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Fairness in education: The Italian university before and after the reform*

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Abstract

In 2001 the Italian tertiary education system embarked in a broad process of reform. The main novelty brought by the reform was a reduction of the length of study to get a first level degree together with the introduction of a 2-years, second level, master degree. This paper aims at studying the effects of the reform in terms of fairness in educational opportunity. In order to do so we first define fairness criteria following a well-developed responsibility sensitive egalitarian literature, we then discuss existing inequality of opportunity measures consistent with these criteria, we show their relationship, and we adapt them to the educational framework. We finally employ this set of measures to show the evolution of fairness in the access to university in Italy before and after the reform.

Keywords: Equality of opportunity, higher education
JEL Classification: D31, D63, C14, I2

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1 Introduction

Equality of opportunity (EOp hereafter) is a central theme in the political agenda of many communities and it is often advocated to justify public intervention in an array of policy areas. However the meaning of EOp remains vague and this may explain part of its popularity. Different authors have interpreted EOp in very diverse ways, ranging from non discrimination to egalitarianism. In the last two decades a number of authors have shown that the possibility to interpret EOp in very distinct ways stems from the dual nature of the EOp principle. EOp is in fact the result of the union of two principles, compensation and responsibility, that are partly compatible and partly conflicting. Fleurbaey (1994, 2008) , Fleurbaey and Maniquet (2003), have explicitly discussed this tension and have proposed fairness criteria that balance between the two principles. In what follow we will endorse their approach to conceptualize different definitions of EOp in education. Equality of educational opportunity (EEOp hereafter) is not easily defined. A number of additional issues challenge such a definition: given that education is the main means to create opportunities for economic and social success should EOp require equal educational outcome instead of equal opportunity in education? Is it meaningful to apply a responsibility principle to children and young adults? Should an educational system reinforce differences in talent or instead compensate for them?

We discuss all these issues in section 2, where, building on the existing literature on fairness and opportunity inequality, we propose our definitions of EEOp. In the same section we make our proposal operational: we introduce a model to measure inequality of educational opportunity (IEOp hereafter). In this model the individual outcome is determined by the joint effect of circumstances beyond individual control, characteristics for which the individuals are held responsible (called effort), and a random factor. In this framework we adapt to the education context four IOp measures that have been already proposed in the literature: *direct unfairness* and *fairness gap*, proposed by Fleurbaey and Schokkaert (2009) within the health context, and $ex-ante$ and $ex-post$ proposed by Peragine (2002) and Checchi and Peragine (2009) within the income inequality context. Moreover, we discuss the relationship among these measures and underline the different ethical principles they embody.

In section 3 our measures are used to evaluate the effect of the recent university reform in Italy. In 2001 the Italian university system embarked in a broad process of reform. The reform was proposed as a solution for a number of problems afflicting the Italian tertiary education sector, among them the fact that enrollment was highly correlated with socioeconomic background. To evaluate wether the reform succeed in improving EEOp we estimate our model of access using four waves of the Istat (Italian Nationa Statistical Office) database on college graduates career. These data contain a wide range of information about the students performance at school and their activity after graduation. We partition relevant variables in circumstances and responsibility characteristics. We then measure unfairness in access to university in two years before the reform (1995, 1998) and two years after (2001, 2004) for all possible variants of our measures. Section 4 presents our results. We obtain an unambiguous reduction of IEOp after the reform which proves to be robust to all measures specifications we adopted. Section 5 concludes.

2 Fairness as equality of educational opportunity

Equality of educational opportunity (EEOp, hereafter) is a widely agreed principle, almost universally considered to be a funding principle of education policy. EEOp principle is not controversial because it merges two powerful ideas: that all young individuals should have equal chance to succeed in life and that more hard working students should emerge in the education competition. Agreement about EEOp principle derives also from its vagueness. Different authors have proposed a number of interpretations ranging from securing the absence of legal discriminatory barriers to access education to equality of educational outcomes. In this section we briefly review the most influential definitions of EEOp, we present a simple model of access to education, and we propose four measure of IEOp.

2.1 Defining EEOp: theoretical framework

The libertarian approach represents the most restrictive interpretation of the EEOp meaning. According to educational libertarians the only legitimate rights are negative, and the state is never allowed to redistribute resources between individuals without their consent (Fleurbaey, 2007). Therefore, as claimed by Friedman (1962), public intervention in education may be only justified in order to correct externalities or ensure a minimum education level[1].

At the opposite extreme there is a strand of the literature that interprets EEOp as equality of educational outcomes. This interpretation focuses on the role of education as an instrumental good: skills acquired in school and university produce income opportunities in the future. Consequently if fairness means equality of opportunity then the source of opportunity should be equalized across all individuals (Howe, 1989).

In between these two extreme perspectives a number of EEOp interpretations have been proposed. The right to "adequate education" has been claimed by some authors (Gutmann, 1987; Curren, 1995). Others propose instead a meritocratic interpretation of EEOp. In this latter perspective education resources should be distributed to those who can make the most use of them, and therefore redistribution should reward the joint effect of talent and effort (Brighouse, 2009).

Roemer (1993, 1998), following a robust philosophical literature[2], argues that to achieve equality of opportunity an education system must neutralize the effects of circumstances on the education attainments and let unaltered the effects of choices; that is it must make all individuals able to freely chose from the same set of possible education attainments. This EEOp definition overlaps to a large extent with what Fleurbaey (2008) calls fairness in a responsibility sensitive egalitarian perspective. As underlined by

[1]These points are agreed by all EEOp declinations.

[2]Dworkin (1981a,b); Arneson (1989); Cohen (1989).

Fleurbaey this definition is based on two distinct principles: compensation and reward[3]. Compensation prescribes to remove inequality in education level due to circumstances beyond individual control, reward to implement a policy neutral with respect to differences due to choices. In a responsibility sensitive approach therefore EEOp means that all students should face the same set of possible choices between education and effort. Then inequality between opportunity sets is inequitable while inequality of actually achieved outcomes within the set of opportunities is not. We share this approach and we represent a simple model of access to university in this theoretical framework.

2.2 A simple model of educational opportunity

We are interested in modeling equality of opportunity in the access to university. After the school, students have two possibilities: they apply for university or they do something else[4]. Hence university enrollment is modeled as a binary variable s, so that for all individuals $k \in \{1, , ..., K\}, s_k \in \{0, 1\}$. Our aim is to define criteria of equality of opportunity with respect to this choice.

Now, a number of variables influence students' educational choice. On the one hand to go to university involves advantages such as expecting better labour market opportunities and spending some years in a stimulating environment. On the other hand, to enroll in a university program involves costs, direct and opportunity or indirect costs. Both advantages and costs are function of circumstances beyond individual control and are evaluated on the basis of individuals' preferences. For example, a student coming from a poor socioeconomic background may find it hard to access credit necessary to pay university fees; on the other hand, coming from a rich and well educated family environment can shape individuals' attitude toward the studying activity. Note that among circumstances there is also the set of mechanisms that regulates the university system: the length of study, the amount of fees, the workload and all other variables that can influence the probability to enroll. A basic ingredient of the EOp literature is the partition of the individual characteristics into circumstances and effort. Hence, all variables influencing the costs and advantages of accessing university that are beyond the individual control are called circumstances $c \in \{c_1, ..., c_n\}$. On the other hand, all individuals' characteristics that influence the university enrollment choice that are under individual control and for whom students are held responsible are called effort e. We assume there are m possible discrete degrees of effort: $e \in \{e_1, ..., e_m\}$.

In our model the two individual traits, e and c, do not fully determine the access probability of individuals: there is a random component, λ, assumed to be independently and identically distributed across individuals: for all $k = 1, ..., K$, $s_k = s(c_i, e_j, \lambda_k)$. For each combination of circumstances c_i and effort e_j,we define the expected value $E(s|c = c_i, e = e_j)$ which corresponds to the probability of accessing the university for individuals endowed with circumstances c_i and exerting effort e_j.Therefore we can represent the

[3] In this context we call reward what Fleurbaey calls liberal reward principle Fleurbaey (2008).

[4] No entrance barriers are assumed, so applying to university means to enroll. This description is appropriate in a public founded University as the Italian one.

population of students as a matrix of expected probability to access university up to an orthogonal random component.

Table 1: Access to university: modeled distribution

	e_1	e_2	...	e_m
c_1	$E(s\|c_1, e_1)$	$E(s\|c_1, e_2)$	...	$E(s\|c_1, e_m)$
c_2	$E(s\|c_2, e_1)$	$E(s\|c_2, e_2)$	...	$E(s\|c_2, e_m)$
	...	...	...	...
c_n	$E(s\|c_n, e_1)$	$E(s\|c_n, e_2)$	...	$E(s\|c_n, e_m)$

We call 'tranche' the portion of student population sharing same effort (in the same column), 'type' the set of students sharing the same circumstances (in the same row); students sharing the same effort and the same circumstance belong to the same 'cell'. All definitions of fairness we will introduce refer to cells and, specifically, to the expected probability associated to the cell. The education system is considered fair if the distribution of probability across cells obeys certain fairness criteria. How the probability is distributed within cells is not considered ethically relevant. This choice is not irrelevant and may be challenged, after all if responsibility is correctly captured by our measure of effort, why variability within cells should be considered unproblematic? However, this choice, which is consistent with the majority of the applied literature, is based on the idea that if in principle we would like not random effect such as luck to affect educational outcome, in practice we believe that the existence of such random component, given that this is uncorrelated with socioeconomic characteristics, can hardly be attribute to the fairness of the educational system. In this perspective EEOp means equal chances and among them equal risk not to succeed because of luck.

2.3 Equality of educational opportunity: from fairness criteria to inequality measures

Following Roemer's (1993, 1998) and Fleurbaey's (2008) theoretical framework in the last decade an extensive literature concerned with the measurement of inequality of opportunity (IOp) has emerged. Measurement methods have attempted to isolate the share of inequalities due to unequal opportunities from inequalities due to individual choices. However, because of the impossibility to find a measure of IEOp consistent with both principles of Compensation and Reward, in specifying their measures most authors have implicitly or explicitly given precedence to the former or the latter principle. The tension between the two principles is well discussed by Fleurbaey and Maniquet (2003) and Fleurbaey (2008): the reward principle prescribes to consider as fair the inequalities among individuals characterized by identical circumstances; on the other hand, some of these inequalities are instead considered as unfair in the compensation perspective, which primarily recognizes as unfair all inequalities among individuals that exerted same degree of effort. Excluding very specific cases, the measures inspired by the two principles necessarily differ and a question arises about which one has to be considered the correct one[5].

In this section, following the approach of Fleurbaey and Schokkaert (2009), we start from basic requirement of fairness and discuss different ways in wich consistent measure of inequality can be derived. The two general principles of fairness are (Fleurbaey and Schokkaert, 2009)

Condition 1 (*Reward).* A measure of unfair inequality should not reflect legitimate variation in outcomes, i. e. inequalities which are caused by differences in effort.

Condition 2 (*Compensation).* If a measure of unfair inequality is zero, there should be no illegitimate differences left; i.e. two individuals with the same effort should have the same outcome.

These two general conditions have been weakened in different ways by the existing literature. Fleurbaey and Schokkaert (2009), building on the literature of fair allocation, propose the following solutions:

Solution 1a (*Conditional equality*) Fleurbaey (2008). *Take a reference responsibility, an education system is fair if all individuals exerting reference responsibility obtain the same outcome.*

Assume $\tilde{e}$ is the reference: then there is EEOp if and only if: $E(s|c_i, \tilde{e}) = E(s|\tilde{e})$ $\forall c_i \in \{c_1, ..., c_n\}$.

Solution 1a satisfies reward and declares inequality between individuals in the same circumstance class as irrelevant; it also obeys to compensation but only for individuals with reference effort: all inequality among them is considered unfair.

Solution 2a (*Egalitarian equivalence*) Fleurbaey (2008). *Take a reference circumstances, an education system is fair if all individuals get the same outcome they would get with unchanged responsibility characteristic but reference circumstance.*

Assume $\tilde{c}$ is the reference: then there is EEOp if and only if: $E(s|(c_i, e_j)) = E(s|\tilde{c}, e_j)$ $\forall e_j \in \{e_1, ..., e_m\}$ *and* $c_i \in \{c_1, ..., c_n\}$.

Solution 2a satisfies fully compensation, as inequality between individuals exerting the same effort is unfair; it also obeys to reward for individuals with reference circumstance: all inequality among them is considered unproblematic.

A different approach to measurement is proposed by Peragine (2002) and Checchi

[5]Formally this impossibilities always arises when the cross derivative of circumstances and effort on outcome differ from zero.

and Peragine (2009).

Solution 1b (*Ex ante approach*) Checchi and Peragine (2009). *An education system is fair if individuals that share the same circumstances have the same expected outcome.*

There is EEOp if and only if: $E(s|c_i) = E(s)\ \forall c_i \in \{c_1, ..., c_n\}$.

Solution 1b focuses on reward but does not guarantee consistency with compensation (or it does if $s(c, e))$ is additive separable).

Solution 2b (*Ex post approach*) Checchi and Peragine (2009). *An education system is fair if individuals that exerted the same effort have the same expected outcome.*

There is EEOp if and only if: $E(s|c_i, e_j) = E(s|c_h, e_j)\ \forall i, h \in \{1, ..., n\},\ \forall j \in \{1, ..., m\}$.

Solution 2b focuses on compensation but does not guarantee consistency with reward (or it does if $s(c, e))$ is additive separable).

Starting from these 4 different fairness criteria, consistent inequality measures can be derived by considering the distance between the actual outcome distribution and the fair distribution.

Hence, Solutions 1a and 2a lead respectively to Direct unfairness (DU), which measures to what extent the actual distribution violates conditional equality, and to Fairness gap (FG), which is a measure of the distance between the observed distribution and egalitarian equivalence. On the other hand, Solutions 1b and 2b lead to $ex-ante$ (EA) and $ex-post$ (EP) measures respectively. The four measures and requirements are reported in table 2 where I is a suitable inequality measure:

Table 2: IEOp measures

generale principle	fairness condition	IEOp measure
reward	conditional equality $E(s|c_i, \tilde{e}) = E(s|\tilde{e})$	DU $I\{E(s|(c_i, \tilde{e})\}$
reward	ex ante approach $E(s|c_i) = E(s)\ \forall c_i \in \{c_1, c_2, ..., c_I\}$	EA $I\{E(s|c_i)\}$
compensation	egalitarian equivalence $E(s|(c_i, e_j)) = E(s|\tilde{c}, e_j)$	FG $I\{E(s|c_i, e_j) - E(s|\tilde{c}, e_j)\}$
compensation	ex post approach $E(s|c_i, e_j) = E(s|c_h, e_j)$	EP $I\{E(s|c_i, e_j) - E(s|e_j\}$

2.4 Relationship between different measures

While the existing literature has discussed differences and compatibilities between DU and FG on one hand (see Fleurbaey and Schokkaert 2009), and ex ante and ex post on the other (see Checchi and Peragine, 2009, Fleurbaey 2009, Fleurbaey and Peragine 2009), in this section we compare the two approaches. To the best of our knowledge, this relationship has not yet been discussed in the literature[6]. Let us start by considering the DU and FG measures. For the sake of clarity we can represent these measures by two matrixes $n \times 1$ and $n \times m$ respectively:

$$DU \quad = I \left\{ \begin{matrix} E(s|c_1, \tilde{e}) \\ E(s|c_2, \tilde{e}) \\ ... \\ E(s|c_n, \tilde{e}) \end{matrix} \right\}$$

$$FG \quad = I \left\{ \begin{matrix} E(s|c_1, e_1) - E(s|\tilde{c}, e_1) & ... & E(s|c_1, e_j) - E(s|\tilde{c}, e_j) & ... & E(s|c_1, e_m) - E(s|\tilde{c}, e_m) \\ ... & ... & ... & ... & ... \\ 0 & ... & 0 & ... & 0 \\ ... & ... & ... & ... & ... \\ E(s|c_n, e_1) - E(s|\tilde{c}, e_1) & ... & E(s|c_n, e_j) - E(s|\tilde{c}, e_j) & ... & E(s|c_n, e_m) - E(s|\tilde{c}, e_m) \end{matrix} \right\}$$

DU and FG are equal if the probability generating process is additively separable[7]. In this special case the advantage in terms of outcome of a circumstance is fixed[8] and each column of the FG matrix become a replication of DU[9]. In the general case DU and FG will differ and this difference signals the existence of the already mentioned tension between the compensation and reward principles. Given that there is no inequality measure that can satisfy both principles, the IEOp measurement problem consists in finding a balance between the two principles. We wish to find a measure that to a certain extent satisfies both compensation and reward.

Consider DU: it measures the inequality in outcome between types. To do so it picks a reference level of effort and measures inequality in the distribution of outcome of individuals exerting reference effort across all circumstances. This measure is fully consistent with the liberal reward principle because it obeys to the condition 1 general requirement. Moreover, for students exerting $\tilde{e}$ DU is also consistent with compensation: it considers unfair all the inequality within tranche $\tilde{e}$. However, for all individuals exerting a different effort, the consistency with the compensation principle is not guaranteed.

[6]There exists a discussion of different conditional equality and egalitarian equivalence allocation rules in Fleurbaey (1994), Moulin (1994), and Fleurbaey (2008), but these discussions do not concern inequality measurement and do not focus on compensation and reward violation as we do.

[7]That is: $E(s|c_i, e_j) = f(c_i) + g(e_j)$ for some functions f, g.

[8]That is, $\forall c_i \neq c_h \in \{c_1, c_2, ..., c_n\}$ and $\forall e_j = e_t \in \{e_1, e_2, ..., e_m\}$, $E(s|c_i, e_j) - E(s|c_h, e_j) = E(s|c_i, e_t) - E(s|c_h, e_t)$.

[9]An additional requirement is of course the replication invariance of I.

We can represent DU's violation of the compensation principle using a matrix (VC) in which each cell contains the difference between the actual outcome and the outcome that is imputed to it when a reference effort is chosen: $E(s|c_i, e_j) - E(s|c_i, \tilde{e})$. The matrix is simply the subtraction of m replications of the DU vector from the modeled distribution matrix (by construction the reference effort column is made of zero).

$$VC \quad = I \left\{ \begin{array}{ccccc} E(s|c_1, e_1) - E(s|c_1, \tilde{e}) & ... & 0 & ... & E(s|c_1, e_m) - E(s|c_1, \tilde{e}) \\ ... & ... & ... & ... & ... \\ E(s|c_n, e_1) - E(s|c_1, \tilde{e}) & ... & 0 & ... & E(s|c_n, e_m) - E(s|c_n, \tilde{e}) \\ \end{array} \right\}$$

Now assume that we drop the requirement to satisfy compensation for a reference and we wish instead to find a measure of inequality between types that minimize the sum of compensation violations. To stick to liberal reward we have to represent each individual in the same type with one and only one measure of outcome. Our problem is therefore: finding the outcome associated to each type that minimizes the sum of violations in each row of VC. The solution of our problem consists in taking the average probability of each row[10]. Translated into DU terms, the reference effort $\tilde{e}$ is the effort that generates the average probability in each type. Note, however, that in this case $\tilde{e}$ is not necessary observed in the population and it is not fixed across types (the same result would be obtained if we were looking at the sum of the violations squared).

The solution of this problem shows the relationship between DU and EA: once the DU set is substituted by the set of the types' average outcome, the inequality measure we get is exactly the $ex - ante$ measure of inequality of opportunity.

Dual to the DU's violation of the compensation principle is the FG's violation of the reward principle.

When we focus on the compensation principle we are compelled to consider any inequality within tranches as unfair. In each tranche inequality is given by the relative advantage of being in different circumstances. To calculate FG we choose a reference circumstance $\tilde{c}$ and we calculate inequality in each tranche as inequality in the distances between the outcome in each cell and the outcome in the reference type cell. By doing so we obtain a matrix of distances in which each row reports the distances in outcome between each type and the reference level (by construction the reference type row is made of zero). If the probability generating process is not additively separable in all other rows, the distances will differ across tranches. These differences suggest that in each tranche the advantage of belonging to a type differs, which is a violation of the reward principle: individuals in the same type should be considered equally well off independently from their effort decision.

This violation is represented by a matrix of reward violations (VR). For each reference circumstance $c_i = \tilde{c}$, row h of VR is the difference between the $h-th$ FG row and

[10] The proof is intuitive as in each row i we are looking for e scalar ρ_i that minimizes $\sum_{j \in m}[E(s|c_i, e_j) - \rho_i]$.

the same row when $c_h = \tilde{c}$. Note that whenever $c_h = \tilde{c}$ the value associated by the FG distribution to the $h-th$ row is 0. Therefore, for each chosen $\tilde{c}$, the matrix of violations is simply the matrix FG. We relax the requirement of consistency with reward for a reference circumstance and we introduce the alternative requirement of minimizing the sum of VR elements. Therefore we wish to find the set of circumstances, one for each tranche, that minimizes the sum of VR's elements (the same result is obtained if we wish to minimize the sum of the violations squared).

$$VR \quad = I \left\{ \begin{array}{ccccc} E(s|c_1,e_1) - E(s|\tilde{c},e_1) & ... & E(s|c_1,e_j) - E(s|\tilde{c},e_j) & ... & E(s|c_1,e_m) - E(s|\tilde{c},e_m) \\ ... & ... & ... & ... & ... \\ 0 & ... & 0 & ... & 0 \\ ... & ... & ... & ... & ... \\ E(s|c_n,e_1) - E(s|\tilde{c},e_1) & ... & E(s|c_n,e_j) - E(s|\tilde{c},e_j) & ... & E(s|c_n,e_m) - E(s|\tilde{c},e_m) \end{array} \right\}$$

It turns out that for each effort degree the reference circumstance that minimize the sum of reward violations is the circumstance that generates the tranche's average outcome[11]. Note that this circumstance does not necessary exist and that is not fix across effort tranches. Once the FG reference outcome in each tranche is substituted by the set of the tranches' average, the inequality measure we obtain is EP[12].

Let us summarize the discussion so far.

Remark *Both DU and EA satisfy Reward; moreover, DU respects compensation for reference effort, while EA minimizes the sum of violations of the principle of compensation. On the other hand, both FG and EP satisfy Compensation; moreover, FG respects reward for reference circumstance, while EP minimizes the sum of violations of the principle of reward.*

Table 3 summarizes these properties.

Table 3: IEOp measures properties for non additively separable probabilities

	reward	compensation	comp. for $\tilde{e}$	rew. for $\tilde{c}$	min $\sum$ CV	min $\sum$ RV
DU	√			√		
FG		√	√			
EA	√				√	
EP		√				√

Finally, we can translate these measures in relative terms:

[11] The proof is intuitive and dual to the DU.

[12] The discussion proves also that $EAP \leq FG$. Note that this result is linked to the Average Egalitarian Equivalence solution proposed by Moulin (1994) whenever effort and circumstances are not correlated and individuals are uniformly distributed across cells.

$$du \quad = I\left\{E(s|c_1,\tilde{e}),...,E(s|c_n,\tilde{e})\right\}$$

$$fg \quad = I\left\{\begin{bmatrix} \frac{E(s|c_1,e_1)}{E(s|\tilde{c},e_1)} & ... & \frac{E(c_1,e_j)}{E(\tilde{c},e_j)} & ... & \frac{E(s|c_1,e_n)}{E(s|\tilde{c},e_n)} \\ ... & ... & ... & ... & ... \\ 1 & 1 & 1 & ... & 1 \\ ... & ... & ... & ... & ... \\ \frac{E(s|c_n,e_1)}{E(s|\tilde{c},e_1)} & ... & \frac{E(c_n,e_j)}{E(\tilde{c},e_j)} & ... & \frac{E(s|c_n,e_1)}{E(s|\tilde{c},e_n)} \end{bmatrix}\right\}$$

$$ea \quad = I\left\{E(s|c_1),...,E(s|c_n)\right\}$$

$$ep \quad = I\left\{\begin{bmatrix} \frac{E(s|c_1,e_1)}{E(s|e_1)} & ... & \frac{E(c_1,e_j)}{E(e_j)} & ... & \frac{E(s|c_1,e_n)}{E(s|e_n)} \\ ... & ... & ... & ... & ... \\ \frac{E(s|c_n,e_1)}{E(s|e_1)} & ... & \frac{E(c_n,e_j)}{E(e_j)} & ... & \frac{E(s|c_n,e_1)}{E(s|e_n)} \end{bmatrix}\right\}$$

These measures are relative versions of DU, FG, EA, and EP[13]. They are not the same whenever the probability generating process is not product separable. And they have exactly the same properties and relationships once expressed in relative terms.

In what follow we will adopt du, fg, ea, and ep as unfairness measures. As shown, these measures differ because they embody different versions of the EOp ethical principles. If we get consistent measures, then our results can be said to be robust to different interpretations of what EEOp means. We consider ea and ep particularly valuable when there is no a priori information on which reference characteristics should be chosen. The Gini index is chosen as suitable inequality measure.

2.5 Measures implementation

This theoretical framework has been in some cases applied to evaluate inequality in educational opportunity. Peragine and Serlenga (2007) apply a non parametric approach to evaluate IOp in the distribution of grades and job market performance of a sample of university graduated. Waltenberg and Vandenberghe (2006) Waltenberg (2009) follow both the non parametric and the parametric approaches to evaluate EOp in educational attainments.

As discussed by these authors to adopt a responsibility sensitive approach to EEOp poses some peculiar problems. First of all can we consider students really responsible for their effort decision? While it is clear that babies cannot be held responsible for their choices it is less clear to what extent a teenager can. This issue has been discussed by De Villè and Trannoy (De Villé, 2003) in the EEOp framework. Trannoy suggests

[13] ea, ep are the measures originally adopted by Checchi and Peragine (2009).

that children cannot exert full responsibility when they are very young (below age $t^\star$) moreover he claims that after time ($t^{\star\star}$) circumstances do not play any role in education. In assuming so he delimitates an age in which effort does not exist, only compensation should be applied, and an age in which only effort play a role, there only reward should be applied. However, if $t^\star$ and $t^{\star\star}$ do not coincide there is a period in which education outcomes distribution should be evaluated adopting a balance of compensation and reward. We do not agree with Trannoy and De Villé when they suggest the existence of time $t^{\star\star}$, there are evidence that the effect of circumstances on educational outcomes never fades out, and for example affects the university graduation grade (Peragine and Serlenga, 2007). We instead focus on $t^\star$ that is, at what age can we start to consider a student responsible for its effort[14]. To understand at which age approximately corresponds $t^\star$ is crucial. If students determine their access at time $t < t^\star$ responsibility plays no role in their educational outcome and there is no point in adopting a responsibility sensitive unfairness measure.

A good benchmark for such a discussion is the legal literature on criminal responsibility. After all if at a certain age individuals are held legally responsible for their actions the same principle is probably implementable in the EEOp framework. Interestingly the minimum age to be brought to court in OECD countries varies around an average of 13 years, followed by the minimum age to leave school (15-16) (Melchiorre, 2004) . This seems to suggest that access to university education, that in Italy takes place around the age of 19, can be evaluated following our methodologies without fear of holding students responsible for choices they do not control. However, following the same reasoning we should question all studies that measures IEOp in students with age around or below the "responsibility age" [15]. The closer educational outcomes are measured to $t^\star$ the more the use of responsibility sensitive measure is difficult to defend. Moreover given that the cognitive skills accumulation process is highly influenced by skills already acquired, one should consider education outcome at time $t^\star$ as one of the circumstances influencing educational achievements, this is the view that we follow.

The second critical point concern the role of talent. It is widely agreed that talent contains an innate component and therefore in this framework should be considered a circumstance and not rewarded as a responsibility characteristic (De Villé, 2003). Nevertheless authors that evaluate IEOp often obtain a measure that consider problematic only observable circumstances such as socioeconomic condition, geographical location or gender[16]. In what follow we partly correct this approach as we believe that to include the educational outcome at $t^\star$ among circumstances in part capture innate ability. If the measure of outcome at 15 and at 19 are fully comparable and the effect of ability on them is fixed over time, then our measure of effort will not be biased by innate ability. However, this assumption is rather strong and we are aware that our choice include

[14] However we also consider unsatisfactory to claim a discontinuity in the process of individual responsibility formation. Responsibility may be better understood as a continuous process in which age and experience improve individual judgment ability. Further research on this issue seems promising.

[15] This is the case for example of Waltenberg and Vandenberghe (2006) that use data on 14 years old Brazilian students, or Ferreira and Gignoux (2007) that use data on 15 years old pupils.

[16] See Peragine and Serlenga (2007) or Waltenberg (2009) for example.

in what should be rewarded a part of circumstance, it implicitly makes our measure a compromise between the Roemer's and meritocratic EEOp *à la* Brighouse[17].

3 Evaluation of the university reform in Italy

3.1 The 2001 University Reform

The Italian university system before the 2001 reform was based on a "unitary one tier" curses scheme, in place since the '30s, in which 4-6 years degree were the sole possible university careers without intermediate exit possibility[18]. In 1990 shorter university degrees were introduced, the Italian system was moving toward a "binary one-tier" model where old courses were coupled with shorter degrees. Moreover in 1990 Ruberti's law introduced the so called *autonomia universitaria* allowing universities to increase the variety of courses and degrees offered. However, both laws remained largely unimplemented by universities until 1999 when a broader reform took place.

In the late '90s many reasons for a comprehensive reform were advocated by policy makers and academics: low enrollment rates, high drop out rates (OECD in 2000 reported a survival rate for tertiary education of 42% in Italy versus an OECD average of 70%), low population share with an university degree (18% against an OECD average of 28%), excessive length of study (MIURST reports in 1998-99 that 38.7% of the total university population was made by students spending in university more years than the legal length of their course), loose links between university and the labour market. Moreover, a major source of concern was that all these phenomena were highly correlated with students socioeconomic background, with low access and low graduation rates for students coming from poor socioeconomic background (Bratti et al., 2008).

The 1999 reform, implemented in the 2001-2002 academic year, transformed the Italian system in a "unitary two-tiers" model: all students enroll in a 3 years degree and then can enroll in a 1 year or 2 years master degree. The change from 4/6 to 3+2 degrees brought also a reform of curricula with a reduction of total number of exams, that were now concentrated in 3 years, expansion of specialization fields and reduction of exams' workloads (Bratti et al., 2007).

Aggregated data seem to show that the reform bought a large effect in terms of enrollment rate in the years following 2001: Ministerial data show that the number of degrees doubled from 2001 to 2006, with a constant increase in the years after the reform (Bondonio, 2006), Istat also shows an increase in enrollment rates from 2001 to 2004 (ISTAT, 2006). However, Istat reports a turnaround after 2004 whith the enrollment rate in 2007-2008 below the pre-reform level. Excluding a short run temporary increase there has been virtually no effect of the reform in terms of aggregated enrollment rate.

[17] Our method is not a meritocratic IEOp measure because it considers unfair inequality due to talent when talent is correlated with circumstances.

[18] Where not differently specified the sources of these paragraph are: (Giannessi, 2006) and ministerial decree law 509/1999.

Many authors attempted to understand what were the consequences of such a reform beside the increase in the enrollment. In particular a debate about the effectiveness of the reform in tackling major limits of the old system has emerged. Cappellari and Lucifora find evidence of higher rate of access to university, especially for low income and talented students (Cappellari and Lucifora, 2008). D'Hombres shows evidence of reduction in drop out rates after reform (d'Hombres, 2007)[19]. Di Pietro and Cutillo find a similar positive effect of the reform with a significant reduction in drop out rates (Di Pietro and Cutillo, 2008). A skeptical explanation of the same phenomena is proposed by Bratti et al. that find an increase in university enrollment and a reduction in drop out rates, but they underline the possible role of the reduction in university standard that followed the reform (Bratti et al., 2007). Among reform evaluation contributions only Cappellari and Lucifora (2008) devote explicitly attention to the focus of our analysis: the effects of the reform in terms of equality of tertiary education opportunity[20]. If on the one hand the literature considered circumstances influencing students performance among determinants of their education achievements, on the other none of the existing reform evaluations have explicitly defined criteria to estimate improvement of the university system in terms of fairness.

3.2 Model specification and data description

In our samples we observe a binary outcome for each individual.

$$s = \begin{cases} 1 & \text{with probability } P(s=1) = P \\ 0 & \text{with probability } P(s=0) = 1-P \end{cases}$$

We introduce an unobservable index function which determines the value of the binary outcome.

$$s^* = \alpha + \beta c + \delta e + \lambda \tag{1}$$

Which outcome prevails is explained by a vector of circumstances c, effort e, and a random component λ whit mean zero and variance standardized logistic. We do not distinguish components of the index function, we observe only:

$$s = \begin{cases} s=1 & \text{if } s^* > 0 \\ s=0 & \text{if } s^* \leq 0 \end{cases}$$

Given that the distribution is symmetric,

$$Pr(s^* > 0|c,e) = Pr(\lambda < \alpha + \beta c + \delta e) = F(\alpha + \beta c + \delta e) \tag{2}$$

[19]Similar positive effect in demand for tertiary education is found by Caroso et al. studying the effects of the Bologna process in Portugal.

[20]Note that Bratti et al. focus on the same issue in a paper which however does not investigate the effect of the reform (Bratti et al., 2008).

Where F is the cumulative distribution function. F is therefore assumed logistic and we estimate a logir model to describe how c and e participate in determining the enrollment rate.

$$Pr(s=1) = F(\alpha + \beta c + \delta e) = \frac{e^{\alpha+\beta c+\delta e}}{1+e^{\alpha+\beta c+\delta e}} \tag{3}$$

The model is estimated and the whole predicted distribution is obtained. In each cell the enrollment rate is substituted by the predicted enrollment rate:

$$s(c_i, e_j) = \frac{e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}e}}{1+e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}e}} \tag{4}$$

This modeled distribution is used to calculate the elements of the IEOp distributions:

$$du_i = \frac{e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}\tilde{e}}}{1+e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}\tilde{e}}} \tag{5}$$

$$fg_{i,j} = [\frac{e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}e}}{1+e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}e}}]/[\frac{e^{\hat{\alpha}+\hat{\beta}\tilde{c}+\hat{\delta}e}}{1+e^{\hat{\alpha}+\hat{\beta}\tilde{c}+\hat{\delta}e}}] \tag{6}$$

$$ea_i = \frac{e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}\bar{e}}}{1+e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}\bar{e}}} \tag{7}$$

$$ep_{i,j} = [\frac{e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}e}}{1+e^{\hat{\alpha}+\hat{\beta}c+\hat{\delta}e}}]/[\frac{e^{\hat{\alpha}+\hat{\beta}\bar{c}+\hat{\delta}e}}{1+e^{\hat{\alpha}+\hat{\beta}\bar{c}+\hat{\delta}e}}] \tag{8}$$

where $\bar{c}$ and $\bar{e}$ are average circumstance and average effort whereas $\tilde{c}$ and $\tilde{e}$ are circumstances and effort of reference, respectively.

We estimate our enrollment model using data from "Indagine sull'Inserimento Professionale dei Diplomati" (IIPD, hereafter) a survey on the transition from secondary school to work and university of a representative sample of Italian students, who completed high school, conducted by Istat. We use waves 1998 (students that completed high school in 1995), 2001 (1998), 2004 (2001) and 2007 (2004). These data contain information on students socioeconomic background, their school curricula and their access to university/labour market after high school. Table 6 presents descriptive statistics for the 4 IIPD waves[21].

In model 2 outcome is obtained by a function of circumstances and effort. We consider as relevant circumstances parental education level (mother/father graduated or not), parental occupation (father unemployed or not), parental job qualification (white/blue collar), gender, kind of secondary school attended (public/private; "liceo"/other schools), and the grade obtained at time $t^\star$ (i.e. secondary school final grade, taken at age 15). The effort level is instead approximated by comparing the grade of the college final

[21] Data differ pretty much from (Cappellari and Lucifora, 2008) as these authors exclude all students graduating in vocational schools.

examination - undertaken at the age 19 - and the above mentioned secondary school final grade. Effort in school is a proxy of how hard a student tried and is generally not observed. In what follows we use the relative variation of students grades at age 15 and at age 19. We believe that improvement in education attainments is a more reliable measure of effort than a single grade as the latter might be influenced by circumstances. If the effect of the circumstances is constant over time, by using the relative variation between grades we might be able to identify the "pure" effort effect - the effort which is independent of circumstances - on the education attainment. As final grades are recorded in 4 levels in the survey both at age 15 and 19, we have 11 possible effort levels: 0.25, 0.33, 0.5, 0.667, 0.75, 1, 1.333, 1.5, 2, 3, 4.

The modeled distribution is therefore made by 11 columns and a number of rows equal to the number of all possible circumstances combinations ($4 \times 2^{11} = 8192$, with many empty cells). Complete descriptive statistics and the regression marginal effects are reported in tables 7-10 in the Appendix A.

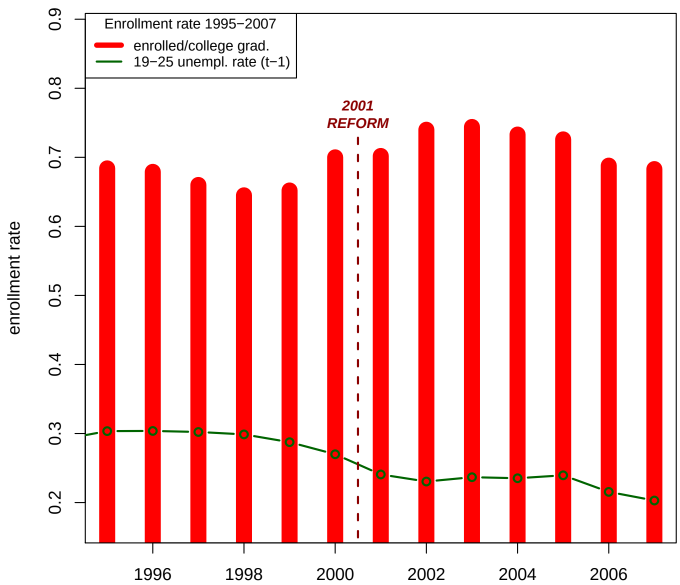
This policy evaluation exercise suffers from a number of weakness. To correctly evaluate the effect of a treatment, such as a reform, we should compare the situation of the treated individuals (the cohort that experienced the reform in our case), with their situation if they would not have been treated. However, since the reform involved all students graduating from college at the same time, this strategy is impossible to implement.[22]. In our analysis we simply compare students from different cohorts, one (or more) pre 2001 and one after 2001. There are a number of issues that might challenge this strategy. First of all students characteristics affecting students achievements may differ across cohorts. This issue is solved by other authors including relevant characteristics as a control in the model. Di Pietro and Cutillo, for example decompose the total change after reform in two parts, one due to change in socioeconomic characteristics of the sample and the other due to the reform (Di Pietro and Cutillo, 2008). In our case this issue does not represent a problem as our measures are weighted by the relative population in each cell and cells represent all possible combination of relevant characteristics.

A second crucial issue concerns the possibility of excluding that observed changes would have taken place even without a reform, i.e. if observed changes are part of a trend, they would have taken place anyway. However, the presence of a trend is excluded looking at the data, Cappellari and Lucifora (2008) for example show that as far as the aggregated enrollment rate is concerned the years before the reform show a decreasing trend (see figure 1). Similarly we include in our IEOp measures two waves before the reform (1995 and 1998) in order to check for the existence of a trend.

Finally, policy evaluation prescribes to consider all other possible exogenous variables that could have influenced education achievements after the reform. Labour market conditions are often considered among the most relevant variables in this context. We expect some positive and some negative influence of unemployment on enrollment rate: higher unemployment reduces the opportunity cost of attending university but increases

[22] Although there was some heterogeneity in the timing of implementation of the reform this could not be exploited as it is clearly not randomly assigned to universities.

Figure 1: Enrollment and youth unemployment rate: Istat and Miur.



the difficulties of financing. however, there are evidence that a worsening of the labour market condition could explain an increase in the enrollment rate of college graduates especially for those coming from poorer socioeconomic sector of the population (Betts and McFarland, 1995). This mechanism could bias our estimates. However, as shown in figure 1, youth unemployment rate (19-25 years) has declined in the years before and after 2001, hence if this trend induces a bias this is toward a larger IEOp.

4 Results

We calculate du, fg, $ex-ante$, $ex-post$, for the 1995, 1998, 2001, and 2004 samples of college graduate. Table 4 reports the results for du, for each of the reference efforts, and for the $ex-ante$ measure. Table 5 reports the quantiles of the fg distribution together with $ex-post$.

Our estimates show unambiguously an improvement in the fairness in university access after the 2001 reform. This conclusion is robust to the large range of measures that we have adopted.

In particular we are able to show that this conclusion is valid both for IEOp measures that give precedence to the compensation principle and for those that focus instead on the reward principle. Nevertheless, this choice does matters for the results. As reported in tables 4 and 5, du is always smaller than fg; and this is consistent with other findings in empirical applications of the same measures. The same relationship exists between $ex-post$ and $ex-ante$.

It is particularly interesting to check how different are the rankings of the distribution of different years generated by different measures. In fact, in general, differences in magnitude generally do not imply any re-ranking. The only ambiguity arises in the relative ranking of the 1995 and 2001 samples, when fairness in access seems to be rather similar.

The reference characteristic also matters. In this case we claim that a comparison between measures is meaningful. It suggests that different references in calculating the same measure affect our estimate of unfairness in a given distribution. The minimum du is obtained taking the maximum effort. The maximum du is obtained taking the minimum effort. Note that the higher the reference the lower is unfairness for all inter mediate reference efforts; this monotonicity suggests that, as far as access to education is concerned, the effect of circumstance in conditioning the outcome is decreasing with the degree of effort. These changes in magnitude again do not imply any re-ranking. The reference circumstance plays also an important role on the fg measure.In the case of reference circumstances it seems impossible to order them in an ambiguous way and therefore the relationship between circumstances and unfairness measures remains less clear. Note also that, as known by construction, $ex-post$ is lower than any fg while $ex-ante$ varies around the du average.

Figure 2: Direct unfairness

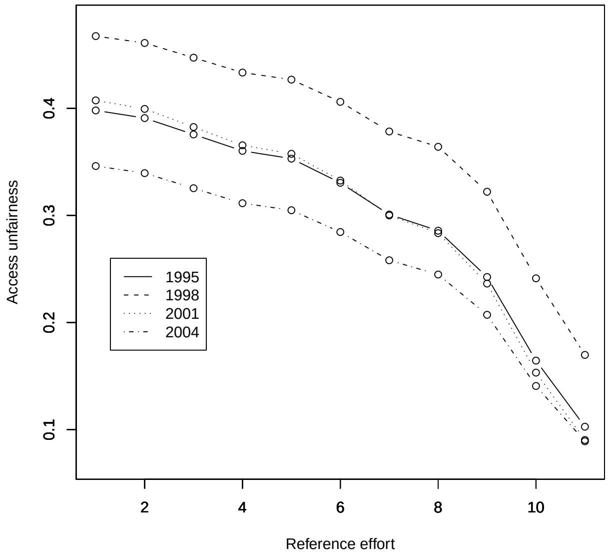


Figure 3: Fairness gap distributions

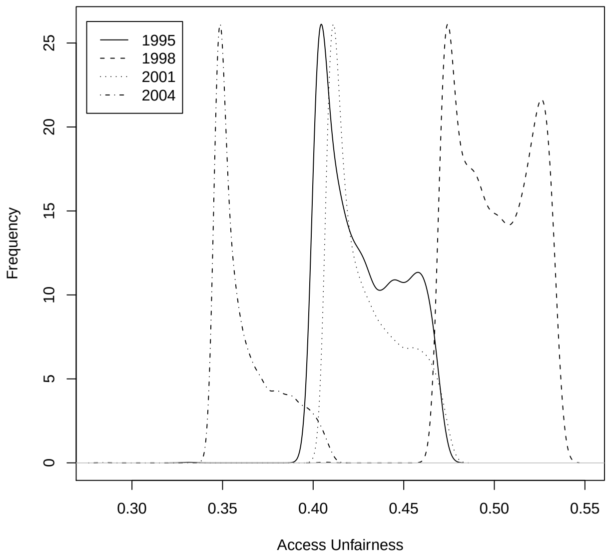


Table 4: Direct unfairness and ex-ante

$\tilde{e}$	1995	1998	2001	2004
$\tilde{e} = 1$	0.398071	0.467451	0.407429	0.346126
$\tilde{e} = 2$	0.390913	0.461049	0.399482	0.339496
$\tilde{e} = 3$	0.375634	0.447312	0.382533	0.325430
$\tilde{e} = 4$	0.360290	0.433415	0.365538	0.311420
$\tilde{e} = 5$	0.353058	0.426827	0.357537	0.304855
$\tilde{e} = 6$	0.330465	0.406072	0.332586	0.284497
$\tilde{e} = 7$	0.300830	0.378406	0.299983	0.258124
$\tilde{e} = 8$	0.285735	0.364094	0.283443	0.244826
$\tilde{e} = 9$	0.242483	0.322105	0.236371	0.207189
$\tilde{e} = 10$	0.164423	0.241273	0.153221	0.140737
$\tilde{e} = 11$	0.102696	0.169759	0.090311	0.089060
$ex - ante$	0.277900	0.340965	0.277841	0.241561

Table 5: fairness gap distributions

year	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	$ex - post$
1995	0.4000	0.4079	0.4241	0.4278	0.4466	0.4720	0.3314
1998	0.4693	0.4809	0.4992	0.5002	0.5198	0.5363	0.4068
2001	0.4078	0.4125	0.4245	0.4300	0.4448	0.4765	0.3326
2004	0.3463	0.3487	0.3556	0.3627	0.3733	0.4103	0.2845

5 Concluding remarks

In this paper we propose a conceptualization of EEOp which is based on the literature on equality of opportunity and responsibility sensitive egalitarianism. This literature has shown how EOp is a complex fairness principle in which different and sometimes conflicting basic principles coexist. An ideal IEOp measure should be consistent with both general principles of compensation and reward, however such a desirable measure is impossible. Following the recent developments of the literature on IOp measurement we have adopted, discussed, and adapted to the educational context two pairs of measures: *direct unfairness* and *fairness gap* due to Fleurbaey and Schokkaert (2009) and $ex-ante$ and $ex-post$ due to Peragine (2002), Checchi and Peragine (2009). We have shown that, each measure gives precedence to one of the principles keeping some kind of consistency with the other one.

We have then adopted these four IEOp measures to evaluate the change in the access to university in Italy in the last 15 years. This exercise is particularly interesting because in 2001 the Italian university system embarked in a broad process of reform. The reform was aimed at solving a number of weaknesses of the system, among them a limited EEOP.

To do so we have partitioned college graduate into groups of students sharing the same circumstances and we have defined a responsibility variable: the relative improvement in their educational outcome during college. We then estimated our measures of unfairness for all possible specifications. Estimates are consistent and show a clear increase in EEOp after the reform.

A Descriptive statistics and regressions' output

Table 6: Summary

variable	1995	1998	2001	2004
N	17947	22060	19741	25249
enrollment	1.1684 (0.7076)	1.2733 (0.7453)	1.1809 (0.7082)	1.2071 (0.7158)
effort	2.163871 (1.0568)	2.1088 (1.0574)	2.1988 (1.1189)	2.3766 (1.1504)
score 15	2.1910 (1.0994)	1.985 (1.1529)	2.1486 (1.049)	2.2546 (1.044)
private	0.1136 (0.3173)	0.0717 (0.2580)	0.1273 (0.3334)	0.0575 (0.2328)
father grad.	0.0534 (0.2249)	0.0524 (0.2229)	0.0885 (0.2841)	0.0963 (0.2950)
mother grad.	0.0396 (0.1951)	0.0402 (0.1965)	0.0694 (0.2542)	0.0845 (0.2782)
father dip.	0.3639 (0.4811)	0.4054 (0.4909)	0.34182 (0.4743)	0.3768 (0.4845)
mother dip.	0.3679 (0.4822)	0.4160 (0.4929)	0.3411 (0.4741)	0.3887 (0.4874)
father unempl.	0.0122 (0.1097)	0.0152 (0.1224)	0.0216 (0.1454)	0.0165 (0.1277)
father w. col.	0.2554 (0.4361)	0.2303 (0.421)	0.3727 (0.4835)	0.3522 (0.4776)
mother w. col.	0.1004 (0.3006)	0.0850 (0.2789)	0.2245 (0.4173)	0.2165 (0.4118)
mother out l.f.	0 0.5726 (0.4947)	0.5882 (0.4921)	0.5162 (0.4997)	0.4656 (0.4988)
liceo	0.3294 (0.4700)	0.2167 (0.4120)	0.2569 (0.4369)	0.3327 (0.4711)
girl	0.5543 (0.4971)	0.5396 (0.4984)	0.5342 (0.4988)	0.5411 (0.4983)
north	0.4020 (0.4903)	0.3803 (0.4854)	0.3891 (0.4875)	0.4801 (0.4996)

All variables are dummy but effort, that ranges from 0.25 to 4, and score at 15, that ranges from 1 to 4.

Table 7: Logit regression 1995, marginal effects

enrollment	$\partial s/\partial x$	Std. Err.	z	$P > \|z\|$	95%	Conf. Int.
effort	0.1697612	0.00714	23.76	0.000	0.155758	0.183764
score 15	0.2042143	0.0054	37.81	0.000	0.193627	0.214801
private	-0.0495374	0.01573	-3.15	0.002	-0.080359	-0.018716
father grad.	-0.0149118	0.02046	-0.73	0.466	-0.055015	0.025192
mother grad-	0.0503403	0.02266	2.22	0.026	0.005936	0.094745
father dip.	-0.061322	0.01024	-5.99	0.000	-0.081397	-0.041247
mother dip.	0.0051752	0.01008	0.51	0.608	-0.014587	0.024938
father unempl.	-0.0467851	0.04071	-1.15	0.250	-0.126577	0.033007
father w. col.	0.144071	0.01042	13.82	0.000	0.12364	0.164502
mother w. col.	0.0710141	0.01778	3.99	0.000	0.036173	0.105855
liceo	0.4062856	0.00829	49.02	0.000	0.39004	0.422532
mother out l.f.	-0.1136842	0.00965	-11.78	0.000	-0.132597	-0.094772
girl	-0.068453	0.00931	-7.35	0.000	-0.08671	-0.050196

LR $chi^2 = 5845.07$, Prob $> chi^2 = 0.0000$
Log likelihood $= -8672.8598$, Pseudo $R^2 = 0.2520$

Table 8: Logit regression 1998, marginal effects

enrollment	$\partial s/\partial x$	Std. Err.	z	$P > \|z\|$	95%	Conf. Int.
effort	0.1327186	0.00585	22.68	0.000	0.121251	0.144187
score 15	0.1700119	0.00468	36.30	0.000	0.160832	0.179192
private	0.0038911	0.0174	0.22	0.823	-0.030216	0.037998
father grad.	-0.0173563	0.01791	-0.97	0.333	-0.052469	0.017756
mother grad.	0.014099	0.02044	0.69	0.490	-0.025968	0.054166
father dip.	-0.0578025	0.00888	-6.51	0.000	-0.075213	-0.040392
mother dip.	-0.0366076	0.00886	-4.13	0.000	-0.053981	-0.019234
father unempl.	-0.0509449	0.03175	-1.60	0.109	-0.113182	0.011292
father w. col.	0.1293336	0.01005	12.87	0.000	0.109637	0.14903
mother w. col.	0.061239	0.01671	3.66	0.000	0.028484	0.093994
liceo	0.4508035	0.00917	49.15	0.000	0.432827	0.46878
mother out l.f.	-0.0838148	0.00871	-9.62	0.000	-0.100893	-0.066737
girl	-0.0143644	0.00824	-1.74	0.081	-0.030514	0.001785

LR $chi^2 = 6756.83$, Prob $> chi^2 = 0.0000$
Log likelihood $= -10704.77$, Pseudo $R^2 = 0.2399$

Table 9: Logit regression 2001, marginal effects

enrollment	$\partial s/\partial x$	Std. Err.	z	$P>\|z\|$	95%	Conf. Int.
effort	0.1836827	0.00645	28.49	0.000	0.171048	0.196318
score 15	0.2098497	0.00517	40.62	0.000	0.199723	0.219976
private	-0.0464328	0.01431	-3.24	0.001	-0.074481	-0.018384
father grad.	0.1989497	0.01799	11.06	0.000	0.163691	0.234209
mother grad.	0.1787406	0.0214	8.35	0.000	0.136792	0.220689
father dip.	0.0766518	0.00996	7.70	0.000	0.057133	0.096171
mother dip.	0.0990043	0.01003	9.88	0.000	0.079355	0.118653
father unempl.	-0.0539063	0.02878	-1.87	0.061	-0.110322	0.002509
liceo	0.3659553	0.00875	41.84	0.000	0.348811	0.383099
father w. col.	0.0714347	0.01003	7.12	0.000	0.05177	0.091099
mother w. col.	0.0513431	0.0131	3.92	0.000	0.02567	0.077016
mother out l.f.	-0.0519146	0.00928	-5.60	0.000	-0.070097	-0.033732
girl	-0.026166	0.00866	-3.02	0.003	-0.043141	-0.009191

LR $chi^2 = 6984.58$, Prob $> chi^2 = 0.0000$
Log likelihood $= -10163.986$, Pseudo $R^2 = 0.2557$

Table 10: Logit regression 2004, marginal effects

enrollment	$\partial s/\partial x$	Std. Err.	z	$P>\|z\|$	95%	Conf. Int.
effort	0.1321386	0.00477	27.69	0.000	0.122786	0.141491
score 15	0.1789516	0.00413	43.36	0.000	0.170863	0.18704
private	-0.0259939	0.01581	-1.64	0.100	-0.056988	0.005
father grad.	0.1448093	0.01241	11.67	0.000	0.120487	0.169131
mother grad.	0.12977	0.01395	9.30	0.000	0.102423	0.157117
father dip.	0.063882	0.00734	8.71	0.000	0.049506	0.078258
mother dip.	0.0892297	0.00734	12.15	0.000	0.074835	0.103625
father unempl.	-0.0340361	0.02507	-1.36	0.175	-0.083164	0.015092
liceo	0.3345468	0.00614	54.50	0.000	0.322516	0.346577
father w. col.	0.0632308	0.00758	8.34	0.000	0.048372	0.078089
mother w. col.	0.046489	0.01014	4.59	0.000	0.026623	0.066355
mother out l.f.	-0.0527415	0.00718	-7.35	0.000	-0.066808	-0.038675
girl	0.012069	0.00664	1.82	0.069	-0.000938	0.025076

LR chi^2 (13) $= 9601.84$, Prob $> chi^2 = 0.0000$
Log likelihood $= -11909.836$, Pseudo $R^2 = 0.2873$

References

Arneson, R., 1989. Equality of opportunity for welfare. Philosophical Studies 56, 77–93.

Betts, J. R., McFarland, L. L., 1995. Safe port in a storm: The impact of labor market conditions on community college enrollments. The Journal of Human Resources 30 (4), 741–765.

Bondonio, D., 2006. La valutazione dell'impatto netto della riforma. Comitato Nazionale per la Valutazione del Sistema Universitario.

Bourguignon, F., Ferreira, F. H. G., Menendez, M., 2007. Inequality of opportunity in Brasil. Review of Income and Wealth 53 (4), 585–618.

Bratti, M., Broccolini, C., Staffolani, S., 2007. Mass tertiary education, higher education standard and university reform: a theoretical analisys. Quaderni di ricerca 227, Università degli studi di Ancona, Dipartimento di Economia.

Bratti, M., Checchi, D., Blasio, G., 2008. Does the expansion of higher education increase the equality of educational opportunities? evidence from italy. IZA Discussion Paper 3361, IZA.

Brighouse, H., 2009. Moral and Political Aims of Education. Vol. The Oxford Handbook of Philosophy of Education. Oxford University Press.

Cappellari, L., Lucifora, C., 2008. The "Bologna Process" and the college enrolment decisions. Discussion Paper 3444, IZA.

Checchi, D., Peragine, V., 2009. Inequality of opportunity in italy. Journal of Economic Inequality forthcoming.

Cohen, G. A., 1989. On the currency of egalitarian justice. Ethics 99, 906–944.

Curren, R. R., 1995. Justice and the threshold of educational equality. Philosophy of Education 50, 239–248.

De Villé, P., 2003. Equal opportunity in the educational system and the ethics of responsibility. Cahier de Recherche du GIREF 17, Girsef.

d'Hombres, B., 2007. The impact of university reforms on dropout rates and students' status: evidence from italy. Tech. rep., Joint Research Centre Institute for the Protection and Security of the Citizen.

Di Pietro, G., Cutillo, A., 2008. Degree flexibility and university drop-out: The italian experience. Economics of Education Review 27, 546–555.

Dworkin, R., 1981a. What is equality? part 1. equality of welfare. Philosophy and Public Affairs 10 (3), 185–246.

Dworkin, R., 1981b. What is equality? part 2. equality of resources. Philosophy and Public Affairs 10 (4), 283–345.

Ferreira, F. H., Gignoux, J., 2007. Towards an understanding of socially-inherited inequalities in educational achievement: Evidence from latin america and the oecd, development Research Group, The World Bank, Washington, DC.

Fleurbaey, M., 1994. L'absence d'envie dans une problématique 'post-welfariste'. Recherches Economiques de Louvain 60 (1), 9–41.

Fleurbaey, M., 2007. Poverty as a form of oppression. Vol. Freedom from poverty as a human right: who owes what to the very poor? of Thomas Winfried and Menko Pogge and Thomas Pogge. Unesco, Ch. 5, pp. 133–155.

Fleurbaey, M., 2008. Fairness, Responsibility and Welfare, 1st Edition. Oxford University Press.

Fleurbaey, M., Maniquet, F., 2003. Compensation and responsibility. In: Arrow, K. J., Sen, A. K., Suzumura, K. (Eds.), Handbook of Social Choice and Welfare 2. Vol. 2. North Holland.

Fleurbaey, M., Peragine, V., 2009. Ex ante versus ex post equality of opportunity. ECINEQ working paper 141.

Fleurbaey, M., Schokkaert, E., 2009. Unfair inequalities in health and helath care. Journal of Helath Economics 28, 73–90.

Friedman, M., Friedman, R. D., 2002. Capitalims and freedom. University of Chicago Press.

Giannessi, F., 2006. La riforma universitaria: evoluzioni e effetti. Approfondimenti, Centro Studi CRUI 1, Conferenza dei Rettori delle Università Italiane.

Gutmann, A., 1987. Democratic Education. Princeton University Press, Princeton, NJ.

Howe, K. R., 1989. In defense of outcome-based conceptions of equal educational opportunity. Educational Theory 39.

ISTAT, 2006. Università e lavoro: orientarsi con la statistica 2006. Tech. rep., ISTAT.

Lefranc, A., Pistolesi, N., AlainTrannoy, 2009. Equality of opportunity and luck: Definitions and testable conditions, with an application to income in france. Journal of Public Economics 93 (11-12), 1189–1207.

Melchiorre, A., 2004. At What Age? ... are school-children employed, married and taken tocourt?, 2nd Edition. The Right to Education Project.

Moulin, H., 1994. La présence d'envie: comment s'en accommoder? Recherches Economiques de Louvain 60 (1), 63–72.

Peragine, V., Serlenga, L., 2007. Higher education and equality of opportunity in italy. IZA Discussion paper 3163, IZA.

Waltenberg, F. D., December 2009. Two procedures for assessing inequality of educational opportunities in Brazil. In: XXXVI Encontro Nacional de Economia. Foz do Iguaçu/PR, pp. 198–210.

Waltenberg, F. D., Vandenberghe, V., 2006. What does it take to achieve equality of opportunity in education? an empirical investigation based on brazilian data. Economics of Education Review 26, 710–724.