Income taxation and equity: new dominance criteria with a microsimulation application

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Abstract

This paper addresses the problem of the normative evaluation of income tax systems and income tax reforms. While most of the existing criteria, framed in the utilitarian tradition, are uniquely based on information about individual incomes, this paper, building upon the opportunity egalitarian theory, proposes new equity criteria which take into account also the socio-economic characteristics of individuals. Suitable dominance conditions that can be used to rank alternative tax systems are derived by means of an axiomatic approach. Moreover, the theoretical results are used to assess the redistributive effects of an hypothetical tax reform in Romania through a microsimulation analysis.

Keywords Income inequality · Inequality of opportunity · Tax reforms · Microsimulation · Progressivity · Horizontal equity

1 Introduction

The normative assessment of income tax reforms most often consists of comparing the post-reform distribution of individual welfare with the pre-reform distribution or possibly that obtained from another reform. This comparison is carried out either by using a specific,

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utilitarian, social welfare function, as it is the case in the optimal income tax literature (Mirrlees 1971), or by using a family of social evaluation criteria, as in the social choice tradition, thereby obtaining only a partial ranking of tax reforms (see for instance Lambert 2001). Both approaches are generally framed in a rigorous welfarist conceptual framework: the individual position, either pre- and post- taxes, is evaluated only in terms of individual utility, which in turn is assumed to depend only on the individual income. Consistently, the equity criteria embedded into the social welfare functions, such as the horizontal and vertical equity principles, are expressed in terms of individual incomes and utilities.

On the other hand, a robust equity theory recently developed in the philosophical and economic literature has proposed opportunity, instead of income, as the proper space for equity judgments. This literature is based on the idea that a society can accept inequalities due to the individual responsibility while objecting to those due to exogenous circumstances. In fact, the ideal of equal opportunities is the product of two independent (and sometimes conflicting) principles: the principle of compensation, stating that differences in individual outcomes which are due to differences in circumstances are unfair and need to be compensated by the society; and the principle of reward, which is concerned with apportion of individual outcomes to effort and, in some of its formulations, states that differences in individual achievements due to effort are equitable and do not need compensation. Two prominent formulations of the reward principle are utilitarian reward, imposing complete neutrality with respect to outcome inequalities due to circumstances, and liberal reward, stating that any redistribution scheme should treat individuals with the same circumstances in an equal way. Alternative versions include agnostic and inequality averse reward.

See Roemer (1998) and Fleurbaey (2008) for book-length discussions of the opportunity egalitarian theory and see Ferreira and Peragine (2016) and Ramos and Van de gaer (2016) and Roemer and Trannoy (2016) for recent surveys of the literature.

The opportunity egalitarian theory may provide an alternative normative framework for the evaluation of tax reforms and tax systems. In particular, we believe that the opportunity perspective may help to lessen the ambiguity on the meaning of a "just taxation" since it explicitly takes into account the different sources of inequality and allows distinguishing between fair and unfair inequalities. Incorporating in a tax-system evaluation framework opportunity egalitarian principles, that are well-rooted in the philosophical and normative debate, allows specifying rigorously the equity principles to be satisfied by a desirable tax system. Moreover, this framework may also be more in tune with the popular equity preferences in western liberal societies: existing evidences show that individuals are more prone to support redistributive policies when most of the inequalities observed are brought about by factors that economic agents cannot control (see Alesina et al. 2018; Guillaud 2013); Cappelen et al. 2021). In this paper we precisely address this issue, that is, the assessment of tax systems and tax reforms from the point of view of equality of opportunity.

Previous examples of applications of the Equality of Opportunity (EOp) framework for the evaluation of different tax systems can be found in Roemer et al. (2003) and in Aaberge and Colombino (2012). Roemer et al. (2003) propose an optimal taxation model used as benchmark to evaluate which income-tax regime is able to equalize the opportunities within eleven European countries. Aaberge and Colombino (2012) propose a second-best analysis and, by using a rich microsimulation model taylored on the Italian income tax, estimate the optimal taxation for both the utilitarian and the opportunity egalitarian criteria.[1] Although

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[1]See also Jacquet and Van de gaer (2011) and Schokkaert et al. (2004) for an analytical discussion on the conflict between standard criteria in the optimal tax literature and the requirements of equality of opportunity.

close in spirit to these papers, our work presents a distinctive feature: while their models are framed into the optimal income tax model *à la* Mirlees, we use a partial dominance approach, which is more in line with the social choice tradition and allows for a more robust ethical assessment. Hence we will be seeking for conditions of dominance of one income tax regime over another according to large families of opportunity egalitarian social evaluation functions.

The first step in our analysis consists in building a social evaluation function expressing our ethical concerns. Now, the two basic principles of fairness in the theory of taxation are horizontal equity, prescribing the "equal treatment of equals" (Musgrave 1959)[2], and vertical equity, prescribing the "differential treatment of unequals". From the opportunity egalitarian viewpoint the variable in terms of which the individuals should be considered as equals, hence deserving equal treatment, or unequals, hence deserving some equalizing treatment, is their set of opportunities. Hence individuals are defined "equals" if they can choose their desired outcome from the same set of opportunities. These individuals eventually differ only in terms of effort; these differences are not relevant form an opportunity egalitarian perspective and can be (but not necessarily need to be) treated in an equal way from the fiscal perspective. On the other hand, individuals are defined "unequals" if the opportunity sets from which they can choose their desired outcome are different.

Hence we need a tractable model of individual opportunities. To this end, following the EOp literature (see Roemer 1998, and Fleurbaey 2008), we introduce a framework in which the individual income is generated by a function that depends on two categories of factors: exogenous circumstances that lie outside the sphere of individual responsibility, assumed to be observable; and effort, which captures all the factors that are within the sphere of individual responsibility and is defined residually after the circumstances are accounted for. Once we have a multidimensional distribution of income and circumstances, we can partition the population into types, a type being a set of individuals characterized by the same circumstances. In the EOp literature the type-specific income distribution, that is the income distribution conditional to circumstances, is interpreted as the opportunity set open to all individuals in that type.

Accordingly, two individuals are normatively "equals" and hence deserve equal treatment if they are in the same type, thus if they have the same circumstances: the ethically relevant characteristics in terms of which identifying the "equals" (and the "unequals") are the individual circumstances.

In fact, one of the two pillars of the EOp theory, the Reward Principle (in one of its formulations, see Fleurbaey 2008) states that individuals with the same circumstances should receive an equal transfer. As already argued in Peragine (2004), this can be interpreted as the opportunity egalitarian version of the Horizontal Equity principle. Likewise, individuals with different sets of circumstances, which have access to different opportunity sets, are "unequals" in terms of opportunity and therefore deserve to be treated differently: more precisely, an opportunity egalitarian policy needs to reduce the inequality between individuals endowed with different circumstances. This is the content of the Principle of Compensation, which can be interpreted as the opportunity egalitarian version of the vertical equity principle. Hence, according to the opportunity egalitarian perspective, the relevant characteristics that identify individuals as equals or unequals, and therefore are relevant for demanding an equal or unequal tax treatment, are the circumstances.

On the other hand, individuals exerting the same efforts are not normatively equals. In fact, despite the same effort, they obtain different outcomes exactly because of the different

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[2]See, *inter alia*, Duclos and Lambert (2000) and Jenkins and Lambert (1999) and Urban and Lambert (2008).

circumstances (hence the different opportunity set) they are endowed with: an inequality (in outcome) that needs to be corrected as it is generated by the different circumstances. This is the content of an alternative version of compensation (called ex-post compensation), which is also an alternative opportunity egalitarian version of the vertical equity principle. See Fleurbaey and Peragine (2013) for a comparison of ex-ante and ex-post versions of compensation. In the present paper we will translate the principles discussed above into formal axioms that will be imposed on the social evaluation functions.

Our approach is consistent with that branch of the literature proposing redistribution mechanisms aimed at reducing inequality of opportunity, and most prominently with the contribution of Bossert and Fleurbaey (1996). However, differently form our work, in their model "irrelevant" and "relevant" characteristics refer, respectively, to circumstances and effort since they derive a redistribution mechanism focusing on post-tax incomes as the main outcome of interest. On the other hand, we focus on tax treatment to build our evaluation model.

Analytically, the evaluation of a tax system in our model will be based on two pieces of information at the individual level: (i) the set of characteristics outside the sphere of individual responsibility, which determine the type of an individual, and (ii) the income change induced by the tax system. Hence we will characterize partial orderings defined over bi-dimensional distributions, where one variable is represented by the set of circumstances defining the type, while the second is the income change, which is cardinally measurable and assumed to be continuous. These orderings will be coherent with social preferences endorsing the equality of opportunity principle.

The framework we propose can be used to complement the standard analysis of the redistributive effect of tax-benefit systems and may give interesting insights for the design of public policies. If two tax-benefit systems have, say, the same impact in terms of income inequality reduction, but in the first case all members of a given socio-economic group who was the most disadvantaged before the tax reform are further impoverished by this reform, whereas in another case this impact is uncorrelated with differences in socio-economic characteristics, our current arsenal of measures fails to distinguish them. This kind of information can be extremely valuable for those policymakers involved in the implementation of mechanisms that target specific groups of the population.

An alternative procedure would consist in computing the difference in social welfare before and after taxation by means of a social welfare function that incorporates EOp ideals (see, among others, Bosmans and Öztürk 2021, Peragine 2002, 2004). While, this procedure is certainly accomplishable, we prefer our approach since it generates results that do not depend on the specific function (and parameters) used to measure social welfare, and thus is robust to larger classes of social welfare functions. Most importantly, our evaluation model builds upon the information of the income change due to taxation at the individual level and only afterwards aggregates these impacts across individuals so as to arrive to a societal evaluation of the impact of taxation. This procedure allows tracking types and makes it possible to study how each single type, or more in general each single socio-economic group of the population, is affected by a tax reform. Moreover, it allows to establish inequality of opportunity principles directly on the evaluator function of the income change determined by the tax systems analysed (and compared), thereby furnishing direct information on their compatibility with respect to the opportunity egalitarian ideal.

Our contribution is analytically related to Bourguignon (2011) who proposes normative criteria to compare tax reforms that are sensitive to the *status-quo* of individuals in the

pre-reform distribution. Our approach is similar to Bourguignon (2011) in that we both eval-
uate bidimensional distributions. However, Bourguignon (2011) adopts a standard utilitarian
approach: in his model the identifying variable with respect to which the equity principles
are formulated is the pre-reform individual income; while in our contribution the identify-
ing variable is the type to which the individual belongs. Such difference clearly reflects the
different underlying equity principles and leads to different welfare criteria.

In the paper we show how the theoretical evaluation model can be put in practice by
comparing the case of an hypothetical tax reform in Romania with the tax regime in place.
This country has been characterized by a peculiar tax history: the progressive system in
place before 2005, based on a tax allowance and five tax rates - ranging from 18% to 40%
- was substituted by a 16% flat tax rate. This reform was motivated by the need to lessen
tax evasion and avoidance and, this aim was only to a limited extent accomplished (Daianu
et al. 2012). By contrast, as it is not difficult to foresee, this tax change was proved to be
quite regressive with the richest quantiles gaining disproportionally more than the poorest.
In our analysis, we first evaluate the distributional impact of the actual system under the
light of equality of opportunity, to understand whether this regime performs badly also when
an opportunity egalitarian perspective is endorsed. We then compare this performance with
that of an hypothetical reform, with same tax levy as the actual one, but based on four
income brackets, with tax rates ranging from 15% to 30%. In order to conduct this study
we develop a microsimulation analysis using the Romanian Survey on Income and Living
Conditions, the Romanian implementation of the European Union Statistics on Income and
Living Conditions (EU-SILC) collected in 2011. We find that the type of reform proposed
in this paper could improve the distributional performance of the tax regime in place, not
only when income inequality matters, but also when opportunity represents the space of
evaluation.

Hence, the contribution of this work is twofold. From a theoretical point of view, we
propose a model for comparing different fiscal systems that is coherent with the norm of
equality of opportunity. This framework will represent a complementary tool for judging
fairness in taxation and, beyond that, comparing taxation regimes by their ability to enhance
equity. From an empirical point of view, we show how to apply our framework to real data
using the Romanian case, providing evidence for the need of a tax reform in Romania in
order to improve its recent poor distributive performance.

The rest of the paper is organized as follows. Section 2 contains the theoretical con-
tribution of the paper. Section 3 presents the results of the empirical analysis. Section 4
concludes. Appendix A provided as a supplementary material contains all the proofs.

2 Tax systems comparisons

In this section we first outline the set up and the standard utilitarian practice used to
assess alternative tax systems and reforms, we then introduce our approach based on the
opportunity perspective.

2.1 The set up

Let $F(y)$ be the initial cumulative distribution of income, with density $f(y)$, and consider
a tax system τ, where a tax system is a function $\tau : \mathbb{R}_+ \to \mathbb{R}$ that associates a tax to a given
level of income. τ may represent any kind of tax scheme - such as tax rate, income brackets,
allowances, negative income tax. We denote by y_τ the final level of income of an individual

with initial income y under tax τ and by $F(y_\tau)$ and $f(y_\tau)$ the relevant post tax cumulative and density distribution functions. Moreover, we denote by $\delta^{(\tau)}(y)$ the income change relative to income y under tax τ and by $F(\delta^{(\tau)}(y))$ the distribution of income changes. The income change can be interpreted either as absolute $(y_\tau - y)$ or relative $\left(\frac{y_\tau - y}{y}\right)$ income change.

Two interpretations are possible with our framework. In the first interpretation, the initial income y is interpreted as pre-tax income and therefore y_τ is interpreted as post tax or net income under tax regime τ. In this interpretation, the income change $\left|\delta^{(\tau)}(y)\right|$ corresponds to tax liability or average tax rates at income y, according to the absolute or relative interpretation, respectively. In the second interpretation, the initial distribution is interpreted as the *status quo* post-tax distribution, i.e., the distribution of net incomes obtained according to the existing tax system and y_τ denotes the level of income obtained by an individual with income y under the alternative tax system τ. Consequently, $\delta^{(\tau)}(y)$ denotes the income change at income y when going from the existing tax system to the new tax system τ. Hence, in the first interpretation the issue is that of evaluating and comparing tax systems; while in the second interpretation we are interested in evaluating and comparing tax reforms.

Our results, as we will see, can be interpreted in both scenarios. In fact, we will focus on the distribution of the income change $\delta^{(\tau)}(y)$. In our setting, the income change $\delta^{(\tau)}(y)$ can take both positive and negative values: in the former interpretation it corresponds to allowing the possibility of a negative income tax, while in the latter interpretation it is normal that going from one tax system to another there are gainers and losers.

The standard practice to evaluate the redistributive effect of a tax system (see Cowell 2000, Lambert 2001) consists in comparing the Lorenz curve associated to the pre-tax income distribution to the same curve associated to the post-tax distribution. In welfare terms, a dominance between the two curves, in fact, implies that the considered tax system is welfare-improving, for all utilitarian social welfare functions based on increasing and concave individual utility functions, with respect to an equal yield proportional tax. In the tax reforms interpretation, consider two alternative and equal yield tax reforms τ_1 and τ_2 : applying the standard approach, we can state that reform τ_1 is preferred to reform τ_2 according to all utilitarian criteria based on increasing and concave individual utility functions if and only if the Lorenz curve of the post-reform distribution under τ_1 dominates the Lorenz curve of the post-reform distribution under τ_2. When evaluating a tax reform, these criteria assume that the ranking of individual incomes is the same before and after the reform, which only sporadically happens in reality. On the base of this observation, Bourguignon (2011) proposes an extension of these criteria in order to include *status-quo* concerns, where *status quo* is intended as the rank in the pre-reform distribution. Furthermore, as pointed out in the introduction, they assume the income of an individual to be the relevant variable. In the next section, by modifying both assumptions, we will be able to obtain some criteria to evaluate the fairness of a tax system according to the EOp perspective.

2.2 The EOp approach

According to the EOp model (Roemer 1998; Fleurbaey 2008; Peragine 2004), the individual income y is a function of two sets of characteristics: the circumstances, $\mathbf{c}$, belonging to a finite set $\Omega = \{\mathbf{c}_1, ..., \mathbf{c}_n\}$, where n is the number of types in the population, and the level of effort, $e \in \Theta \subseteq \Re_+$. The individual cannot be held responsible for $\mathbf{c}$, which is fixed over time, but she is, instead, responsible for the effort e. Income is generated by a function $g : \Omega \times \Theta \rightarrow \mathbb{R}_+$, such that $y = g(c, e)$. This model excludes the existence of random

components.[3] The function g is assumed to be the same for the whole population. Given an income distribution $F(y)$ and initial circumstances defined by Ω, it is possible to partition this distribution into groups called "types" and including all individuals sharing the same circumstances. Thus, for any $i = 1, ..., n$, type i is the set of individuals with circumstances c_i; the income distribution of type i is represented by $F_i(y)$, with population share q_i and mean income $\mu_i(y)$. We denote by $(F; \Omega)$ the resulting bivariate distribution and by $\mathbb{F}$ the set of admissible distributions. Last, let us assume that types can be ordered on the base of their mean income such that $\mu_1(y) \leq ... \leq \mu_i(y) \leq ... \leq \mu_n(y)$.

We now introduce a tax τ. As before, we denote by y_τ the individual income after tax τ and by $F(y_\tau)$ the overall income distribution after tax. We can write $F(y) = \sum_{i=1}^{n} q_i F_i(y)$ and $F(y_\tau) = \sum_{i=1}^{n} q_i F_i(y_\tau)$ for the initial and final distribution respectively. Given this analytical framework, the focus of the analysis is the income prospects of individuals of the same type, represented by the type-specific income distributions $F_i(y)$ and $F_i(y_\tau)$. These distributions are interpreted as the set of opportunities open to each individual in type i, respectively before and after tax τ. In other words, the observable actual incomes of all individuals in a given type are used to proxy the unobservable ex ante opportunities of all individuals in that type.

As explained in Section 2.1, the framework we outline here can be used to evaluate either the tax system in place or a tax reform. Hence, analogously to $\delta^\tau(y)$, the income generating function is subject to a dual interpretation. In the case of tax system evaluations, the income generating function $y = g(c, e)$ represents market income, that is, the income that would be assigned to each individual in the absence of (or before) government intervention, and $y_\tau = g(c, e, \tau)$ represents the net income arising from the application of the tax schedule[4] that is going to be evaluated. Instead, when the aim is to evaluate or compare tax reforms, the income generating function $y = g_\tau(c, e, \tau)$ is interpretable as the income that prevails with the tax system in place and that is going to be compared to the income that would prevail with the tax reform, that could be expressed by $y = g(c, e, \tau')$. In this last case, $\delta^\tau(y)$ becomes the relative or absolute difference between the income generated by circumstances, effort, and the tax system in place and the income that would be generated by circumstances, effort, and the tax system resulting from the reform design.

Let $F_i\left(\delta^{(\tau)}(y)\right)$ be the cumulative distribution function of the individual income change within type i, and let $\delta_i^{(\tau)}(p)$ be the income change generated by tax τ for an individual belonging to type i and ranked p in the distribution of income change specific to that type. That is, for each type i, $\delta_i^{(\tau)}(p)$ is the value of the left inverse cumulative distribution $F_i^{-1}\left(\delta^{(\tau)}(y)\right)$ at p, denoting the income change experience by the individual ranked p in $F_i\left(\delta^{(\tau)}(y)\right)$: $\delta_i^{(\tau)}(p) := \inf(\delta : F_i\left(\delta^{(\tau)}(y)\right) \geq p)$. Note that, while types are ordered increasingly according to the level of their average income, within types individuals are sorted non-decreasingly according to the level of their income change. Thus, our model will retain the principle of anonymity within type and non-anonymity between types.[5]

Given any $(F, \Omega) \in \mathbb{F}$, we denote by $(\delta^{(\tau)}, \Omega)$ the associated bivariate distribution of income change generated by the tax system τ and by D the set of admissible distributions

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[3]See Van de Gaer (1993) and Lefranc et al. (2009) for an alternative approach, which recognizes the role of luck, in addition to circumstances and effort, in determining the individual outcome.

[4]See Fleurbaey (2008) for a similar representation.

[5]Given this particular construction, p does not identify effort, which is instead given by the percentile in the within type distribution according to the Roemer's identification assumption, and not by the within type distribution of income change.

of income change induced by tax. We are interested in the normative ranking of the bivariate distributions from the set D. That is, we examine a binary preference relation of an opportunity egalitarian social decision-maker. We assume that this relation is a continuous ordering, hence it has its representation via a function $W : D \rightarrow R$ that we call "social welfare change". Thus, within this framework, the evaluation of the social welfare change associated to an income tax is assumed to be a function of the individual income changes and the individual original socio-economic conditions.

It can be expressed as follows:

$$W(\delta^{(\tau)}, \Omega) = \sum_{i=1}^{n} q_i w_i(v, \delta^{(\tau)}) \tag{1}$$

where $w_i(v, \delta^{(\tau)}) = \int_0^1 v_i(p) \delta_i^{(\tau)}(p) \, dp$ and $\int_0^1 v_i(p) = 1 \; for \; all \; i = 1, ..., n$.

Equation 1 states that the evaluation of the social welfare change of a tax system is obtained as a weighted sum of income changes, where each income change is aggregated first within each type and than across types, and where types are ordered according to their average income in the pre-tax (or pre-reform) distribution.[6] In details, $w_i(v, \delta^{(\tau)}) = \int_0^1 v_i(p) \delta_i^{(\tau)}(p)$, $\forall i = 1, ..., n$ can be interpreted as the welfare change associated to type ranked i in $F(y)$. The function $v_i(p) : [0, 1] \longrightarrow \mathbb{R}_+$ expresses the social weight attached to income change that takes place at p in $F_i(\delta)$ (Yaari 1988).[7] It captures the preferences of a social planner with respect to an ideal tax system. The social evaluation function introduced in (1) is assumed to satisfy standard properties. To see this, given our bidimensional framework, we proceed in two steps. The first step elucidates the properties of the function capturing the type specific welfare change, $w_i(v, \delta^{(\tau)})$. The second step sheds lights on the properties of the aggregator $W(\delta^{(\tau)}, \Omega)$.

To fulfill the first step, the following properties are considered.

Standardization For all $x \in \mathbb{R}$, if $\delta_i^{(\tau)}(p) = x$ for all $p \in [0, 1]$ then $w_i(v, \delta^{(\tau)}) = x$.

According to Standardization, if each individual in a generic type i experiences the same income change due to taxation, the welfare change associated to that generic type i can be appropriately represented by that value.

Monotonicity For all $\alpha \in \mathbb{R}_+$ and $\tau, \tau' \in \mathbb{R}$, if $\delta_i^{(\tau)}(p) = \delta_i^{(\tau')}(p) + \alpha$ and $\delta_i^{(\tau)}(q) = \delta_i^{(\tau')}(q)$ for all $p, q \in [0, 1]$ such that $p \neq q$, $w_i(v, \delta^{(\tau)}) \geq w_i(v, \delta^{(\tau')})$.

Monotonicity is also a standard property and requires that a social planner should prefer income increments to income reductions. All else equal, a positive tax will not increase welfare change associated to a type i, whereas a negative tax will not decrease it.

Independence For all $p, q \in [0, 1]$ such that $p \neq q$, $\frac{\partial^2 w_i(v, \delta^{(\tau)})}{\partial \delta_i(p) \partial \delta_i(q)} = 0$.

With the Independence property, we assume that the effect of each individual's income change on type specific welfare change is independent of that experienced by any other individual in the same type.

We can then state the following claim (see Appendix A in the supplementary material for the proof).

Claim 1. Given a generic type $i = 1, ..., n$, the type specific welfare change, $w_i(v, \delta^{(\tau)})$, satisfies Standardization, Monotonicity, Independence.

To fulfill the second step, the following properties are considered.

Normalization If $w_i(v, \delta^{(\tau)}) = 0$ for all $i = 1, ..., n$, then $W(\delta^{(\tau)}, \Omega) = 0$.

According to Normalization, the social welfare change implied by the tax system under evaluation will be equal to zero if each type specific welfare change equals zero.

Pareto If $w_i(v, \delta^{(\tau)}) \geq w_i(v, \delta^{(\tau')})$ for all $i = 1, ..., n$, then $W(\delta^{(\tau)}, \Omega) \geq W(\delta^{(\tau)}, \Omega)$.

The property of Pareto implies that the social welfare change due to taxation is sensitive to the sign and magnitude of each types specific income chance.

Decomposability For all $i, j = 1, ..., n$ such that $i \neq j$, $\frac{\partial^2 W(\delta^{(\tau)}, \Omega)}{\partial w_i(v, \delta^{(\tau)}) \partial w_j(v, \delta^{(\tau)})} = 0$.

According to Decomposability, it is possible to isolate the impact of the welfare change specific to each type in the determination of the social welfare change induced by a tax system.

Utilitarianism For all $i = 1, ..., n$, $\frac{\partial^2 W(\delta^{(\tau)}, \Omega)}{\partial^2 w_i(v, \delta^{(\tau)})} = 0$.

Utilitarianism requires that at the societal level we retain neutrality in the distribution of the type-specific welfare change.

Last, we conclude with a standard population independence axiom, which proves to be useful for comparison purposes when one deals with populations of different size.

Population For all $i = 1, ..., n$ and $r \in \mathbb{N}_{++}$, if $w^r = (\underbrace{w_1, ..., w_1}_{r \text{ times}}, ..., \underbrace{w_n, ..., w_n}_{r \text{ times}})$, then

$W(\delta^{(\tau)}, \Omega) = W(\delta^{(\tau)}, \Omega^r)$.

We can then state the following claim (see Appendix A in the supplementary material for the proof).

Claim 2. The social welfare change $W(\delta^{(\tau)}, \Omega)$ satisfies Normalization, Pareto, Decomposability, Utilitarianism, Population, in addition to Standardization, Monotonicity, Independence for the type specific welfare change $w_i(v, \delta^{(\tau)})$ for all $i = 1, ..., n$.

2.3 Income taxation and opportunity egalitarianism

In the previous section, (1) makes clear that in order to evaluate a tax system, we can aggregate the social welfare change due to the tax experienced by each type, weighted by the relevant population share, using type-specific weighting functions. In this section we discuss how different value judgments concerning the ideal design of a tax system coherent with the EOp theory can be expressed in this framework by imposing some additional properties to the function capturing the social welfare change due to taxation. These properties will in turn define different classes of social welfare change functions (SWC).

We start with the evaluation of the tax treatment of individuals belonging to the same type. The first property is *Within Type Neutrality*.

Property 1 (*Within Type Neutrality*). For all $i = 1, ..., n$ and $\tau, \tau' \in \mathbb{R}$, let $\epsilon \in \mathbb{R}_{++}$, if $\delta_i^{(\tau)}(p) = \delta_i^{(\tau')}(p) + \epsilon$ and $\delta_i^{(\tau)}(q) = \delta_i^{(\tau')}(q) - \epsilon$ for all $p, q \in [0, 1]$ such that $p \neq q$, and if $\delta_i^{(\tau)}(s) = \delta_i^{(\tau')}(s)$ for all $s \in [0, 1]$ such that $s \neq p, q$, then $W(\delta^{(\tau)}, \Omega) = W(\delta^{(\tau')}, \Omega)$.

This property says that the transfer of a small amount of income ϵ, from a fraction dp of the population at quantile p of type i distribution of income change to a fraction dp of the population at the quantile q of the same type i's distribution of income change (with $p, q \in [0, 1]$ and $p \neq q$), does not have any impact on the overall welfare change. This property expresses the social irrelevance of possible differences in the tax treatment of individuals in the same type. Clearly, this property clashes with the idea of equal treatment of individuals in the same type (principle of horizontal equity) and we propose it as a benchmark. Next property, in fact, concerning the tax treatment of individuals in the same type, captures the horizontal equity principle, as proposed in the present framework, and is labeled *Opportunity Horizontal Equity*.

Property 2 (*Opportunity Horizontal Equity*). For all $i = 1, ..., n$ and for all $\tau, \tau' \in \mathbb{R}$, let $\gamma \in \mathbb{R}_{++}$, if $\delta_i^{(\tau)}(p) = \delta_i^{(\tau')}(p) + \gamma$, $\delta_i^{(\tau)}(s) = \delta_i^{(\tau')}(s) - \gamma$, and $\delta_j^{(\tau)}(q) = \delta_j^{(\tau')}(q)$ for all $p, q, s \in [0, 1]$ such that $q \neq p, s$ and $p \leq s$, $W(\delta^{(\tau)}, \Omega) \geq W(\delta^{(\tau')}, \Omega)$.

Property 2 expresses a preference for the equal treatment of equals, identified as the individuals in the same type, hence endowed with the same circumstances. More precisely, according to Property 2, the lower the inequality in the tax treatment of individuals in the same type, the higher the social welfare. This property was originally introduced by Fleurbaey and Peragine (2013), who label it "minimal reward" and interpret it as a minimal requirement dictated by the liberal reward principle, prescribing the equal treatment of individuals with the same circumstances. By requiring that inequality in the tax treatments of individuals in the same type should be kept as lower as possible, this property reflects the preferences of a social planner whose ideal tax scheme should not alter the inequalities among individuals within each type.

The next property is concerned with individuals belonging to different types, and hence is expression of the vertical equity principle.

Property 3 (*Opportunity Vertical Equity*). For all $i, j, k = 1, ..., n$ and $\tau, \tau' \in \mathbb{R}$, let $\alpha \in \mathbb{R}_{++}$, if $\delta_i^{(\tau)}(p) = \delta_i^{(\tau')}(p) + \alpha$, $\delta_j^{(\tau)}(p) = \delta_j^{(\tau)}(p) - \alpha$, $\delta_k^{(\tau)}(p) = \delta_k^{(\tau')}(p)$ for all $k \neq i, j$ and $i \leq j$ and for all $p \in [0, 1]$, $W(\delta^{(\tau)}, \Omega) \geq W(\delta^{(\tau')}, \Omega)$.

Property 3 reflects the vertical equity principle, where the characteristics defining the unequals are the individual circumstances. More precisely, the property says that the transfer of a small amount of income α, from a fraction dp of the population at quantile p of type i's distribution of income change to a fraction dp of the population at the same quantile p of type j's distribution of income change (with $p \in [0, 1]$ and $i \leq j$) — that is a transfer between individuals at the same rank in their respective type specific distribution of income change — does not decrease the social welfare change due to taxation. Therefore, recalling that our framework retains the principle of anonymity with respect to types, $W(\delta^{(\tau)}, \Omega)$ reflects the preferences of a social planner whose ideal tax system should be conceived and

designed to reduce the income inequalities between the different types of the population, that is, the inequalities between the opportunity sets open to individuals with different circumstances. Property 3 would prescribe the following changes: (i) augmenting the tax on a richer type in order to increase by the same amount the positive transfer to a poorer type; (ii) reducing the positive transfer of a richer type to increase by the same amount the positive transfer to a poor type; (iii) augmenting the tax on a richer type in order to reduce by the same amount the tax of a poorer type.

The last property we consider is the following.

Property 4 (*Increasing Opportunity Horizontal Equity*). For all $i, j, k = 1, ..., n$ and for all $\tau, \tau' \in \mathbb{R}$, let $\gamma \in \mathbb{R}_{++}$, if $\delta_i^{(\tau)}(p) = \delta_i^{(\tau')}(p) + \gamma$, $\delta_i^{(\tau)}(p + \rho) = \delta_i^{(\tau')}(p + \rho) - \gamma$, $\delta_j^{(\tau)}(p) = \delta_j^{(\tau')}(p) + \gamma$, $\delta_j^{(\tau)}(p + \rho) = \delta_j^{(\tau')}(p + \rho) - \gamma$, and $\delta_k^{(\tau)}(p) = \delta_k^{(\tau')}(p)$ for all $k \neq i, j$ and $i \leq j$, $W(\delta^{(\tau)}, \Omega) \geq W(\delta^{(\tau')}, \Omega)$.

Property 4 states that the more disadvantaged is the type, the more the change in social welfare will be sensitive to inequality of that tax burden among the individuals of that type. Thus, it introduces a diminishing sensitivity to horizontal inequity. The social evaluation of a tax-system increases more the more disadvantaged is the type within which the progressive transfer of income change takes place.

Property 3 and 4 together link vertical and horizontal equity, saying that horizontal equity is more important within worst-off types.

We are then left with the following classes of functions to measure the social welfare change due to a tax system.

- $\mathbf{W}_3$ is the class of social welfare change functions constructed as in (1) and with social weight functions satisfying Property 3;
- $\mathbf{W}_{1,3}$ is the class of social welfare change functions constructed as in (1) and with social weight functions satisfying Properties 1 and 3;
- $\mathbf{W}_{2,3,4}$ is the class of social welfare change functions constructed as in (1) and with social weight functions satisfying Properties 2, 3, and 4.

Before proceeding with the derivation of dominance condition, it is worth noticing that the ethical principles embedded into the families of social welfare change functions $\mathbf{W}_3$, $\mathbf{W}_{1,3}$ and $\mathbf{W}_{2,3,4}$ are expression of a rigorous interpretation of the opportunity egalitarian theory, according to which only the income differentials due to circumstances are to be reduced by the income tax, while the remaining inequalities are declared as not deserving any compensation and redistribution. Alternative families of social evaluation functions are proposed by Aaberge and Colombino (2012) and Roemer et al. (2003). Aaberge and Colombino (2012) propose social evaluation functions which combine opportunity egalitarianism and outcome egalitarianism, hence express inequality aversion both between and within types. Roemer et al. (2003), on the other hand, propose a social evaluation function which is similar to ours in reflecting inequality aversion only with respect to the circumstances-base inequalities; however, Roemer et al. (2003) adopt a function which expresses extreme inequality aversion, thereby obtaining maximin criteria: in their framework, only the individuals with the lowest endowment of circumstances do matter for the social judgments.

2.4 Results

We now turn to identify a range of conditions to be satisfied for evaluating the distributive impact of tax systems (tax reforms) in terms of opportunity egalitarianism, for the different families of SWCs described above. All proofs are gathered in Appendix A provided as a supplementary material.

Note that tax reform and tax system evaluations usually assume the same pre-reform or pre-tax distribution, hence in the propositions pre-tax and post-tax distributions as well as pre-reform and post-reform distributions are characterized by the same type partition. That is, the number of types and the population size of each type is the same in the pre-tax (pre-reform) and post-tax (post-reform) distribution.

Beginning with the SWC of the type $\mathbf{W}_3$ the following result holds.

Proposition 1 *Consider two alternative tax systems* τ_A *and* $\tau_B \in \mathbb{R}$ *and the resulting bivariate distributions* $(\delta^{(\tau_A)}\Omega)$, $(\delta^{(\tau_B)}\Omega) \in D$, $W(\delta^{(\tau_A)}, \Omega) \geq W(\delta^{(\tau_B)}, \Omega), \forall W \in \mathbf{W}_3$ *if and only if*

$$\sum_{i=1}^{k} q_i \delta_i^{(\tau_A)}(p) \geq \sum_{i=1}^{k} q_i \delta_i^{(\tau_B)}(p), \forall k = 1, ..., n, \forall p \in [0, 1] \tag{2}$$

The condition expressed in proposition 1 is a sequential inverse first order stochastic dominance. It has to be checked at each step of the sequential procedure, starting from the most disadvantaged type in the pre-tax distribution, then adding the second most disadvantaged, then the third, and so on. The condition to be satisfied at each stage is a first order dominance of the inverse distribution of income change generated by the tax system *A* over that generated by the tax system *B*. In order to compare two tax systems, a social planner endorsing preferences described by $\mathbf{W}_3$ would not only focus on the extent of tax-induced income change, but also on its vertical distributional impact, while it would be agnostic with respect to its horizontal distributional impact.

We now turn to the second class of SWC, that is $\mathbf{W}_{1,3}$.

Proposition 2 *Consider two alternative tax systems* τ_A *and* $\tau_B \in \mathbb{R}$ *and the resulting bivariate distributions* $(\delta^{(\tau_A)}\Omega)$, $(\delta^{(\tau_B)}\Omega) \in D$, $W(\delta^{(\tau_A)}, \Omega) \geq W(\delta^{(\tau_B)}, \Omega), \forall W \in \mathbf{W}_{1,3}$ *if and only if*

$$\sum_{i=1}^{k} q_i \mu_i^{(\tau_A)} \geq \sum_{i=1}^{k} q_i \mu_i^{(\tau_B)}, \forall k = 1, ..., n \tag{3}$$

where $\mu_i^{(\tau_A)} = \int_0^1 \delta_i^{(\tau_A)}(p) \, dp$ *and* $\mu_i^{(\tau_B)} = \int_0^1 \delta_i^{(\tau_B)}(p) \, dp$

Proposition 2 is a sequential dominance of the weighted average changes in types. That is, take the worst type in the pre-tax distribution, check that the average income change of the individuals in that type is no lower under tax system *A* than under tax system *B*; then add the second worst type and check for the same dominance; then add the third, and so on and repeat the check at every step. In this case, the dominance condition depends not only on the extent of the income change, but also on the incidence of taxes on the different types. According to this proposition, the final judgment on the comparison between two

tax systems will also depend on its vertical (opportunity) distributional impact, while being neutral with respect to its horizontal distributional impact.[8]

We then turn to the last family of SWC, that is $\mathbf{W}_{2,3,4}$.

Proposition 3 *Consider two alternative tax systems τ_A and $\tau_B \in \mathbb{R}$ and the resulting bivariate distributions $(\delta^{(\tau_A)}\Omega)$, $(\delta^{(\tau_B)}\Omega) \in D$, $W(\delta^{(\tau_A)}, \Omega) \geq W(\delta^{(\tau_B)}, \Omega)$, $\forall W \in \mathbf{W}_{2,3,4}$ if and only if*

$$\sum_{i=1}^{k} q_i \int_0^p \delta_i^{(\tau_A)}(s)\,ds \geq \sum_{i=1}^{k} q_i \int_0^p \delta_i^{(\tau_B)}(s)\,ds, \forall k = 1, ..., n, \forall p \in [0, 1]. \qquad (4)$$

The condition characterized in Proposition 3 is a sequential second order inverse stochastic dominance, to be checked starting from the poorest type in the pre-tax distribution, then adding the second, then the third, and so on. The condition to be satisfied at each stage is that the cumulated sum of the individual income change, within each type, be no lower under tax A than under tax B.

A point is in order here. In the case considered in Proposition 2, that is the case in which we compare tax systems imposed on the same pre-tax distribution, comparing the income changes induced by the two fiscal systems is equivalent to compare the respective post-tax income distributions, where types are ordered according to their rank in the pre-tax distribution. More precisely, the condition expressed in terms of income changes can equivalently be expressed in terms of post-tax incomes: that is, $[\sum_{i=1}^{k} q_i \mu_i^{(\tau_A)} \geq \sum_{i=1}^{k} q_i \mu_i^{(\tau_B)}$, $\forall k = 1, ..., n]$ is equivalent to $[\sum_{i=1}^{k} q_i \mu(y_{\tau_A}) \geq \sum_{i=1}^{k} q_i \mu_i(y_{\tau_B})$, $\forall k = 1, ..., n]$, where, with obvious notation, $\mu_i(y_{\tau_A})$ represents the average income of type i after tax τ_A.

Analogous equivalences, however, do not hold for the cases of Proposition 1 and Proposition 3, since within each type individuals are ordered anonymously on the basis of their income change, hence the dominance based on income changes is not equivalent to the dominance based on post tax incomes.

2.5 Aggregate indexes

In this section we introduce two families of aggregate measures that, on the base of the dominance conditions discussed above, allow for the assessment of the opportunity-distributional impact of a tax system or of a tax reform, namely opportunity-sensitive vertical and horizontal incidence. These indexes can provide information concerning the specific features of the tax systems compared that are complementary to those obtained from the application of the dominance conditions derived in the previous section.

In fact, as advocated in the literature,[9] it is interesting to isolate and identify the pure opportunity regressivity/progressivity feature of a tax system from other features. Therefore, the first family of measures we wish to propose is aimed at disentangling and capturing the *opportunity vertical equity* of a tax regime, assuming neutrality with respect to horizontal

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[8]The condition characterized in Proposition 2 may be also interpreted in terms of Type Opportunity Growth Incidence Curve (OGIC) dominance introduced by Peragine et al. (2014). In fact, the dominance condition contained in Proposition 2 is equivalent to the cumulated type OGIC dominance. Therefore, this proposition provides a normative justification for the use of the type OGIC in ranking two tax regimes. See also Palmisano and Peragine (2014).

[9]See, for instance, Jenkins and Van Kerm (2016), Palmisano and Van de gaer (2016), and Van de gaer and Palmisano (2021).

equity. These measures can be used to evaluate different regimes on the base of their ability to favor the income change of the most disadvantaged individuals as compared to those most advantaged. A natural way of measuring this progressivity in an opportunity egalitarian perspective is represented by the family of indexes that we denote by OVE (from *Opportunity Vertical Equity*).

$$OVE = \frac{\sum_{i=1}^{n} q_i v_i \mu_i^{(\tau)}}{\sum_{i=1}^{n} q_i v_i} - \bar{W}^*. \tag{5}$$

Here $\bar{W}^* = \sum_{i=1}^{n} q_i \mu_i^{(\tau)}$ is the overall income change and $\mu_i^{(\tau)} = \int_0^1 \delta_i^{(\tau)}(p)dp$ is the average income change experienced by individuals in the type $i = 1, ..., n$. Equation (5) represents a general family of aggregate measures and specific scalar measures can be obtained from it by simply choosing the proper functional form for the weighting function v_i, consistent with the requirement that $v_i \geq v_{i+1} \geq 0$. Hence, OVE represents a measure of the incidence of a tax-system in alleviating (worsening) economic disparities among individuals of different types, either in absolute (if $\delta_i^{(\tau)}(p)$ refers to absolute income change) or in relative (if $\delta_i^{(\tau)}(p)$ refers to relative income change) terms. This index is equal to 0 if every type undergoes the same income change; it is positive in case of (absolute or relative) opportunity-progressivity and negative in case of (absolute or relative) opportunity regressivity. A particularly interesting interpretation of (5) is obtained when $\delta_i^{(\tau)}(p)$ is expressed in relative terms, which would correspond to the income change every type would experience in case of proportional taxation.

The first component of OVE satisfies all properties discussed above with the exception of Property 2 (*Opportunity Horizontal Equity*) and 4 (*Increasing Opportunity Horizontal Equity*). Taken alone, this component could be used to complement the dominance condition rationalized in Proposition 2. Indeed, in case of equal benchmark W^* across the distributions compared, when the application of the dominance conditions provided by Proposition 2 allows to generate an unambiguous ranking, this ranking is equivalent to the one obtained from the computation of OVE. In case of different benchmark distributions, the ranking provided by the index OVE could differ from that arising by the application of Proposition 2. This is because, by subtracting the average welfare change, the index is normalizing for the efficiency aspect and focusing specifically on opportunity progressivity issues (Property 3). In fact, the first component of OVE is sensitive to both the distribution of income change among the individuals and the mean of individuals' income change values: doubling all individual change values does not affect the distribution of income change, but doubles the value of W^*.

The second family of measures we propose aims at isolating and quantifying the *opportunity horizontal inequality* component of a tax regime, assuming neutrality with respect to vertical inequality. This family is given by the following expression:

$$OHI = \bar{W}^* - \sum_{i=1}^{n} q_i \int_0^1 v(p) \delta_i^{(\tau)}(p)dp. \tag{6}$$

recalling that $v(p)$ satisfies the following normalization condition: $\int_0^1 v(p)dp = 1$. In this case $\bar{W}^* = \sum_{i=1}^{n} q_i \mu_i^{(\tau)}$ is interpreted differently from (5): it represents the overall income change that would have resulted in the presence of a horizontal equal taxation. This index is equal to 0 in case of horizontal equity, which is the case of a within type proportional tax when $\delta^{(\tau)}$ is measured in relative terms and if the concept of relative inequality is considered. It is positive if the tax reform is affected by horizontal inequality. Also in this case,

specific measures of horizontal inequality can be obtained by specifying the functional form of the social weight $v(p)$.

This measure does not satisfy Property 1, 3, and 4 since it deliberately neglects opportunity vertical considerations. Moreover, the informational content generate by this index is relevant given that none of the above dominance conditions focuses only and specifically on opportunity horizontal equity. The ranking provided by index OHI could differ from that arising by the application of Proposition 3, this is because, by subtracting for the average welfare, the index is putting aside efficiency concern and only focusing on horizontal equity issues (Property 2).

It is worth noticing that, with the exception of Peragine (2004), the existing literature does not provide other tools that are specifically designed to evaluate the distributional implications of a fiscal regime from the EOp perspective. However, while the indexes of opportunity redistribution and horizontal inequity introduced by Peragine (2004) are informative only when we compare tax systems applied on the same pre-tax distribution, our indexes do not suffer from this restriction.[10] In fact, Peragine (2004)'s framework requires information about the density distribution of the baseline income distribution, our framework does not require such information. Our framework, instead, requires information about the inverse of the cumulative distribution function of income changes within each type.

3 Income tax in Romania: a reform's microsimulation

3.1 Personal income tax in Romania

Before 2005 a progressive income taxation system was in place in Romania. It was based on a tax allowance (210 Romanian Lei, increasing by 50% for each additional dependent) and five tax rates ranging from 18% to 40%. The personal income tax in Romania was reformed in 2005 with the main objectives of stimulating economic growth and reducing tax evasion and avoidance. Today the personal income tax is based on a 16% flat tax rate.[11] All individuals that earn non exempted income pay the personal income tax. The tax base is obtained subtracting a tax allowance and other minor deductions from gross income minus social contributions.[12]

The introduction of a flat tax rate was associated with good performance in the short run in terms of tax revenues mainly due to an increase in the VAT revenue. However, the medium run benefit in terms of revenue is less clear (Daianu et al. 2012) and the expected positive effects in terms of employment and growth have been rather weak according to what is suggested by Schiau and Moga (2009). The redistributive effects of the reform have

[10] See Roemer et al. (2003) and Aaberge and Colombino (2012) for different criteria - based on the optimal taxation theory - that can be used to evaluate the distributional implications of a fiscal regime from the EOp perspective.

[11] A complete description of the Romanian fiscal system and of the characteristics simulated in EUROMOD can be found in Stroe et al. (2014). We consider only the personal income tax which is the only policy involved in the proposed reform.

[12] All incomes are expressed in monthly 2012 Lei. For pensioners the tax allowance has a maximum of 1000 Lei per month. Employees who have a monthly gross wage under or equal to 3000 Lei gets a tax allowance (ta) of 250 Lei increased by 100 Lei fro each dependent (maximum tax allowance 650). The deduction is applied only on wages and only at the main job or activity. If the gross wage is between 1001 and 3000 Lei, the personal deduction is decreasing with income and its amount is established by applying the following formula: $ta \times \left(1 - \frac{(wage-1000)}{2000}\right)$.

been clearly regressive, with the top quantiles gaining disproportionally more than poorer households: according to Eurostat inequality in Romania increased after the reform and was the highest in EU27 in 2007. Not surprisingly in Voinea and Mihaescu (2009) have suggested: *"[...] to replace the flat tax by a progressive tax, with two or three brackets, with large differences between them."* Voinea and Mihaescu (2009, p. 39). Although the main reason to reform the tax is redistributive in terms of income, we consider interesting to evaluate the effect of such a reform also in the space of opportunities. Thus, in the rest of the paper, we take the fiscal system in place in Romania in 2012 as the baseline scenario and we assess the distributive effect of a fiscal reform inspired by Voinea and Mihaescu (2009)' proposal, in the space of opportunity.

The reform proposal is based on four income brackets obtained updating those of the tax system in place before 2005. The tax rates are: 10% for taxable income up to 400 Lei, 15% for additional income up to 900 Lei and below 1,500 Lei, 20% above 1,500 and below 2200 Lei, and 30% above this threshold. The reform guarantees the same income tax revenue for the state and the majority of income earners gain from it: the amount due is reduced for the bottom 80% of the tax payers (about 19 Lei less).

3.2 Data and methods

The analysis is developed through EUROMOD microsimulation, using the Romanian Survey on Income and Living Conditions, Romanian implementation of the European Union Statistics on Income and Living Conditions (EU-SILC) collected in 2011. Unfortunately, EUROMOD is not updated each time an EU-SILC wave is released. For a few waves, including 2011, the microsimulation model is not updated. For this reason, in order to use the 2011 wave, we have updated the original 2011 data for Romania. This implies the updating, cleaning, and imputation necessary to meet all EUROMOD's requirements (see Sutherland and Figari (2013) for the net-gross conversion procedure in EUROMOD).

After that we have used EUROMOD version G1.0 to simulate two income distributions: *i)* the Romanian income distribution in 2012 (fiscal system in place in 2012), *ii)* and the "reform" scenario: a simulated hypothetical distribution for 2012 in which the flat rate personal income tax is replaced with a progressive tax based on four tax rates: 10%, 15%, 20%, 30%.

The original EU-SILC sample is representative of the Romanian population and has been obtained applying a two-stage probability sampling of housing units. Income information refers to incomes earned in 2010 but are expressed in 2012 household equivalized income. Where the household is defined as all persons sharing the same dwelling and equivalent income is obtained dividing total income by the square root of the number of the household components.

We restrict the analysis to working-age individuals. As reported above, in order to evaluate the effect of the reform in terms of equality of opportunity, we use the special module on Intergenerational Transmission of Disadvantages, containing information on socioeconomic background characteristics that can be used to define circumstances. The module does not involve the entire sample but includes only the sub-sample of individuals aged between 25 and 65.

Moreover, we further restrict the sample excluding individuals with negative disposable household incomes. Our sample is therefore made of all individuals between 25 and 65 reporting a non-negative disposable income and having non-missing information about parental occupation and education. In case one or more adults in the household do not satisfy these criteria we consider only household members that do. Although these restrictions

are necessary to be able to carry out the dominance tests that interest us, it should be emphasized that they have the effect of reducing our ability to generalize the conclusions of our exercise to the entire Romanian population.

We use two circumstance variables to define the types: parental education and parental occupation when the respondent was around 14 years old.[13] Parental education is defined as the highest level attained by either of the parents and is categorized in three groups: *low education* when at most only one of the two parents attained elementary education, *medium education* when both parents had elementary education, *high education* when at least one parent had secondary or higher education. Parental occupation status is based on the highest ISCO 88 occupation status of the parents, grouped into four categories: *highly skilled non-manual* (ISCO between 11 and 34), *lower-skill non-manual* (41-52), *skilled manual* (61-83), and *elementary occupation* (91-93). The total population is thus partitioned into 12 types. This number is the result of a trade-off between the detail of information and the statistical reliability of the estimates. We consider only 12 types in order to have sufficient observations within each type to obtain statistically reliable estimates of our measures. Each type is then partitioned into 4 quantiles according to the income change experienced from before to after tax. Again, 4 is the maximum number of quantiles that allows us to have groups with a sufficient sample size for the bootstrapping procedure.

Standard errors and 95% nonparametric percentile confidence intervals for all our estimates are obtained with 2,000 bootstrap replicates of each statistic (Davison and Hinkley 1997).

Table 1 reports the list of types together with their population shares, the average of equivalent gross incomes and the average of net equivalent incomes in both the baseline and the reformed scenario. Types are ranked according to their average gross equivalent income. Rankings seem to be driven by the level of parental education.[14] In particular, all types with high parental education are the highest-ranked before and after tax, in both the actual tax system and the simulated reform.

3.3 Redistributive effects

We start our analysis by providing an assessment of the distributional effects of the reform according to standard egalitarian perspective, hence only focusing on the household disposable equivalent income distribution and considering, as already explained above, the whole and representative population. Table 2 reports the Gini and Mean Logarithmic Deviation (MLD) indices of income inequality and the average equivalent income of three distributions: the gross income distribution, the net income distribution with the fiscal system in force, the net income distribution with the reform. Both systems appear to be progressive: inequality from gross to net income always decreases. However, the reform is clearly more redistributive than the fiscal system in place in 2012, in particular the difference between the Gini index of the post-tax income distribution with the actual tax system and the Gini index of the of the post-reform distribution is statistically significant at the 95% level. The

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[13]The choice of these circumstances is consistent with the existing evidence on inequality of opportunity in transition economies. For instance, the European Bank for Reconstruction and Development (2017) Transition Report as well as Brunori et al. (2018), in their analyses of inequality of opportunity in the transition countries based on a rich set of circumstances, show that in Romania parental education is likely to be the single most important circumstance to predict income later in life.

[14]See Machin and Vignoles (2004) on the connections between education, income and the extent of intergenerational mobility in economic status and Andren et al. (2005) on the relevance of education in Romania.

Table 1 Descriptive statistics

type	par. occupation	par. educ.	size	pop. share	μ_{2012}^{GROSS}	μ_{2012}^{NET}	μ_{REFORM}^{NET}
1	Skilled manual	Low	94	0.0111	985.93	801.51	808.55
2	Highly skilled non-manual	Low	882	0.11065	1113.82	899.85	905.07
3	Elementary occupation	Medium	515	0.0604	1240.30	983.22	988.65
4	Skilled manual	Medium	2230	0.2610	1244.47	986.84	994.65
5	Highly skilled non-manual	Medium	2536	0.2844	1283.98	1013.17	1019.09
6	Elementary occupation	Low	553	0.0536	1311.77	1060.34	1056.40
7	Lower skilled non-manual	Low	12	0.0013	1324.55	1147.68	1152.22
8	Lower skilled non-manual	Medium	321	0.0415	1568.19	1226.38	1225.78
9	Skilled manual	High	156	0.0228	1827.85	1406.58	1414.63
10	Lower skilled non-manual	High	464	0.0652	2027.40	1557.00	1543.32
11	Elementary occupation	High	136	0.0209	2307.51	1699.40	1641.52
12	Highly skilled non-manual	High	512	0.0713	2355.92	1756.47	1713.32

Note: μ_{2012}^{GROSS} denotes the average gross income in 2012; μ_{2012}^{NETS} denotes the average net income in 2012 with the actual tax system; μ_{2012}^{REFORM} denotes the average net income in 2012 if the tax reform were put into place. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0

Table 2 Distributive effect of the tax system in force and the hypothetical reform

|	Gross 2012	Net 2012	Net Reform
Gini	0.3712 (0.3674, 0.3749)	0.3247 (0.3211, 0.3281)	0.3168 (0.3135, 0.3199)
MLD	0.2748 (0.2675, 0.2825)	0.1928 (0.1882, 0.1968)	0.1847 (0.1808, 0.1896)
avg. eq. income	1,265.71 (1252.32, 1279.40)	1,030.32 (1021.38, 1039.47)	1,030.98 (1022.30, 1040.02)

Note: 'Gross 2012' denotes the distribution of gross incomes in 2012; 'Net 2012' denotes the distribution of net incomes in 2012 with the actual tax system; 'Net Reform' denotes the distribution of net incomes 2012 if the tax reform were put into place; 'avg. eq. income' indicates to the average of equivalent incomes for each of the three distributions considered. Confidence intervals in parenthesis. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0

disaggregated effect of moving from the baseline scenario to the reformed fiscal system is represented by the difference between the Growth Incidence Curve (GIC) introduced by Ravallion and Chen (2003), generated by the actual fiscal regime, and the GIC that would be generated by the reform and is reported in Fig. 1. The GIC plots the quantile specific relative income change from the pre-tax to the post-tax distribution. Given that apart from the personal income tax all the other taxes and transfers are unchanged, the change in equivalent disposable income under the two scenarios is low and significantly different from zero only for the very richest quantiles. The absence of dominance is clearly due to the fact that we are comparing the actual system with an equal-levy reform. However, because of the progressivity of the reform, the point estimates of the quantile specific changes are positive for the bottom 80% of the distribution and monotonically decreasing with the rank.

We now shift our focus to the space of opportunities. Before discussing our results, let us clarify two methodological choices. First, $\delta^{2012}(p)$ refers to the change from gross to net income with the tax system in force in 2012, while $\delta^R(p)$ refers to the change from gross to net income with the reform. Second, the analysis is performed by considering both absolute and relative income changes.

We start with Proposition 1, which incorporates aversion to inequality between types but remains agnostic with respect to inequality within types. This proposition must be checked sequentially. First, within each type, we order individuals increasingly on the base of the income change experienced. We then divide each type distribution into four quantiles $\pi = (.25, 0.5, 0.75, 1)$. We estimate the following:

$$\sum_{i=1}^{k} q_i \delta_i^{(R)}(\pi) - \sum_{i=1}^{k} q_i \delta_i^{(2012)}(\pi) \geq 0, \forall k = 1, ..., 12, \forall \pi \in [0, 1]$$
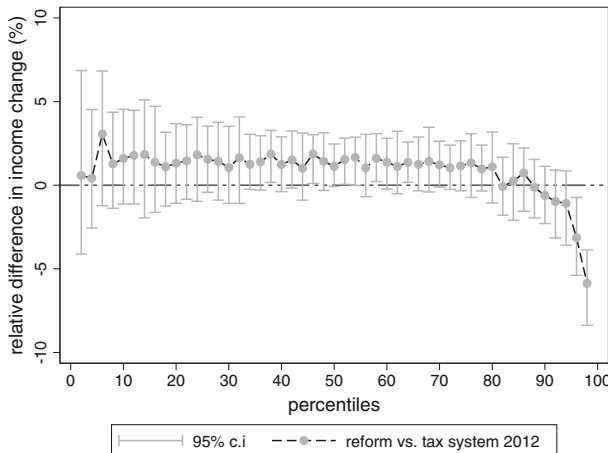
Fig. 1 Distributive effect of the reform, egalitarian perspective

Note: Difference between the relative income change generated by the actual tax system with respect to the gross income distribution and the relative income change generated by the reform with respect to the gross income distribution. The difference is computed for each percentile of the gross income distribution. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0

The first step consists of checking the dominance of the income change of each π quantile for the individuals in the poorest type 1 between pre-tax and post-tax income generated under the reform, with respect to the same change generated by the system in place. The second steps, instead, requires to sum, quantile by quantile the income change of type 1 and 2 and, again, to check the dominance between the tax system hypothesized and that in force, weighted by the respective type population share, at each quantile π. We repeat the same procedure for the ten remaining steps, by adding less poor types at each step, up to type 12. Figure 2 reports the result of this check at each quantile and type, for both the absolute (left panel) and relative (right panel) change. Proposition 1 is satisfied if we find a statistically significant positive value for this difference at all steps. This is again not the case, in fact, as we can observe from the figure, at each sequential aggregation, the dominance is positive for all except the poorest quantile of income change. This implies that, with this kind of reform, a social planner would tax more the most taxed individuals within each type, as compared to the baseline scenario, while he would tax less the three least taxed individuals.[15] Hence, although most of the distribution seems to benefit from the reform, we cannot safely rank the two tax systems when the social planner is in favor of opportunity vertical equity but agnostic with respect to opportunity horizontal equity.

We now illustrate the result of this normative comparison by imposing more restrictions on the social evaluation function. That is we assume that a social planner is averse to inequality between type but neutral with respect to inequality within type. Hence we apply the test proposed in Proposition 2, which is also checked sequentially, starting from the worst type up to the richest type. We estimate the following:

$$\sum_{i=1}^{k} q_i \mu_i^{(R)} - \sum_{i=1}^{k} q_i \mu_i^{(2012)} \geq 0, \forall k = 1, ..., 12$$

That is, at the first step we start form type 1 and we check the dominance of the average change from pre-tax to post-tax income, experienced by its individuals and weighted by its population share under the reform, with respect to the same change experienced under the tax system in force. At the second step, we add the average change experienced by the individuals of type 2, weighted by the population share of this type, and we check again the positivity of this dominance. We repeat the same procedure for the remaining 10 steps. The test is represented in Fig. 3, which plots against each type the cumulated weighted average income change, both in absolute (left panel) and relative (right panel) terms. Proposition 2 is satisfied if we find a statistically significant positive value for this difference at all steps. Note that, the test in Proposition 2 is a sequential test for the difference in partial means of income change, weighted by the population share of the first i types.[16] This test finally allows us to rank the two tax systems: the reform dominates the actual Rumanian tax-regime according to the family of social evaluation functions that are in favor of opportunity vertical equity, but neutral to opportunity horizontal equity. In fact, Fig. 3 shows that the coordinates of the curves are always positive.

Last, we provide a comparison between the two tax systems when horizontal equity is also a matter of concern for the social planner. Thus, we apply the test presented in

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[15]The 95% bootstrapped confidence intervals for this test are reported in Tables 4 and 5 of Appendix B. The bootstrap procedure is stratified by types. This means that every sample contains exactly the same proportion of observations in each type. This implies a lower than usual heterogeneity of bootstrap samples and may implies a higher risk of type 1 error and a lower risk of a type 2 error.

[16]The 95% bootstrapped confidence intervals for this test are reported in Tables 6 and 7 of Appendix B.
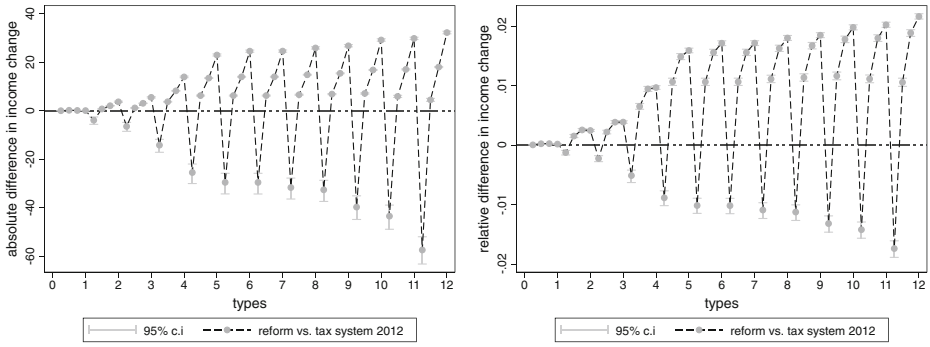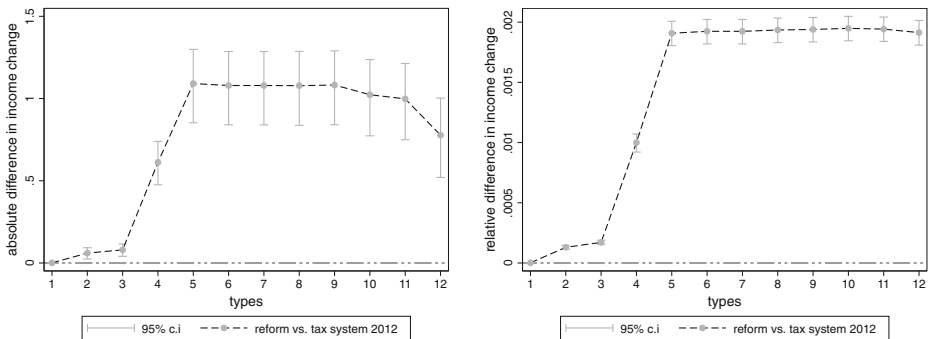
Fig. 2 Distributive effect of the reform, opportunity egalitarian perspective - Proposition 1
Note: Test of Proposition 1 for absolute income change (left) and relative income change (right) generated by the tax system. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0

Proposition 3. As done in Proposition 1, we partition each the type-specific distribution of income change into four quantiles of income change: $\pi = (0.25, 0.5, 0.75, 1)$. We then estimate the following:

$$\sum_{i=1}^{k} q_i \int_0^{\pi} \delta_i^{(R)}(q)\, dq - \sum_{i=1}^{k} q_i \int_0^{\pi} \delta_i^{(2012)}(q)\, dq \geq 0, \forall k = 1, ..., 12, \forall p \in [0, 1]. \quad (7)$$

We start from the poorest type $i = 1$ and, at each cumulated quantile $\pi = 0.25, 0.5, 0.75, 1$, we have to check the dominance of the individual income change, weighted by the population share of type 1, generated by the reform with respect to the change generated by the actual system. The second steps, instead, requires to sum, quantile by quantile, the income change of type 1 and 2 and, again, to check the positivity of this dominance, weighted by the respective type population share, at each cumulated quantile π. We repeat the same procedure for the ten remaining steps, by adding the less poor type at each step, up to type 12.

Fig. 3 Distributive effect of the reform, opportunity egalitarian perspective - Proposition 2
Note: Test of Proposition 2 for absolute income change (left) and relative income change (right) generated by the tax system. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0
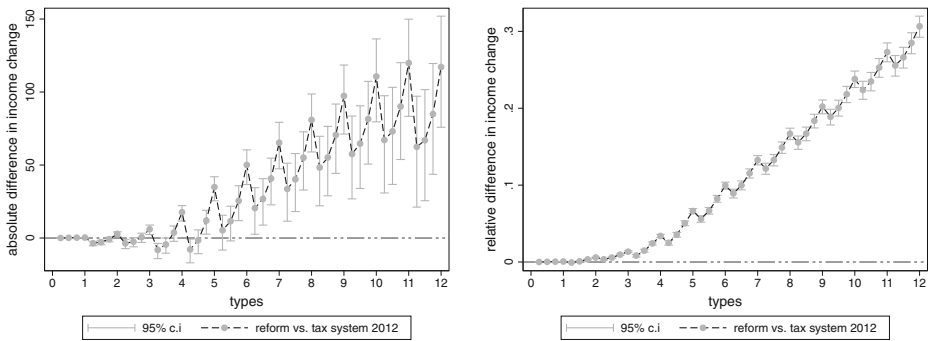
Fig. 4 Distributive effect of the reform, opportunity egalitarian perspective - Proposition 3
Note: Test of Proposition 3 for absolute income change (left) and relative income change (right) generated by the tax system. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0

Figure 4 reports the result of this check at each cumulated quantile and type, for both the absolute (left panel) and relative (right panel) change. Proposition 3 is satisfied if we find a statistically significant positive value for this difference at all steps. Unfortunately, when the social planner endorses concerns for both vertical and horizontal equity, it is not possible to establish a clear dominance between the fiscal regime in force and the tax reform hypothesized. As it is possible to grasp from the figure, this difference is negative for some of the quantiles of income change within the poorest types.[17]

In sum, although in most cases the positivity of the cumulated income change seems to support the power of the reform against the actual tax system, we cannot safely rank the two tax systems when the social planner is in favor of both opportunity vertical and horizontal equity.

We conclude our analysis with the assessment of the reform and the comparison with respect to the system in place, by computing the aggregate indexes described in Section 2.4. The value of these indexes, for (R) and (2012) and their difference are reported in Table 3, both for absolute and relative income changes. The first index we consider is OVE, which captures the vertical equity of a tax system in the space of opportunities.[18] It turns out that OVE is positive for (R) and (2012), implying that both systems are alleviating the disparities between the socio-economic groups we are considering in these illustrations. However, the progressivity of the reform tends to be higher than that of the actual system in place. This result supports the evidence that the reform is more desirable than the actual system in place, when the social planner is averse to inequality between types, which emerged from the test of proposition 2. The second index we consider is OHI, which captures the horizontal equity of a tax reform in the space of opportunity.[19] The positivity of OHI for the two systems compared suggests that they both contain a certain degree of horizontal inequity. However, the higher value of OHI for (2012) implies that the reform is again more socially desirable than the fiscal system in force, when horizontal inequality matters.

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[17]The bootstrapped 95% confidence intervals of the test are reported in Tables 8 and 9 of Appendix B.

[18]We use the following wights: $v_i = \frac{i}{n(n+1)\frac{1}{2}}$.

[19]We use the following weights: $v(p) = \frac{2p}{m(m+1)}$, where m is the number of quantiles.

Table 3 Aggregate indexes, opportunity egalitarian perspective

	2012	0.95 c.i.	0.95 c.i.	REFORM	0.95 c.i.	0.95 c.i.	difference	0.95 c.i.	0.95 c.i.
OVE (absolute income)	40.1677	36.1126	44.0852	45.1284	40.1442	49.7587	4.9607	4.0487	5.8528
OVE (relative income)	0.0119	0.0098	0.0139	0.0139	0.0117	0.0160	0.0020	0.0017	0.0022
OHI (absolute income)	116.3856	110.7707	122.8405	122.6192	115.5343	130.7570	−6.2336	−8.2003	−4.3324
OHI (relative income)	0.0655	0.0635	0.0674	0.0677	0.0655	0.0697	−0.0021	−0.0028	−0.0015

Note: OVE (relative) and OVE (absolute) refer to the OVE index introduced in Section 2.4, computed considering respectively the relative income changes and the absolute income changes generated by the tax system. OHI (relative) and OHI (absolute) refer to the OHI index introduced in Section 2.4, computed considering respectively the relative income changes and the absolute income changes generated by the tax system. **Source**: Authors' elaboration based on EUSILC 2011 & EUROMOD G1.0

4 Conclusions

In this paper, we have investigated the possibility of developing a model for the normative assessment of tax systems and reforms, that is consistent with the emerging theory on Equality of Opportunity. In so doing, we have argued that the opportunity egalitarian theory may provide an alternative key to reinterpret the definition of a 'just taxation'. To this aim, we have proposed a reinterpretation of the classical vertical and horizontal equity principles, under the light of the opportunity egalitarian principles. In particular, vertical equity has been formulated by looking at individuals characterized by different circumstances, hence having access to different set of opportunities. Whereas horizontal equity has been formulated with reference to individuals characterized by same circumstances. We have framed these reinterpretations by means of an axiomatic procedure and, through it, we have obtained a set of dominance conditions that can be used to rank tax regimes or to compare the effects of different tax reforms. On the base of these dominance criteria, we have then suggested two aggregated indexes to measure the extent of the opportunity vertical and horizontal equity.

We have shown the applied relevance of our framework by illustrating empirically the effect of a hypothetical tax reform in Romania. The tax reform simulated - inspired by the current debate about taxation in that country - is a revenue-neutral change in the current tax rates and based on four income brackets, with marginal rates ranging from 15% to 30%. The implementation of a similar reform could be challenging since it is a zero-sum game in which the least advantaged gain but the wealthier part of the population loses. A similar reform proposal has been previously justified on the ground of inequality reduction (Voinea and Mihaescu 2009). A government that is sufficiently adverse to inequality would certainly find this tax reform proposal convincing. By contrast, the introduction of the flat tax in 2005 was justified on the efficiency ground: simpler and lower taxes were introduced to stimulate growth, which in the medium run should have increased also tax revenue. Although the empirical literature has questioned the efficiency gain of the 2005 reform (Daianu et al. 2012; Todor 2018), the implementation of the reform tested in this paper could face the typical equity-efficiency dilemma, in which moving to a more redistributive fiscal system may bring an efficiency cost. We contribute to this discussion by showing that a more progressive tax system dominates the status quo even when the policy maker is not adverse to inequality, provided that it is sufficiently adverse to inequality due to factors over which the individuals have no control (measured as between-type inequality). This is an important argument in favour of a more progressive taxation in Romania as, while higher levels of inequality - and hence a less progressive taxation - can in principle be justified on the efficiency ground, opportunity inequalities are typically considered a source of inefficiency and slower growth (Marrero and Rodríguez 2013; Ferreira et al. 2018).

The ethical principles embedded into our proposed families of social evaluation functions, and the resulting dominance conditions, are expression of a rigorous interpretation of the opportunity egalitarian theory, according to which only the income inequalities due to circumstances are to be reduced by the income tax, while the remaining inequalities, falling into the domain of the reward principle, are declared as not deserving any compensation and redistribution.

Although the principles inspiring our evaluation criteria are not new and in fact are rooted in the equality of opportunity literature, our paper is the first attempt to provide a measurement framework for the evaluation of the fairness of tax systems and reforms according to the EOp ideal.

An alternative, more egalitarian approach, could be proposed by using social evaluation functions which express ethical concern for both the circumstances-based inequalities and for the residual effort-based inequalities (see, along these lines, Aaberge and Colombino (2012), whose exercise is however framed into an optimal taxation model). It would be interesting to obtain the distributional conditions implied by such families of social evaluation functions and to explore the relevant new empirical results. We leave this extension for future investigation. A further extension of our analysis could be developed by using a richer microsimulation model: following a standard practice in the analyses of dominance conditions of tax systems and tax reforms, we have used a static model, where the behavioral effect of the different tax treatments are explicitly ignored. However, exploring the consequences of using richer, behavioral models, as those typically employed in exercises of applied optimal taxation, is an interesting and challenging area for future research.

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