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BEHIND THE ATKINSON INDEX:
MEASURING EQUALITY OF OPPORTUNITY IN HEALTH

PAOLO LI DONNI, VITOROCCO PERAGINE E GIUSEPPE PIGNATARO

società italiana di economia pubblica

dipartimento di economia pubblica e territoriale – università di Pavia

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Abstract. In this paper we address a measurement of equality of opportunity in health applying alternative methodologies generated by the path independent Atkinson index of equality. The literature suggests that inequalities in health between social classes can be partly disentangled by differences in lifestyles and socio-economic conditions. Using data from the British Household Panel Survey (1996-2005), we consider father's social class as a proxy for circumstances and smoking as a measure for individual effort. Results suggest a great incidence of the direct effect of the individual behaviours in terms of lifestyles reducing the indirect contribution of social background. Different policy scenarios for targeting health interventions on individual responsibility can be imagined as a consequence.

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PRELIMINARY DRAFT, PLEASE DO NOT QUOTE

1. Introduction

Theories of justice differ basically because of differences about value judgements. In the last decade there has been a renewed interest in welfare and normative economics in measuring equality of opportunities (EOp, hereafter) which considers both theoretical and empirical issues in many fields.

Since the 70's several authors like Rawls [42], Sen [44], Dworkin [16] propose a more radical notion of EOp based on primary goods, capabilities, resources, then Arneson [3] and Cohen [12] focus respectively on: "opportunity for welfare" and "access to advantage". They practically introduce the concept of individual responsibility in the opportunity egalitarian literature.

However, it was only with Roemer [43]'s contribution that the question about the different implementation of responsibility was put into place. This idea suggests that all individuals who have exercised the same degree of effort receive the same outcome, regardless of circumstances. This can be obtained by assigning unequal resources in order to compensate factors beyond the individual's control. The outcomes should be different just because individuals exert different personal responsibilities. That's called *levelling the playing field* procedure. A public policy may compensate individuals who suffer from circumstances leaving free them to assume their choices.

While many studies have assessed the existence of inequality of opportunity in education, earnings, income distribution (Bourguignon *et al.* [9], Ferreira and Gignoux

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[19], Lefranc *et al.* [36], Pistolesi [41], fewer have addressed inequality of opportunity in health (Dias [14] and Trannoy *et al.* [47]).

Empirical evidence underlines strong and long-lasting inequalities in health related to current socioeconomic status as expressed by Wagstaff and van Doorslaer [51] or Bommier and Stecklov [6]. The individual behaviours have no role in this methodology especially in terms of responsibility. However, Fleurbaey and Shokkaert [23] point out that the literature on health inequality implicitly accepts that health inequalities within a socioeconomic group are less problematic than health inequalities between socioeconomic groups. [1] Policy-makers are more concerned about some causes of observed overall inequality, like socioeconomic background, than about other causes. The EOp concept must draw some distinctions between fair and unfair sources of inequality in health. Measuring "unfair" inequalities implies that a distinction between causal variables leading to ethically legitimate inequalities and causal variables leading to ethically illegitimate inequalities must be introduced.

This paper evaluates the relationship between health status, social background and individual decisions measuring health in equality terms. It presents a decomposition of the path independent Atkinson index of equality of value 1 of the inequality aversion parameter ε.

Our idea is to consider the role of family determinism among the determinants of equality of opportunity in health. Health status in adulthood is affected by an individual's social background, an idea well rooted in the literature. The literature proposes on one side, the indirect effect of socio-economic conditions of parents on individual professions and implicitly on their own health status, while, on the other side, the effect of the family behaviours directly on individual health status, see Balia and Jones [4][2]. In other words, the first effect suggests that individuals have a higher probability to make their own father's job and this channel has some influences on their health status. Instead, the second effect captures the individual behavior which is related with father's profession e.g. Roemer [43] argues that there exist different classes of workers which tend to smoke more than other professions. In this case, there's a strong probability that the individuals "copy" their parental behaviors. We want to measure equality of opportunity in health status decomposing overall equality into a component due to missing opportunities and another part due to individual responsibility.

To sum up, in section 2, we review the Atkinson index of inequality according to Atkinson (1970). In section 3, based on Peragine [39], we describe a unified framework for the measurement of inequality of opportunity. Then, in section 4 and 5, we develop the Atkinson index related to the class of opportunity egalitarian social welfare function. Section 6 suggests two different approaches, the type and the tranche approach, applying the path independence property. In section 7 and 8, a description of the BHPS data and the econometric setting is proposed. In section 9,

[1] They propose two measures of inequality of opportunity in health: *direct unfairness* and *fairness gap*. The former is related to the variations in health in the hypothetical distribution in which all legitimate sources of variation are kept constant; while, the latter is linked to the differences between the actual distribution and the hypothetical distribution in which all illegitimate sources of variation have been removed.

[2] They find that endogenous lifestyles strongly contribute to inequality in mortality, reducing the contribution of socioeconomic factors.

estimation and decomposition results are commented. Conclusions follow in section 10.

2. Definition of the Atkinson index

Welfare-based measures may provide useful conditions to rank income distributions according to equality of opportunity. Such complete ordering requires the definition of the specific functional form of the social welfare function (SWF; hereafter). A crucial role in welfare measurement of inequality is played by the Atkinson's index of inequality which is directly related to the class of additive SWFs. Given an income distribution $Y = \{y_1, ..., y_j, ..., y_m\} \in R_+^{N^Y}$ and an individual utility function $\mathrm{U_i}$: $\mathrm{R}_+ \rightarrow \mathrm{R}_+, \mathrm{i} = 1, ..., \mathrm{N}$; a standard utilitarian SWF $W : \mathrm{R}_+ \rightarrow \mathrm{R}_+^N$ can be expressed as:

$$W(Y) = \frac{1}{N}\sum_{i=1}^{N} U_i(y_i) \tag{1}$$

which says that the social welfare is represented by the average utility of the N individuals in the society. Atkinson [2] proposes a measure of inequality which relates the equally distributed equivalent (*ede*, hereafter) income y_e to the actual mean income. The *ede* income y_e is identified as the hypothetical level of income that each individual should receive in order to keep the society to the same level of social welfare stemmed from the actual incomes. According to Atkinson [2], the functional form $U_i(y_i)$ is the following:

$$U_i(y_i) = \frac{1}{1-\varepsilon} y_i^{1-\varepsilon} \text{ if } \varepsilon > 0 \ \varepsilon \neq 1 \tag{2}$$

$$U_i(y_i) = \mathrm{logy}_i \text{ if } \varepsilon = 1 \tag{3}$$

which depends on the society's degree of inequality aversion ε. Hence, for example, if $\varepsilon = 0$, then $U_i(y_i)= \mathrm{y}_i$, i.e., the SWF collapses to mean income. This condition implies that the higher the mean income, the higher the social welfare. Instead, if ε increases, a rise in lower incomes receives relatively more weight in the production of social welfare even if in a decreasing way. This means that the SWF must be concave as shown in the Atkinson [2]'s specification. The inequality aversion parameter ε reflects different value judgements which leads to different settlements of the SWF. The *ede* income y_e is implicitly defined as follows:

$$\mathrm{W}(\mathrm{y}_1, ..., \mathrm{y}_\mathrm{N}) = \mathrm{W}(\mathrm{y}_e, ..., \mathrm{y}_e)$$

Therefore, from expressions (2) and (3), we can get that:

$$U(y_e) = \frac{1}{1-e} y_e^{1-e} \tag{4}$$

Hence, the SWF, depicted in (1), can then be expressed as:

$$W(Y) = \frac{1}{N}\sum_{i=1}^{N} \frac{1}{1-\varepsilon} y_i^{1-\varepsilon} \tag{5}$$

Then, an expression of the *ede* income y_e, derived by the SWF, can be directly given by:

$$\frac{1}{N}\sum_{i=1}^{N}\frac{1}{1-\varepsilon}y_i^{1-\varepsilon}=\frac{1}{N}N\frac{\mathrm{y}_e^{1-\varepsilon}}{1-\varepsilon}$$

such that:

$$y_e=\left[\frac{1}{N}\sum_{i=1}^{N}y_i^{1-\varepsilon}\right]^{1-\varepsilon}\ \text{if}\ \varepsilon>0\ \varepsilon\neq 1 \tag{6}$$

$$y_e=\left[\prod_{i=1}^{N}y_i\right]^{\frac{1}{N}}\ \text{if}\ \varepsilon=1 \tag{7}$$

Therefore, according to the positive values of inequality aversion parameter ε, the Atkinson index of inequality I_A of the distribution Y can be expressed as:

$$I_A(Y)=1-\frac{y_e}{\mu}=1-\frac{\left[\frac{1}{N}\sum_{i=1}^{N}y_i^{1-\varepsilon}\right]^{1-\varepsilon}}{\mu}\ \text{if}\ \varepsilon>0\ \varepsilon\neq 1 \tag{8}$$

$$I_A(Y)=1-\frac{y_e}{\mu}=1-\frac{\left[\prod_{i=1}^{N}y_i\right]^{\frac{1}{N}}i}{\mu}\ \text{if}\ \varepsilon=1 \tag{9}$$

Hence, for example, if $\epsilon\to 0$, y_e decreases and I_A increases. If $\epsilon\to\infty$, the Rawlsian criterion is applied, i.e. the SWF becomes more and more inequality averse. An interesting trait of the Atkinson index of inequality is that it directly displays a SWF in shortened form. For any income distribution, given the the value of Atkinson inequality and the mean income, it's possible to compute the level of welfare through the *ede* income y_e.

3. The model

Given a society of N individuals, we identify the individual health status y as the joint result of individual healthy decision (effort) E and social circumstances C, based on Peragine [39]. Particularly, circumstances are set out as all factors for which individuals have not control. They belong to a finite set $\Omega=\{\mathrm{C}_1,...,\mathrm{C}_j,...,\mathrm{C}_m\}$ with $|\Omega|=\mathrm{m}$. Instead, effort variable summarizes all factors for which individuals have full responsibility, denoted by a scalar variable $\mathrm{E}\in\Theta$. The value of the effort level E isn't observable. Individual outcome is generated by a unknown function $\mathrm{g}:\Omega\times\Theta\to\mathrm{R}_+$ such that:

$$y=g(C,E) \tag{10}$$

Therefore, it's possible to rank individuals according to their circumstances such that $\mathrm{C_{j+1}}\succ\mathrm{C_j}$ where $\mathrm{j}\in\{1,...,\mathrm{m}-1\}$. Then we propose two different partitions of the populations in order to measure opportunity inequality. Let us divide the population into m subgroups, each one identified by a variable $\mathrm{C_j}\in\Omega=\{\mathrm{C}_1,...,\mathrm{C}_j,...,\mathrm{C}_m\}$. Therefore, for each $\mathrm{C_j}\in\Omega$, we call "type-j" the set of individuals whose set of circumstances is $\mathrm{C_j}$. Let N_j^Y be the number of people in type j of distribution Y, such that $\sum_{j=1}^{m}N_j^Y=N^Y$. We stand for $y_j=\left\{y_{j,1},....,y_{j,N_j^Y}\right\}\in\mathrm{R}_+^{N_j^Y}$, the type-$j$ income distribution. Finally, the overall income profile Y can be expressed as:

$$Y = \{y_1, ..., y_j, ..., y_m\} \in R_+^{N^Y} \tag{11}$$

From the income profile Y, expressed in (11), we can identify a methodology called the type approach. It focus on ex-ante inequalities between individuals with the same circumstances. We interpret the inequality within types as due to different degrees of responsibility and the inequality between types as originated by differential circumstances i.e. it's a measure of inequality of opportunity. It follows that:

For the type approach, there's equality of opportunity if and only if the expected value of the outcome is the same regardless of the type. In this case, a measure of inequality of opportunity shouldn't reflect variations due to responsibility variable.

Moreover, an alternative partition of the income profile Y can be realized. It's possible to rank individuals according to their degree of responsibility $\mathrm{E} \in \Theta$. We call tranche E the set of individuals whose responsibility is equal to E. The responsibility variable isn't observable. Therefore, a proxy in order to compare the degree of effort of individuals in different types is required. We follow Roemer [43]'s statistical solution applying the quantile of the income distributions as inter-type comparable measure. Thus, considering types $1, ..., \mathrm{m}$, we define the tranche p in population N as the subset of individuals whose are at the $p^{th} - rank$ of their respective type distributions. We have k quantiles, denoted by $\mathrm{p} \in \{1, ..., \mathrm{k}\}$. Working in a discrete framework, we need to assume that, for all $j \in \{1, ..., \mathrm{m}\}$, N_j^Y is divisible by k. Considering a given type-j,with the relevant income vector $y_j \in \mathrm{R}_+^{N_j^Y}$, let us denote the vector of incomes in quantile p of type j by $y_{j,p} \in \mathrm{R}_+^{N_j^Y/k}$. Similarly to the type-partitions introduced above, we can define a disjoint partition of the population into tranches, where the tranches are the set of individuals identified by the effort variable. If N_j^Y/k is the number of people in quantile p of type j, then $\sum_{j=1}^{m} N_j^Y/k = N/k$ is the number of individuals in any tranche p. Therefore, the subset of the population, identified by type, who have exercised a degree of responsibility p, is represented by the following tranche-p vector,$y_p = \{y_{1,p}, ..., y_{j,p}, ..., y_{m,p}\} \in R^{N/k}$ with the relevant mean income denoted by μ_p^Y. Accordingly, the outcome profile $Y \in R_+^N$ can now also be written as:

$$Y = \{y_1, ..., y_p, ..., y_k\} \in R_+^N \tag{12}$$

Notice that the population of each type N_j with $j \in \{1, ..., \mathrm{m}\}$ are not predetermined; thus we consider outcome distributions with different type partitions. From the profile Y, expressed in (12), we now identify a methodology called the tranche approach which focus on ex-post inequalities among individuals at the same responsibility level. We now interpret the inequality between tranches as due to different rewards of the individuals while the inequality within tranches is due to different circumstances i.e. it's a measure of inequality of opportunity. It follows that:

For the tranche approach, there's equality of opportunity if and only if all those who exerted the same degree of effort have the same outcome, regardless of circumstances.

Both approaches are consistent with the equality of opportunity principle. They implicitly define different rankings of the society decomposing the overall inequality into an "inequality of opportunity" and an "inequality of responsibility" components.

4. The type approach

4.1. **Opportunity egalitarian Atkinson SWF.**

In this subsection, following the type structure, we seek for a SWF expressing the opportunity egalitarian principle with respect to the Atkinson index, i.e. we characterize the class of Atkinson SWFs expressed above in terms of equality of opportunity. First, based on (1)-(3), we propose an additive, individualistic and symmetric form of Atkinson SWF in the case of an income distribution partitioned into m types:

$$W = \frac{1}{N}\sum_{j=1}^{m}\sum_{i=1}^{N_j} U_j(y_{ij}) \tag{13}$$

where $U_j(y_{ij})$ are type-dependent utility functions. For the opportunity egalitarian principle, we require further restrictions on the functions $U_j(y_{ij})$. Particularly, Peragine [39] proposes three suitable conditions to characterize the family of Opportunity Egalitarian SWFs. Here, we introduce such properties just for a distinctive utility function according to Atkinson[2][3]. For a given individual i in type j we have that:

$$U_j(y_{ij}) = \frac{1}{1-\varepsilon_j} y_{ij}^{1-\varepsilon_j} \text{ if } \varepsilon_j > 0 \ \varepsilon_j \neq 1 \tag{14}$$

Now, we introduce some properties that the functions $U_j(y_{ij})$ should satisfy. Property 1 expresses the *monotonicity* assumption which ensures that an increase in the outcome doesn't reduce the social welfare:

$$\text{(P.1) } \forall \text{j} \in \{1, ..., \text{m}\} \ \forall \text{y} \in [0, \bar{y}] \ \frac{\partial U_j(y_{ij})}{\partial y} \geq 0 \tag{15}$$

Given our specific functional form, (15) implies that:

$$\forall \text{j} \in \{1, ..., \text{m}\}, \forall i = 1, ..., N_j$$

$$\frac{1-\varepsilon_j}{1-\varepsilon_j} y_{ij}^{1-\varepsilon_j - 1} = y_{ij}^{-\varepsilon_j} \geq 0$$

With the next property, we assume that the opportunity egalitarian Atkinson's SWF is averse to inequalities within each type:

$$\text{(P.2) } \forall \text{j} \in \{1, ..., \text{m}\}, \ \forall \text{y} \in [0, \bar{y}], \ \frac{\partial U_j^2(y_{ij})}{\partial y^2} \leq 0 \tag{16}$$

Applying our specific functional form, it follows that:

$$\forall \text{j} \in \{1, ..., \text{m}\}, \forall i = 1, ..., N_j$$

$$-\varepsilon_j y_{ij}^{-\varepsilon_j - 1} \geq 0$$

[3]A similar result is obtained for $\varepsilon = 1$ by appropriately substituting products for summations

This condition says that for individuals in the same opportunity set, the surplus derived by an extra money is constant or decreasing as income increases, i.e., a reduction in income inequality within types may have constant or increasing effect in terms of welfare. Further, property 3 is crucial because it permits to characterize the aversion to inequality in the opportunity distributions of income. With no reranking in the types-mean distributions, this assumption involves the idea that a transfer of income from an individual in a higher type to an individual in a lower one doesn't decrease the social welfare. That is, the marginal increase in the utility functions $U_j(y_{ij})$ is a decreasing functions of opportunity. For the opportunity egalitarian Atkinson's SWF, we can then express such proposition as:

$$\text{(P.3) } \forall \text{j} \in \{1, ..., \text{m}\},\ \forall \text{y} \in [0,\bar{y}], \tag{17}$$

$$\frac{\partial U_j(y_{ij})}{\partial y} \geq \frac{\partial U_{j+1}(y_{ij})}{\partial y}$$

given our specific functional form, (17) implies the following:

$$\forall \text{j} \in \{1, ..., \text{m}\}, \forall i = 1, ..., N_j$$

$$y_{i,j}^{-\varepsilon_j} = y_{i,j+1}^{-\varepsilon_{j+1}}$$

In order for (17) to be true, the following condition is implied:

$$\varepsilon_j \leq \varepsilon_{j+1} \tag{18}$$

This means that the inequality aversion must be lower, the most deserving is the type. At a first sight, this looks like a quite strange requirement for the opportunity egalitarian principle. However, given the type-dependency of $U_j(y_{ij})$, and looking at (14)we note that ε_j must be greater than zero in order to maintain the concavity assumption of the utility function. It may be argued that as the general level of income rises we are more concerned about inequality i.e. the utility function rises as income increases but in a decreasing way. On this perspective, (18) point out that the type-dependent utility function is less concave the lower is the type examined. That's reasonable because it implies that the more deserving is the utility function, the lower it decreases as income rises.

4.2. **Opportunity egalitarian Atkinson SWF.**

We are now ready to get an opportunity egalitarian expression of the Atkinson index. Starting by a combination of (13) and (14), the opportunity egalitarian Atkinson SWF is given by:

$$W = \tfrac{1}{N} \textstyle\sum_{j=1}^{m} \sum_{i=1}^{N_j} \tfrac{1}{1-\varepsilon_j} y_{ij}^{1-\varepsilon_j} \tag{19}$$

Let the sequence of *type*-dependent *ede* outcomes $(\text{y}_{e1}, ..., \text{y}_{ej}, ..., y_{em})$ be defined by:

$$\tfrac{1}{N} \textstyle\sum_{j=1}^{m} \sum_{i=1}^{N_j} \tfrac{1}{1-\varepsilon_j} y_{ij}^{1-\varepsilon_j} = \tfrac{1}{N} \sum_{j=1}^{m} \sum_{i=1}^{N_j} \tfrac{1}{1-\varepsilon_j} \text{y}_{ej}^{1-\varepsilon_j} \tag{20}$$

Clearly, for each type $j \in \{1, ..., \text{m}\}$, the *ede* income y_{ej} is given by:

$$\sum_{i=1}^{N_j} \frac{1}{1-\varepsilon_j} y_{ij}^{1-\varepsilon_j} = N_j \frac{1}{1-\varepsilon_j} \mathrm{y}_{ej}^{1-\varepsilon_j} \tag{21}$$

which implies that:

$$\mathrm{y}_{ej} = \left[\frac{1}{N_j} \sum_{i=1}^{N_j} y_{ij}^{1-\varepsilon_j} \right]^{\frac{1}{1-\varepsilon_j}} \tag{22}$$

We can define the opportunity egalitarian Atkinson index of inequality within type-j I_A^j as follows:

$$I_A^j = 1 - \frac{\mathrm{y}_{ej}}{\mu_j} \tag{23}$$

Then we propose an aggregate index of inequality within all the types I_A^W which corresponds to the within-subgroups inequality proposed by Blackborby *et al.* [5], the weights being the population shares $p_j = \frac{N_j}{N}$:

$$I_A^W = 1 - \frac{\sum_{j=1}^{m} p_j \mathrm{y}_{ej}}{\mu} \tag{24}$$

Eq. (24)implies that I_A^W reflects the income inequality due to responsibility factors. Now, in order to obtain an overall index of inequality consistent with the opportunity egalitarian SWF, let us suppose that the inequality aversion condition introduced in (18) holds with strict equality: i.e., $\varepsilon_j = \varepsilon_{j+1}$ $\forall$ j $\in \{1, ..., \mathrm{m}-1\}$. We denote by ε as the inequality aversion parameter which is equal for each type j. From (20) and (22)let the *ede* income y_e be defined by:

$$\frac{1}{N} \sum_{j=1}^{m} \sum_{i=1}^{N_j} \frac{1}{1-\varepsilon} y_{ij}^{1-\varepsilon} = \sum_{j=1}^{m} \frac{N_j}{N} \sum_{i=1}^{N_j} \frac{1}{N_j} \frac{1}{1-\varepsilon} \mathrm{y}_{ij}^{1-\varepsilon} =$$

$$= \sum_{j=1}^{m} \frac{N_j}{N} \frac{1}{1-\varepsilon} y_{ej}^{1-\varepsilon} = \frac{1}{N} N \frac{\mathrm{y}_e^{1-\varepsilon}}{1-\varepsilon} \tag{25}$$

It follows that:

$$y_e = \left[\sum_{j=1}^{m} \frac{N_j}{N} \sum_{i=1}^{N_j} \frac{1}{N_j} y_{ij}^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{26}$$

Then, we can express the overall opportunity egalitarian Atkinson index of inequality I_A for the entire distribution such that:

$$I_A = 1 - \frac{y_e}{\mu} = 1 - \frac{\left[\sum_{j=1}^{m} \frac{N_j}{N} \sum_{i=1}^{N_j} \frac{1}{N_j} y_{ij}^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}}{\mu} \tag{27}$$

In order to make further decompositions, an expression of the Atkinson index of equality E_A can be provided:

$$E_A = (1 - I_A) \tag{28}$$

while from (24) the Atkinson index of equality within types E_A^W is given by:

$$E_A^W = (1 - I_A^W) \tag{29}$$

5. The tranche approach

5.1. **Opportunity egalitarian Atkinson index.**

We now propose a symmetrical exercise to the one showed in the previous section focusing on the tranche approach. Hence, an alternative formulation for the opportunity egalitarian Atkinson SWF consistent with the tranche approach can be proposed:

$$W = \frac{1}{N} \sum_{p=1}^{k} \sum_{i=1}^{N_p} V_p(y_{ip}) \tag{30}$$

where now we divide the overall outcome profile $Y \in R_+^N$ in k tranches. For the opportunity egalitarian principle, as in the case of type approach, some restrictions on the function $V_p(y_{ip})$ are required[4]. For a given individual i in tranche p we have that:

$$V_p(y_{ip}) = \frac{1}{1-\varepsilon_p} y_{ip}^{1-\varepsilon_p} \text{ if } \varepsilon_p > 0 \ \varepsilon_p \neq 1 \tag{31}$$

By definition $N_p = N_q$, $\forall$p, q $\in \{1, ..., \text{k}\}$,. Given the monotonicity assumption, inequality aversion within tranche is counted in:

$$\forall \text{p}, \text{q} \in \{1, ..., \text{k}\}, \forall \text{y} \in [0, \bar{y}], \frac{\partial V_p^2(y_{ip})}{\partial y^2} < 0 \tag{32}$$

Given our specific functional form, this property implies that:

$$\forall \text{p} \in \{1, ..., \text{k}\}, \forall i = 1, ..., N_p, -\varepsilon_p y_{ip}^{-\varepsilon_p - 1} < 0$$

This condition says that for individuals in the same tranche, the surplus, derived by an extra money, is decreasing as income increases i.e. a reduction in income inequality within tranches may have increasing effect in terms of welfare. Given the tranche definition, the inequality aversion between tranches isn't required. This implies that the utility functions do not need to be tranche-specific, such that $V_p = V_q$, $\forall$p, q $\in \{1, ..., \text{k}\}$ and $\varepsilon_p = \varepsilon$,$\forall$ p $\in \{1, ..., \text{k}\}$, i.e., a unique inequality aversion parameter is therefore taken into account.

5.2. **Opportunity egalitarian Atkinson index.**

An opportunity egalitarian index can be now defined in the case of tranche-partition of the population. From (30) and (31), we obtain that:

$$W = \frac{1}{N} \sum_{p=1}^{k} \sum_{i=1}^{N_p} \frac{1}{1-\varepsilon} y_{ip}^{1-\varepsilon} \tag{33}$$

Let the sequence of *tranche*-dependent *ede* incomes $(\text{y}_{e1}, ..., \text{y}_{ep}, ..., y_{ek})$ be defined by:

$$\frac{1}{N} \sum_{p=1}^{k} \sum_{i=1}^{N_p} \frac{1}{1-\varepsilon} y_{ip}^{1-\varepsilon} = \frac{1}{N} \sum_{p=1}^{k} \sum_{i=1}^{N_p} \frac{1}{1-\varepsilon} \text{y}_{ep}^{1-\varepsilon} \tag{34}$$

where for each tranche $p \in \{1, ..., \text{k}\}$, the *ede* income y_{ep} is given by:

$$\sum_{i=1}^{N_p} \frac{1}{1-\varepsilon} y_{ip}^{1-\varepsilon} = N_p \frac{1}{1-\varepsilon} \text{y}_{ep}^{1-\varepsilon} \tag{35}$$

It follows that:

[4] Similar result for $\varepsilon_p = 1$ can be proposed.

$$\mathrm{y}_{ep} = \left[\frac{1}{N_p}\sum_{i=1}^{N_p} y_{ip}^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{36}$$

We can define the opportunity egalitarian Atkinson index of inequality for the p-tranche I_A^p as follows:

$$I_A^p = 1 - \frac{\mathrm{y}_{ep}}{\mu_p} \tag{37}$$

while the opportunity egalitarian Atkinson index within tranches I_A^W corresponds to the within-subgroups inequality proposed by Blackborby *et al.* [5], the weights being the population shares $p_p = \frac{N_p}{N}$:

$$I_A^W = 1 - \frac{\sum_{p=1}^{k} p_p \mathrm{y}_{ep}}{\mu} \tag{38}$$

In the tranche framework, (38) reflects the opportunity inequality in the income distribution. Further, from (34) and (36), let the *ede* income y_e be defined by:

$$\begin{aligned} \frac{1}{N}\sum_{p=1}^{k}\sum_{i=1}^{N_p}\frac{1}{1-\varepsilon}y_{ip}^{1-\varepsilon} &= \sum_{p=1}^{k}\frac{N_p}{N}\sum_{i=1}^{N_p}\frac{1}{N_p}\frac{1}{1-\varepsilon}\mathrm{y}_{ip}^{1-\varepsilon} = \\ &= \sum_{p=1}^{k}\frac{N_p}{N}\frac{1}{1-\varepsilon}y_{ep}^{1-\varepsilon} = \frac{1}{N}N\frac{\mathrm{y}_e^{1-\varepsilon}}{1-\varepsilon} \end{aligned} \tag{39}$$

such that:

$$y_e = \left[\sum_{p=1}^{k}\frac{N_p}{N}\sum_{i=1}^{N_p}\frac{1}{N_p}y_{ip}^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{40}$$

An opportunity egalitarian Atkinson index I_A in the tranche approach is now defined as:

$$I_A = 1 - \frac{y_e}{\mu} = 1 - \frac{\left[\sum_{p=1}^{k}\frac{N_p}{N}\sum_{i=1}^{N_p}\frac{1}{N_p}y_{ip}^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}}{\mu} \tag{41}$$

As above, in order to make further decompositions, the Atkinson index of equality $E_A = (1 - I_A)$ and the Atkinson index of equality within types $E_A^W = (1 - I_A^W)$ may be derived.

6. Measuring equality of opportunity

6.1. Path independent decomposition.

The traditional literature of income inequality decomposition by population subgroups starts by the definition of the between-group and the within-group components for the additive inequality measures. The between-group part is interpreted as the inequality of a hypothetical distribution in which each individual income is replaced by the mean income (or *ede* income) of the subgroup. Instead, the within-group component is a weighted sum of the subgroup inequality levels. The aggregate measure can be obtained by the sum of the two components. The only measures that meet this decomposability property are the *Generalised Entropy* (GE hereafter) indices as shown by Bourguignon [7] and Cowell [13]. Unfortunately, both components aren't independent between each other. Shorrocks [45] show that changes in the between inequality can produce some modifications not only in the between-group component but also in the within-group one, even though there may have been no change in within-group inequality. Foster and Shneyerov [24] investigate an additive decomposition property that they call "path independent decomposability", which requires the independence among the between- and the within- group components. They characterize the class of inequality measures which satisfy this property.[5] The Atkinson indices are not additively decomposable. Particularly, Blackborby *et al.* [5] study a multiplicative decomposition for this family in terms of equality indices using a welfare theory approach. However, also in this case, both between- and within- components aren't independent between each other. Therefore, based on Foster and Shneyerov [24], Lasso de la Vega and Urrutia [32] characterize the inequality measures which satisfy the path independent multiplicative property. All the measures of this family are generated by the the Atkinson index of value 1 of the inequality aversion parameter ε. As regards the opportunity egalitarian principle, Checchi and Peragine [11] show that a complete decomposition of the inequality of opportunity ordering can be determined through the class of the path independent inequality measures. Particularly, they use the mean log deviation taking the arithmetic mean as the reference income. They provide a new methodology to decompose overall inequality in an "ethically acceptable" and an "ethically offensive" parts. Here, we seek for a similar procedure exploiting the path independent multiplicative property. Taking the arithmetic mean as the representative income, the Atkinson index of equality for $\varepsilon = 1$ can be applied. We decompose the Atkinson index for $\varepsilon = 1$ with reference to a generic partitions consistent with both type and tranche approaches. It follows that the Atkinson index of equality E_A is given by:

$$E_A = \frac{\left[\prod_{i=1}^{N} y_i\right]^{\frac{1}{N}}}{\mu} \tag{42}$$

where the Atkinson index of inequality I_A is expressed as:

$$E_A = 1 - I_A$$

Let E_A^B be the between-group component which can be interpreted as the equality associated with a population of m egalitarian partitions. It follows that:

$$E_A^B = \frac{\prod_{j=1}^{m} (\mu_j)^{p_j}}{\mu} \tag{43}$$

where μ_j is the mean income of the partition-j and the population share $p_j = N_j/N$. Hence, we define the Atkinson's equality index within partition-j E_j as follows:

$$E_j = \frac{\left[\prod_{i=1}^{N_j} y_{ij}\right]^{\frac{1}{N_j}}}{\mu_j} \tag{44}$$

From eq. (43) and (44), the Atkinson index of equality E_A can be further portrayed into:

[5]The only index of the GE family which satisfy this property is the mean log deviation

$$E_A = \frac{\left[\prod_{i=1}^{n} y_i\right]^{\frac{1}{n}}}{\mu} = \frac{\prod_{j=1}^{m}\left(\frac{\left[\prod_{i=1}^{n_j} y_{ij}\right]^{\frac{1}{n_j}}}{\mu_j}\mu_j\right)^{p_j}}{\mu} = \frac{\prod_{j=1}^{m}(E_j\mu_j)^{p_j}}{\mu} \tag{45}$$

By construction, the within part of the Atkinson index of equality is defined as the product of the equality index for each partition-j.

$$E_A^W = \frac{E_A}{E_A^B} = \frac{\prod_{j=1}^{m}(E_j\mu_j)^{p_j}}{\mu}\frac{\mu}{\prod_{j=1}^{m}(\mu_j)^{p_j}} = \frac{\prod_{j=1}^{m}E_j^{p_j}}{\mu} \tag{46}$$

Finally, it follows that:

$$E_A = E_A^W E_A^B \tag{47}$$

Equation (47) can be transformed through the logarithmic transformation as follows:

$$ln(E_A) = ln(E_A^W) + ln(E_A^B) = \textstyle\sum_{j=1}^{m} p_j(lnE_j) + ln(E_A^B) \tag{48}$$

This implies that the Atkinson index of equality E_A can be linearized so that the percentage change of its components is additively decomposable. Now we are ready to measure overall equality and to decompose it into an opportunity and responsibility components applying the Atkinson index to both type and tranche strategies.

6.2. **The type approach.**

For the overall health profile $Y \in R_+^{N^Y}$, , we consider the three following reference vectors:

(a)$\mathrm{Y} = \left\{\mathbf{y}_1, ..., \mathbf{y}_j, ..., \mathbf{y}_m\right\}$

(b)$\mathrm{Y}_B = \left\{\mu_{\mathbf{y}_1}1_{N_1}, ..., \mu_{\mathbf{y}_j}1_{N_j}, ..., \mu_{\mathbf{y}_m}1_{N_m}\right\}$

(c) Y_W= $\left\{\tilde{\mathbf{y}}_1, ..., \tilde{\mathbf{y}}_j, ..., \tilde{\mathbf{y}}_m\right\}$

where $\mu_{\mathbf{y}_j}$ is the mean outcome of the type-j vector, 1_{N_j} is the unit vector of size N_j and $\tilde{\mathbf{y}}_j$ is obtained by rescaling each individual income i in type-j as:

$$\forall j \in \{1, ..., m\}\,, \forall \mathrm{i} \in \{1, ..., \mathrm{N}_j\}$$

$$y_j^i \rightarrow \frac{\mu_Y}{\mu_{\mathbf{y}_j}} y_j^i$$

In this case, **(a)** is the overall income vector, **(b)** eliminates within-types equality, and **(c)** eliminates between-types equality. This means that by measuring the equality in the smoothed distribution (Y_B), obtained by replacing each health outcome i with its type mean $\mu_{\mathbf{y}_j}$, we capture only and fully the between-types equality, which, in turn, in the types approach reflects the opportunity equality. On the other hand, by rescaling all type distributions until all types have the same mean outcome, we are left with an health profile (Y_W) which express the equality within-types. This can be interpreted as equality due to individual responsibility. Therefore, considering any two income distributions X, $Y \in R_+^N$ and a given measure of equality

$E_A : R_+^N \rightarrow R_+$, we say that distribution X exhibits a lower degree of opportunity equality than distribution Y if and only if $E_A(X_B) > E_A(Y_B)$. Particularly, using the path independent Atkinson index of equality E_A, we obtain the following decomposition:

$$E_A(Y_B) = \frac{E_A(Y)}{E_A(Y_W)} \tag{49}$$

where Opportunity Equality $[E_A(Y_B)]$ can be interpreted as the ratio between Overall Equality $[E_A(Y)]$ and Equality of Responsibility $[E_A(Y_W)]$[6]. Eq. (49) can also be expressed in a linear way as:

$$\ln\left[E_A(Y_B)\right] = \ln[E_A(Y)] - \ln[E_A(Y_W)]$$

6.3. **The tranche approach.**

Hence, the tranche strategy focus on the health vector $Y = \{y_1, ..., y_p, ..., y_k\}$ where the tranche-partition in $p \in \{1, ..., k\}$ include all individuals with the same amount of effort. We define the tranche p vector as:

$$\mathbf{y}_p = \{y_{1,p}, ..., y_{j,p}, ..., y_{m,p}\} \in R_+^{\frac{N}{k}}$$

Let us consider the three following reference vectors:

(a) $Y = \left\{\mathbf{y}_1, ..., \mathbf{y}_p, ..., \mathbf{y}_k\right\}$

(b) $\mathrm{Y}_B = \left\{\mu_{\mathbf{y}_1} 1_{N/k}, ..., \mu_{\mathbf{y}_p} 1_{N/k}, ..., \mu_{\mathbf{y}_k} 1_{N/k}\right\}$

(c) $\mathrm{Y}_W = \left\{\tilde{\mathbf{y}}_1, ..., \tilde{\mathbf{y}}_p, ..., \tilde{\mathbf{y}}_k\right\}$

where $\mu_{\mathbf{y}_p}$ is the mean outcome of the tranche-p vector, $1_{N/k}$ is the unit vector of size $\frac{N}{k}$ and $\tilde{\mathbf{y}}_p$, $\forall p \in \{1, ..., k\}$, is obtained by rescaling each individual income i in tranche-p as:

$$\forall j \in \{1, ..., m\}, \forall p \in \{1, ..., k\},$$

$$y_p^i \rightarrow \frac{\mu_Y}{\mu_{y_p}} y_p^i$$

Here, **(a)** is the overall income vector; **(b)** eliminates the equality within tranches and **(c)** eliminates the equality between tranches. This means that by measuring the equality in the smoothed distribution (Y_B), obtained by replacing each income i with its tranche mean income $\mu_{\mathbf{y}_p}$, we capture only and fully the equality between tranches, which, in turn, is interpreted as the equality due to individual responsibility. Then, by rescaling all tranche distributions until all tranches have the same mean income, we obtain the standardized distribution (Y_W) which identifies the equality within tranches. This reflects the equality of opportunity in the distribution. Therefore, considering any two income distributions $X, Y \in R_+^N$ and a given measure of equality $E_A : R_+^N \rightarrow R_+$, we say that distribution X exhibits a lower degree of opportunity equality than distribution Y if and only if $E_A(X_W) > E_A(Y_W)$. Moreover, using the path independent Atkinson index of equality E_A, it follows that:

[6]Given the path independent property of the Atkinson index for $\varepsilon = 1$, eq. (49) is equivalent to:

$$E_A^B(Y) = \frac{E_A(Y)}{E_A^W(Y)}$$

$$E_A(Y_W) = \frac{E_A(Y)}{E_A(Y_B)} \tag{50}$$

where Opportunity Equality $[E_A(Y_W)]$ can be interpreted as the ratio between Overall Equality $[E_A(Y)]$ and Equality of Responsibility $[E_A(Y_B)]$[7]. Eq. (50) can also be expressed in a linear way as:

$$\ln [E_A(Y_W)] = \ln[E_A(Y)] - \ln[E_A(Y_B)]$$

7. Data

We use data from the last 10 waves, from 1996 to 2005, of the British Household Panel Survey (BHPS). The BHPS is a longitudinal cohort survey of adult members of a nationally representative sample of British households, including Scotland, Northern Ireland and Wales. It provides detailed information on demographic, socioeconomic and health conditions on an annual base from all the adult in the household. As mentioned above our main interest is to provide an empirical appraisal to the Atkinson index of equality with particular focus on investigate the influence of social background on individual health status. In attempting to identify this effect we follow the previous literature on income related health inequality (see e.g. van Doorslaer and Jones [48], van Doorslaer and Koolman [49], Wagstaff and van Doorslaer [50]) to choose proxies capturing the individual health status, the effort and the social background (circumstances). Descriptive statistics and variable definitions for the final unbalanced panel of 16204 individuals are reported in table 1.

7.1. **Measurement of Health.**

As in many other longitudinal survey, the BHPS includes a measure of self-assessed health (SAH): respondents are asked to rate their own health on a five point categorical scale ranging from very poor to excellent health status. It is assumed that these responses are generated by a corresponding continuous latent variable representing self-perceived health. This simple ordinal measure of subjective health has been shown to be a good predictor of mortality, morbidity and subsequent use of health care (see e.g. Idler and Benyamini [30]) and has been found that a continuous health measure obtained from the ordinal responses of SAH is highly correlated with other individual health measures (Gerdtham *et al.* [26]). SAH has been widely employed in many studies focusing on the relationship between health, socioeconomic status and life style (e.g., Contoyannis and Jones [10], Ettner [18], Frijters *et al.* [25]). Furthermore many empirical appraisals on income related health inequality rely deeply on this variable as main outcome of the analysis (e.g. van Doorslaer and Koolman [49], van Doorslaer and Jones [48] Wagstaff *et al.* [52]). Following Wagstaff and van Doorslaer [50] and Wildman and Jones [53] we dichotomise SAH by assigning a value of one to those in good health or better and zero otherwise. Therefore SAH measures perceived health as the percentage of individuals who reports fair, good

[7]Given the path independent property of the Atkinson index for $\varepsilon = 1$, eq. (50) is equivalent to:

$$E_A^W(Y) = \frac{E_A(Y)}{E_A^B(Y)}$$

or very good health status. Although this practice results in a loss of information since multiple-category are collapsed in a binary variable, it does not require any assumption on the scale of SAH into true health (van Doorslaer and Jones [48].

In addition to the above indicator of health status, other measures are included in order to capture individual health. These refer to i) whether or not the respondent has any self-reported functional limitations, ii) the number of the fifteen listed health problems in the survey,[8] and iii) the score of General Health Questionnaire (Goldberg and Williams [27]). The latter consists of 12 individual elements covering many aspect of psychological well-being. For each of these elements respondents are asked to assign a score ranging from 0 (bad) to 3 (good) describing how they felt when responding to each item. Our measure is obtained applying the Likert scale (Likert [37]), which ranges from 0 to 36 and is rescaled to be increasing in good health.

A glance to table 1 reveals that about 65% of individuals in the sample declares to be in good health and the percentage does not vary significantly over waves. Moreover about 20% of sample reports no health limitations to daily activity and the average GHQ score is 24.

7.2. **Measures for circumstances.**

Most of the literature on inequality of opportunity defines circumstances as all variables that do not entail individuals' responsibilities like genetic endowment (Trannoy *et al.*, [47]), parental education (Bourguignon *et al.* [8]) and parental income (Lefranc *et al.* [35]; Pistolesi, [41]). Generally it is hard to find in the available surveys detailed information or proxies for individual circumstances. Although limited the BHPS contains information on the father's social class when individual aged 14. We use it as proxy of individual circumstances. In particular BHPS measures father's social condition in eight categories with respect to the type of job performed such as: professional, managerial, skilled non manual, skilled manual, partly skilled, unskilled and unemployed.

7.3. **Measure for effort.**

The differences in health status that are due to lifestyles are often seen as ethically justified by individual freedom of choice (Fleurbaey and Schokkaert [23]). The only available infomration for this aspect of health is related to smoking. We use it as a responsibility proxy since it is under individual control and then can be interpreted as a legitimate source of health inequalities. The literature suggests that individual behaviours reflect the influence of personal circumstances. Information on whether or not the individual currently smokes is included. It is worth noting that the full sample is made up by individuals whose behaviours are mostly healthy. About 75% of the individuals in the sample are not smokers. Moreover we consider the lifestyle variables as the number of cigarettes smoked, i.e., smoking is defined in terms of number of cigarettes smoked per day. We consider that the decision about smoking is influenced by circumstances (a problem addressed in the next sections). Table 3 reports the percent of smoker by father's social class when at the age of 14. Descriptive statistics show that the number of smokers is higher for individual with

[8]The 15 health problems listed are: problems with arms, hands or legs; sight; hearing; skin conditions/allergy; chest/breathing; heart/blood pressure; stomach or digestion; diabetes; anxiety or depression; alcohol or drugs; epilepsy; migraine; cancer; stroke; other.

lower father social condition. This may indicate that father's condition may affect health either directly and directly through the smoking decision.

7.4. **Additional controls.**

In addition to the above variables we also include a reach set of controls. Socio-economic variables include educational level, economic status, job characteristics, income and geographical area. Educational attainments are separated in the following groups: no qualifications, non-advanced qualifications (including apprenticeships and secondary education), and advanced qualifications (higher degree, first degree, teaching and 'other' qualifications). In the second and third group there is around 45% and 20% of sample. Economic status is separated into four groups: employed, unemployed, retired and other economic status (including student, family care or any other status). Job characteristics refer respectively whether individual is in a no permanent part-time job.

Income is measured as log of annual household income, deflated and equivalised using the McClements equivalence scale (Taylor [46]). This variable gives the total income in the reference year defined as the 12 months prior to the start of the interview period (the 1 September of the year in question).

Geographical area is divided into six broad categories: London (as the reference category), south-east England (excluding London), the rest of England; Wales, Scotland and North Ireland.

Other demographic factors are also taken into account in the analysis: age, ethnic group and sex. Since our focus in mainly focus on the effect of social background on health controlling for controlling for individual responsibility we consider individuals older than 20. Moreover to allow for non linear effect on health we also include second polynomial function of age. Ethnic group is divided in black, white and other ethnic group.

Finally, a vector of dummies by year is included to account for aggregate health shocks, time-varying reporting changes and any effects of age which are not captured by observables.

8. Econometric method

In order to decompose the opportunity egalitarian Atkinson index of equality, we need a measure of the individual health status (y^*) which take into account both the effect of social background (C) and the individual effort (E). The dynamic nature of the BHPS's data (unbalanced panel) allows to correct for individual-specific unobservable effects in the error term (Wooldridge [54]).

As mentioned above SAH was originally coded as a categorical variable. When this type of variable is employed in the empirical analysis of health inequality, the conventional econometric approach relies on the ordered probit or logit model to obtain linear predictions that can be used as a measure of individual health (e.g van Doorslaer and Jones [48]). Since the decomposition (49) is defined over $\Re_+$ we draw inspiration from Wagstaff and van Doorslaer [50] to obtain individual health measures estimating the following univariate random effect probit model where the binary dependent variable (y_{it}) equals 1 if $y^*_{i,1} > 0$ or zero otherwise, and y^*_{it} is the underlying self-perceived health, such that:

$$y_{it}^{*} = \alpha_i + X_{it}^{'}\beta + E_{it}^{'}\delta + C_{it}^{'}\gamma + a_i + \epsilon_{it} \tag{51}$$

where X is the vector of control variables exogenously given, E refers to the vector of lifestyle decisions and C represents the vector of social background. The disturbance terms are represented by two components a_i and ϵ_{it}. The former is the individual effect which is treated as random, while the latter is the idiosyncratic disturbance. The random effect model will provide efficient estimates of the parameters β, δ, γ and it also provide information on how much of the variability in health is due to individual effect. Empirical appraisal to this model requires the estimation of a random effect probit model through the maximum likelihood, which can be expressed as the following:

$$\ln L = \sum_{i=1}^{n} \left\{ \ln \int_{-\infty}^{\infty} \prod_{t=1}^{T} \left(\Phi \left[(2y_{it-1}) \left(\alpha_i + X_{it}^{'}\beta + E_{it}^{'}\delta + C_{it}^{'}\gamma \right) \right] \varphi\left(a\right) da \right) \right\} \tag{52}$$

where Φ is the bivariate normal cumulative distribution function, ϕ is the bivariate normal density function of the random effects.

9. Results

9.1. **Health Measurement.**

In this section we present estimated parameters describing the relationship between the probability to report at least fair/good health and the individual life style, characteristics and socioeconomic background as report in the (51). It is useful to stress that this empirical specification is not a structural model for health and therefore its estimates cannot be given a causal interpretation. However, it might provide a empirical framework to model the demand for health and estimates provide an indication of how exogenous changes in health determinants can affect the degree of inequality in health.

Estimated parameters for the probability of report good health during the period 1996 to 2005 are reported in table 4. A glance at the results for the effect of father's social class on health reveals that better socioeconomic condition of father when individual was 14 years old is positively associated with good health. Individuals born to a father, who was at the bottom of the social scale (unskilled professional occupation), significantly are less likely to report good health than the descendants of father with professional or managerial occupation. Moreover the effect seems to monotonically vary in magnitude with the father's social class condition. Individuals having a father unemployed are about 7% less likely to have good health than individuals whose father is in working status.

Let us consider now the effect of responsibility's variable on health. Results show that the number of cigarettes smoked per day is statistically significant and negatively associated with health, although the magnitude is relatively small (about 3%). This could be related to the fact that father's social status may also drive smoking choice and then affects indirectly individual health through this decision. To deal with this endogeneity problem we follow Fleurbay and Schokkaert [23] and estimate simultaneously the probability to report at least fair/good health and the probability to smoke conditional on individual social background at age of 14 and the set of observable characterless. Empirically it can be done by estimating a recursive bivariate random effect probit. This estimation strategy captures the residual association between the two choices by allowing correlation between disturbances. Conditional on observables the rejection of the null hypothesis of no correlation between residuals would indicate endogeneity of smoking choice. We implemented this test in our sample and found a correlation between residuals of .015. The estimated standard-error is .012; thus we cannot reject the null hypothesis concluding that conditional on observables the two choices can be estimated by running separately two simple random effect probit models (see e.g Greene [28]).

Giving a glance to the estimated parameters for the individual demographic characteristics (see table 4) one notes that female are 4% more likely to be in good health than man, while age affect negatively individual health, thought it is significant only for the non linear effect. Ethnic origin (black and white) are positively associated with health status but coefficient is only significant for the dummy "white".

Quite interesting effects are proposed by job specification. Individuals with a *no permanent* and *part time* job are negatively, but not significantly, associated with health status. Differently individual socioeconomic status, education and income has a positive effect on health. In particular, those with any qualification or above are about 8% and 13% more likely to report good health than those without qualification. The contribution of these last three variables is likely to play a significant role in driving income-related inequality with respect to social background. Finally time dummies are included in order to reveal trends in health status or problems over the ten-year period. It seems to be that the probability of good health decrease over time. Moreover the effect for year 1999 seems to be relatively larger in magnitude if compared with the other. This can be related to a change in the frame of the answer for SAH (see Hernandez-Quevedo *et al.* [29]).

9.2. **Decomposition Results.**

The analysis of the Atkinson index of equality confirms and strengthens the results obtained with the probability model. We evaluate the role of smoking and social background as determinants of equality in health. We first note that the percentage of overall equality for health status is about 76/77% (tables 7 and 8) in 1997. This suggests that the equality about health status is high in UK and this is true both by measuring it with the type and the tranche approaches. Now we look at the decomposition of the overall equality into an opportunity and a responsibility components as suggested in section 6.

We first consider the type approach. Decomposing equality in health status, the type strategy suggests that there is equality of opportunity if and only if the expected value of health is the same regardless of the type. According to this methodology, first, we realize that there's a higher percentage of equality of opportunity (computed between types) about 99% which implies that social background does not discriminate at all (in terms of opportunity) in health context. Second, the incidence of equality of opportunity with respect to overall equality is less than 1% almost constant from 1996 to 2005. This implies that equality of opportunity in the type approach explains just a little part of overall equality. This suggests that the equality due to responsibility components (computed within types) have a higher impact, i.e., the incidence of the lifestyle decisions about smoking accounts for more than 99% of overall equality. This approach seems to assign to smoking variable a key role in the explanation of equality in health.

The tranche approach suggests that there is equality of opportunity if all those who have the same lifestyle decisions (about smoking or not) have the same health status. According to this methodology, first, we observe a strong equality of opportunity (computed within tranches) about 99% except for 1999 and 2004. The equality due to responsibility components (computed between tranches) is high around 70%. First, these results imply that there exists a homogeneous effect of smoking among individuals, independently by the social referred classes. Smoking proves harmful similarly for all individuals. Second, different to the type approach, the incidence of equality of opportunity in terms of overall equality strongly increase around 99%. This result suggests that the equality of the smoking effects among individuals accounts for the greatest component of overall equality. We note that the incidence of equality of opportunity for the tranche approach is definitively around 99% on health status. The fundamental role of smoking variable as determinant of equality in health is also supported by the tranche strategy. Moreover independently by the approach chosen, we observe that the incidence of equality of opportunity is almost constant from 1997 to 2005.

The literature on health inequality identifies the channels by means of which social background affects the future generations. On one side an indirect effect of socioeconomic conditions of parents have an influence on individual professions and implicitly on their own health status. On the other side the effect of parental behaviours influences directly the individual health status. We point out that both approaches are providing the same information. The result suggests a great incidence of the direct impact of smoking which reduces the indirect impact of social background. A comparison with other two studies about inequality of opportunities in health for France and UK is proposed. Trannoy *et al.* [47] suggests that there exists inequality of opportunity in health in France according to social background using a stochastic dominance approach. They show that differences in social classes are found to have a higher impact on inequality of opportunities in health focusing on intergenerational transmission. However they address this issue without disentangling the role of health-behavioural decisions from social circumstances (parents' health). Similar to our decomposition results, instead, Dias [14] shows that there exists inequality of opportunity in health in UK particularly caused by differences in lifestyle decisions. Given that the influence of circumstances on health is often channelled through effort, he proposes that some complementary educational policies may help to reduce inequality of opportunity in health.

10. Concluding Remarks

In the last decade some economists provide different analytical tools and empirical assessments aimed at facilitating the measurement and the reduction of inequality of opportunity in education, earnings and so on. However very few studies have addressed the issue of inequality of opportunity in the context of health. In this chapter we focus on a new decomposition methodology based on the Atkinson index of equality. We consider the BHPS data to shed light on equality of opportunity in UK. The opportunity egalitarian theory proposes some distinctions between fair and unfair sources of inequality. A simple behavioural model which relates the health status of each individual to healthy-behavioural decisions (responsibility component) and social background (opportunity component) is considered. In particular our idea is to evaluate the role of family determinism among the ranges of determinants of equality of opportunity in health. The literature on health inequality suggests that social background may influence the actual individual health status through a direct effect of the family behaviours and an indirect effect of socioeconomic conditions of parents. In order to assess the impact of lifestyles and social background we estimate a univariate probability model for health status. The decomposition analysis show a great incidence of the individual behaviours in terms of smoking which distinctly reduces the indirect contributions of social background. The empirical evidence is broadly in line with the normative debate, see Van Doorslaer and Jones [48] and Wagstaff and Van Doorslaer [51]. The issue at stake is about which variables policymakers are to be concerned. The results here suggest this debate is a nontrivial one given the strict association between lifestyles and social classes. Different policy scenarios for targeting health interventions on smoking can be imagined as a consequence.

Appendix A. Parameters' estimates

Table 1. Sample Characteristics and Variable Definition

Variable	Mean	Std. Dev.	Description
sah	0.632	0.482	1 if good very good health, 0 otherwise
hlim	0.275	0.447	1 if Health limits daily activities, 0 otherwise
hlprbnum	1.264	1.374	# of health problems
ghq	23.282	5.401	General Health Questionnaire score in a scale of 36
Lghq	23.23	5.369	General Health Questionnaire score in the previous wave
Lhlim	0.264	0.441	Health limits daily activities in the previous wave
Lhlprbnum	1.217	1.345	# of health problems in the previous wave
cignum	3.942	8.025	# of cigarettes smoked per day
sex	0.55	0.497	1 if female, 0 otherwise
age	0.496	0.167	Age/100 in years at 1st December of current wave
age2	2.739	1.781	Squared individual age
black	0.005	0.07	1 if black, 0 otherwise
white	0.978	0.145	1 if white, 0 otherwise
seuk	0.26	0.438	1 if geographical area is South-East of UK, 0 otherwise
wales	0.134	0.34	1 if geographical area is Wales, 0 otherwise
london	0.059	0.236	1 if geographical area is London, 0 otherwise
scotland	0.164	0.37	1 if geographical area is Scotland, 0 otherwise
northie	0.084	0.277	1 if geographical area is North-East of UK, 0 otherwise
restuk	0.084	0.277	1 if geographical area is the rest of UK, 0 otherwise
income	9.979	0.765	Equivalised annual real household income in pounds
unemp	0.025	0.157	1 if economic status is unemployed, 0 otherwise
retired	0.244	0.43	1 if economic status is retired, 0 otherwise
otherjb	0.141	0.348	1 if economic status is student, family care or any other job, 0 otherwise
nonperjob	0.036	0.187	1 if job is not permanent, 0 otherwise
ptime	0.137	0.344	1 if job is part time, 0 otherwise
noadu	0.453	0.498	1 if non-advanced qualifications, 0 otherwise
adu	0.202	0.401	1 if advanced qualifications, 0 otherwise
type1	0.046	0.210	1 if father professional occupation is professional, 0 otherwise
type2	0.200	0.4	1 if father professional occupation is managerial, 0 otherwise
type3	0.079	0.27	1 if father professional occupation is skilled non-manual, 0 otherwise
type4	0.388	0.487	1 if father professional occupation is skilled manual, 0 otherwise
type5	0.138	0.345	1 if father professional occupation is partly skilled, 0 otherwise
type6	0.049	0.216	1 if father professional occupation is unskilled, 0 otherwise
type7	0.015	0.121	1 if father professional occupation is armed forces, 0 otherwise
type8	0.034	0.181	1 if father unemployed, 0 otherwise
type9	0.051	0.219	1 if father deceased or unknown, 0 otherwise
yr96	0.072	0.25	Dummy for wave 6
yr97	0.073	0.26	Dummy for wave 7
yr98	0.087	0.281	Dummy for wave 8
yr99	0.084	0.277	Dummy for wave 9
yr00	0.115	0.319	Dummy for wave 10
yr01	0.115	0.319	Dummy for wave 11
yr02	0.122	0.328	Dummy for wave 12
yr03	0.117	0.322	Dummy for wave 13
yr04	0.109	0.312	Dummy for wave 14
yr05	0.105	0.307	Dummy for wave 15

N=89728

Table 2. Description of main variables over years

Year	Sample Size	Mean age	% in good health	Mean of # cigarettes
1996	6514	47.4	70.7	4.11
1997	6553	47.8	70.4	4.08
1998	7771	48.7	67.6	4.25
1999	7522	49.1	44.6	4.11
2000	10317	49.3	66.1	4.08
2001	10322	49.8	67.3	4.14
2002	10987	49.5	67.4	3.96
2003	10523	50.1	67.7	3.81
2004	9793	50.9	41.5	3.58
2005	9426	51.4	69.1	3.44

Table 3. Smoker/Non-smoker related to the father's social class

	Smoker		
Fath.Soc.Class	**No**	**Yes**	**%**
type1	3,505	618	15.0
type2	14,250	3,731	20.7
type3	5,426	1,674	23.6
type4	25,458	9,350	26.9
type5	9,011	3,367	27.2
type6	3,016	1,403	31.7
type7	968	374	27.9
type8	3,398	1,149	25.3
type9	2,006	1,024	33.8

Table 4. Estimated parameters and marginal effect - Probit Model

Variable	Coef.	Std. Err.	Marg. Eff.	Std. Err.
cignum	-0.0097***	(0.0010)	-0.0034***	(0.0003)
type2	-0.0353	(0.0482)	-0.0126	(0.0173)
type3	-0.1180**	(0.0544)	-0.0429**	(0.0202)
type4	-0.1478***	(0.0468)	-0.0529***	(0.0168)
type5	-0.1215**	(0.0509)	-0.0440**	(0.0188)
type6	-0.2095***	(0.0602)	-0.0775**	(0.0230)
type7	-0.0994	(0.0861)	-0.0361	(0.0319)
type8	-0.1927***	(0.0655)	-0.0711**	(0.0249)
type9	-0.0690	(0.0604)	-0.0249	(0.0221)
sex	0.1219***	(0.0191)	0.0433***	(0.0067)
age	-0.3495	(0.3129)	-0.1243	(0.1113)
age2	0.0923***	(0.0307)	0.0328***	(0.0109)
white	0.3493***	(0.0712)	0.1321***	(0.0280)
black	0.2308	(0.1435)	0.0771*	(0.0446)
income	0.0607***	(0.0115)	0.0215***	(0.0041)
unemp	-0.0871**	(0.0415)	-0.0315**	(0.0152)
retired	-0.0920***	(0.0304)	-0.0330***	(0.0110)
otherjb	-0.2092***	(0.0245)	-0.0768***	(0.0092)
nonperjob	-0.0177	(0.0351)	-0.0063	(0.0125)
ptime	-0.0027	(0.0228)	-0.0009	(0.0081)
adu	0.4101***	(0.0295)	0.1359***	(0.0089)
noadu	0.2368***	(0.0233)	0.0836***	(0.0081)
seuk	0.0635***	(0.0246)	0.0224***	(0.0086)
wales	0.1089***	(0.0295)	0.0379***	(0.0100)
scotland	0.0164	(0.0275)	0.0058	(0.0097)
northie	0.1252***	(0.0329)	0.0433***	(0.0110)
london	-0.0227	(0.0407)	-0.0081	(0.0146)
time7	0.0128	(0.0305)	0.0045	(0.0108)
time8	-0.0352	(0.0295)	-0.0126	(0.0106)
time9	-1.0707***	(0.0290)	-0.4073***	(0.0101)
time10	-0.0789***	(0.0284)	-0.0284***	(0.0103)
time11	-0.0070	(0.0287)	-0.0024	(0.0102)
time12	-0.0541*	(0.0288)	-0.0194*	(0.0104)
time13	-0.0563*	(0.0291)	-0.0202*	(0.0105)
time14	-0.3494***	(0.0338)	-0.1309***	(0.0131)
time15	0.3762***	(0.0346)	0.1228***	(0.0102)
hlim	-1.0090***	(0.0204)	-0.3750***	(0.0074)
hlprbnum	-0.3768***	(0.0075)	-0.1340***	(0.0027)
ghq	-0.0530***	(0.0014)	-0.0188***	(0.0005)
Lhlim	-0.4525***	(0.0209)	-0.1672***	(0.0079)
Lhlprbnum	-0.0910***	(0.0073)	-0.0323***	(0.0026)
Lghq	-0.0201***	(0.0014)	-0.0071***	(0.0005)
Constant	2.0334***	(0.1646)	-	-
Log Likelihood	-37314.012			
# of Observations	89728			
# of Individual	16204			

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Equality decomposition of health status by type approach

	Overall Equality	Opportunity Equality*	Responsibility Equality**	Incidence Opportunity Equality
1996	0.773803	0.998827	0.774711	0.45%
1997	0.755987	0.998714	0.756960	0.45%
1998	0.707721	0.998046	0.709106	0.56%
1999	0.480497	0.994805	0.483006	0.71%
2000	0.693773	0.997856	0.695263	0.58%
2001	0.698832	0.998077	0.700178	0.53%
2002	0.702701	0.998314	0.703887	0.47%
2003	0.708325	0.998083	0.709685	0.55%
2004	0.595012	0.995575	0.597656	0.85%
2005	0.766406	0.998605	0.767477	0.52%

* E_A^B = equality between-types
** E_A^W = equality within-types

Table 6. Equality decomposition of of health status by tranche approach

	Overall Equality	Opportunity Equality*	Responsibility Equality**	Incidence Opportunity Equality
1996	0.762791	0.999364	0.763276	99.76%
1997	0.744048	0.999493	0.744426	99.82%
1998	0.695007	0.999332	0.695472	99.81%
1999	0.463924	0.998965	0.464405	99.86%
2000	0.679951	0.999123	0.680548	99.77%
2001	0.685721	0.999158	0.686299	99.77%
2002	0.690070	0.999119	0.690678	99.76%
2003	0.694421	0.999323	0.694891	99.81%
2004	0.578523	0.998615	0.579325	99.74%
2005	0.753828	0.999363	0.754308	99.77%

* E_A^B = equality between-tranche
** E_A^W = equality within-tranche

Table 7. Equality decomposition of health status by type approach MLD

	Overall Inequality	Opportunity Inequality*	Responsibility Inequality**	Incidence Opportunity Inequality
1996	0.070832	0.000703	0.070128	0.99%
1997	0.073921	0.000769	0.073152	1.04%
1998	0.076296	0.001057	0.075238	1.38%
1999	0.052611	0.001250	0.051361	2.37%
2000	0.072824	0.001064	0.071760	1.46%
2001	0.071880	0.000963	0.070917	1.33%
2002	0.071245	0.000842	0.070402	1.18%
2003	0.074556	0.000997	0.073559	1.33%
2004	0.038778	0.000871	0.037907	2.24%
2005	0.068091	0.000763	0.067328	1.12%

Table 8. Equality decomposition of health status by tranche approach MLD

	Overall Inequality	Opportunity Inequality*	Responsibility Inequality**	Incidence Opportunity Inequality
1996	0.073473	0.000376	0.073096	99.48%
1997	0.072388	0.000287	0.072101	99.60%
1998	0.074523	0.000340	0.074183	99.54%
1999	0.049690	0.000221	0.049469	99.55%
2000	0.071238	0.000406	0.070832	99.42%
2001	0.074339	0.000411	0.073928	99.44%
2002	0.073574	0.000428	0.073145	99.41%
2003	0.072973	0.000331	0.072641	99.54%
2004	0.036540	0.000239	0.036300	99.34%
2005	0.067078	0.000328	0.066749	99.51%

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Università di Palermo and University of York
E-mail address: plidonni@unipa.it

Università di Bari
E-mail address: v.peragine@dse.uniba.it

Università Cattolica di Milano
E-mail address: giuseppe.pignataro@inwind.it