equality ( $RE^{MT}$ ,  $RE^{BD}$ ). All can be applied to a benefit system or net tax and benefit system, simply by re-interpreting  $N$  as respectively income including benefits or income including benefits and net of tax.

In particular we see, from the above sketch of redistribution measures, that pre-tax inequality is brought inextricably into the measurement, and in a different manner for each different measure. But the methodologies can as well be applied using transplanted tax and/or tax and benefit schedules, and this will free the measurement exercise from the confounding effects of pre-tax distributional differences.

<sup>5</sup>  $H$  may be negative if there are few or no exact pre-tax equals in the sample;  $H$  is an estimate only, and can be an underestimate.

<sup>6</sup> In practical terms, an iteration procedure is employed in order to find the pre-tax threshold which divides the population into two: those who pay no tax and those who are taxed 100 percent on income above the threshold; see also footnote 6 in Fellman et al. (1999).



Let  $F(x)$  be the distribution function for pre-tax income in a given country, and, as before, let  $u = u(x)$  be some attribute of a person or household having  $x$  before tax. If  $g(x)$  is a mapping of pre-tax incomes into  $\mathbb{R}^+$ , the conjugate mapping  $u^g(x) = g(u(g^{-1}(x)))$ , i.e.  $u^g = g \circ u \circ g^{-1}$ , operates on the distribution  $F \circ g^{-1}$ . If an isoelastic function  $g(x)$  can be found such that  $F \circ g^{-1}$  is the standard lognormal distribution, call this  $\ln(0,1)$ ,<sup>7</sup> then as Dardanoni and Lambert (2002) have shown, the conjugate of the pre-tax/post-tax income mapping  $x \rightarrow n$  can be regarded as the transplant of the tax system into  $\ln(0,1)$ . This can be done with the data of each country, to enable a set of comparisons, of the actions of transplants upon  $\ln(0,1)$ , in which actual tax schedules have all been adjusted for pre-tax distributional differences. In fact the lognormal is not required for this “transplant and compare” procedure; whenever within-country pre-tax income distributions differ in logarithms only by location and scale, an appropriate “reference” distribution can be selected, and the comparisons made with tax systems that have been adjusted for international differences in pre-tax location and scale. Empirically, one wants to find that, for each country  $i$ , there exist  $a_i$  and  $b_i > 0$  such that the distribution of  $a_i + b_i \ln(x)$  is sufficiently close to the chosen reference distribution, where  $x$  is pre-tax income. Thus, the method implies finding estimates of  $a_i$  and  $b_i$  that minimize the differences between the two distributions in terms of location and scale. This corresponds to finding the intercept and slope in a traditional OLS regression, and the  $R^2$  statistic becomes the relevant measure of goodness-of-fit. The post-tax income values are then adjusted by the fitted deformation function  $g_i(x) = e^{a_i} x^{b_i}$  before making comparisons of redistributive effect. See Lambert and Thoresen (2009, pp. 237-239) for more on this.<sup>8</sup>

## 4. Data and definitions

Information about redistributive effects of the personal income tax across countries are computed from the LIS database (<http://www.lisproject.org>), which provides a high-quality source of internationally comparable data on household incomes. The selection of countries has been restricted by availability of information about pre-tax income distributions and the demand for information across countries from approximately the same time period. This leaves us with data from 14 countries in the time period 1999-2001 (Australia (AUS), Canada (CAN), Denmark (DNK), Finland (FIN), Germany (DEU), Israel (ISR), Netherlands (NLD), Norway (NOR), Poland (POL), Sweden (SWE), Switzerland (CHE), Taiwan (TWN), United Kingdom (UK) and the United States (US)) and information about 1 country from 1997, Belgium (BEL). We have utilized estimates of summary measures across countries provided by LIS, but mainly we have employed information from the LIS data by submitting SAS-programmes to the micro data bases of the respective countries, obtaining tailor-made measures.<sup>9</sup>

The sizes of the datasets vary, from observations on more than 80,000 Danish households to about 3,600 households for Switzerland. For all datasets, income and tax variables are measured in “equivalent values”, which means that the nominal values have been weighted by an equivalence scale (the square root of number of household members). The representation of each household when obtaining summary measures of inequality

<sup>7</sup> That is to say,  $y \sim \ln(0,1) \Leftrightarrow \ln(y) \sim N(0,1)$ , where  $N(0,1)$  is the standard normal distribution.

<sup>8</sup> In particular, before undertaking the regressions, the sample sizes have to be equalized. See footnote 23 in Dardanoni and Lambert (2002).

<sup>9</sup> In particular for the “transplant and compare” method it has been crucial to have access to micro data for each country.

depends on the number of household members; this is often characterized as employing the individual as the unit of analysis.

Following from our focus on effects of both tax and transfer policies, we present constellations for both the tax and expenditure side of governments' interventions with respect to one pre-tax/transfer definition of income, corresponding to what Milanovic (2000) characterize as *factor P income*: income (including pensions) before tax and social transfers, where the latter includes social insurance transfers and social assistance transfers (see <http://www.lisproject.org/techdoc.htm> for further details). This means that countries' initial conditions are determined by pre-tax/transfer income inequality. The different measures of redistribution are, however, obtained by use of the income variables in question. For instance, estimates of tax redistributive effects are derived by inputting the inequality of gross income (including taxed and non-taxed transfers) and the inequality of post-tax income; see Section 3 for descriptions of different measures. Thus, in the scatter plots that are used to describe links, we use measures of pre-tax/transfer income inequality to define countries' place in the international pre-intervention hierarchy.

In some of the constellations information from LIS is combined with information from OECD, who for instance have produced measures of the "social inclination" of the expenditure side of the budgets; such measures are presented and utilized in OECD (2004, 2005, 2008).

## 5. Relationships between pre-tax/transfer income inequality and redistribution for different definitions

### 5.1 Redistribution according to standard constellations

We constructed a sequence of graphs, showing the elements of each country's constellation for the personal income tax and expenditure side, plotted against pre-tax/transfer income inequality. These show relationships between pre-tax/transfer inequality and six (Gini and Atkinson index based) measures of income tax redistribution,  $\{RE^{RS}, RE^{MT}, RE^{PO}, RE^F, RE^{BD}, RE^{KI}\}$  as well as two measures of vertical tax effects,  $\{V^K, V^{UL}\}$ , and four measures that characterize the expenditure side of the budget, including redistributive effects of transfers and progressivity of cash benefits. Also shown are relationships between pre-tax/transfer inequality and some appropriate measures of the size of government. Pre-tax/transfer income inequality is measured by the Gini coefficient, except for charts that show the measures of redistribution based on the Atkinson index ( $RE^{BD}, RE^{KI}$ ), for which (correspondingly) pre-tax/transfer income inequality is measured by the Atkinson index (as also indicated in the diagrams).

#### *Measures of the overall redistributive effects of income tax systems*

Figure 1 shows that redistribution is increasing in pre-tax/transfer income inequality for all six measures of income tax redistribution, as signified by the straight line plots in each diagram, derived from ordinary least squares (OLS) regressions. Of course, it is somewhat "heroic" to carry out regressions with such a limited number of data points, but it provides a helpful way to summarize the empirical links. For each straight line in the diagrams we have specified parameter values for intercept and slope, along with a  $t$ -value for the slope. Without putting too much emphasis on the results of these regressions, it is interesting to note that the  $t$ -values

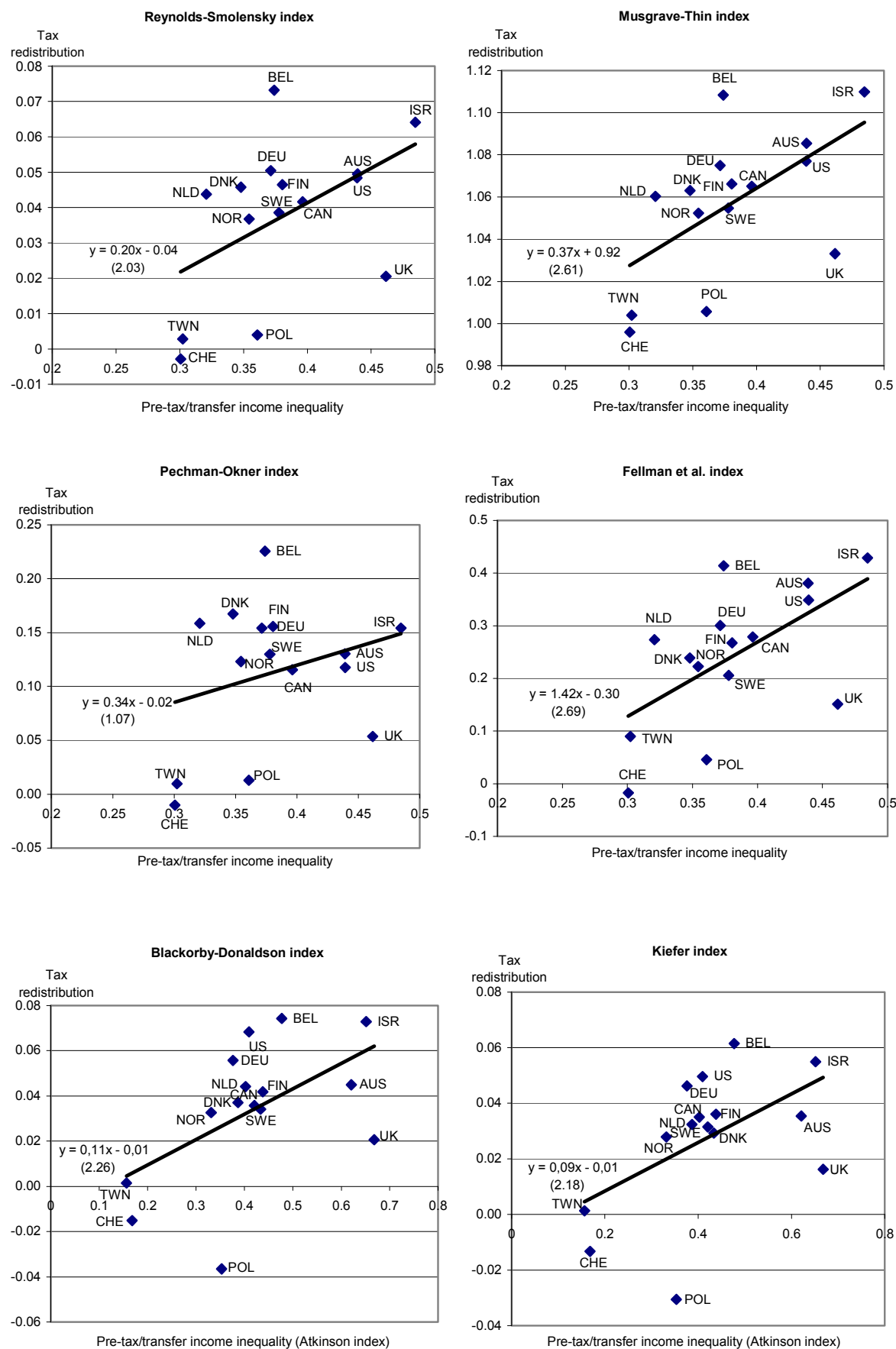
for some of the diagrams indicate significant results for reasonable test levels (given the degrees of freedom).

We see that placements of different countries are rather similar according to all measures of redistribution, illustrated by upward slopes of the fitted straight lines for all five measures. However, we see a difference between measures that normalize redistribution by pre-tax inequality ( $RE^{PO}$ ) and those with others forms of normalization ( $RE^{RS}$ ,  $RE^{MT}$ ,  $RE^F$ ,  $RE^{BD}$ ,  $RE^{KI}$ ).<sup>10</sup> For instance, the three Scandinavian countries (Denmark, Norway and Sweden) are less redistributive than the US according to the latter group of measures, whereas results for the Pechman-Okner measure ( $RE^{PO}$ ) indicate that redistribution is higher in the Nordic countries than in the US. The fitted relationship is non-significant in the Pechman-Okner case. In Section 5.2 we present a type of “normalization” which goes much further, the “transplant-and-compare” version of redistribution (Dardanoni and Lambert, 2002): redistributive effect is measured in terms of a common base, whereby pre-tax income inequality differences between countries are entirely eliminated before measurement takes place.

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<sup>10</sup> For  $RE^{BD}$  and  $RE^{KI}$  the relative inequality aversion parameter of the Atkinson index is set to  $e = 1$ . Relationships are similar both for the Blackorby-Donaldson and the Kiefer indices when  $e = 0.5$ . The index  $RE^F$  employs the extended Gini. Our results in Figure 1 are for the standard Gini ( $\nu = 2$ ). We also observe positive relationships for  $\nu = 1.5$  and  $\nu = 2.5$ , but upward slope parameter is insignificant for  $\nu = 1.5$ .

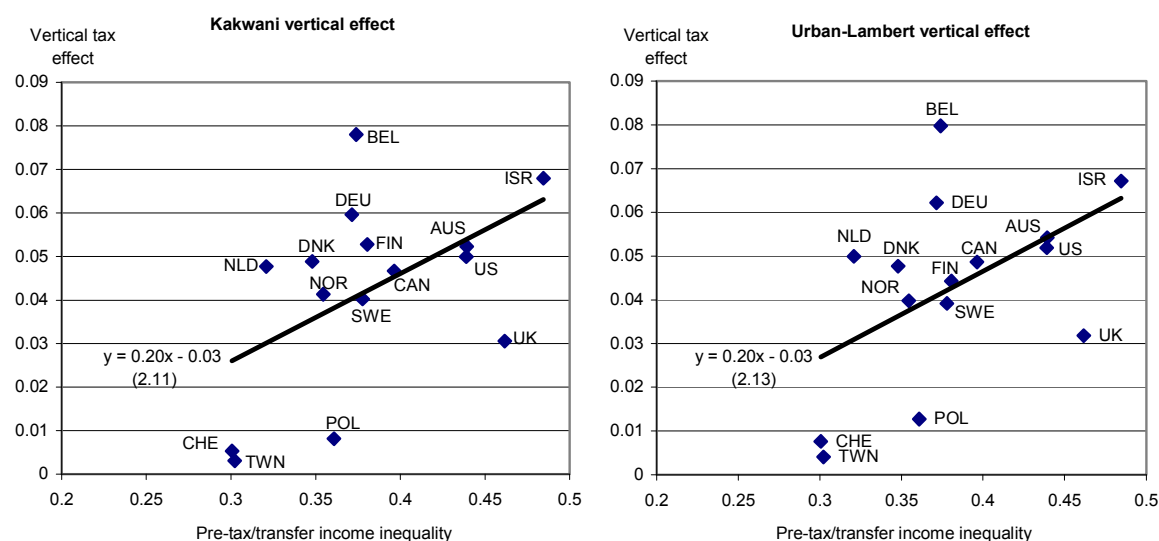
**Figure 1. Relationship between tax redistribution and pre-tax/transfer income inequality**



## Vertical effects

As already noted in Section 3, overall redistribution and vertical redistribution are not the same thing if the tax system involves horizontal differences in tax treatment and/or rerankings. Figure 2 presents diagrams for two vertical measures: the measure  $V^K$  of Kakwani (1977) and the measure  $V^{UL}$  of Urban and Lambert (2008). We see that relationships between vertical effects and pre-tax inequality basically follow the same pattern as in Figure 1, which means that differences between countries according to horizontal effects are limited.<sup>11</sup> Again we see a clear positive link between pre-tax income inequality and redistribution – in this case, vertical redistribution, and we see that the three Scandinavian countries all are less vertically redistributive than the US.

**Figure 2. Relationship between vertical effects of the personal income tax and pre-tax/transfer income inequality**



## Size measures

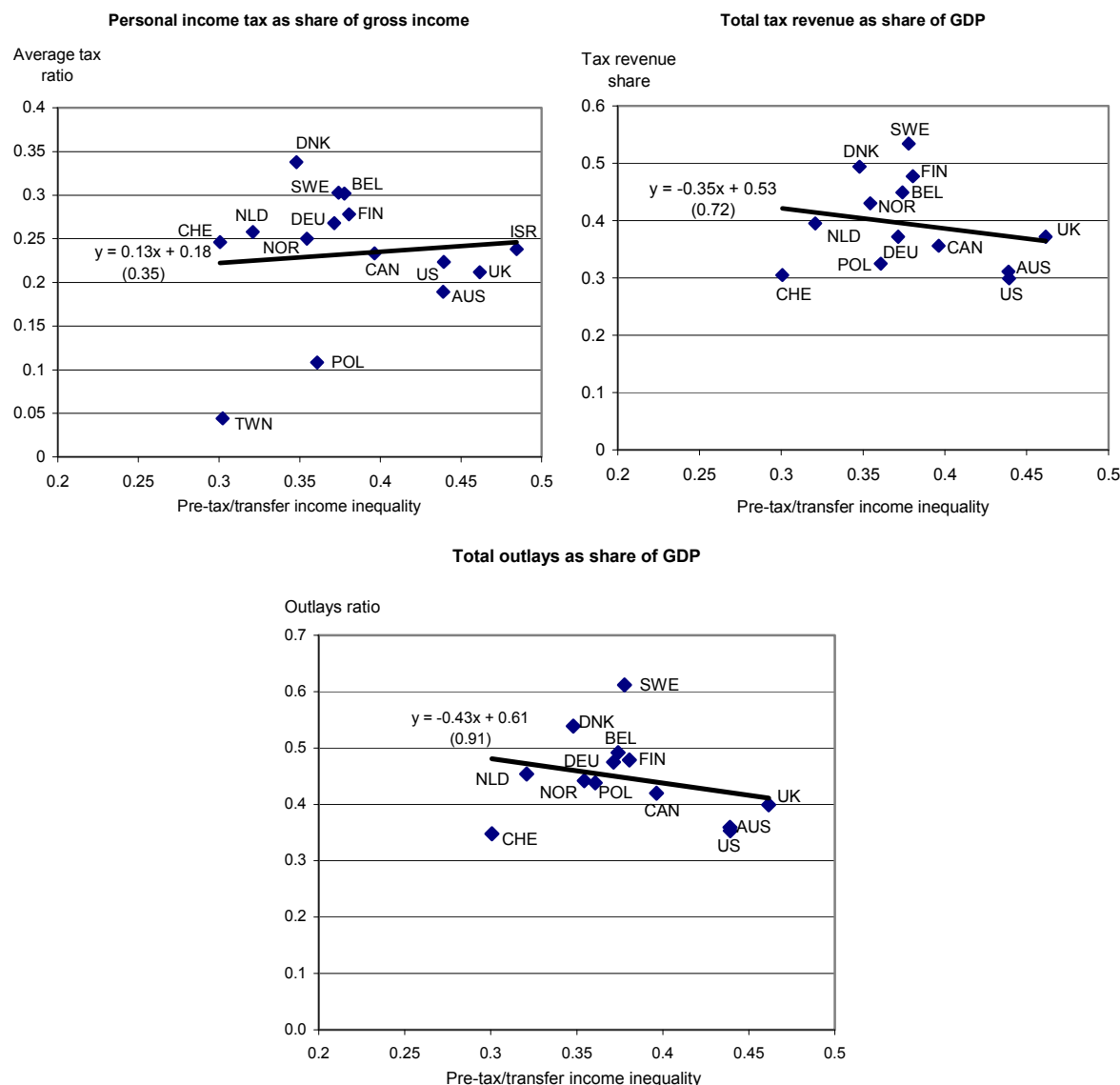
Next, we turn to links between pre-tax income inequality and what we might call the *size* of the government. We use three measures of size: the share of total income taken in personal income tax (this is the tax ratio  $g$ , already introduced), the share of GDP accounted for by total tax revenue, (including corporate taxes, indirect taxation, etc), and total government outlays (consolidations of accounts for the central, state, and local governments plus social security) as a share in GDP. The two latter measures of government size are based on data from OECD (2004) for the years 2000 and 2001.

Contrary to the redistribution findings, here the relationships are weak, indeed they come close to exhibiting negative correlation.<sup>12</sup> For instance, average tax rates and governmental outlays are higher in the Scandinavian countries than in the US, as one would expect.

<sup>11</sup> However, from a tax policy perspective, it can of course be very important to distinguish between horizontal and vertical effects.

<sup>12</sup> One would expect there to be a close relationship between incomes and budgetary outlays in the long run, but in the short run the discrepancies are in fact a key issue when discussing government size; see for instance Romer and Romer (2009).

**Figure 3. Relationship between measures of the size of government and pre-tax/transfer income inequality**



### *The “social inclination” and redistributive effects of the expenditure side*

As noted in Section 2, many authors associate redistribution with features of the expenditure side of the budget. In Figure 4 we present four diagrams, describing relationships between pre-tax/transfer income inequality and redistribution characteristics of the expenditure side. The diagram in the upper left corner of Figure 4 is based on the LIS data, whereas the three others are derived by combining information from LIS (the pre-tax/transfer rankings) and OECD data sources.<sup>13</sup> We measure “social inclination” by two measures of expenditure side dispersion: transfer redistributive effects and progressivity of the cash benefits<sup>14</sup>, and two

<sup>13</sup> As these data do not include measures for Israel and Taiwan, the sample is reduced to 13 countries in Figure 4. This opens up the possibility of results being influenced by different sample sizes. We have, however, verified that the result for the transfer redistributive effects (diagram in the upper left corner) survives the exclusion of Israel and Taiwan, although the  $t$ -value is reduced.

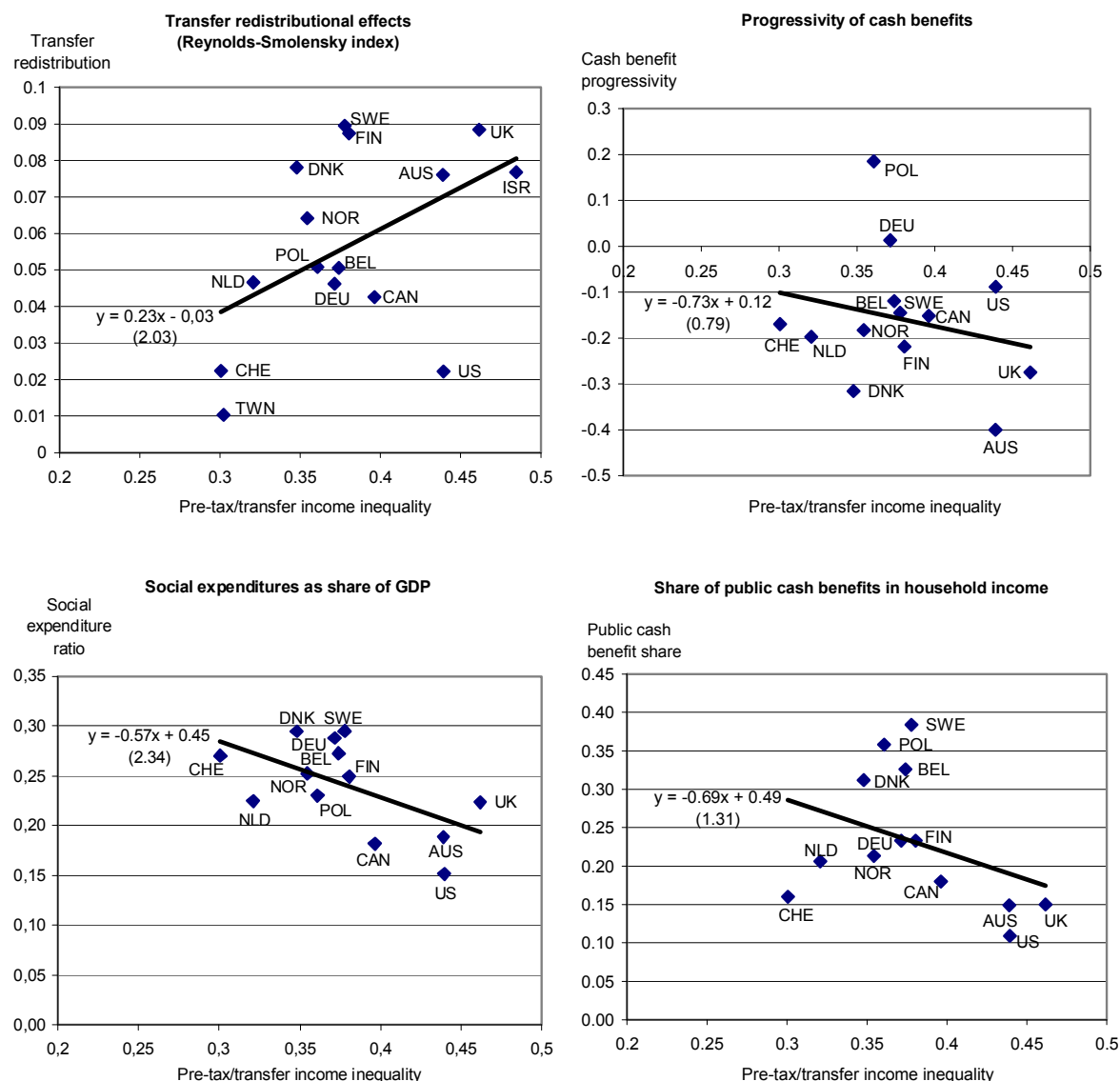
<sup>14</sup> The measurement of progressivity of cash benefits uses concentration coefficients for the mid-2000s, see also the description of the Kakwani decomposition in Section 3.2.

“size” measures: the share in GDP for 2001 of social expenditures (cash benefits and benefits in-kind with one or more social goals) and public cash benefits as a share of disposable income for the mid-1990s. The transfer redistributional effects are measured by comparing distributions of pre-tax/transfer income and pre-tax income, see more details in Section 4.

Note that if poorer income groups receive a higher share of transfers than their share of disposable income, the concentration coefficient involved in the measurement will be negative. Given this, the two upper diagrams of Figure 4 show basically similar effects of transfers: in countries with high pre-tax/transfer inequality, transfers have larger offsetting effects. However, note that the relationship for the progressivity of cash benefits is very weak. In contrast no such links are seen for the measures of the amounts of transfers. This illustrates that there is not necessarily a relationship between how much is used for social support and the progressivity of what is used (which is independent of size). Correspondingly, we see that the UK and Australia are at the low end in terms of shares of social expenditures and cash benefits, but both countries are among the most transfer redistributional and have high, large and negative transfer progressivities. This may well illustrate the trade-off between low-income targeting and the size of redistributive budgets (universalism), as emphasized by e.g. Korpi and Palme (1998).

However, note that these charts also reflect the fact that systems of social protection vary across countries, both with respect to how the benefits are funded and how social programmes are structured. Thus, when interpreting the results we should have in mind that differences between countries may also be due to measurement problems. A high value of social expenditures as share of GDP may reflect a high level of the social welfare system. However, if the beneficiaries have to pay taxes on these benefits, social expenditures net of taxes as a share of GDP may be at the same level as in countries with lower social expenditures relative to GDP. For instance, it should be noted that public cash benefits are reported net of taxes for Poland.

**Figure 4. Relationship between measures of expenditure side characteristics and pre-tax/transfer income inequality**



## 5.2 Redistribution according to the transplant and compare method

In the previous section redistribution was measured and illustrated in a number of ways, and it was evident that conclusions vary somewhat according to different definitions. This contrasting evidence clearly invites confusion around such questions as “which country is most redistributive?”

Here we direct attention to another measurement problem. As noted in Section 2, interpretation of results may have been confounded by different studies employing different estimation methods. For instance, Milanovic (2000) identifies links by using a “within country” estimator, whereas many other studies discuss the redistribution hypothesis in a “between country” mode, and this difference may not be innocuous. We suggest that closer attention should be given to a measure of redistribution not generally seen in this field,

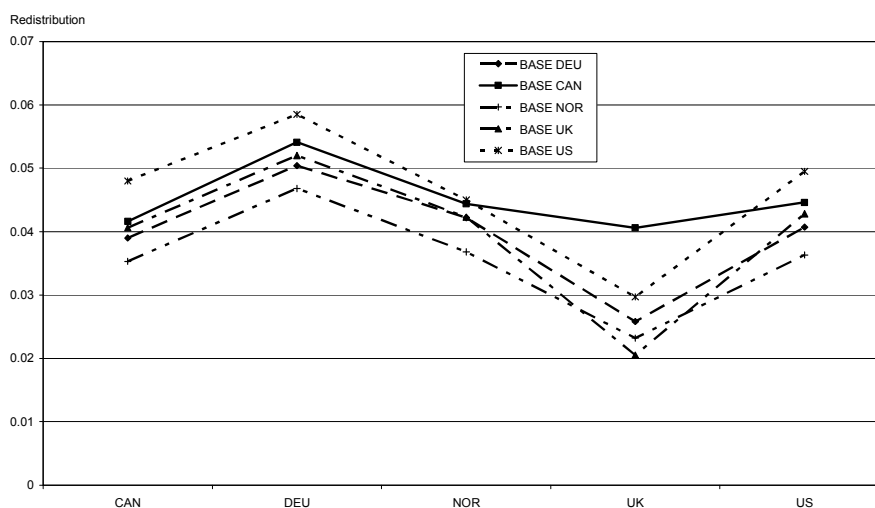


namely the common-base method of the “transplant-and-compare” version of redistribution (Dardanoni and Lambert, 2002).

According to our reading of the redistribution hypothesis and other conjectures of the link between pre-tax inequality and redistribution, the most relevant measure(s) of redistribution would come from using a methodology that provides result in terms of a common baseline: one would like to see how countries’ redistributive efforts would compare if computed for (hypothetically) the *same* level of pre-tax income inequality. This is our rationale for repeating our analysis using the “transplant and compare” method.<sup>15</sup> This exercise relates to the measurement of tax redistributions of the type presented in Figure 1, but the same reasoning would apply to the expenditure side and to a joint tax and benefit system.

The transplant and compare method necessitates adjusting post-tax income values by a fitted deformation function, whose parameter estimates are obtained by OLS regression, as explained in Section 3 and described in further details in the Appendix. A vital precursor to the comparisons we shall undertake is to validate the base independence of results. Do results depend on the choice of reference distribution, i.e. on whether the pre-tax income distribution of (for instance) the US or Norway is employed as the base? In Figure 5, we show how one measure of redistribution compares for five selected countries, using each of those five countries as the reference pre-tax income distribution in turn. The figure shows strong similarities between descriptions of redistributive effects for different bases.<sup>16</sup>

**Figure 5. Redistributive effects (Reynolds-Smolensky index) of the personal income tax according to the transplant and compare procedure for different reference distributions. Results for Germany, Canada, Norway, the UK, and the US.**



<sup>15</sup> The conflation of pre-tax income distributions with tax redistributive effects has led authors in the past to search for evidence according to a common base to come closer to identifying efforts by policy-makers to redistribute income; see particularly Kasten et al. (1994) and Thoresen (2004) for discussions of over time developments in tax progressivity and redistribution, employing tax simulation models to simulate effects of tax schedules for different years on the same pre-tax income distribution.

<sup>16</sup> In fact, we encountered some difficulty with respect to income distribution of the UK, which is also reflected by the results in Figure 5. More details are given in the Appendix. See also Lambert and Thoresen (2009) in which the base independence question is extensively discussed (for a single country over time).

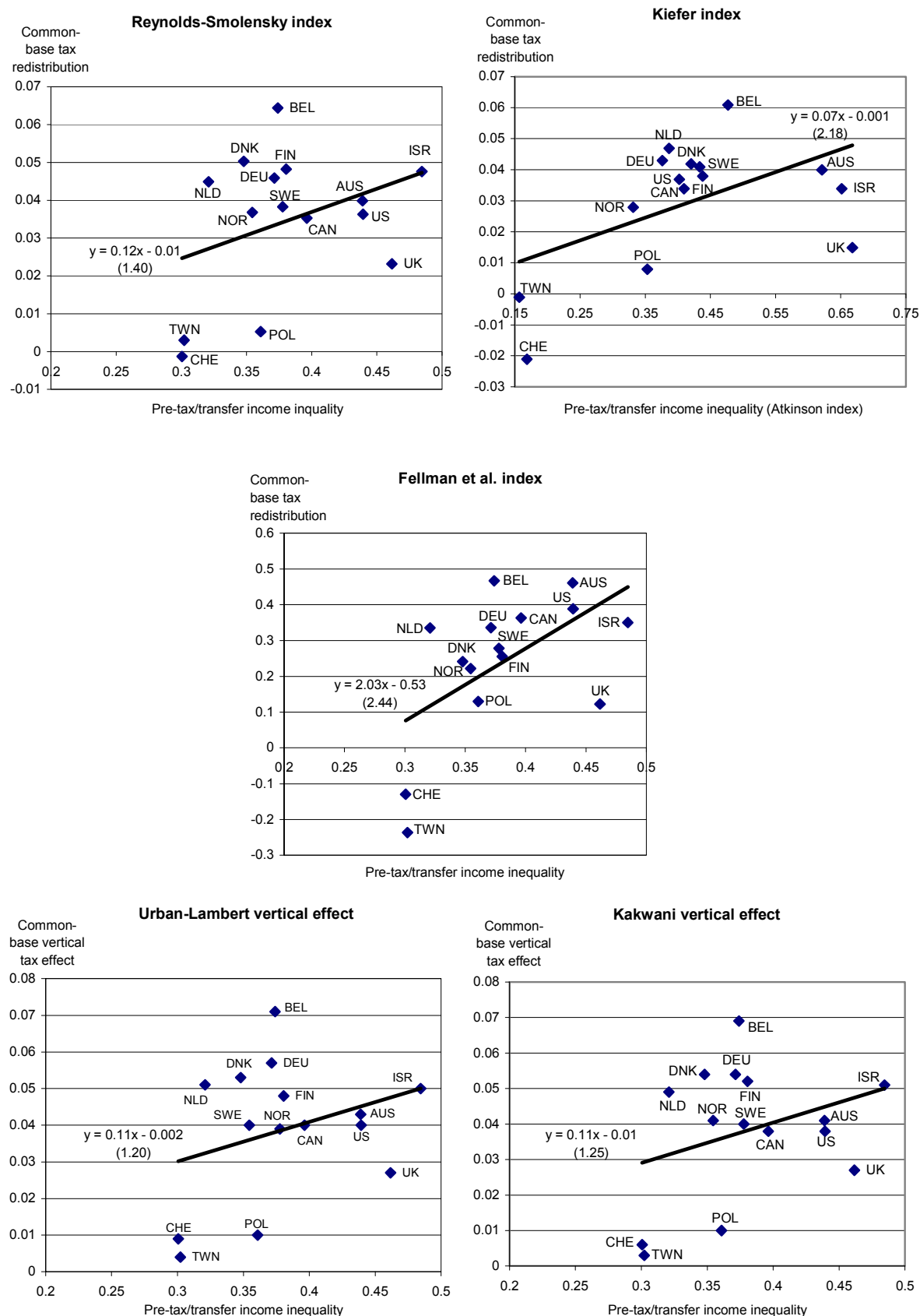
Now we are ready to put measures of redistributive effect derived by following the “transplant and compare” procedure together with information about pre-tax income inequality. We do this in Figure 6. Is there a relationship between common-base redistribution and pre-tax/transfer income inequality? In contrast to the descriptions of such relationships we explored in Figure 1, now redistribution *for a reference level of pre-tax income inequality* is measured on the vertical axis. As for the choice of measure(s) of redistribution among  $\{RE^{RS}, RE^{MT}, RE^{PO}, RE^F, RE^{BD}, RE^{KI}\}$ , since the effect of differences in pre-tax income inequality levels are controlled for directly under the “transplant and compare” procedure, results would not be expected to depend on whether an index with or without normalization with respect to pre-tax inequality were used. In Figure 6, we show results for three measures of overall redistribution and two measures of vertical redistribution. For overall redistribution, these are the Gini-based and Atkinson index-based unnormalized measures  $RE^{RS}$  and  $RE^{KI}$ , and the measure  $RE^F$ , which is normalized with respect to the socially optimal inequality-reducing yardstick tax. For vertical effects, we use the measures  $V^K$  and  $V^{UL}$ . We chose Norway as the reference country providing the common base.<sup>17</sup>

In Figure 6, common-base redistribution and pre-tax income inequality are plotted together. The figure includes fitted linear relations with upward slopes, but as reflected by the  $t$ -value (in parentheses), the identification of these relationships is weak in three of the charts – those for the Reynolds-Smolensky index and the two measures of vertical effects – whereas the links for the Kiefer index and the Fellman et al. measure are clearly positive. Thus, these results also signify that the choice of index for redistribution is important. The relationship between countries’ common-base redistributive efforts for the personal income tax and their pre-tax income inequality levels is weaker than for standard measures of redistribution. The positive relationship for  $RE^F$  is interesting because this measure captures redistributive effort relative to an optimal design of taxes, suggesting perhaps that countries with high inequality succeed in taxing people more closely to the relevant optimum. According to the measures  $RE^{RS}$ , the US, Sweden and Norway are about equally redistributive, whereas Denmark stands out as most redistributive among the Scandinavian countries.

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<sup>17</sup> This means that the measure for Norway for pre-tax income inequality is used when calculating estimates for redistributive effects in each other country.

**Figure 6. Common-base tax redistributive and tax vertical effects vs pre-tax/transfer income inequality**



## 6. Summary

Given the data we have had available for this study, for 15 countries from the LIS database, we see a rather clear picture concerning the conflicting results on the relationship between pre-tax/transfer income inequality and redistribution. When each income tax system is evaluated according to its own pre-tax/transfer inequality baseline, personal taxes appear to be more redistributive in more unequal countries (we saw this in both *RE* and *V*), even though results to some extent depend on the choice of index. Similarly, we also see indications that transfers are more targeted in countries with high pre-tax/transfer income inequality, whereas different measures of the size of the government intervention (both for the tax and expenditure side) have either no relation or a negative relation to the initial condition. This contrasting evidence clearly invites confusion around such questions as “which country is most redistributive?”.

We believe that what many authors actually have in mind, when discussing the relationship between income inequality and redistribution across countries, is the concept of *redistributional effort for (hypothetically) the same level of pre-tax income inequality*. For the redistribution hypothesis and other conjectures of the link between pre-tax inequality and redistribution, certainly, the most relevant measure(s) of redistribution would be common-base measures – those of the Dardanoni and Lambert (2002) variety, which come from applying the “transplant and compare” methodology to raw tax and income data.

Thus, the cross-country tax redistributional effects of the personal income tax, as seen in Figure 1 and reported in many other studies, are functions of the measurement system adopted, which has until now been the traditional one, in which the existing pre-tax inequality values for the various countries inevitably condition the results, but confound comparative work. The results of using the “transplant and compare” procedure in this study show weaker relationships for tax redistributional and tax vertical effects than results according to traditional methods. Thus, the common-base evidence presented here suggests that there may well be *no link* between pre-tax/transfer income inequality and redistributional effects of the personal income tax, in a cross-country perspective. In that sense the present approach supports neither the redistribution hypothesis nor the “Robin Hood paradox” depiction of the relationship.

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## **Appendix. Some practical details about the transplant and compare method**

As seen in Section 3, the “transplant and compare” method of Dardanoni and Lambert (2002) means that comparisons of redistributive policies are undertaken when pre-tax income inequality differences have been controlled for. The method is based on finding a deformation function  $g(x)$  (where  $x$  is pre-tax income) that can be used to define a modified post-tax income schedule that operates on the distribution  $F \circ g^{-1}$ . A key result of Dardanoni and Lambert (2002) is that base-independent results are guaranteed, i.e. it does not influence results whether the pre-tax income distribution of let us say Norway or the US is used as base, when the deformation function is isoelastic (and only then). Empirically, this is approached here by, for each country  $i$ , identifying  $a_i$  and  $b_i > 0$  such that the distribution of  $a_i + b_i \ln(x)$  is sufficiently close to the chosen reference distribution. Thus, the method implies finding estimates of  $a_i$  and  $b_i$  that minimize the differences between the two distributions in terms of location and scale, corresponding to finding the intercept and slope in a traditional OLS

regression, and then using these estimates to produce post-tax incomes that are adjusted by the fitted deformation function.

As already noted we use the distribution of pre-tax income of Norway as the reference, and transform each country's distribution into this common base by results from a number of regressions, where log of pre-tax income of Norway is regressed against the pre-tax log income distribution of each of the other 14 countries we have data for through LIS. Before carrying out the regressions some data trimming has been done. First of all, to remove effects of outliers, all records with negative or zero income have been dropped. Then datasets have been bottom-coded at 1 percent of mean pre-tax income and top-coded at 50 times the median; see also Brandolini and Smeeding (2007) for similar (but not identical) data manipulations of LIS data. Next, the datasets have been adjusted to the same sample size; we have used sizes of 5,000 observations and 10,000 observations, dependent on the size of the samples in question. Note also that in the procedures to derive Norway-adjusted estimates of redistribution we add in an error term, which has been drawn from a normal distribution; see also Lambert and Thoresen (2009) for further discussion of practical issues concerning implementation of "transplant and compare" method.

The results of the 14 OLS regressions that are used to establish the common-base results are presented in Table A1. We see that the slope estimates are above or below 1 dependent on whether the respective pre-tax income distributions are more equal ( $b > 1$ ) or more unequal ( $b < 1$ ) than the pre-tax income distribution of Norway, involving either expansion ( $b > 1$ ) or contraction ( $b < 1$ ) in the transformation to replicate the Norwegian distribution. The last column shows how well the regression estimates in combination with data from respective countries are able to reproduce the pre-tax income distribution of Norway, in terms of estimates for the inequality of pre-tax income. The largest deviation is observed for the regression against Switzerland (CHE), which overshoots pre-tax income inequality by 6.4 percent. Note that in the calculation of the common-base redistributive effects, see Figure 6, we employ actual values for pre-tax income inequality for Norway; alternatively we could have used the deformation function both for pre-tax and post-tax income distributions.<sup>18</sup>

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<sup>18</sup> This issue is extensively discussed in Appendix C in Lambert and Thoresen (2009).



**Table A1. Results from OLS regressions: log of pre-tax income of Norway as the dependent variable**

| Countries | Intercept, $a$ | Slope, $b$    | R-square | Pre-tax income inequality of Norway for transplants (Gini index), diff. to actual value for Norway (0.299) in parentheses |
|-----------|----------------|---------------|----------|---------------------------------------------------------------------------------------------------------------------------|
| AUS       | 4.467 (0.015)  | 0.781 (0.001) | 0.984    | 0.292 (-2.3%)                                                                                                             |
| BEL       | 0.737 (0.024)  | 0.863 (0.002) | 0.979    | 0.285 (-4.5%)                                                                                                             |
| CAN       | 4.302 (0.006)  | 0.789 (0.001) | 0.995    | 0.287 (-3.9%)                                                                                                             |
| CHE       | 0.301 (0.026)  | 1.108 (0.002) | 0.977    | 0.318 (6.4%)                                                                                                              |
| DEU       | 2.989 (0.009)  | 0.884 (0.001) | 0.991    | 0.292 (-2.4%)                                                                                                             |
| DNK       | -1.165 (0.015) | 1.099 (0.001) | 0.988    | 0.299 (0.1%)                                                                                                              |
| FIN       | 0.430 (0.014)  | 1.023 (0.001) | 0.986    | 0.303 (1.5%)                                                                                                              |
| ISR       | 4.362 (0.025)  | 0.732 (0.002) | 0.955    | 0.312 (4.6%)                                                                                                              |
| NLD       | 1.348 (0.015)  | 1.032 (0.001) | 0.991    | 0.284 (-5.0%)                                                                                                             |
| POL       | 3.041 (0.006)  | 1.004 (0.001) | 0.995    | 0.293 (-1.8%)                                                                                                             |
| SWE       | 0.529 (0.006)  | 0.973 (0.001) | 0.997    | 0.283 (-5.2%)                                                                                                             |
| TWN       | -1.092 (0.019) | 1.040 (0.001) | 0.980    | 0.307 (2.9%)                                                                                                              |
| UK        | 4.787 (0.015)  | 0.806 (0.002) | 0.963    | 0.310 (3.7%)                                                                                                              |
| US        | 5.445 (0.008)  | 0.684 (0.001) | 0.987    | 0.295 (-1.3%)                                                                                                             |