DEMB Working Paper Series

N. 114

Comparing redistributive efficiency of tax-benefit systems in Europe

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July 2017

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Abstract

In empirical analysis, the Kakwani index is the most frequently used indicator for comparing progressivity across countries and over time. The Kakwani is often assumed to measure to what extent a policy design is targeted to the poor. It has, however, a major drawback: it is not defined for net tax incidence—that is, the whole system of taxes and benefits. Moreover, it is defined over different intervals for different pre-tax income distributions and different average tax rates. This paper proposes an index based on the concept of relative redistributive efficiency that is not affected by these drawbacks.

The Redistributive Efficiency index was compared to the Kakwani index for taxes/benefits in EU countries by using Euromod baselines. In addition, the Redistributive Efficiency index was computed on the whole tax-benefit system; that is, taxes and benefits were evaluated together. Only Ireland and the UK combine high levels of redistributive efficiency with a relevant amount of tax revenues and social expenditures. They obviously obtain very high redistribution, above 15 points. Most of the countries considered show an intermediate level of redistribution (between 7 and 12 points), but with a different mix. A group of Central and Northern European countries plus Slovenia and Hungary combine medium levels of redistributive efficiency and medium size, while some Southern European countries (Spain and Portugal) and new members compensate a rather low amount of transfer and taxes with quite high levels of efficiency.

The remaining new member states and Southern EU countries show a very low level of redistribution, below 7 points. Interestingly, they vary in the level of tax burden and of resources devoted to benefits but all of them show a poor Redistributive Efficiency. This suggests that low Redistributive Efficiency plays a key role in explaining why certain countries perform a limited amount of redistribution.

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Introduction and main conclusions

Did the new policy adopted by the government disproportionally harm the poor? Could the alternative reform recently proposed reduce the loss for low income families? Such questions are inevitable in times of widening market inequality, shrinking welfare expenditures and policies of budget consolidation. Reducing resources for welfare also reduces the equalizing impact of fiscal policies, but two reforms with the same impact on the public budget may have a very different effect on income distribution. Whether and to what degree public resources are used efficiently in reducing inequality has become a commonplace subject of political debate in the last decades and it has been a central point of academic researches on inequality for a much longer time.

Academic researchers have dealt with this issue in order to answer a variety of research questions. A number of studies have investigated whether certain types of welfare regimes are more selective than others (Esping-Andersen, 1990; Ferrera, 1996). In doing that, researchers have mainly used a qualitative description of tax-benefit systems, for example the extent to which means testing has been used. Other authors focused on whether tax-benefit systems providing more resources to those at the bottom of the income distribution (instead of spreading them more evenly among the general population) are likely to have a higher equalizing impact (Korpi and Palme, 1998; Nelson, 2004; Marx et al., 2013). The measure they used to quantify how much a benefit is targeted to the poor was the concentration index of the benefit in question. A huge number of studies have analysed the role of progressivity of policy instruments in reducing income inequality. In this case it is not possible to give a complete report of the instruments used because of the very large number of papers written on the subject, but certainly the indices most commonly used to measure progressivity are the Kakwani (1976, 1977) and the Suits (1977).

The object of all these studies has not been just to examine the *redistributive effectiveness* of policies, but also the role played specifically by policy *design*—how *efficiently* do redistributive policies reduce income inequality? Though the idea of *redistributive efficiency* has been frequently hinted at, no researchers have explicitly referred to such a concept, as far as I know[1]. Indeed, the role of policy design in redistribution has been examined with a number of different tools, none of which is suitable to quantify *redistributive efficiency.* Extensive recourse to means testing is not the only way to design a highly redistributive benefit. Transfers can also be focused on the poor by using an appropriate targeting system. On the other hand a means testing system with very high income thresholds might be almost completely ineffective in excluding the rich from state transfers.

The reason why a qualitative description of how common means testing is in a benefit system is not a good enough measure of *redistributive efficiency* is rather intuitive, but the reason that statistical quantitative methods (such as concentration index and progressivity indices) are also not suitable is more complex to explain. The concentration index reaches the maximum value if the tax is entirely paid by the richest individual; conversely, it reaches its minimum if the whole amount of benefits is given to the poorest one. In fact, if total tax amount is sufficiently small, making the richest individual pay the entire burden will result in the most equalizing impact on income distribution. As the average tax rate increases, however, concentrating the tax on just one individual will not lead to the maximum equalizing impact; on the contrary, it could even worsen income distribution by reducing the post-tax income of the richest person below the income of the second richest person, as the tax becomes greater than the income gap between them. As the tax rate increases still further, the net income of the richest person will fall below the third richest one, and so on. To avoid richer taxpayers moving down in income ranking (*re-ranking*) as an effect

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[1]The term "redistributive efficiency" actually, has already been used by D. Coady and E. Skoufias (2004), but with a different meaning. They studied the impact of targeting benefits on the poor.

of tax burden, real taxes are designed with effective marginal rates lower than 100%. Because of the upper limit of marginal tax rates, increasingly high tax revenue can be obtained only by splitting tax burden among an increasingly large number of taxpayers, making people less and less rich pay taxes. In conclusion, an important consequence of assuming marginal rates lower than 100% is that in reality the upper (maximum) limit of the concentration index of a tax decreases as tax revenue increases. It may happen that even the most redistributive very high tax could have a smaller concentration index than a not very redistributive little tax. Therefore, comparison of such indices is a *redistributive efficiency* evaluation if only same-size taxes are involved. Similar conclusions can be reached for the concentration index applied to benefits.

Even if we were dealing with taxes and benefits of the same size there would be an additional major problem with the concentration index. It is not defined for net tax, wherein a whole tax-benefit system is considered. This was not an important issue in the past, when microdata on taxes were scant and data on benefits virtually non-existent. But it is a relevant limitation now, when large sets of microdata on household incomes, benefits and taxes are available; nowadays redistributive analyses on whole tax-benefits systems have become relatively common[2]

The Kakwani index has been used even more than the concentration index. The Kakwani measures *progressivity as departure from proportionality.* It is defined as the difference between the concentration index of the tax and the Gini index of income before tax; it shares with the concentration index both the mentioned problems: the upper limit changes with the tax size and it is not defined for net fiscal incidence.

In this paper an intuitive global index based on the concept of *relative redistributive efficiency* that is not affected by these problems is proposed. The *Redistributive efficiency* index presented here has fixed limits, regardless of the tax size, from 0 (minimum efficiency) to 1 (maximum efficiency). It is decomposable into efficiency of single policy instruments and it allows decomposing redistributive impact into two components: redistributive efficiency and a component that depends only on market income distribution and policy instrument size.

The paper is organized as follows: Part 1 will describe the limits of the Kakwani index and will introduce the concept of maximum redistribution. Part 2 will describe the new index of redistributive efficiency. Part 3 will present the index applied to compare redistributive efficiency in EU countries.

Some previous findings on tax benefit systems based on the Kakwani and concentration index will be re-examined to find out if they still hold with the *redistributive efficiency index*.

Our results do not show any correlation between average tax rate and *redistributive efficiency*. This suggests that previous findings of a negative relationship between the average rate and the Kakwani (Verbist and Figari 2014) relied on the dependence of the Kakwani's upper limit on tax size.

I found that both the Kakwani and the *redistributive efficiency* index of benefits are positively related to redistributive impact.

The *redistributive efficiency* index has been computed for the whole tax benefit systems (considering taxes and benefits together) for 27 EU countries. Three groups have been identified. A first group of countries has a significant amount of resources devoted to redistribution and high *redistributive efficiency;* as expected, these countries show a high level of redistribution. In the middle, there are several countries with a moderate level of redistribution; some of them show rather high *redistributive efficiency*, others a moderate degree of efficiency. Finally, there is a group of countries with a low level of redistribution. Some of these countries employ a significant amount of resources for welfare, while others devote much less to welfare, but all of them show a very low value of *redistributive efficiency*. Indeed, the lower tail of the

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[2] In fact there are too many researches to give an exhaustive list. It worth mentioning, among others: Immervoll et al. (2006), OECD (2008), OECD (2011), Immervoll, H. and L. Richardson (2011), Avram at al. (2014)
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redistributive efficiency distribution is entirely made up of these underperforming countries. This suggests that low *redistributive efficiency* plays a key role in explaining why certain countries perform a very limited amount of redistribution.

1. BACKGROUND

Progressivity of net fiscal incidence

For the sake of simplicity, in the following, only one global measure of redistribution (proposed by Reynold and Smolensky in 1977) and the Kakwani progressivity index will be discussed, but most of the conclusions apply also to other ATR progressivity indices (Pfaehler, 1987), such as the Suits (1977).

The Reynold-Smolensky index (Π^{RS}) is the most commonly used index *of redistribution*. A description of progressivity indices is beyond the scope of this paper, where only a few essential concepts will be mentioned. A general description of different sorts of indices and an exhaustive analysis of progression indicators within Lorenz's dominance framework is provided by Lambert (2001) and by Seild et al. (2013).

The Reynold-Smolensky index (Π^{RS}) measures redistribution as the difference between the Gini index of income before tax (G_{Y+T}) and the Concentration index of disposable income (C_Y), ordered by income before tax.

$$1.1. \; \Pi_T^{RS} = G_{Y+T} - C_Y \qquad\qquad\qquad \Pi_T^{RS} \leq G_{Y+T}$$

In sections 1 and 2 I assume absence of re-ranking, that is, the ordering of persons according to income before and after tax is the same. In this case the concentration (C_Y) and the Gini index of income after tax coincide.

Reynolds-Smolensky for total tax is decomposable into single components:

$$1.1a \; \Pi_T^{RS} = \sum \frac{(1-t_i) \Pi_{t_i}^{RS}}{(1-t)}$$

Where t_i is the average tax rate of the single tax "i" and $t = \sum t_i$.

Kakwani (1976, 1977) showed that Π_T^{RS} can be decomposed into other two components:

$$1.2. \; \Pi_T^{RS} = \frac{t}{(1-t)} * (C_T - G_{Y+T})$$

Where C_T is the coefficient of concentration of tax (ordered by income before tax) and t is average tax rate. I refer to the first component ($\frac{t}{(1-t)}$) as *"rate effect"* and to the second one as *"progressivity as departure from proportionality"* or *Kakwani index* (Π_T^K)[3]:

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[3] Pfähler(1987) shows that a similar decomposition applies also to every other scale invariant redistribution index, which satisfy Pigou-Dalton principle of transfers, such as Suits index.

$$1.3. \; \Pi_T^K = (C_T - G_{Y+T}) \qquad\qquad 1.3a \; -(1 + G_{Y+T}) < \Pi_T^K < (1 - G_{Y+T})$$

The Kakwani index (Π_T^K) provides a measures of *progressivity as departure from proportionality.* It compares the tax under examination with a yield equivalent fictional tax scheme whose equalizing impact is known in advance. Specifically, the reference hypothetical tax scheme is a proportional tax whose redistributive impact is always zero. The concentration index of a proportional tax has exactly the same value of the concentration index of the tax base; therefore, Π_T^K may be interpreted as the distance of distributive effect of a tax (T) from the (non) distributive impact of a proportional tax of the same size (of any size, actually).

The reason for the appeal of decomposition *1.2* is easy to explain. Tax systems typically differ in *design* and in *size*; the decomposition is thought to allow one to distinguish the impact due to each of the components: the rate effect depends on total revenue (the size), while in empirical analysis the Kakwani index is often used to measure the effect of *tax design*, independently from amounts involved.

Kakwani (1977) also showed that Π_T^K can be decomposed into single tax components (Π_{Ti}^K):

$$1.4. \; \Pi_T^K = \Sigma \; t_i / t * \Pi_{Ti}^K$$

Where ($\frac{t_i}{t}$) is the share of the single tax T_i on total tax revenue

Redistributive impact of benefits is measured in a similar way, but benefits, unlike taxes, are equalizing if they are disproportionally in favour of the poor. Technically, benefits have an equalizing impact if they are *regressive.* That is benefits are equalizing if they have a *negative* Kakwani index. Apart from the sign, redistribution and progressivity of tax and benefits are measured in a similar way. Specifically, the Reynolds-Smolensky index may also be decomposed into *rate effect* and *progressivity as departure from proportionality* for benefits:

$$1.2.b) \; \Pi_B^{RS} = (G_{Y-B} - C_Y) = \frac{-b}{(1+b)} * (C_B - G_{Y-B}) = \frac{-b}{(1+b)} * \Pi_B^K$$

Where b is the ratio of benefits on income, C_B is the coefficient of concentration of benefits (ordered by incomes before benefits G_{Y-B}), Π_B^{RS} is the redistributive impact of benefits (Reynolds-Smolensky index) and Π_B^K the Kakwani of benefits.

The matter is more troublesome if one puts together taxes and benefits and tries to evaluate progressivity of the whole tax-benefit system. Following Lambert (2001, ch. 11) I define net taxes (T_N) as the difference between the taxes paid and the benefits received by each individual k:

$$1.5. \; T_{Nk} = T_k - B_k$$

Then *redistributive* impact of net tax is defined as:

$$1.6. \; \Pi_N^{RS} = G_{Y+T-B} - G_Y = \frac{(1-g)\Pi_T^{RS} + (1+b)\Pi_B^{RS}}{(1-t+b)}$$

The Kakwani index, instead, is not defined because it is not possible to compute the concentration index of T_N. T_{Nk} assumes a negative value if the benefits received exceed the taxes paid by the individual k. For this reason, the concentration curve (and therefore concentration index) of T_{Ni} is not "well behaved": it may

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assume values bigger than 1 and lower than 0 (Lambert, 2001, p 276). Even neglecting this issue, it is possible to show that the Kakwani index does not work in the case of net tax. A progressivity index for net tax can be constructed, by using (1.4.), as the weighted sum of Π_B^K and Π_T^K:

$$1.7. \; \Pi_N^K = \frac{t\Pi_T^K - b\Pi_B^K}{t-b}$$

The obvious problem here is that $\Pi_N^K \to \infty$ as b approaches t (Lambert, 2001; Kiefer, 1984)[4].

The conclusion is that the Kakwani index does not enable one to evaluate progressivity when taxes and benefits are both taken in account simultaneously. This is a severe weakness since progressivity of pure transfers, of negative income taxes and of complete tax-benefit systems cannot be assessed by using Kakwani index.

The Maximum Redistribution and the effective Kakwani upper limit.

A well-known inconvenient feature of the Kakwani is that upper and lower limits are not fixed, but depend on pre-tax income distribution. The Kakwani index ranges from *-(1+G_{Y+T})*, corresponding to maximum regressivity, to *(1 -G_{Y+T})*, maximum progressivity.

A closer look highlights that the question is even more complex. An easy way to provide a glimpse of the issue is to show that equation *1.2* does not hold for the whole Kakwani's (theoretical) range. Substituting the theoretical maximum Kakwani in *1.2* we obtain:

$$\Pi_T^{RS} = \frac{t}{(1-t)} * (1 - G_{Y+T})$$

If $t > G_{Y+T}$ then $\Pi_T^{RS} > G_{Y+T}$, this violates the condition (1.1) $\Pi_T^{RS} \le G_{Y+T}$ and implies $C_Y < 0$; in other words, the concentration curve of incomes after tax lies above the line of perfect distribution. The violation of this condition implies that individuals are ranked differently according to pre tax and disposable income. The richest persons according to income before tax become the poorest after tax; this is called *re-ranking*. This extreme example makes clear that in real tax-benefit systems there must be some condition that avoids *re-ranking* and in doing that affects the actual limit of Kakwani. This condition is that effective marginal rates must be lower than 100%. Indeed, It is possible to show that, for any given average tax rate, there is a single *tax design* that ensure the *maximum redistribution*. Therefore, with that tax design we have the maximum values of the Reynolds-Smolensky index; any tax design that results in a higher Kakwani index implies some re-ranking and a lower Reynolds-Smolensky.

For a given average tax rate t, the *maximum redistribution* (Π_{MRT}^{RS}) is provided by a *flat rate tax (T_{MR})* with personal allowance *(A)* and a nominal tax rate equal to 100% (Fig. 1a)

$$1.8a \; T_{MRk} \; = \; (Y_k - A) \qquad if \;\; Y_k \; >= A \qquad ; \; T_{MRk} \; = \; 0 \;\; otherwise.$$
$$1.8b \; Y_{MRTk} \; = \; A \qquad\quad if \;\; Y_k \; >= A \qquad ; \; Y_{MRTk} \; = \; Y_k \; otherwise$$
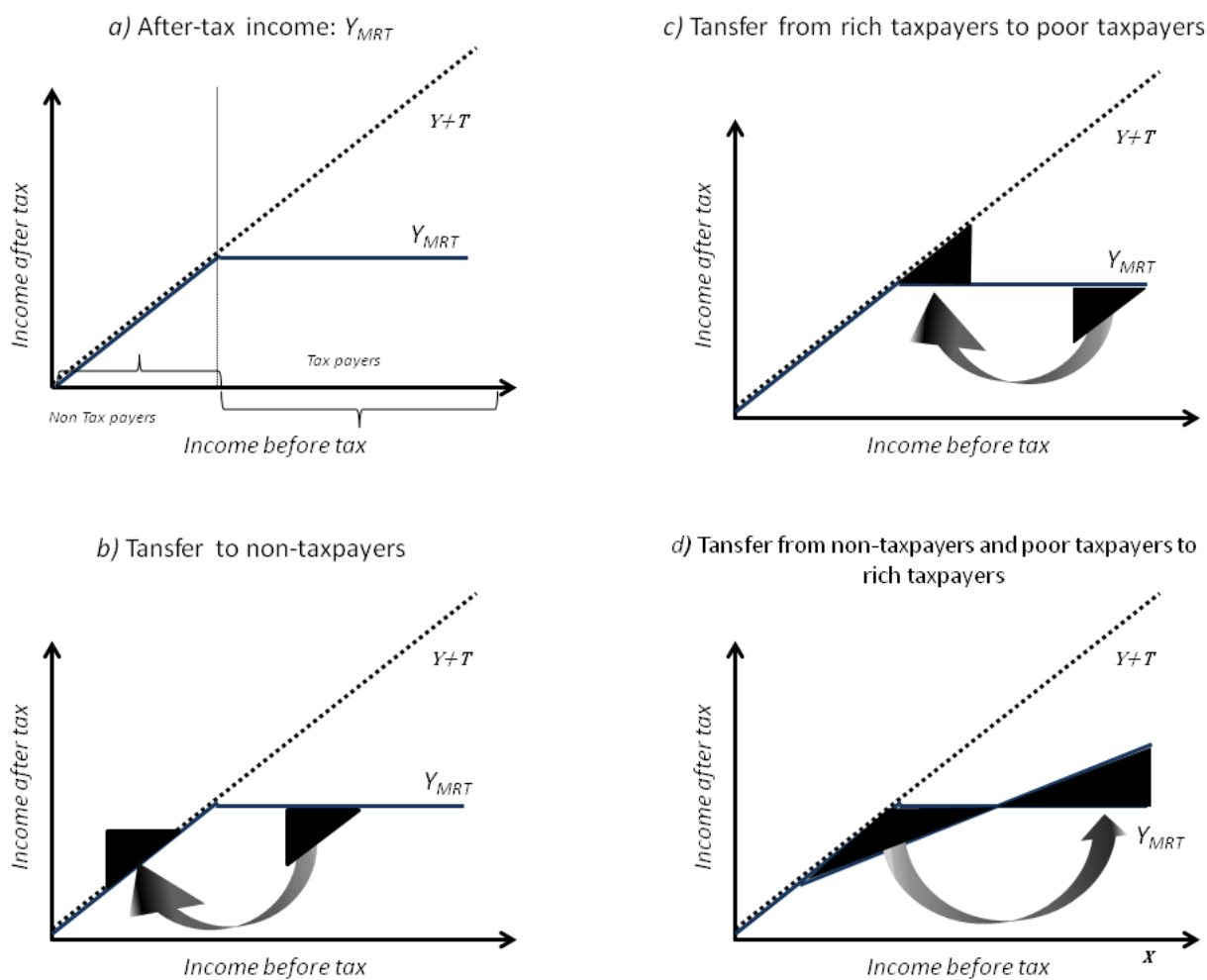
Where Y_{MRT} is post-tax income.

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[4] A similar problem arises with Suits index (Lambert 2001). Unlike for the Kakwani, for Suits index ad hoc solutions for this problem were propose by Kienzle E.C.(1981, 1982) and Bridges B. (1984)

It may be shown that any other *tax design* involves a post-tax income distribution more unequal than Y_{MRT}, in terms of the Gini index. I assume that the taxes being compared all have the same amount, so that any after-tax income resulting from (any) tax different from T_{MR} can be reproduced starting from Y_{MRT} and carrying out transfers from one individual to another. A transfer from individual A to individual B means higher taxes paid by A and lower taxes paid by B. The impact of all possible transfers is shown in Fig. 1. I assume $T_K \geq 0$, and therefore a transfer to non-taxpayers (Fig. 1b) is not allowed, because non-taxpayers would end up with a post-tax income bigger than their pre-tax one—they would receive benefits instead of paying taxes.

Transfers from (pre-tax income) richer taxpayers to poorer ones (Fig. 1c) are allowed and they produce an increase of post-tax income inequality due to *re-ranking*, since as a result of T_{MR} all taxpayers have the same post-tax income equal to A (Fig. 1a). Only one additional type of transfers is possible: from non-tax payers (and poor tax payers) to (richer) taxpayers (Fig. 1d); it is do not necessarily involve *re-ranking*, but it is a transfer from the poor to the rich. The Gini index respects the Pigou-Dalton transfer principle and therefore the latter type of transfer leads to a more unequal post-tax income distribution.

Fig. 1 The Most Redistributive Tax

a) After-tax income: Y_{MRT}

c) Tansfer from rich taxpayers to poor taxpayers

b) Tansfer to non-taxpayers

d) Tansfer from non-taxpayers and poor taxpayers to rich taxpayers

A nice feature of the *Most Redistributive Tax (T$_{MR}$)* is that it can be computed with simple microsimulation techniques and using the same microdata necessary to compute the Reynols-Smolensky and the Kakwani: total value of tax under examination and individual value of income before tax. Then also the Reynolds-Smolensky index (Π_{MRT}^{RS}) and Kakwani index (Π_{MRT}^{K}) corresponding to maximum redistribution can be computed using the same data:

1.9a. $\Pi_{MRT}^{RS} = \dfrac{t}{(1-t)} \, \Pi_{MRT}^{K}$

1.9b $\Pi_{MRT}^{K} = (C_{TMR} - G_Y)$

Where C_{TMR} is the concentration index of T_{MR}. Note that T_{MR} is paid entirely by the richest individual only if the average tax rate is implausibly low; the value of C_{TMR} is typically lower than 1 and Π_{MRT}^{K}*<(1-G$_Y$)*.

For most of the reasonably big taxes, the Kakwani index corresponding to the maximum distribution is lower than its maximum. An increase of the Kakwani index beyond Π_{MRT}^{K} would lead to a *reduction* of redistribution because this is possible only in presence of marginal tax rates bigger than 100% and *re-ranking*.

I have shown that though the Kakwani upper limit presented in *1.3a* could hold for the Kakwani index in general, if the Kakwani is applied to a tax it is necessary to either limit the *effective upper bound* to Π_{MRT}^{K} or give up to the condition of marginal tax rates not bigger that 100%. In the latter case, redistribution is not monotonically non-decreasing with the Kakwani. It goes without saying that the condition on marginal tax rates is essential for any sensible discussion on taxes and benefits and it will be maintained in the following[5].

I will proceed with the analysis of the properties of Π_{MRT}^{K} and Π_{MRT}^{RS}.

Given that the only tax rate of T_{MR} is fixed at 100%, total tax amount changes only if tax allowance is modified: an increase of tax allowance reduces tax revenue and a reduction of tax allowance increases it. The impact of changes of tax allowances on progressivity as departure from proportionality and redistribution has been studied by Keen et al. (2000). They found that *if the tax schedule is proportional* (as in our case), an increase of allowance (namely a reduction of average tax rate) leads to an increase in the Kakwani index and a decrease in the Reynolds-Smolensky index. This provides a more rigorous proof of the dependency of Kakwani limit on average tax rate and the conclusion is that the *effective upper limit* of the Kakwani (Π_{MRT}^{K}) decreases as average tax rate *(t)* increases.

The reasoning applied to the Kakwani for taxes can be extended to benefits with only small adaptations.
The most distributive scheme can be identified for benefits as well. For a given total amount of benefit, the *maximum redistribution* (Π_{MRB}^{RS}) is provided by a Minimum income scheme *(B$_{MR}$)* with income limit *(B)* and 100% *withdrawal rate*.

$B_{MRk} = (B-Y_k)$ if $Y_k <= B$; $B_{MRk} = 0$ *otherwise.*

$Y_{MRBk} = B$ if $Y_k\ <= B$; $Y_{MRBk} = Y_k$ otherwise

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[5] This is not to say that effective marginal rates bigger that 100% are completely unseen in real tax-benefit systems. Discontinuities and incomes subjected to more than one tax (or social contribution) occasionally do cause effective marginal rates bigger than 100%. More frequently, re-ranking is due to the treatment of non-income characteristics, such as the presence of income dependents in the family. This latter case concerns horizontal equality rather than vertical equality, and must be studied with different tools.

Where Y_{MRB} is post-benefit income. A line of reasoning similar to the one applied to the most distributive tax can be used for the most redistributive benefit (B_{MR}). Similarly to taxes, it may be shown that for any benefit scheme involving the same amount of resources as B_{MR}, after-benefit income can be reproduced starting from Y_{MRB} and performing a pure transfer. A transfer from individual A to individual B leads to a smaller benefit to individual A and a bigger transfer to individual B. Any transfer from a non-beneficiary is not allowed because it involves negative benefits (that is they would pay taxes instead of receiving benefits). Transfers from less poor (in pre-benefit income) beneficiaries to the poorer would lead to re-ranking and to a more unequal income distribution. Transfers from poorer beneficiaries to other beneficiaries lead directly to a more unequal income distribution.

Symmetrically to taxes, the most distributive benefit (B_{MR}) is less regressive than the Kakwani lower limit, that is $\Pi^K_{MRB} > -(1+G_Y)$. Moreover (B_{MR}) becomes less regressive as total benefit amount increases, the Kakwani of the most distributive benefit (Π^K_{MRB}) is increasing with benefit average rate (b). Unlike for taxes, however, there is not any previous research on a general relationship between benefit progression and income limits; for this reason a simple proof is provided in *Appendix 1,* where the dependence of Π^K_{MRB} on income limit (B) is discussed.

2. REDISTRIBUTIVE EFFICIENCY INDEX

The objective of this part is to develop an index of *Redistributive Efficiency* (Π^E) without the flaws previously seen for the Kakwani index. The *Redistributive Efficiency index* is defined for net tax; it is monotonically increasing with equalizing impact of the tax, the benefit and the net tax.

The simple starting idea is based on a change of benchmark. *Redistributive Efficiency* (Π^E) compares the observed redistribution to the redistribution produced by the most distributive tax (or the most distributive benefit) of the same size of the tax (benefit) under examination, rather than measuring progressivity as departure from proportionality.

While the Kakwani is the distance between concentration index of the actual tax and the concentration index of a hypothetical proportional tax, the redistributive efficiency index uses the most distributive tax as the counterfactual tax.

Progressivity as departure from proportionality does not need the actual computation of the counterfactual equally yield proportional tax (benefit), since all proportional taxes and benefits have the same *Kakwani* and *Reinolds-Smolensky* value, zero. Unlike proportional taxes and benefits, the concentration index of the most distributive tax (benefit) depends on average tax (benefit) rate; for this reason T_{MR} (B_{MR}) must be really simulated. Once T_{MR} and B_{MR} are simulated, the corresponding Reynolds-Smolensky redistributive indices Π^{RS}_{MRT} and Π^{RS}_{MRB} can be computed as:

$2.1.a \ \Pi^{RS}_{MRT} = (G_{Y+TMR} - G_Y)$
$2.1.b \ \Pi^{RS}_{MRB} = (G_{Y-BMR} - G_Y)$

Then the Redistributive Efficiency index can be computed as the ratio between the actual redistribution and the maximum attainable with the same amount of resources:

$2.2a \ \Pi^E_T = \dfrac{\Pi^{RS}_T}{\Pi^{RS}_{MRT}}$ $\qquad\qquad\qquad\qquad\qquad 0 \leq \Pi^E_T \leq 1$

$$2.2b \; \Pi_B^E = \frac{\Pi_B^{RS}}{\Pi_{MRB}^{RS}} \qquad\qquad\qquad 0 \le \Pi_B^E \le 1$$

Redistributive Efficiency has a number of noticeable properties. For simplicity, in the following they will be presented for Π_T^E only, since the generalization to Π_B^E is straightforward.

First, an attractive feature is that Π_T^E has fixed bounds; it ranges from 0, in case of proportionality, to 1 if redistributive impact of the tax or benefit matches the most redistributive one.

Second, Redistributive Efficiency is also equal to the ratio between the actual Kakwani and the Kakwani of the most distributive tax.

Using *1.2* for substituting Π_{MRT}^{RS} and Π_T^{RS} in *2.2a* and 2.2b yields:

$$2.3 \; \Pi_T^E = \frac{\Pi_T^{RS}}{\Pi_{MRT}^{RS}} = \frac{\Pi_T^K}{\Pi_{MRT}^K}$$

Third, similarly to the decomposition into rate effect and Kakwani, this framework allows a decomposition of the Reynolds-Smolensky index into two components due respectively to the amount of resources employed and the tax design:

$$2.4 \; \Pi_T^{RS} = \Pi_T^E \Pi_{MRT}^{RS}$$

Where Π_{MRT}^{RS}, the maximum redistribution, depends only on tax amount and pre-tax income distribution and Π_T^E, redistributive efficiency, depends on tax design.

Finally, Π_T^E is decomposable into contribution of single components. Using the 1.1a decomposition for Π_T^{RS} yields:

$$2.5 \; \Pi_T^E = \sum \frac{(1-t_i)}{(1-t)} \Pi_{ti}^E \frac{\Pi_{MRTi}^{RS}}{\Pi_{MRT}^{RS}}$$

where Π_{ti}^E is the Redistributive Efficiency of tax i and Π_{MRTi}^{RS} is the Reynolds-Smolensky of the most redistributive tax with the same size of tax i.

Redistributive Efficiency, amount of resources and net fiscal system

Progressivity as departure from proportionality is usually interpreted as a comparison between concentration indices of the actual tax/benefit and the concentration index of equal-yield proportional ones. It may look like computation of the Kakwani really involves a comparison with a counterfactual tax of the same amount as the one under examination. But all proportional taxes have the same concentration of the tax base, so that the correct definition of tax size seems not really of interest when computing the Kakwani. Instead, the concentration of the most redistributive tax depends on the size; therefore, the correct definition of the amount of resources employed is essential for the computation of the redistributive efficiency index.

Unfortunately, in real tax benefit systems the definition of the size of taxes and benefits is not always an elementary task. There are several cases in which it is not easy to decide whether some tax credits are more appropriately classified as benefits. Typical examples are tax expenditures and negative taxes. Similar doubts arise about the benefits: a withdrawal rate on a benefit works like a tax surcharge on beneficiaries'

market incomes. Indeed, Meade proposed a Citizen's Income plus a "*Withdrawal Surcharge* over the lower range of [...] income" (Meade, 1995, p. 69), instead of a minimum income. Though a minimum income and a basic income plus an additional tax on lower market incomes are the same, they look very different as far as both redistributive efficiency and progressivity are concerned. The first is just a benefit. The second is a benefit (with more resources employed, a lower efficiency and a lower progressivity than minimum income) plus an explicit regressive tax.

In fact, as long as taxes and benefits are considered separately, conclusions will inevitably be affected by a certain degree of uncertainty due to the decisions we have to make on whether a tax is actually a benefit reduction or whether tax relief is a benefit in disguise. The use of the concept of *net fiscal system* allows resolution of the ambiguity inherent in the definition of taxes and benefits. The net tax incidence is *(1.5)* the difference between the taxes paid and the benefits received by *each* individual. For a person, net fiscal system can have a positive or a negative value. A positive value (the taxes paid are bigger than the benefits received) means that she is a net payer to the government, while a negative value means that he is a net recipient. I have already shown that it is not possible to compute the concentration index of net tax; it is necessary to deal with quantities that assume either positive (taxes) or negative (benefits) values. Hence I define individual *Net tax* (T_{Nk}) and *Net benefit* (B_{Nk}) rather than individual *Net fiscal system* as such:

2.6.a $T_{Nk} = T_k - B_k$ if $T_k > B_k$ $T_{Nk} = 0$ *otherwhise*

2.6.b $B_{Nk} = B_k - T_k$ if $T_k < B_k$ $B_{Nk} = 0$ *otherwhise*

The definition of individual net tax and benefit allows the computation of total amount of Net tax and Net benefit. Consequently, it is possible to simulate the most redistributive net fiscal system and to calculate the redistributive efficiency index of total tax-benefit system:

2.7 $\Pi_N^E = \dfrac{\Pi_N^{RS}}{\Pi_{MRN}^{RS}}$ $0 \leq \Pi_N^E \leq 1$

Note that T_{NK} and B_{NK} are smaller than actual taxes or benefits for individuals who receive benefits *and* pay taxes because 2.6.a and 2.6.b imply that all benefits received by net payers are treated as tax reliefs and that all taxes payed by net receivers are treated as benefit reductions. As a consequence, if at least one individual pays taxes and receives benefits, the values of total net tax (T_N) and total net benefit (B_N) used to compute the most redistributive net tax and the most redistributive net benefit are smaller than budgetary total taxes and total benefits.

3. REDISTRIBUTIVE EFFICIENCY IN EUROPEAN COUNTRIES

This section is devoted to the analysis of Redistributive Efficiency and Progressivity in 27 European countries. First, Π^{RE} will be computed for taxes and benefits separately, so that Redistributive Efficiency can be compared with the Kakwani index. Then the Redistributive Efficiency index will be calculated for the net fiscal systems, namely considering taxes and benefits together.

data

The following analysis is based on data provided by the Euromod model, version G1.0+. Euromod is a tax-benefit microsimulation model for the European Union; a clear and complete description of the model can be found in Sutherland and Figari (2013). The baselines used here refer to 2012 incomes and tax-benefit systems. Euromod simulations are based on individual data derived from EU-SILC survey for most countries; for some other countries input data are from national household budget surveys or national SILC. Also, the year of data collection differs among considered countries. Input data are described in *Appendix 2.*

Equations and income definitions

Euromod provides household disposable income by components. Market income includes income from labour (net of employer social contributions), incomes from capital and other market incomes. Tax includes income tax, property tax and local tax; indirect taxes are not included. Euromod includes all benefits in cash (many simulated, some from input data), but not benefits in kind (such as public health services and education). Household disposable income is equal to market income minus taxes and employee social contributions plus cash benefits. The empirical analysis will be carried out on household equivalent incomes obtained using OECD modified equivalence scale[6].

In the following taxes and employees social contributions will be always considered together and, for sake of simplicity, called just "taxes." Unlike other important previous studies (OECD, 2008; OECD, 2011; Immervoll and Richardson, 2011), public old age and survivor pensions will not be included in the following analysis. This is not to say that pensions do not cause redistribution, but it is just a recognition that the methodology adopted here does not allow evaluation of it. Evaluating the redistributive impact of taxes and benefits involves the implicit calculation of counterfactual scenarios. What if taxes and benefits were not provided by the state? The implicit answer here is that in the absence of state intervention the provision of benefits and tax revenue would be negligible. That is a rather reasonable assumption for most benefits and taxes; economic theory suggests that benefits would be severely under-provided in a market economy and common sense suggests that very few people would pay taxes if not obliged. Indeed, even the most aggressive opponents of this type of static analysis advocate for the introduction of second order efficiency effects (such as the impact on labour supply) in the counterfactual scenario, but not for considering substitutive private provision of taxes and benefits.

Things are different for old-age pensions, though. There is unquestionable evidence that all societies provide for some old age provisions, through private pension schemes, savings or household arrangements, regardless of state intervention. Public pensions are compulsory saving/insurance systems that are bound to crowd out private provisions for old age to some extent. The construction of a counterfactual with such substitutive private provisions would be necessary for a thorough evaluation of the redistributive impact of public pension schemes.

reranking

For this final empirical analysis we must give up the assumption of absence of re-ranking because in real tax-benefit systems the presence of re-ranking is inevitable even if marginal nominal tax rates are lower than 100%. Reranking is generally due to the treatment of households different in non-income

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[6] OECD modified equivalence scale gives value 1 for the first adult in the household, 0.5 for each additional adult and 0.3 for each child. Every individual aged below 14 is considered a child.

characteristics (such as the number of components or presence of dependents) or to a non-homogenous treatment of different income sources[7]. In order to be able to take in account the presence of re-ranking a few changes in equations are necessary.

For taxes, Reynolds-Smolensky decomposition (equation 1.2) changes into:

$$3.1.\ \Pi_T^{RS} = (G_{Y+T} - G_Y) = (G_{Y+T} - C_Y) - R_{KT} = (\frac{t}{(1-t)}) * \Pi_T^K - R_{KT}$$

Where G_Y and C_Y are, respectively, the Gini index and the concentration index of disposable income, G_{Y+T} is Gini index of income before taxes. The ordering variable is disposable income plus taxes. Re-ranking effect R_{KT} is the difference between Gini and concentration index of disposable income:

$$R_{KT} = (G_Y - C_Y)$$

Similarly to equations 3.1, the Reynolds-Smolensky decomposition for benefits (equation 1.2b) changes into:

$$3.2.\ \Pi_B^{RS} = (G_{Y-B} - G_Y) = (G_{Y-B} - C_Y) - R_{KB} = (\frac{-b}{(1+b)}) * \Pi_B^K - R_{KB}$$

Where G_Y and C_Y are, respectively, the Gini index and the concentration index of disposable income, G_{Y-B} is Gini index of disposable income net of benefits. Re-ranking effect R_{KB} is the difference between Gini and the concentration index of disposable income. Disposable income minus benefits is the ordering variable for concentration indices.

Finally, also equation 2.3[8] has to be changed into:

$$3.3\ \Pi_T^E = \frac{\Pi_T^{RS}}{\Pi_{MRT}^{RS}} = \frac{\Pi_T^K}{\Pi_{MRT}^K} - \frac{R_{KT}}{\Pi_{MRT}^{RS}}$$

Results

This simple empirical analysis was first carried out on taxes and then on benefits separately to highlight similarities and differences between the Redistributive Efficiency index and the Kakwani index. Finally Π^E was computed for the entire tax-benefit system, that is on net fiscal systems.

Fig. 2 shows the Kakwani index (K), the Redistributive efficiency index (R-E),the Reynold-Smolensky index (R-S) and average tax rate (t) for taxes. Part a) and part b) contain the same variables, but in the first all countries are ordered by the Kakwani, while in the latter countries are ordered by Redistributive Efficiency; this will allow the robustness of previous findings on the relation between Kakwani index and average tax rate to be tested. Verbist and Figari (2014) found a negative correlation between progressivity as departure from proportionality and the level of tax burden. They conclude that tax rate and progressivity are "*rather substitutes than complements*" and that it "*confirms the different policy options adopted by governments across Europe even when the policy aim in terms of redistribution is the same.*"

[7] For re-ranking due to vertical and horizontal inequity see Lambert 2001 pg.238.

[8] The equivalent equation for benefits is $\Pi_B^E = \frac{\Pi_B^{RS}}{\Pi_{MRB}^{RS}} = \frac{\Pi_B^K}{\Pi_{MRB}^K} - \frac{R_{KB}}{\Pi_{MRB}^{RS}}$

Both part a) and b) show that Π^E and Π^K differ significantly. As expected, the discrepancies between the two indices appear to be clearly explained by average tax rate level.

Fig. 2a confirms the negative correlation between the Kakwani index and tax level. Yet, the correlation disappears if Redistributive Efficiency is used instead of Progressivity as Departure from Proportionality (Fig. 2b). This contradictory evidence leaves room for further investigations on the role played by the reduction of the upper limit of the Kakwani as the average tax rate increases. Previous results seem to depend on the technical dependence of effective Kakwani upper limit on tax size, rather than alternative policy strategies adopted by European governments with similar attitude toward redistribution.

Fig. 2: Taxes and social contribution
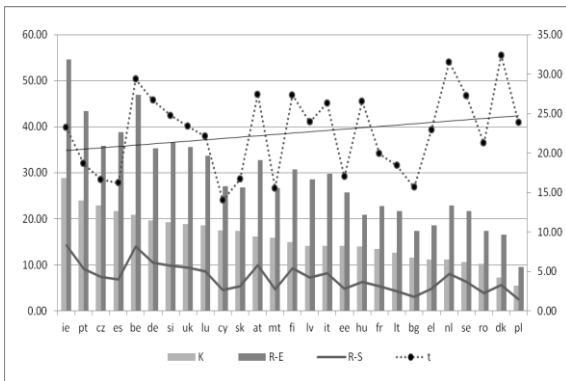
a-Ordered by kawani index   b- Ordered by Redistributive Efficiency index
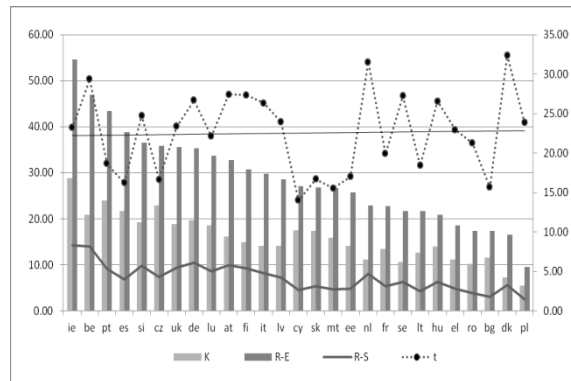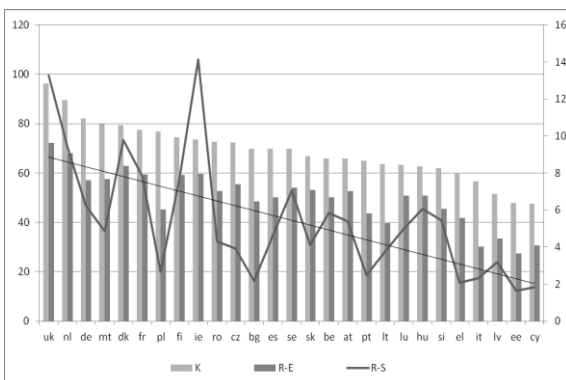

Fig. 3: Benefits

a-Ordered by kawani index   b- Ordered by Redistributive Efficiency index
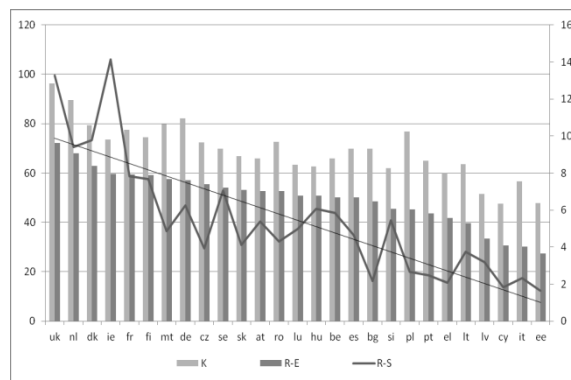

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Fig. 3 shows the Kakwani index (K), the Redistributive Efficiency index (R-E) and the Reynolds-Smolesnsky (R-S) index for benefits. Part a) and part b) contain the same variables, but countries are ordered differently: in part a) countries are ordered by decreasing Kakwani index and in part b) they are ordered according to Redistributive Efficiency index. In case of benefits we will analyse the issue on whether countries with transfers more targeted to the poor do distribute more than other countries.

The debate was opened by Korpi and Palme (1998), who found that "*The more we target benefits at the poor and the more concerned we are with creating equality via equal public transfers to all, the less likely we are to reduce poverty and inequality*". They call their findings the "*paradox of redistribution*".

Korpi and Palme's (1998) conclusions were largely based on the positive relation between the concentration index of benefits and redistribution[9] found in the countries they considered, although their discussion about differences among welfare systems was far more articulated. Their findings imply that welfare models more targeted on the poor are able to devote a much lower amount of resources to social expenditure. It has to be noted that a negative relation between the concentration index of the benefits and the amount of resources in not sufficient, per se, to cause the fall of redistribution as the concentration of benefits increases.

Fig. 4 Net fiscal systems
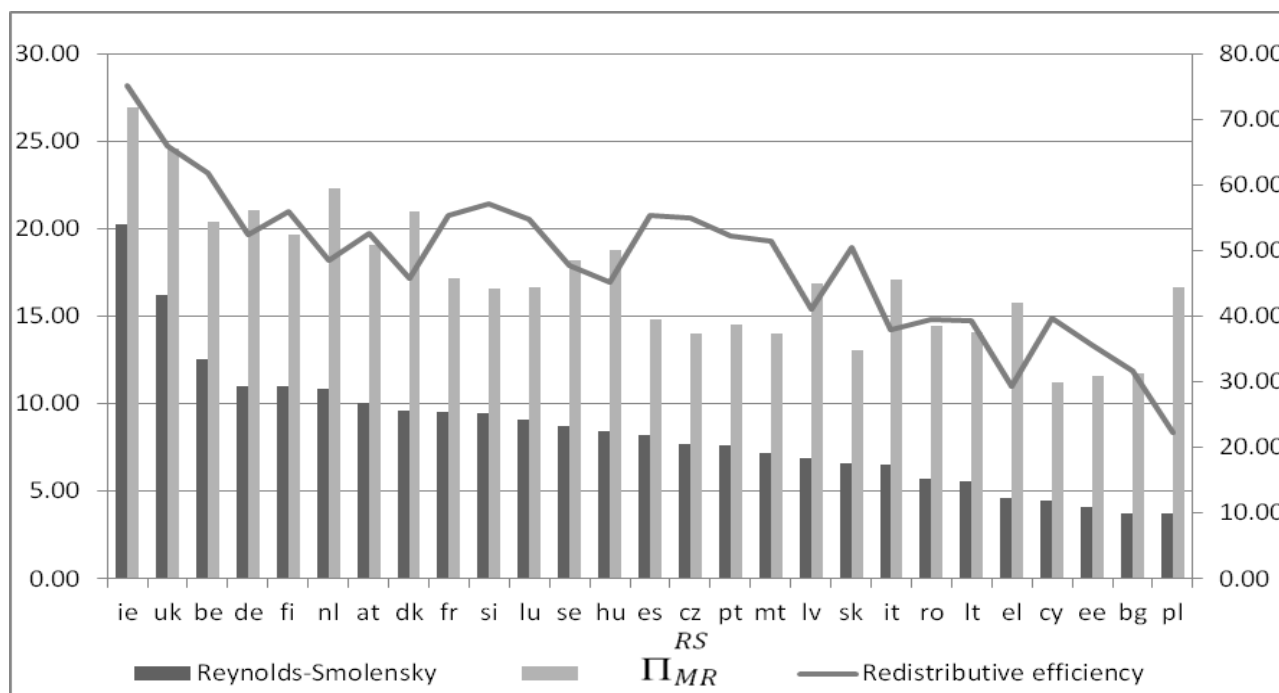
In Fig. 3 the Kakwani is presented with the sign changed, in order to make clearer the two pictures. The Redistribution index (Reynold-Smolensky) seems to decrease as the Kakwani index decreases (fig.3a). This confirms more recent results obtained by Marx et al. (2013), who found that the redistributive paradox does not hold any more. The positive correlation between targeting transfers to the poor and redistribution is even more apparent (Fig. 3b) if we use the Redistributive Efficiency index as the measure of the targeting.

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[9] If benefits are mainly targeted to the poor, the concentration index is negative and its value increases (decrease in absolute value) as the share of benefits received by the poor decreases. Concentration index is positive if a disproportionate share of benefits is given to the rich. Korpi and Palme (1998) measure redistribution as the percentage change of gini index of income caused by benefits.

Looking at the Kakwani of taxes and benefits does not provide any hints on progressivity of the whole net fiscal system. We have already seen how taking into account the overlapping of taxes and benefits over the same individuals is important for a correct evaluation of the impact of the whole tax-benefit system. Even neglecting this issue, the comparison of Fig. 2 to Fig. 3 highlights that countries with very progressive taxes (such as Portugal and Ireland) often do not have very regressive benefits; therefore, it is impossible to guess how much the whole tax-benefit system is targeted to the poor. The Redistributive Efficiency index is the only tool that enables to such an evaluation.

Fig.4 shows the Redistributive Efficiency, the Reynolds-Smolensky and the Maximum Redistribution (Π_{MR}^{RS}) indices for net fiscal system. Countries are ordered by Reynolds-Smolensky.

A clear pattern of redistribution and Redistributive Efficiency emerges from the picture. The two Anglo-Saxon countries (UK and Ireland) present a very high level of redistribution and redistributive efficiency. Then, there is a large group with average levels of redistribution; the Reynolds-Smolenky index lies between 12.5 and 7 points for as many as 15 countries. Some of these countries obtain their redistributive impact with higher Redistributive Efficiency and others with higher Maximum Redistribution, without a clear pattern. Finally there are ten countries with very low levels of redistribution, below 7 points. Interestingly, all of them show a poor Redistributive Efficiency (except Slovakia) while the Maximum Redistribution varies significantly; a few of them, notably Italy and Poland, have a maximum redistribution index even bigger than some countries belonging to the average redistribution group. As it emerges, low Redistributive Efficiency plays an important role in explaining the poor redistributive impact of the underperforming tax-benefit systems.

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Appendix 1

B1 and B2 are two minimum income schemes:

$\quad$ $B1(x) = b1 - x$ if $x \leq b1$; $\ 0\ $ otherwise

$\quad$ $B2(x) = b2 - x$ if $x \leq b2$; $\ 0\ $ otherwise

Where x is income before benefits.

If $b1 < b2$, $B1(x)$ involves a smaller amount of resources than $B2(x)$

To be equalizing, benefits have to be regressive. A sufficient condition for $B1(x)$ to be more regressive than $B2(x)$ is that Lorenz curve of B1 ($L_{B1}(x)$) dominates Lorenz curve of B2 ($L_{B2}(x)$).

This condition is not strictly true because $L_{B1}(x) = L_{B2}(x) = 1$ if $x > b2$.

The condition can be restated so that $B1(x)$ is more regressive than $B2(x)$ if Lorenz dominance holds when x is smaller than $b2$.

A.1 $B1(x)$ is more regressive than $B2(x)$ if :

$\quad$ $L_{B1}(x) > L_{B2}(x)$ $\qquad\qquad\qquad\qquad$ if $x < b2$

$\quad$ $L_{B1}(x) = L_{B2}(x) = 1$ $\qquad\qquad\qquad$ otherwise.

Condition $L_{B1}(x) > L_{B2}(x)$ is clearly true if $b1 \leq x \leq b2$, since $1 = L_{B1}(x) > L_{B2}(x) < 1$.

Hence it remains to prove that:

A.2 $\qquad$ $L_{B1}(x) > L_{B2}(x)$ $\qquad\qquad\qquad$ if $x < b1$.

Condition A.2 is similar to the "qualified Lorenz dominance" used by Keen et al. 2000.

I show that this is true for any value of income smaller than $b1$

Consider any distribution $X = (x1, x2)$ where: $x1 < x2 < b1$:

$\quad$ $B1(x1) = b1 - x1$

$\quad$ $B2(x1) = b2 - x1$

$$L_{B1}(x1) = \frac{b1 - x1}{(b1 - x1) + (b1 - x2)}$$

$$L_{B2}(x1) = \frac{b2 - x1}{(b2 - x1) + (b2 - x2)}$$

Then condition *A.2.* implies:

$$\frac{b1 - x1}{(b1 - x1) + (b1 - x2)} > \frac{b2 - x1}{(b2 - x1) + (b2 - x2)} \Rightarrow$$

$$0 > (b1 - b2)(x2 - x1). \Leftrightarrow b1 < b2$$

Hence $B1(x)$ is more regressive of $B2(x)$ if $b1 < b2$, that is if total expenditure for B1 is lower than total expenditure for B2

Appendix 2

Euromod database

Country	code	Input data	Policy year
Austria	at	EU-SILC 2008	2012
Belgium	be	EU-SILC 2010	2012
Bulgaria	bg	EU-SILC 2008	2012
Cyprus	cy	EU-SILC 2008	2012
Czech Republic	cz	EU-SILC 2008 (+ variables from national SILC)	2012
Denmark	dk	EU-SILC 2008	2012
Estonia	ee	EU-SILC 2008	2012
Finland	fi	EU-SILC 2008	2012
France	fr	national data 2010	2012
Germany	de	EU-SILC 2010	2012
Greece	el	EU-SILC 2010	2012
Hungary	hu	EU-SILC 2010	2012
Ireland	ie	EU-SILC 2008	2012
Italy	it	national SILC 2010	2012
Latvia	lv	EU-SILC 2010	2012
Lithuania	lt	EU-SILC 2010 (+ variables from national SILC)	2012
Luxembourg	lu	EU-SILC 2008 (+ variables from PSELL3)	2012
Malta	mt	EU-SILC 2009	2012
Netherland	nl	EU-SILC 2008	2012
Poland	pl	EU-SILC 2008 (+ variables from national surveys)	2012
Portugal	pt	EU-SILC 2008	2012
Romania	ro	EU-SILC 2010	2012
Slovakia	sk	national SILC 2010	2012
Slovenia	si	EU-SILC 2010 (+ variables from national SILC)	2012
Spain	es	EU-SILC 2010	2012
Sweden	se	EU-SILC 2008	2012
United Kingdom	uk	Family Resources Survey 2008/9	2012

source EUROMOD data documentation