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Abstract

This paper proposes a method to quantify the contribution of inequalities of opportunities and inequalities due to differences in effort to be in good health to overall health inequality. It examines three alternative specifications of legitimate and illegitimate inequalities drawing on Roemer, Barry and Swift's considerations of circumstances and effort. The issue at stake is how to treat the correlation between circumstances and effort. Using a representative French health survey undertaken in 2006 and partly designed for this purpose, and the natural decomposition of the variance, the contribution of circumstances to inequalities in self-assessed health only differs of a few percentage points according to the approach. The same applies for the contribution of effort which represents at most 8%, while circumstances can account for up to 46%. The remaining part is due to the impact of age and sex.

Keywords: equality of opportunity; inequality decomposition; health; effort; circumstances; variance; France

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1. Introduction

Recent developments in the philosophical literature regarding fairness and social justice identify some types of inequality as more objectionable than others. A number of authors (Dworkin 1981; Arneson 1989; Cohen 1989; Roemer 1998; Fleurbaey 2008) have argued that the most obvious justification for making a distinction between "legitimate" and "illegitimate" differences in outcomes is that the former differences can be attributed to factors for which the individual is responsible, whilst the latter differences can be attributed to factors which the individual is not responsible. Following Roemer's framework (1998), the determinants of any outcome can be separated into two components: "circumstances", which are exogenous to the person, such as family background, and "effort", which can be influenced by the person.

This divide may be illustrated by recent debates in the United Kingdom about whether smokers and alcoholics should be candidates for lung and liver transplants. The issue at stake was whether such patients should be considered to have caused their own illness and therefore denied access to transplants (Webb and Neuberger 2004; Bramstedt and Jabbour 2006). The debate was triggered by George Best's controversial liver transplant[1]. In the Guardian on the 5th of October 2005[2], Professor Nigel Heaton, who heads the liver unit at King's College hospital in London and carried out the former Manchester United footballer's operation in 2002, said "*livers are in short supply and the waiting list has grown over the past two to three years. If you knew someone was going to be recidivist you wouldn't take them on for a transplant. The problem is there's just no way of spotting who those people are*". The shortage of liver donors increases pressure on surgeons to pick patients who are likely to benefit most from transplant operations and so, many hospitals within the National Health Service have incorporated a six month alcohol abstinence criterion before organs are transplanted, called the "six month rule" in an effort to select optimal candidates. The rule has two purposes: allowing the liver to recover in the absence of alcohol and observation of the patient to verify that he remains alcohol free with the hope of reducing the risk of relapse after transplantations. It is likely that another motivation is

[1] The soccer legend George Best was given a liver transplant in 2002 after battling with alcoholism for all his adult life. After receiving his liver transplant, he was seen out drinking more than once. He had been warned repeatedly that drinking would kill him, even after his transplant. He died three years later.

[2] *Alcohol abusers should not get transplants, says Best surgeon*, Ian Sample, science correspondent, The Guardian, Wednesday 5 October 2005.

that the acute shortage of organs requires a fair allocation criterion and maintenance of an unhealthy lifestyle can be considered as a voluntary choice carrying with it individual responsibility. This rule illustrates the respect of the "principle of natural reward", i.e. the respect of the impact of effort variables on individual outcome in the health sphere, while the "principle of compensation", which proposes to compensate individuals for inequalities linked to circumstances characteristics would be exemplified by the full coverage of the cost of the transplantation.

Despite the growing interest of policymakers as well as economists in equality of opportunity in health (see for instance Sen 2002; Phillips 2006; Fleurbaey 2006; Dias and Jones 2007; Fleurbaey and Schokkaert 2009) empirical applications remain scarce (Dias 2009; Jusot et al. 2009; Trannoy et al. 2009; Dias 2010). The main reason is that implementation of equal-opportunity policies requires the identification of the contribution of circumstances and effort to observed inequality. This paper proposes a tentative answer to this question by quantifying inequality of opportunity in health inequality in France using a survey from 2006 (Allonier et al. 2008).

Effort is particularly difficult to specify, as it is hard to observe and measure. However, it can be argued that efforts which are done to invest in health capital are easier to observe than efforts in other fields, such as human capital. Lifestyles, such as doing exercise, having a balanced diet, sleeping well, not smoking or not drinking too much, are widely accepted as examples of effort in relation to health, representing individual choices. On this basis, health appears to be a good candidate for an empirical exercise to quantify inequalities of opportunities, that is, inequalities of outcomes that are explained by circumstances not by effort.

Although the description of effort is likely to be less opened to criticism in the health field than in other fields, the precise definitions of the effort to be rewarded and of the circumstances to be compensated for is an open debate in the philosophical literature, mainly because these two determinants cannot be assumed to be independent. More precisely, the issue at stake is how to treat the correlation between circumstances and effort from an ethical point of view.

The challenge in defining effort is illustrated by the debate between Roemer and Barry, considering the case of an Asian student. Roemer observes that *"Asian children generally work hard in school and thereby do well because parents press them to do so. The familial pressure is clearly an aspect of their environment outside their control.*" (Roemer 1998, p.22). According to Roemer, an equal-opportunity policy must respect the individual effort in an approach where *"we could somehow disembody individuals from their circumstances*" (Roemer 1998, p. 15). As a consequence, the extra effort of the Asian student must not be rewarded because it is determined by a characteristic outside his control. Barry responds that nevertheless, *"the fact that their generally high levels of effort were due to familial pressure does not make their having expended high levels of effort less admirable and less deserving than it would have been absent such pressure"* (transcription of Barry's position according to Roemer 1998, p.21). From this point of view, which is the mainstream view in the literature on

incentives, the extra effort of the Asian student should be entirely rewarded and the lack of familial pressure on other types of students should not be compensated[3].

This debate can easily be transposed in the field of health. For instance, is it legitimate to hold the sons of smokers who smoke, less responsible than the sons of non-smokers who smoke? For Barry, this distinction is irrelevant. For Roemer the part of smoking which can be attributed to family background is a circumstance and not an effort. This position is likely less debatable when risk behaviour such as smoking, alcohol abuse or being overwheight is linked to genetic characteristics (see Agrawal and Lynskey 2008 for a review of compelling suggesting that dependence is influenced by heritable factors).

A second issue arises because of the impossibility of respecting the principles of compensation and natural reward for all generations. If we consider that family pressure to educate children is a parental effort, the definition of circumstances to be compensated is less obvious. The transmission of values through parental effort may result in what is seen as effort exerted by the next generation. For instance, eating vegetable and fruits when you were a child makes you more prone to adopt such a diet as an adult. If you give precedence to the young generation in the application of the principle of compensation, then you should consider that the whole initial background represents circumstances, including parental effort despite the link with children's effort. Conversely, if you give precedence to the past generation in the application of the principle of natural reward, then that parental effort must be respected whatever its consequences to the next generation. This latter position corresponds to Swift's viewpoint (Swift 2005; Sorensen 2006; Brighouse and Swift 2009) which argues that *"To the extent that the reproduction of inequality across generations occurs through the transmission of cultural traits, it does so substantially (though not exclusively) through intimate familial interactions that we have reason to value and protect. Preventing those interactions would violate the autonomy of the family in a way that stopping parents spending their money on, or bequeathing money to their kids would not."* (Swift 2005, p. 271). In effect, from Swift's point of view, the family is an association and in Rawls' justice theory, the 'basic liberties' – among them freedom of association – have lexical priority over fair equality of opportunity and the principle of difference (Rawls 1999).

This leads to three possible divides between circumstances and effort. In what we call Barry's view, circumstances are past variables and efforts are the variables which reflect the free will of the present generation. In Roemer's view, the vector of circumstances includes all past variables and the descendant's effort must be cleaned from any contamination coming from circumstances. In Swift's view, the vector of circumstances only includes past variables which have no consequences on children

[3] A possible interpretation of the difference in opinion between Roemer and Barry is that it tallies with a classical opposition in moral philosophical between the control view point and the preference view point. Authors as Arneson (1989) and Cohen (1989) support the view that individuals should be held responsible for factors that are within their own control, while for instance Dworkin (1981) thinks that individuals should be held responsible for their preferences. In that interpretation, Barry would endorse the preference view point and Roemer the control opinion.

effort. In other terms the vector of circumstances must be cleaned from any correlation with child's effort[4].

The goal of this paper is not to discuss the ethical relevance of these views and even less to choose among them. Our purpose is to assess if, empirically, it matters which view is adopted in the measurement of inequalities of opportunity in health. We can observe *a priori* that Roemer's view minimises the magnitude of legitimate inequality in health, whereas Swift's view minimises the magnitude of illegitimate inequality. Our question is to what extent it makes a difference in our appraisal of the respective contribution of circumstances and effort in overall inequality. We propose a simple method to measure the contribution of circumstances and effort of inequalities in health for each view and provide an empirical evaluation in France, based on a representative health survey in 2006. This method relies on the decomposition of variance which has a nice interpretation in the context of equality of opportunity.

The following section describes the methodology. Section 3 describes the data and in particular, the additional questionnaire which we designed to obtain a comprehensive description of effort in health and the circumstances that impact upon health. Section 4 presents the analysis results as well as several robustness checks supporting our findings. A discussion and concluding remarks form the final section.

2. Method

The method we propose consists of two steps. In the first step, we rely on a reduced model to estimate the association between health status and respectively circumstances and effort. In the second step we measure the magnitude of inequalities in health and the respective contributions of circumstances and effort.

2.1 Estimation strategy

In contrast to Fleurbaey and Schokkaert (2009) who propose to focus on a structural model to distinguish the role played by circumstances from the role played by effort on health status, we are primarily interested in capturing correlations between health, effort and circumstances respectively. We are not aiming to understand the causal links existing between determinants. This shortcut is endorsed by the ethical position that every unobservable linked to circumstances is considered as a circumstance and the same goes for effort. For example, at the current state of science, the genes of individuals, whether they are parents or children, are not observed in most data bases. Let us assume that a given gene is associated with an addictive behaviour. This gene will be assimiliated to effort since it is an

[4] An asymmetric version may be more palatable for those who find this recipe too extreme. Swift's view will only apply to parents who had exerted a better or higher effort than the average parents. Having "bad parents" will continue to appear as a circumstance. Descendants who are enough unlucky to have bad parents will be compensated but descendants coming from "good parents" will not be penalised by the redistribution system.

unobservable variable correlated to an effort variable. Then the only ethical issue which is not settled is the status of the correlation between circumstances and effort. In the framework of a reduced form, we can offer an econometric transcription of the three positions detailed in the introduction about the treatment of the correlation between effort and circumstances. Under assumptions, it is enough to consider a reduced model which is straightforward to estimate as there are only three possible groups of determinants of inequalities in health: circumstances, effort and demographic characteristics.

Let us assume that individual health status *H* is a function of a vector of circumstances *C*, a vector of effort variables *E*, age and sex captured by the vector of demographic variables *D* and a residual term *u:*

$$H = f(C, E, D, u) \quad \text{(Eq. 1)}$$

The vector of circumstances consists of a set of variables beyond individual control which may be related to health status. The literature on health determinants suggests an influence of childhood conditions and family background on health status in adulthood (see for example Currie and Stabile 2003; Case et al. 2005; Dias 2009; Lindeboom et al. 2009; Trannoy et al. 2009). Therefore parental health status, parental lifestyles, parental education, parent's socioeconomic status, financial situation during childhood and place of birth are candidate circumstance variables in our analyses. The vector of effort variables capture individual decisions to invest in health capital, such as lifestyles (see for example Balia and Jones 2008; Contoyannis and Jones 2004; Dias 2009).

Age and sex are included to capture biological determinants of health status. Of course, these biological determinants are circumstances in the very sense of the word. Their impact is also distorted by social habits and features of the health care system. We consider it is meaningful to distinguish their influence from the impact of usual circumstances in the framework of this paper, since the discussion opened by the three opinions expressed in the introduction concerns solely family and social circumstances.

A possible interpretation of the residual term appeals to pure luck and others random factors (accident for instance) which cannot be captured by the other determinants. In a regression, the residual term will be uncorrelated to other factors and then its distribution will be even-handed with respect to circumstances, a requirement of equality of opportunity (see Lefranc et al. 2009).

Other outcomes variables such as individual's income, education level or socioeconomic status are not included among the regressors because they probably are endogenous variables and may be correlated with past health (see for example Adams et al. 2003 and Adda et al. 2003 for discussion on this issue). In addition, they are also partly determined by circumstances and it has been shown that the influence of circumstances on health status is mainly indirect through the influence on health status of education and socioeconomic status (Trannoy et al. 2009). At this stage, we are less interested in knowing the pathways through which a factor has an impact on the health outcome. Nevertheless, since

we are interested in the respective effects of *C*, *E* and *D* on *H*, the estimated coefficients will partially reflect the effects of these variables on income, education and SES.

In this framework, systematic differences in health explained by circumstances will be considered as inequalities of opportunities in health, whereas differences in health explained by effort will be recognised as legitimate.

The analysis of equality of opportunities becomes more difficult when we recognise that circumstance and effort are not independent. For example, smoking initiation has been found to be related to mother's education, and parents' smoking behaviour (Dias 2009; Göhlmann et al. 2009; Power et al. 2005). Living with a lone mother during childhood seems to be also associated with greater risks of smoking among young adults (Francesconi et al. 2009). Alcohol consumption among young adults has also been related to father's alcohol consumption (Zhang et al. 1999) and alcoholism in adulthood is also more frequent among individuals who have known adverse childhood circumstances and whose parents were alcohol addicts (Anda et al. 2002). As regard to adult obesity, it is associated with economic conditions in childhood (Power et al. 2005) and to mother's obesity before pregnancy (Laitinen et al. 2001). Furthermore, the timing of maternal employment significantly affects the child's overweight status in later adulthood (von Hinke Kessler Scholder 2008). In France, tobacco smoking, alcohol consumption and regular exercise are more frequent among young adults from lower social origins (Etilé 2007) and obesity in adulthood has been found related to parents' socioeconomic status and episodes of financial hardships during childhood, in particular among women (Khlat et al. 2009).

Considering the interdependence between family background and health related behaviours, there are different views in literature with respect to what belongs to effort and circumstances and we will on focus on three of them which have been exposed in the introduction. We introduce hereafter the estimation framework to test empirically each of those views and highlight their different impacts on the measurement of inequalities of opportunities in health.

According to Barry, descendant's effort has to be fully respected whatever the influence of past circumstances on effort decisions. It allows regressing directly circumstances and efforts variables on health status to measure the correlation between health status and individual efforts in health capital investment on the one hand, and the correlation between health status and circumstances on the other. The health status H_i^B of individual *i* can then be written as follows in Barry's context:

$$H_i^B = \lambda^B + \alpha^B C_i + \beta^B E_i + \gamma^B D_i + u_i \quad \text{(Eq. 2)}$$

Equation (Eq. 2) allows us to test the condition of equality of opportunity in Barry's view by testing the equality of $\hat{\alpha}_B$ to zero. Independence between C_i and E_i is not required.

Roemer's definition of equality of opportunity requires the descendant's effort to be purged of any contamination coming from circumstances. This concept leads to estimate an auxiliary equation which regresses E_i, the effort of individual *i*, against C_i, the circumstances.

It allows isolation of a residual term e_i, the relative effort, which represents individual effort purged from circumstances[5]:

$$E_i = \lambda + \delta C_i + e_i \quad \text{(Eq. 3)}$$

We then substitute the vector of effort E_i for the estimated relative effort $\hat{e}_i$ in the equation of health status. The health status H_i^R of individual *i* can be written in Roemer perspective's as follows:

$$H_i^R = \lambda^R + \alpha^R C_i + \beta^R \hat{e}_i + \gamma^R D_i + u_i \quad \text{(Eq. 4)}$$

Equation (Eq. 4) allows testing the condition of equality of opportunity in Roemer's view by testing the equality of $\hat{\alpha}_R$ to zero, since C_i and e_i are independent.

From Swift's viewpoint, parents' own efforts have to be fully respected in the application of the principle of natural reward in order to encourage parents to transmit a value on effort to their children. In this perspective, the principle of compensation requires including in the vector of circumstances only past characteristics variables purged of their consequences for children effort. As a consequence, the vector of circumstances[6] must be cleaned from any correlations with effort.

Therefore it is necessary to estimate an auxiliary equation which aims at isolating a residual term, which represents circumstances purged from descendant effort. We regress circumstances C_i according to effort E_i as follows[7]:

$$C_i = \tau E_i + c_i \quad \text{(Eq. 5)}$$

We then substitute the vector of circumstances C_i for the estimated relative circumstances $\hat{c}_i$ in the equation for health status. The health status H_i^S of individual *i* in Swift's framework can then be decomposed as follows:

$$H_i^S = \lambda^S + \alpha^S \hat{c}_i + \beta^S E_i + \gamma^S D_i + u_i \quad \text{(Eq. 6)}$$

Equation (Eq. 6) allows us to test the condition of equality of opportunity in Swift's framework by testing the equality of $\hat{\alpha}_S$ to zero, since $\hat{c}_i$ and E_i are independent.

[5] The issue of purging effort from demographic variables in Roemer's perspective has both its pros and cons. Physical exercice comes to mind as an example where it seems odd not to control age (people will reduce exercise when older because of ageing-related health problems independently from a lack of effort). On the opposite, gender does not provide an excuse for the exercice of individual responsibility with respect to smoking or other lifestyles. In the empirical part, we again argue this point in a case by case basis.

[6] As a matter of fact, a strict version of this principle should only require purging the educational parental effort from its consequences on children destiny. However in many contexts, we will not dispose the full description of educational parental effort. Hence, to deal with this imperfection of information, it will be more acute to embrace the full set of circumstances and to clean them from descendant's effort. In doing that, we will obtain a kind of upper bound for Swift's approach.

[7] We consider that controlling demographic variables in Swift's auxiliary equations is not ethically justified. For instance, controlling gender could lead to justify different parental effort in the transmission of healthy lifestyles according to the sex of their child. Analogously, controlling age would mean that birth-rank commands difference in parental effort that are meaningful from an ethical point of view.

In all three approaches, demographic variables are treated on the same footing. This way of doing allows us to interpret the differences in results as differences coming from the treatment of the correlation between effort and circumstances. A large part of the health differences related to biological factors are probably recognised as inescapable at a certain point[8]. Whether this makes health differences due to biological factors legitimate is a philosophical issue that we will not investigate.

2.2 Inequality measurement

The previous framework permits the calculation of the *predicted* health status[9] in each of the three frameworks as follows:

in Barry's context, $\hat{H}_i^B = \hat{\alpha}^B C_i^j + \hat{\beta}^B E_i + \hat{\gamma}^B D_i$ (Eq. 7a)

in Roemer's context, $\hat{H}_i^R = \hat{\alpha}^R C_i + \hat{\beta}^R \hat{e}_i + \hat{\gamma}^R D_i$ (Eq. 7b)

in Swift's context, $\hat{H}_i^S = \hat{\alpha}^S \hat{c}_i + \hat{\beta}^S E_i + \hat{\gamma}^S D_i$ (Eq. 7c)

It appears that there are three different sources of health inequality: circumstances, effort and demographics.

Let us note $\hat{H}_C$ the circumstances-related source of inequalities, $\hat{H}_E$ the effort-related source and $\hat{H}_D$, the demographic-related one. $\hat{H}_C$ corresponds to the first terms of the right-hand side, $\hat{H}_E$ corresponds to the second terms, and $\hat{H}_D$ corresponds to the last terms.

We are interested in quantifying the magnitude of health inequality related to each of these sources. We need to measure inequality using an index which is decomposable by sources and whose decomposition has certain properties, (symmetry; independence of the level of disaggregation; consistent decomposition; population symmetry). We argue in favor of the variance if we are interested in an absolute index and the square of the coefficient of variation if we are interested in a relative index. Shorrocks (1982) showed that if we are interested in an absolute measure of inequality, i.e. a measure invariant to a translation, the variance is a good index and the natural decomposition of the variance is the only one with the desired properties. The same is true for the square of the coefficient of variation, if we are interested in a relative measure of inequality, i.e. a scale invariant measure. Its decomposition by sources is the same as that of the variance. This index belongs to the entropy class.

[8] It could be argued that health differences by age classes are legitimate since they reflect the human destiny and everyone will experiment them soon or later over the life cycle. However, health differences could also depend on the social environment and so, be considered as partly illegitimate.

[9] Since the health status is assessed by a qualitative binary variable, the equations are estimated using Probit regressions. As a consequence, we can use the predicted latent health status as a linearly decomposable measure of health status.

The same relative decomposition[10] for both indices applies. Therefore it does not matter whether we choose an absolute or relative inequality coefficient. The contribution of a source in the natural decomposition of variance is simply given by the covariance between each source of health and the outcome.

In each context j=B, R, S, the decomposition of the variance of health status $\sigma^2(\hat{H}^j)$ is given by:

$$\sigma^2(\hat{H}^j) = \text{cov}(\hat{H}_C, \hat{H}^j) + \text{cov}(\hat{H}_E, \hat{H}^j) + \text{cov}(\hat{H}_D, \hat{H}^j) \quad \text{(Eq. 8)}$$

The contribution of circumstances-related health source is given for Roemer and Swift with j=R, S by

$$\text{cov}(\hat{H}_C, \hat{H}^j) = \sigma^2(\hat{H}_C) + \rho_{CD}\sigma(\hat{H}_C)\sigma(\hat{H}_D) \quad \text{(Eq. 9)}$$

with ρ_{CD} the correlation coefficient between circumstances and demographics variables, $\sigma(\hat{H}_C)$ the standard error of circumstances-related source of inequalities and $\sigma(\hat{H}_D)$ the standard error of demographics-related source of inequalities.

Analogously, for the effort-related source, we have for Roemer and Swift with j=R, S:

$$\text{cov}(\hat{H}_E, \hat{H}^j) = \sigma^2(\hat{H}_E) + \rho_{ED}\sigma(\hat{H}_E)\sigma(\hat{H}_D) \quad \text{(Eq. 10)}$$

with ρ_{ED} the correlation coefficient between effort and demographics variables, $\sigma(\hat{H}_E)$ the standard error of effort-related source of inequalities and $\sigma(\hat{H}_D)$ the standard error of demographics-related source of inequalities. For Barry, the right hand side of Eq. 9 and Eq. 10 contains an additional term relative to the correlation between effort and circumstances.

It should be noticed that the contribution of circumstances to health inequality in the natural decomposition of the variance has then a nice interpretation in the equality of opportunity context. Indeed, Fleurbaey and Schokkaert (2009) propose two approaches for measuring unfair inequalities. The first one, called *inequality direct unfairness*, measures the inequality in health that remains when we have removed all legitimate inequalities, i.e. the share of health inequalities due to effort and demographic characteristics[11]. To get a precise definition, we need to define a reference level. The mean is an obvious candidate. One can easily shows that the *inequality direct unfairness* Θ_{DU} can be written as follows when the variance is used for measuring inequalities and the reference is the mean:

$$\Theta_{DU} = \sigma^2(\hat{H}_C + (\mu(\hat{H}^j) - \mu(\hat{H}_C))1) \quad \text{(Eq. 11)}$$

[10] Each source represents the same proportion of the total inequality.

[11] For this interpretation to be valid, we need to define a dichotomous world, where we can clearly oppose legitimate to illegitimate inequalities. Demographics are then pushed into the basket of legitimate inequalities.

with 1 the unit vector, $\mu(\hat{H}^j)$ the mean of health status and $\mu(\hat{H}_C)$ the mean of circumstances-related source of inequalities.

The second one, called *fairness gap*, measures the difference between total inequality in health and inequality in health that remains when we have removed illegitimate inequalities, i.e; the share of health inequalities due to circumstances. One can easily show that the *fairness gap* Θ_{FG} can be written as follows when the variance is used for measuring inequalities and the reference is the mean:

$$\Theta_{FG} = \sigma^2(\hat{H}^j) - \sigma^2((\hat{H}^j - \hat{H}_C) + \mu(\hat{H}_C)1) \quad \text{(Eq. 12)}$$

It can be readily established[12] that the contribution of circumstances-related source of health inequality with the natural decomposition of the variance is just half of the two above interpretations for the three views:

$$\frac{1}{2}(\Theta_{DU} + \Theta_{FG}) = \text{cov}(\hat{H}_C, \hat{H}^j) \quad \text{(Eq. 13)}$$

3. Data

The French Health, Health Care and Insurance Survey (ESPS survey) is a general population survey carried out by the Institute for research and information in health economics (IRDES) since 1988 (Allonier et al. 2008). It gathers data on health status, access to health care services, health insurance and economic and social status of individuals aged 16 years and above. The 2006 survey included questions on living conditions during childhood and parent's health status and health-related behaviours when the respondent was 12 years old. This set of retrospective questions was answered by the main respondent in each household. The sample contains 6,074 individuals (2,485 men and 3,589 women). The advantage of the ESPS survey is that it contains information on both parents and adult descendants on a nationally representative sample of the French population.

The variable of interest is health in adulthood as measured by self-assessed health (SAH). Individuals were asked to evaluate their health answering the question "*In general would you say that your health is…very good, good, fair, poor, or very poor?*" SAH is widely used in health economics and has been shown to predict mortality (Idler and Benyamini 1997) as well as health-care utilisation (DeSalvo et al. 2005). In the context of the ESPS survey, SAH has been found to be highly correlated with reported disability and number of chronic diseases (Tubeuf and Perronnin 2008). More than 70% of the respondents reported that they had good or very good health.

Three sets of independent variables are considered in the model: circumstances, effort as measured by individual behaviour influencing health, and demographic characteristics. For the sake of sample size and because missing values for parental characteristics may come, in addition from usual

[12] See for instance Shorrocks (1982) pp. 209-210.

causes of non response in interview surveys, from weakened family bonds or from a non nuclear family structure which have been found as a determinant a health status (Montgomery et al. 1996), a 'non response' category has been generated whenever a characteristic was unknown for a share of respondents. The summary statistics of the main variables used in the paper are shown in Table I.

3.1 The vector of circumstances

Due to the specific questions on childhood conditions, circumstances are measured by a large set of variables. Four types of circumstances variables are considered: parents' socioeconomic status, parents' health status, parents' lifestyles and family economic situation during childhood.

Parents' socioeconomic status is measured by both professional status and education level and is available for both parents. Professional status is measured in six categories for the father, namely farmer, craftsman, manager, associate professional, office worker and elementary occupations. A seventh category is added for mothers, homemakers. Five levels are available for education: dropped out, primary school, secondary school 1, secondary school 2, and university degree.

Parents' health is measured in two different ways. On one hand, the descendant retrospectively self-assesses the health status of his parents when he was 12 years old, answering the question: "*When you were 12 years old, how was your father/mother/carer's health status in general? Very good, good, fair, poor, very poor, or deceased*". The three latter categories are summarised in a single category in the model estimation. In addition, the respondent reports parents' date of birth, whether they are still alive at the time of the survey and their date of death, if applicable. Using these variables, we can identify parents with high longevity (i.e. parents who died older than the median age at death of their generation) and parents with a short longevity (i.e those who died younger or same age as the median age at death of their generation). The second variable for parents' health is composed of three different categories: being alive, having had a high longevity and, having had a short longevity. The proportion of alive parents is 63.4% for mothers and 44.9% for fathers.

Two parental health-related behaviours are available in the survey: smoking and alcohol consumption. The descendant reports whether the father, the mother or someone else was smoking in the household when they were 12 years old and whether the father, the mother or someone else was having problems with alcohol in the household. Three binary indicators are used in the analysis measuring father's smoking, mother's smoking and father's alcohol problems. Respondents reported more unhealthy lifestyles for fathers than mothers: over 30% of fathers had problems with alcohol and more than 60% were smoking, whereas less than 10% of mothers are reported as smokers.

Finally, the descendant retrospectively reports whether he considered the financial situation of his family to be very comfortable, comfortable, difficult, or very difficult when he was 12. More than 50% of respondents report that the financial situation of their family was comfortable or very

comfortable. Economic hardships and isolation experienced during childhood are also considered[13]. The respondent reports whether his family ever required help from friends or association for accommodation because of financial difficulties or was homeless at some point during his childhood. They are then asked whether they have suffered sustained social isolation because of adverse life events happened to them or their relatives (war, migration, incarceration….) during childhood. The analysis includes a single indicator identifying whether the individual has experienced economic hardships or/and isolation during childhood. This was positive in 6% of the study sample.

3.2 The vector of effort

Three types of individual efforts are considered: health-related behaviours toward smoking, obesity and vegetables consumption; each of which is considered as a binary variable.

The first effort variable categorises people as currently a non-smoker and a regular smoker; the second effort variable categorises people as non-obese or obese – body mass index (BMI) greater than or equal to 30[14]. BMI was calculated using self-reported height and weight. Clearly, body mass index does not represent a pure indicator of effort since it may also reflect some genetic influence. The Roemer approach can get rid of this impact if data were available. The last effort variable categorises people as eating vegetables every day or not eating vegetables every day.

A substantial majority of the sample report healthy lifestyles; 73% are currently non smoker, 87% are non obese and 77% report that they eat vegetables every day.

As we argue previously, cleaning effort variables from demographics in Roemer's strategy calls for a case by case discussion. Purely lifestyle variables do not represent good candidates for such a treatment. The obesity case is clearly more complex. First the proportion of obese people does not vary much according to gender (only a half-point of difference). Second, there is a clear pattern of increasing obesity along the life cycle, with four more times obese people for the age group 60-70 than for 16-30. It is clear that when getting older, it becomes more difficult (costly) to fight overweight. However, obesity represents a large deviation with respect to the equilibrium between size and weight. It is likely an extreme position to argue that age represents a handicap to avoid obesity. We will not go that far and we do not control age in the auxiliary equation for obesity.

3.3 Econometric strategy

In the first set of analyses, we follow Barry's view and estimate a model describing the correlations between health and a comprehensive set of childhood and family circumstances as well as three individual effort variables.

[13] The 5% non response rate for this indicator is explained by the fact that questions on adverse life experiences during childhood were asked during an other stage of the survey and were not asked to all individuals included in this study.

[14] BMI in kg/m2= weight/height²

In the second set of analyses, three independent equations corresponding to the three individual effort variables are first estimated in order to explain the association between, circumstances and effort in Roemer's framework.

In the third set of analyses, we consider Swift's framework of circumstances and effort. Prior to measuring the influence of circumstances and efforts on health, we estimate a set of 14 circumstances independent equations according to the three individual effort variables.

Finally, we identify and measure the magnitude of inequalities of opportunity in health in the three alternative viewpoints.

The health status variable as well as the three effort variables are qualitative binary variables and so the equations are estimated using Probit regression. The equation of main interest analyses the marginal effects of circumstances and efforts on the probability of reporting a "very good" or a "good" health status versus a "fair", a "poor", or a "very poor" health status[15]. Multinomial logit models are used for the circumstances, excepted for parental health-related behaviours for which Probit models are used. Therefore the equations presented in the previous section correspond to the latent variables underlying the binary indicators of self-assessed health status, tobacco non smoking, avoidance of obesity and daily vegetable consumption, and each circumstance categories.

The non linear specification used does not allow us to undertake a direct estimation of the relative effort $\hat{e}_i$ and the relative circumstances $\hat{c}_i$. We thus compute generalised residuals (see appendix 1), which correspond to the conditional expected value of the residuals given the outcomes (Dubin and McFadden, 1984 ; Gourieroux et al., 1987).

4. Results and discussion

4.1 Health, circumstances and efforts: a reduced-form model

Table II shows the marginal effects of effort and circumstances on the probability of reporting good or very good health, computed at the means of the independent variables for each scenario. The second column of Table II shows the result of the estimation of equation (Eq. 2) corresponding to Barry's framework. The results corresponding to Roemer's framework (Eq. 4) are presented in the third column of Table II. They have been obtained by introducing relative effort in the place of actual effort variables. The relative efforts correspond to the generalised residual terms of the three auxiliary equations regressing efforts variables by circumstances (Eq. 3) whose results are presented in Table III. The results corresponding to Swift's framework (Eq. 6) are presented in the fourth column of Table II. They have been obtained introducing relative circumstances in the place of actual circumstances (Eq. 5). The relative circumstances correspond to the generalised residuals of 3 Probit models and 11

[15] An ordered Probit model estimating SAH rejects the test of parallel lines.

Multinomial Logit regression models of each type of circumstances on the vector of effort variables. The results of these models are presented in Table IV.

When looking quickly at Table II, we have to keep in mind that the marginal effects are not comparable for effort variables between Barry and Roemer approaches since these variables are different from a mathematical point of view. They are dummy variables in the former approach and continuous variables in the latter. The same remark holds for circumstances variables for Barry and Roemer on one hand and Swift on the other hand. However, it is still meaningful to compare the signs of the marginal effects, since they report the result of testing the rejection of the null hypothesis of the equality of the coefficient to the coefficient of the reference category[16] (see column (e) for Swift'scenario).

As expected, consistent across the scenario the probability of having a good or very good SAH reduces with age and is higher for men than for women.

All three individual effort variables are positively and significantly associated with good health in all contexts. When the individual is non smoker, non obese or eats vegetables daily then he is likely to report a better health status. However, only marginal effects associated to effort variables in Barry and Swift's scenarios are comparable. The marginal effects of avoidance of obesity are particularly striking comparing with other effort variables. In comparison with obese people, non obese people are 13.4 percentage points more likely to report very good or good health in Barry's context and this effect reaches 16.4 in Swift's context. Similarly, the absence of smoking is an important determinant of reporting better health; but the marginal effect is considerably smaller than the one associated with avoidance of obesity, with a magnitude of 7.1 percentage points in both contexts. Finally, eating vegetables daily is significantly associated with an increase of 5.1 percentage points in the probability of being in good health in both contexts. It is important to recall that obviously the results do not convey a causal meaning.

A large set of circumstances are also significantly associated with good health. As underlined before, the sign of marginal effects are comparable in all scenarios. There are clearly many more significant categories in Barry and Roemer's scenarios than in Swift's scenario. This means that circumstances purged of the correlation of effort are a much less good predictor of SAH. At this stage, the interplay between cicurcumstances and effort seems to play a significant role explaining differences in perceived healh. Father's health , mother and father's relative longevity, adverse life experience, father and mother's occupation are the specific circumstances that are no more significant in Swift's scenario. We are not going to comment further in that direction as long as the results of the two intermediate tables have not been detailed. We now focus on the magnitude of marginal effects associated to circumstances in both Barry and Roemer's frameworks.

[16] In Swift's scenario, generalised residuals are introduced for each category, including the reference category itself which cannot be labelled as such. Consequently, column (d) reports the result of the usual test of the null hypothesis of equality of the coefficient to 0.

In line with previous empirical studies (Ahlburg 1998; Cournil and Kirkwood 2001; Case et al. 2005; Llena-Nozal 2007; Trannoy et al. 2009), parents' health as well as their relative longevity positively and significantly influence health. Any descendant, whose mother was assessed as being in less than very good health when the descendant was 12, is less likely to report good / better health and the percentage points associated with the mother's level of health increase with a worsening of the mother's reported health. However, for the father, results are only significant for fair health: individuals whose father was assessed as fair health when they were 12 are less likely to report good health, with a marginal effect equal to 6.5 percentage points in Barry's scenario. Regarding the longevity, having deceased parents is a statistically significant determinant of worse health. Differences between a short and a high longevity are not very relevant when we consider fathers but more interesting regarding mothers. Compared to alive mothers, having a mother who died at old age is associated with a 6.9 percentage points lower probability of good health in Barry's scenario whereas having a mother who died at a young age is associated with a 3.9 percentage points lower probability (5.9 and 4.2 in Roemer's). It seems indeed that having an alive mother is a better signal for one's longevity than having a deceased mother. What is striking is that this positive correlation is also true for SAH[17].

Among parent's health-related behaviours, father's alcohol problems are the main determinant of descendant's SAH. Individuals who report that their father was having problems with alcohol when they were 12 years old are more likely to report a less than good health status, with a marginal effect around 3.5 percentage points. Furthermore, the father's smoking behaviour also reduces the probability of reporting good health from 1.7 to 2.5 percentage points however this is only significant at the 10% level in the Roemerian framework. As for mother's smoking, it is never significant.

Adverse events during childhood are statistically significant determinants of health deterioration: spells of economic hardships or social isolation show an 8.0 (resp. 8.7) percentage point lower probability of reporting good health in Barry's scenario (resp. in Roemer's scenario). This is in line with previous work showing that past adverse life experiences is associated with a poorer health status independently of current socioeconomic position (Shaw et al. 1999; Kahn et al. 2006 ; Cambois and Jusot 2010). Similarly, as compared to individuals who reported very difficult family financial situation during their childhood, those reporting difficult, comfortable or very comfortable situations are strongly more likely to be in better health. We can notice a breaking point between reporting a very difficult financial situation as compared to other categories. Compared to a very difficult situation, reporting a difficult situation corresponds to 4.7 percentage point higher probability of reporting good or very good health in Barry's scenario.

The education level of the mother is significantly associated with good health regardless of the scenario and the higher the diploma, the higher the marginal effect on health: compared to descendants of dropped-out mothers, having a mother who went to primary school (respectively university) is

[17] Given that we control the age of descendant, we thus implicitly control the age of the ascendant.

associated with a 8.8 (respectively 11.9) percentage points higher probability of good health in Barry's framework. This finding is consistent across the frameworks and displays higher marginal effects in Roemer's scenario. Paternal education however is significant only for secondary school diploma. It is associated with approximately an 8.5 percent higher probability of reporting good health in Barry's context. This is consistent with results using the UK National Child Development Study (Dias, 2009) which found that the education of the mother had a larger effect than the education of the father.

Unlike father's occupation which was not statistically significant in the model, being born to a mother who was a farmer increased the probability of reporting good health by approximately 4.7 percent compared to being born to a mother in elementary occupations. However, this finding is significant in Roemer's framework only. Individuals who did not know the occupation of their mother or did not have a mother are more likely to report a poorer health status (non response category).

The birth region, as measured by territorial development and planning zones (ZEAT), describes significant effects on health reports. Compared to individuals born in "*Bassin Parisien*", those born in overseas regions or in foreign countries have a 9 percent lower probability of reporting good health in both frameworks and the difference in probability is lowered by 4.0 to 5.1 percentage points for those born in the East region, the South West region, and in the East centre region.

4.2 Understanding the correlation between circumstances and efforts

In Roemer's framework, the lower marginal effects associated with the generalised residual terms of the three effort variables are explained by the significant influence of several circumstances on effort variables, as suggested by the results of the three Probit regressions of effort characteristics presented in Table III. The absence of smoking, the absence of obesity and vegetables intakes are strongly correlated to parents' longevity, parents' health-related behaviours towards smoking and alcohol, parents' occupation, mother's education level, and birth regions, and less significantly correlated to parents' health and adverse life experiences. Furthermore, since the marginal effects associated with efforts variables are purged from any contamination by circumstances when we put the analysis within Roemer's perspective, the effect of circumstances on health is increased in terms of significance and magnitude (Table II). We illustrate with some examples to which extent the results we observe in Roemer's context can be explained by this purge.

The marginal effect associated with the fact of having a mother who was farmer increases from an insignificant 4.1 percentage points in Barry's scenario to a significant 4.7 percentage points in Roemer's scenario (Table II). This change in significance comes from the high correlation linking the fact of having a mother farmer and being non smoker: in Table III, sons of mothers who were farmers have a highly significant 8.1 percentage point higher probability of being non smoker. Similarly, the marginal effects associated with all the categories of mother's education increase by at least 1 percentage point in Roemer's framework compared to Barry's framework (Table II) and this is due to the strong association between mother's education and individual's avoidance of obesity (Table III).

Finally, the higher negative marginal effect on health of being born in East region in Roemer's scenario than in Barry's scenario (Table II) comes from the 5.6 percentage points lower probability of vegetable daily consumption associated with this specific region (Table III).

Swift's perspective is clearly different and helps to shed light on some other phenomena regarding the correlation between effort and circumstances. Table IV presents the marginal effects of the auxiliary equations of Swift's scenarios where each circumstance is purged from efforts. The easiest interpretation of that exercice is to say that Table IV describes how the observation of descendant's lifestyle helps to better predict its family and regional origin. A first look at Table IV, reveals that smoking is not a good predictor of your regional origin, at the exception of the Paris region. On the opposite, diet and obesity tell us more about where the descendant comes from. Quite interestingly, non obese and eating vegetables make the descendant more likely to be native from South-West close to Spain or Center-East (Lyon) close to Italy and less likely to be born in the North close to Belgium and the East close to Germany. France is famous to be at the crossroads of Western Europe where northern and southern influence melt and here comes in an illustration in terms of diet and weight problems. Now going back to Table II, it helps us to understand why the marginal effect of non obese on health raises up to 16 % for Swift perspective although it is bound to 13% for Barry. The correlation between the circumstances and non obese is captured by this variable which makes its impact bigger.

4.3 The relative contribution of each source to inequalities in health.

Using the estimated coefficients of the previous Probit models of the Table II, we can assess how the magnitude of inequalities of opportunity in health changes with the three alternative views.

The last column of Table V gives the magnitude of inequalities in health in the three different scenarios, which is assessed using the variance of the predicted latent health status (Eq. 8). We notice that the magnitude of inequalities in health is very similar across scenarios.

The second, third and fourth columns of Table V recapitulate the share of sources of inequalities in health from one framework to the other. The contribution of circumstances to inequalities in health ranges between 44.5% and up to 46.4% according to the scenario, whereas the contribution of efforts ranges between 6.1% to 8.1%. These findings show the impressive contribution of inequalities of opportunities to overall inequalities in health in France. It is comparable to the contribution of demographic variables which represents almost half of inequalities in health.

The results show also a small difference in the appraisal of the respective contributions of circumstances and effort in overall inequality if we rely on one framework or another.

Inequalities of opportunities are the highest in Roemer's framework and represents 46.4% of inequalities in health. In the Roemerian case, the contribution of circumstances to inequalities in health incorporates both the direct effect of circumstances on health and the effect of circumstances going through individual efforts in health whereas Barry's framework ignores this latter component. As for

Swift's framework, the share of inequalities that can be judged as illegitimate is minimised and represents 44.5% of overall inequalities.

Regarding efforts, Swift's framework exhibits the highest contribution of effort-related characteristics: it is almost equal to 8.1%. The contribution of effort to health inequalities in this framework[18] is 2 percentage points higher than in Roemer's framework. The discrepancy between the two estimations is surpringly small.

Finally, the share represented by demographic variables is around half of inequalities in health in the three scenarios.

4.4 Robustness checks

The robustness of our contribution results has been tested within five other specifications presented in Table VI.

We firstly ignore all unsignificant circumstances (their value is replaced by zero in the estimate of the latent predicted health status) in the computation of the contribution to the variance. The variance of predicted health becomes much lower in Swift's scenario than in the two other scenarios. It reflects the much lower power of prediction of cleaned circumstances as testified by the quite large number of categories which are found to be non significant. By the same token, the contribution of circumstances in Swift's scenario is reduced to 38.9% whereas the contribution of efforts is much higher in Swift's scenario and represents 11.5%. This value represents the highest figure for the relative contribution of effort for all the variants. The relative contributions are less affected in the two other scenarios.

Secondly, considering that we have a larger set of circumstances than the set of effort variables, we only focus on the three most significant circumstances in the full model, namely mother's health, father's longevity and mother's education and calculate the variance under those conditions. The total inequality is reduced to 0.38 and the contribution of demographics variables represents almost two thirds of it. The contribution of efforts to health inequality in the three scenarios is very similar to the contribution of efforts in the full model (8.4% in Swift's framework and 6.9% in Roemer's scenario). Since circumstances are less numerous, the contribution of circumstances is lower than in the full model but a 2 percentage points difference is still observed between Roemer and Swift's scenarios, which supports our benchmark findings.

Third, we only consider parents' health status, longevity and health-related behaviors among the circumstances. The differences between contributions within the three scenarios are less marked but a similar pattern applies: the contribution of effort is maximised in Swift's scenario representing 9% of

[18] A maximal version of Swift's concept is considered in Eq. 6, but we have attempted different variations (see footnotes 3 and 5) around Swift's position. Nevertheless, in view of the small fraction represented by the inequality due to differences of effort, we have decided not to pursue in this direction.

total inequality (8.4% in Roemer's scenario) and the contribution of circumstances is higher in Roemer's scenario with 35% of total inequality.

Forth, we then retain parents' socioeconomic status (occupation and education level) and economic conditions during childhood among circumstances. Health inequality is thus explained in Swift's scenario at 9.1% by efforts (7.2% in Roemer's scenario) and 23.1% by circumstances (25.2% in Roemer's scenario). Comparing the results of this scenario with the previous one, it appears thus that parents' health-related circumstances explain a larger part of health inequalities than parents' socioeconomic status and this may come from the intergenerational transmission of health showed in Trannoy et al. (2009).

We finally calculate total health inequality with only mothers' characteristics and then only fathers' characteristics. The level of circumstances-related inequalities is higher when we only consider mothers' characteristics, which suggests that mother's characteristics explain more health heterogeneity than father's characteristics.

All in all, the contribution of circumstances is much higher than the contribution of effort in all scenarios. What is striking is that the contribution of effort never is beyond 11.5% regardless of the specification and does not approach half of the contribution of circumstances in the most favorable scenario.

5. Conclusion

This paper sought to quantify the respective share of inequalities of opportunities and legitimate inequalities in overall inequality in health in France. It also discusses the cut-point between legitimate and illegitimate inequalities according to three viewpoints from the literature on social justice on how should be treated the correlation between circumstances and effort. We used a simple method firstly to measure the relative contributions of circumstances and effort to inequalities in health and secondly to compare the findings obtained under three different conceptions about the correlation within a reduced form. Under Barry's view, the correlation is split between effort and circusmtances according to the rules of regression. Under Roemer's view, all the correlation is treated as a circumstance. Under Swift's view, all the correlation adds to effort. These two latter conceptions may be seen as extreme. Their interest is to offer a kind of lower and upper bound for the contribution of effort to health inequality. The empirical evaluation, based on a representative French Health Survey in 2006, shows that the share of inequalities of opportunities in health inequalities does not vary much (44.5% to 46.4%) according to the adopted definition of individual effort and circumstances. Still, compared to Roemer's conception, Swift's conception leads to a 33% increase in the share of legitimate inequalities. This figure is all but negligible but since effort counts little in our data set, it does not make a large difference to consider one view rather than another, and the contribution of effort is comprised between a lower bound of 6% and an upper bound of 8%. Regardless of the viewpoint, the bottom line of our findings is that the share

of inequality related to circumstances remains very large in comparison to the share of inequalities related to effort. Adult health is significantly determined by parents' social background, as measured by their education level and their professional status, financial situation during childhood, parents' health status, as measured by both longevity and self-perceived health status, and finally parents' smoking and alcohol problems. The analysis of the association between effort and circumstances has also emphasised intergenerational transmission of lifestyles in relation to smoking and diet.

However, our approach has some drawbacks. Firstly, analogously to any non linear regression-based inequality analyses, we only decompose the contribution of effort and circumstances within the explained part of health inequality. We can suspect that there is an unexplained part in these regression-based inequality measures due to the presence of unobserved heterogeneity in econometric models for cross sectional data. Indeed, Van Doorslaer and Jones (2002), using the Canadian National Population Health Survey of 1994, shows that while a regression model for health explains up to a 96% of the concentration index, only 48% of total inequality in health, as measured by the Gini index, can be explained by the same model. Secondly, self-assessed health has been found to suffer from individual reporting heterogeneity (Bago d'Uva et al., 2007). Nevertheless, a French study shows that SAH is the least biased health indicator as compared to several other indicators (Devaux et al., 2008). However, it would be nice to replicate the methodology on different health variables, such as longevity, handicap, etc. Finally, it would have been preferred to have other measures for individual effort such as eating breakfast, sleeping and physical exercice as in Balia and Jones (2004). And yet, looking at the results obtained from these authors[19], it is doubtful that the magnitude of the contribution of effort would have changed dramatically, provided we have had the data.

These considerations open the debate on the determinants to be tackled for the reduction of health inequalities: health-related behaviours or poor effects of past conditions. Nevertheless, causality analyses are still needed to establish the appropriate public policies to tackle or compensate for those inequalities or to cope with more sophisticated ethical positions.

[19] See table 1, results for equation (2) p.22. It gives results from regressing SAH to lifestyle and socio-economic variables. Only non obese and exercice are significant.

6. References

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7. Tables

Table I. Descriptive statistics

	Frequency	Percentage
Sex		
Men	2485	40.91
Women	3589	59.09
Age		
less than 30	842	13.86
30 -39	1226	20.18
40-49	1280	21.07
50-59	1119	18.42
60-69	698	11.49
more than 70	909	14.97
Self-assessed health		
Very good	1177	19.38
Good	3279	53.98
Fair	1351	22.24
Poor	211	3.47
Very poor	56	0.92
Health-related behaviours		
Non smoker	4444	73.16
Daily vegetable consumption	4691	77.23
Non Obese	5305	87.34
Childhood circumstances		
Mother's self-assessed health		
Very good	2273	37.42
Good	2698	44.42
Fair	736	12.12
Poor. very poor and deceased	314	5.17
Non response	53	0.01
Father's self-assessed health		
Very good	2470	40.67
Good	2331	38.38
Fair	601	9.89
Poor. very poor and deceased	388	6.39
Non response	284	4.68
Mother's longevity		
Short longevity	1044	17.19
High longevity	1012	16.66
Alive	3851	63.4
Non response	167	2.75
Father's longevity		
Short longevity	1358	22.36
High longevity	1606	26.44
Alive	2725	44.86
Non response	385	6.34
Parents' health-related behaviours		
Father's alcohol problems	1926	31.71
Father's tobacco smoking	3835	63.14
Mother's tobacco smoking	523	8.61
Childhood circumstances		
Adverse life experiences		
No adverse life experience	5361	88.26
During childhood	351	5.78
Non response	362	5.96
Financial situation	6074	100
Very confortable	294	4.84
Confortable	2929	48.22
Difficult	2249	37.03
Very difficult	507	8.35
Non response	95	1.56
Mother's occupation		
Farmer	551	9.07
Craftmen	360	5.93
Manager	126	2.07
Associate prof.	440	7.24
Office worker	1914	31.51
Elementary jobs	956	15.74
Inactive	1547	25.47
Non response	180	2.96
Father's occupation		
Farmer	761	12.53
Craftmen	492	8.1
Manager	617	10.16
Associate prof.	718	11.82
Office worker	574	9.45
Elementary jobs	2593	42.69
Non response	319	5.25
Mother's education level		
Drop out	448	7.38
Primary school	3178	52.32
Secondary school 1	980	16.13
Secondary school 2	482	7.94
University degree	380	6.26
Non response	606	9.98
Father's education level		

Drop out	336	5.53
Primary school	2822	46.46
Secondary school 1	1036	17.06
Secondary school 2	371	6.11
University degree	570	9.38
Non response	939	15.46
Total sample	6074	100

Table II. Marginal effects of efforts and circumstances on the probability of reporting a good health status in the three scenarios (Probit models)

	Barry's scenario		Roemer's scenario		Swift's scenario		
Regressors	(a)		(a) (b)		(a) (c)	(d)	(e)
Health related behaviours							
Non smoking	0.0708	***	0.0394	***	0.0702	***	***
Non obese	0.1336	***	0.0656	***	0.1642	***	***
Vegetable	0.0511	***	0.0287	***	0.0512	***	***
Sex							
Female	-0.0310	***	-0.0310	***	-0.0309	***	***
Age classes (ref: more than 70)							
Less than 30	0.2503	***	0.2497	***	0.2496	***	***
30-39 years old	0.2524	***	0.2522	***	0.2524	***	***
40-49 years old	0.2192	***	0.2193	***	0.2194	***	***
50-59 years old	0.1755	***	0.1760	***	0.1760	***	***
60-69 years old	0.1556	***	0.1562	***	0.1554	***	***
Father's health (ref: very good)					-0.0247		
Good	-0.0009		0.0007		-0.0245		
Fair	-0.0649	***	-0.0628	***	-0.0441		
Poor. very poor	-0.0160		-0.0091		-0.0092		
Non response	0.0149		0.0192		0.0062		
Mother's health (ref: very good)					-0.1318		
Good	-0.0346	**	-0.0368	**	-0.2076		**
Fair	-0.1036	***	-0.1086	***	-0.0953	**	
Poor. very poor	-0.1153	***	-0.1194	***	-0.0570	**	
Non response	-0.1233		-0.1348	*	-0.0275		
Father's relative longevity (vs. alive)					0.0146		
Short longevity	-0.0374	**	-0.0462	**	-0.0153		
High longevity	-0.0343	*	-0.0327	*	-0.0150		
Non response	-0.1052	**	-0.1210	***	-0.0408	*	
Mother's relative longevity (vs. alive)					0.0588		
Short longevity	-0.0389	**	-0.0417	**	-0.0031		
High longevity	-0.0686	***	-0.0588	***	-0.0261		
Non response	-0.0411		-0.0267		-0.0049		
Parents' health-related behaviours							
Father's smoking	-0.0172		-0.0246	*	-0.0111		
Mother's smoking	0.0059		-0.0019		0.0024		
Father's alcohol problems	-0.0345	**	-0.0366	***	-0.0207	**	**
Adverse life experiences (vs. no)					0.4502		
During childhood	-0.0801	***	-0.0874	***	-0.0063		
Non response	0.0057		0.0042		0.0391		
Family financial situation (ref: very difficult)					-0.0247		
Very comfortable	0.0534	*	0.0477		0.0100		
Comfortable	0.0621	***	0.0602	***	0.0625		
Difficult	0.0466	**	0.0488	**	0.0329		
Non response	0.0700		0.0755	*	0.0128		
Mother's occupation (vs elementary jobs)					0.0001		
Farmer	0.0411		0.0471	*	0.0207		
Craftmen	-0.0143		-0.0041		-0.0147		
Manager	0.0803		0.0815		0.0336		
Associate prof.	0.0207		0.0266		0.0049		
Office worker	0.0254		0.0269		0.0460		
Inactive	0.0156		0.0237		0.0254		
Non response	0.0671	*	0.0675	*	0.0279		
Father's occupation (vs elementary jobs)					-0.1442	*	
Farmer	0.0073		0.0118		-0.0392		*
Craftmen	-0.0189		-0.0162		-0.0417	**	
Manager	-0.0055		0.0042		-0.0398		
Associate prof.	0.0084		0.0178		-0.0331		*
Office worker	0.0050		0.0059		-0.0293		*
Non response	0.0299		0.0322		0.0002		*
Mother's education level (vs drop out)					-0.0696	***	
Primary school	0.0879	***	0.1001	***	-0.0991		
Secondary school 1	0.1061	***	0.1167	***	-0.0072		**
Secondary school 2	0.1132	***	0.1236	***	0.0108		***
University degree	0.1190	***	0.1269	***	0.0204		***
Non response	0.0598	*	0.0657	**	-0.0360		
Father's education level (vs drop out)					-0.0280		
Primary school	0.0423		0.0398		-0.0420		
Secondary school 1	0.0375		0.0328		-0.0169		
Secondary school 2	0.0848	**	0.0838	**	0.0255		**
University degree	0.0509		0.0487		-0.0014		
Non response	0.0204		0.0120		-0.0320		
Birth region (vs. Bassin Parisien)					0.1037	*	
Parisian region	0.0010		0.0047		0.0763	**	
North	-0.0353		-0.0391		0.0292		**
East	-0.0475	*	-0.0509	**	0.0279		**
West	-0.0029		0.0010		0.0777	*	

South West	-0.0510	**	-0.0414	*	0.0268	**
East Centre	-0.0402	*	-0.0295		0.0441	**
Mediterranean	-0.0132		-0.0111		0.0360	*
Non metropolitan France	-0.0909	***	-0.0895	***	0.0126	***
Obs probability	0.7336		0.7336		0.7336	
Predicted probability at x-bar	0.7712		0.7712		0.7715	
Pseudo R2	0.1743		0.1742		0.1747	

(a) Significance levels of test of rejecting the hypothesis of the nullity of the coefficient: *** 1%, **5%, *10%.
(b) In Roemer's scenario, the generalised residuals of the auxiliary equations presented in table III are substituted to children health-related behaviours.
(c) In Swift's scenario, the generalised residuals of the auxiliary equations presented in table IV are substituted to childhood circumstances.
(d) Significance levels of test of rejecting the hypothesis of the equality to 0 of the coefficient.
(e) Significance levels of test of rejecting the hypothesis of the equality to the coefficient to the coefficient of the reference category: *** 1%, **5%, *10%.

Table III. Results of the auxiliary estimation for Roemer's view: Marginal effects of circumstances on the probability of doing efforts (Probits models)

	Non smoker		Non obese		Eating vegetables	
Regressors	(a)		(a)		(a)	
Father's health (ref: very good)						
Good	-0.0169		0.0229	**	-0.0070	
Fair	-0.0209		0.0197		0.0081	
Poor. very poor	-0.0081		0.0379	**	0.0287	
Non response	-0.0615		0.0374		0.0432	
Mother's health (ref: very good)						
Good	0.0251	*	-0.0241	**	-0.0140	
Fair	0.0188		-0.0325	**	-0.0312	
Poor. very poor	0.0073		-0.0108		-0.0600	**
Non response	-0.0143		-0.0379		-0.0916	
Father's relative longevity (vs. alive)						
Short longevity	-0.0132	***	-0.0567	***	-0.0105	
High longevity	-0.0585		-0.0424	***	0.0665	***
Non response	-0.0156		-0.0862	**	-0.0481	
Mother's relative longevity (vs. alive)						
Short longevity	0.0557	***	-0.0526	***	0.0005	
High longevity	0.1572	***	-0.0337	**	0.0668	***
Non response	0.0951	**	0.0052		0.0928	**
Parents' health-related behaviours						
Father's smoking	-0.0803	***	-0.0084		-0.0269	**
Mother's smoking	-0.0864	***	-0.0112		-0.0154	
Father's alcohol problems	-0.0275	**	-0.0012		0.0015	
Adverse life experiences (vs. no)						
During childhood	-0.0763	**	-0.0080		-0.0017	
Non response	-0.0231		-0.0023		0.0175	
Family financial situation (ref: very difficult)						
Very comfortable	-0.0542		-0.0096		-0.0387	
Comfortable	-0.0123		0.0072		-0.0435	**
Difficult	0.0231		0.0115		-0.0183	
Non response	0.0720		0.0089		0.0318	
Mother's occupation (vs elementary jobs)						
Farmer	0.0812	***	0.0014		0.0430	
Craftmen	0.0481	*	0.0190		0.0792	***
Manager	-0.0481		0.0053		0.0557	
Associate prof.	0.0010		0.0301		0.0439	*
Office worker	-0.0143		0.0103		0.0232	
Inactive	0.0201		0.0303	**	0.0538	***
Non response	-0.0238		0.0148		0.0010	
Father's occupation (vs elementary jobs)						
Farmer	0.0749	***	-0.0075		0.0348	
Craftmen	0.0208		0.0011		0.0236	
Manager	0.0725	**	0.0191		0.0442	*
Associate prof.	0.0657	***	0.0270	*	0.0281	
Office worker	0.0199		-0.0150		0.0315	*
Non response	0.0041		0.0345		-0.0602	
Mother's education level (vs drop out)						
Primary school	0.0308		0.0534	***	0.0408	
Secondary school 1	0.0112		0.0581	***	0.0620	**
Secondary school 2	0.0243		0.0631	***	0.0524	
University degree	-0.0243		0.0755	***	0.0312	
Non response	-0.0157		0.0425	**	0.0086	
Father's education level (vs drop out)						
Primary school	-0.0154		-0.0234		0.0317	
Secondary school 1	-0.0524		-0.0147		0.0049	
Secondary school 2	-0.0652		0.0093		0.0338	
University degree	-0.0493		-0.0056		0.0288	
Non response	-0.0673	*	-0.0350		0.0039	
Birth region (vs. Bassin Parisien)						
Parisian region	0.0032		0.0199		0.0165	
North	-0.0144		-0.0098		-0.0143	
East	-0.0029		-0.0017		-0.0560	**
West	-0.0116		0.0448	***	-0.0427	**
South West	-0.0048		0.0569	***	0.0143	
East Centre	0.0267		0.0465	***	0.0319	
Mediterranean	-0.0207		0.0239		-0.0052	
Non metropolitan France	0.0379	*	-0.0059		-0.0212	
Obs P.	0.7316		0.8734		0.7723	
Predicted P at x-bar	0.7502		0.8851		0.7807	
Pseudo R2	0.0709		0.0479		0.0332	

(a) Significance levels of test of rejecting the hypothesis of the nullity of the coefficient: *** 1%, **5%, *10%.

Table IV. Results of the auxiliary estimation for Swift's view: Marginal effects of effort variables on the probability of having been exposed to circumstances (Multinomial Logit Models)

Dependent Variables	Non smoker		Non obese		Eating vegetables	
Father's health (a) (b)						
Very good	0.0137		0.0171		0.0274	*
Good	0.0101		0.0035		-0.0188	
Fair	-0.0031		-0.0089		0.0038	
Poor. very poor	-0.0008		-0.0057		0.0059	
Non response	-0.0198	***	-0.0059		-0.0184	***
Mother's health (a) (b)						
Very good	-0.0229		0.0557	***	0.0424	***
Good	0.0158		-0.0179		-0.0169	
Fair	0.0044		-0.0250*		-0.0115	
Poor. very poor	0.0038		-0.0107		-0.0114	
Non response	-0.0012		-0.0020		-0.0026	
Father's relative longevity (a) (b)						
Short longevity	-0.0262	**	-0.0746	***	-0.0267	**
High longevity	0.1474	***	-0.0769	***	0.0952	***
Alive	-0.1035	***	0.1698	***	-0.0450	***
Non response	-0.0177	**	-0.0183	*	-0.0236	***
Mother's relative longevity (a) (b)						
Short longevity	0.0337	***	-0.0972	***	-0.0113	
High longevity	0.1266	***	-0.0504	***	0.0655	***
Alive	-0.1639	***	0.1551	***	-0.0566	***
Non response	0.0037		-0.0075		0.0025	
Parents' health-related behaviours (a) (c)						
Father's smoking	-0.0834	***	-0.0513	***	-0.0088	
Mother's smoking	-0.0600	***	0.0122		-0.0088	
Father's alcohol problems	-0.0420	***	-0.0564	***	-0.0015	
Adverse life experiences (a) (b)						
No adverse life experience	0.0349	***	0.0149		-0.0031	
During childhood	-0.0259	***	-0.0128		-0.0022	
Non response	-0.0090		-0.0022		0.0053	
Family financial situation (a) (b)						
Very comfortable	-0.0148	**	-0.0019		0.0028	
Comfortable	-0.0333	**	0.0455	**	-0.01861	
Difficult	0.0508	***	-0.0139		0.0110	
Very difficult	-0.0062		-0.0284	**	-0.0029	
Non response	0.0035		-0.0012		0.0020	
Mother's occupation (a) (b)						
Farmer	0.0699	***	-0.0256	**	0.0170	*
Craftmen	0.0126	*	0.0045		0.0204	***
Manager	-0.0104	**	0.0099	**	0.0046	
Associate prof.	-0.0132	*	0.0398	***	0.0086	
Office worker	-0.0784	***	0.0273		-0.0207	
Elementary job	-0.0157		-0.0337	**	-0.0438	***
Inactive	0.0433	***	-0.0197		0.0221	*
Non response	-0.0080		-0.0024		-0.0083	
Father's occupation (a) (b)						
Farmer	0.0868	***	-0.0237	*	0.0300	***
Craftmen	0.0019		0.0051		0.0131	
Manager	-0.0067		0.0466	***	0.0221	**
Associate prof.	0.0052		0.0482	***	0.0068	
Office worker	-0.0134		-0.0149		0.0078	
Elementary job	-0.0545	***	-0.0573	***	-0.0526	***
Non response	-0.0193	***	-0.0040		-0.0272	***
Mother's education level (a) (b)						
Drop out	0.0120	*	-0.0537	***	-0.0229	***
Primary school	0.0969	***	-0.0592	***	0.0191	
Secondary school 1	-0.0425	***	0.0493	***	0.0118	
Secondary school 2	-0.0125		0.0386	***	0.0092	
University degree	-0.0243	***	0.0410	***	0.0067	
Non response	-0.0296	***	-0.0158		-0.0239	***
Father's education level (a) (b)						
Drop out	0.0137	**	-0.0255	**	-0.0179	**
Primary school	0.1082	***	-0.0639	***	0.0490	***
Secondary school 1	-0.0478	***	0.0426	***	-0.0195	*
Secondary school 2	-0.0093		0.0296	***	0.0110	
University degree	-0.0144	*	0.0507	***	0.0194	**
Non response	-0.0504	***	-0.0336	**	-0.0420	***
Parents' health-related behaviours (a) (c)						
Father's smoking	-0.0834	***	-0.0513	***	-0.0088	
Mother's smoking	-0.0600	***	0.0122		-0.0088	
Father's alcohol problems	-0.0420	***	-0.0564	***	-0.0015	
Birth region (a) (b)						
Parisian region	-0.0216	**	0.0177		0.0173	*
Bassin Parisien	-0.0040		-0.040	**	0.0051	

North	-0.0126		-0.0258	**	-0.0079	
East	-0.0054		-0.0210	*	-0.0279	***
West	0.0063		0.0346	***	-0.0193	*
South West	0.0069		0.0335	***	0.0182	**
East Centre	0.0156	*	0.0339	***	0.0266	***
Mediterranean	-0.0062		0.0091		0.0055	
Non metropolitan France	0.0211	**	-0.0424	***	-0.0177	*

(a) In multinomial Logit models, the marginal effects correspond to the change of the probability to belong to each category versus all other categories for a discrete change of the dummy variables associated to children' health-related behaviours from 0 to 1.

(b) Significance levels of test of rejecting the hypothesis of the nullity of the marginal effect: *** 1%, **5%, *10%.

(c) The associations between children's health-related behaviours and parents' health-related behaviours have been estimated separately for each parents' health-related behaviour using binary Probit models.

Table V. Decomposition of inequalities in health according to the three sources, circumstances, effort and demographics (Benchmark case)

Full model	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	45.70%	6.71%	47.59%	0.435
Roemer's scenario	46.43%	6.14%	47.43%	0.435
Swift's scenario	44.54%	8.14%	47.32%	0.437

Table VI. Decomposition of inequalities in health according to the three sources, circumstances, effort and demographics: Robustness checks

With zero for non significant coefficients	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	43.74%	6.81%	49.45%	0.413
Roemer's scenario	44.62%	6.47%	48.91%	0.413
Swift's scenario	38.90%	11.50%	49.61%	0.319

With 3 circumstances (mother's health, father's longevity, mother's education)	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	32.17%	7.45%	60.38%	0.383
Roemer's scenario	32.87%	6.85%	60.28%	0.384
Swift's scenario	30.72%	8.40%	60.89%	0.382

With only parents' health status related circumstances	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	34.83%	8.42%	56.75%	0.362
Roemer's scenario	35.04%	8.37%	56.59%	0.362
Swift's scenario	34.12%	8.95%	56.93%	0.364

With only parents' socioeconomic status related circumstances	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	24.45%	7.85%	67.70%	0.377
Roemer's scenario	25.19%	7.17%	67.63%	0.377
Swift's scenario	23.14%	9.10%	67.76%	0.376

With only father's circumstances	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	28.54%	8.13%	63.33%	0.369
Roemer's scenario	29.79%	6.19%	64.02%	0.365
Swift's scenario	27.33%	9.16%	63.50%	0.369

With only mother's circumstances	Contribution of circumstances-related health source to inequalities	Contribution of effort-related health source to inequalities	Contribution of demographic-related health source to inequalities	Total inequality (Variance)
Barry's scenario	34.62%	7.62%	57.77%	0.384
Roemer's scenario	34.21%	8.14%	57.64%	0.385
Swift's scenario	33.58%	8.59%	57.83%	0.383

Appendix 1 : General residuals

The qualitative nature of efforts and circonstances variables within the analysis does not allow us to undertake a direct estimation of relative efforts $\hat{e}_i$ and relative circumstances $\hat{c}_i$, which respectively correspond to efforts purged from any correlation with circunstances in Roemer's scenario and to circumstances purged from any correlation with efforts in Swift's scenario. Therefore, we estimate the relative efforts and the relative circumstances computing generalised residuals. We expose both the cases of binary and polytomic variables.

If we firstly consider binary outcomes such as being a current smoker in the case of effort or having a father which was a smoker in the case of circumstance, we assume that Y^*, the unobservable latent variable underlying the binary outcome Y is a linear function of a vector of explanatory variables X and an error term η :

$$Y^* = Xb + \eta \quad \text{(A1)}$$

with $Y^* \geq 0$ when $Y = 1$, and $Y^* < 0$ when $Y = 0$.

As Y^* is unobservable, the residual term $\hat{\eta}$ cannot be observed. According to Gourieroux et al. (1987), it can be replaced by its best prediction, called the generalised residual, which is its conditional expected value given the outcome.

If we assume that the error term η is normally distributed, we use binary Probit models to regress binary outcomes and the generalised residual can be computed as follows:

$$E(\eta/Y) = \frac{\varphi(Xb)}{\Phi(Xb)[1-\Phi(Xb)]}[Y - \Phi(Xb)] \quad \text{(A2)}$$

where φ and Φ respectively are the density and cumulative density function of *N(0,1)*.

If we now consider polytomous unordered outcomes such as circumstances like father's occupation or birth region , we use multinomial logit models (Dubin and McFadden, 1984) to purge those circumstances from any correlation with efforts variable. When modelling, we assume the existence of *K* latent variables Y_k^* *(k=1, ...K)* corresponding to the *K* categories (including the reference category) of the observed qualitative variable Y.

Each latent variable Y_k^* is assumed to be a linear function of a vector of exploratory variables X and an error term η_k with a standard Type I extreme value distribution :

$$Y_k^* = Xb_k + \eta_k \quad \text{(A3)}$$

For identification issue, the parameters b_k are assumed to equal zero for the reference category.

The outcome variable $Y = j$ is observed if and only if the category $j \in (k = 1,...,K)$ is chosen, which happens when:

$$Y_j^* > \max_{s \neq j} Y_s^* \qquad \text{(A4)}$$

with $s \in (k = 1,...,K)$

The generalised residuals of each latent variable can be computed as follows:

$$E\left(\eta_j / Y_j^* > \max_{s \neq j} Y_s^*\right) = -\ln P_j \frac{\sqrt{3}}{\pi} \qquad \text{(A5 a)}$$

$$E\left(\eta_s / Y_j^* > \max_{s \neq j} Y_s^*\right) = \frac{P_s \ln(P_s)}{1 - P_s} \frac{\sqrt{3}}{\pi}, \forall s \neq j \qquad \text{(A5 b)}$$

with $P_j = P(Y = j / X) = \frac{\exp(Xb_j)}{\sum_{k=1}^{K} \exp(Xb_k)}, \forall j = 1,...., K$

It should be noticed that the generalised residuals needs not be equal to zero for the reference category. The introduction of both the generalised residuals of efforts as explanatory variables in the health equation in Roemer's scenario and the generalised residuals of circumstances in the health equation in Swift's scenario, implies that coefficients or maginal effects are not directly comparable with Barry's scenario. First, the marginal effects associated to generalised residuals are not directly comparable to those associated to dummy variables because of scale difference: generalised residuals are continous variables. Moreover, in the case of polytomous outcomes, a generalised residual is introduced for each category, including the reference category itself. Therefore each generalised residual describes the propensity to belong to a specific category versus all the other categories and not in reference to the reference category. However in all cases, the signs of the marginal effects associated to relative efforts and relative circumstances remain interpretable and indicate whether the characteristics has a positive or a negative association with health status.