HEALTH ECONOMICS
Health Econ. **22**: 1470–1495 (2013)
Published online 24 January 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/hec.2896

CIRCUMSTANCES AND EFFORTS: HOW IMPORTANT IS THEIR CORRELATION FOR THE MEASUREMENT OF INEQUALITY OF OPPORTUNITY IN HEALTH?

FLORENCE JUSOT[a], SANDY TUBEUF[b,*] and ALAIN TRANNOY[c]

[a]*PSL, Université Paris-Dauphine, LEDa-LEGOS, Paris, France*
[b]*Academic Unit of Health Economics, University of Leeds, Leeds, UK*
[c]*Aix-Marseille Université (Aix-Marseille School of Economics), EHESS & CNRS, Marseille, France*

ABSTRACT

The way to treat the correlation between circumstances and effort is a central, yet largely neglected issue in the applied literature on inequality of opportunity. This paper adopts three alternative normative ways of treating this correlation championed by Roemer, Barry and Swift and assesses their empirical relevance using survey data. We combine regression analysis with the natural decomposition of the variance to compare the relative contributions of circumstances and efforts to overall health inequality according to the different normative principles. Our results suggest that, in practice, the normative principle on the way to treat the correlation between circumstances and effort makes little difference on the relative contributions of circumstances and efforts to explained health inequality. Copyright © 2013 John Wiley & Sons, Ltd.

Received 7 February 2011; Revised 3 July 2012; Accepted 29 November 2012

KEY WORDS: circumstances; efforts; equality of opportunity; health; inequality decomposition; variance decomposition

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, whereas 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 'efforts', which are under the control of the person. Equality of opportunity is achieved when circumstances do not play any role in the resulting outcome, which will then only depend on the exercise of freedom.

The genuine interest for this concept among policymakers may be illustrated for health care by recent debates in the UK 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'[1] and their 'alcoholic liver disease is self-induced'.[2] Therefore, 'alcoholic cirrhosis has been a controversial indication for

*Correspondence to: Academic Unit of Health Economics, Leeds Institute of Health Sciences, University of Leeds, Charles Thackrah Building, Room 2.10, 101 Clarendon Road, Leeds LS2 9LJ, UK. E-mail: s.tubeuf@leeds.ac.uk

[1]See page 263 in Bramstedt and Jabbour (2006).
[2]See page 63 in Webb and Neuberger (2004).

transplants' (Bramstedt and Jabbour, 2006 p.263), and denying access to transplants for these patients has been suggested. The debate was triggered by George Best's controversial liver transplant.[3] In the Guardian on 5 October 2005,[4] 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 6-month alcohol abstinence criterion before organs are transplanted, called the '6-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 transplantation. It is likely that another motivation is 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', that is, the respect of the impact of effort variables on individual outcome in the health sphere, whereas 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; Rosa-Dias and Jones, 2007; Fleurbaey and Schokkaert, 2009), empirical applications remain scarce (Rosa-Dias, 2009; Jusot *et al*., 2009; Trannoy *et al*., 2010; Rosa-Dias, 2010; Tubeuf *et al*., 2012; Garcia Gomez *et al*., 2012). The main reason is that implementation of equal-opportunity policies requires the identification of the contribution of circumstances and efforts to observed inequality. Efforts are particularly difficult to specify, as it is hard to observe and measure. Lifestyles, such as doing exercise, having a balanced diet, not smoking or not drinking too much, are widely accepted as examples of efforts in relation to health, representing non-constrained individual choices. On this basis, health appears to be a good candidate[5] for an empirical exercise to quantify inequalities of opportunities that are inequalities of outcomes being explained by circumstances not by efforts.

The precise definitions of the efforts to be rewarded and of the circumstances to be compensated for are 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 efforts from an ethical point of view. We found three different philosophical concepts on that issue that has never been deeply discussed in economics and that we propose to consider and apply to the health field. The goal of this paper was not to discuss the ethical relevance of these views and even less to choose among them. Our purpose was to assess if, empirically, it matters which view is adopted in the measurement of inequalities of opportunity in health. We propose a simple method to measure the contributions of circumstances and efforts of inequalities in health for each view and provide an empirical evaluation in France, on the basis of a representative health survey in 2006 partly designed for this purpose. This method consists of a decomposition of the variance of health status, which has not been used for this purpose. Moreover, we propose a useful interpretation of this decomposition in the context of equality of opportunity.

The following section describes the three alternative normative approaches drawing on Roemer, Barry and Swift's viewpoint on circumstances and efforts. Section 3 describes the data and in particular, the additional

[3]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 3 years later.

[4]Alcohol abusers should not have transplants, says Best's surgeon, Ian Sample, science correspondent, The Guardian, Wednesday 5 October 2005.

[5]Mental health could raise a problem for the implementation of equal-opportunity policy. In some cases, it is difficult to state whether or not mental illness negates a person's responsibility for their decisions – a point of view often taken by lawyers. However, avoidance of problematic alcohol or illegal drug consumption is a personal effort made to avoid addiction and related mental health problems.

DOI: 10.1002/hec

questionnaire we designed to have a comprehensive description of efforts in health and childhood circumstances that may impact upon health. Section 4 presents the methods we used to illustrate empirically the debate between those three normative views. Section 5 presents the analysis results as well as several robustness checks supporting our findings. A discussion and concluding remarks form the final section.

2. THREE VIEWS ABOUT THE CORRELATION BETWEEN EFFORTS AND CIRCUMSTANCES

The challenge in defining efforts 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'.[6] According to Roemer, an equal-opportunity policy must respect the individual efforts in an approach where 'we could somehow disembody individuals from their circumstances'.[7] As a consequence, the extra efforts of the Asian student must not be rewarded because it is determined by a characteristic outside his control. Barry (2005) 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'.[8] From this point of view, which is the mainstream view in the literature on incentives, the extra efforts of the Asian student should be entirely rewarded, and the lack of familial pressure on other types of students should not be compensated.[9]

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 overweight is linked to genetic characteristics (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, then the definition of circumstances to be compensated is less obvious. The transmission of values through parental efforts may result in what is seen as efforts 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 efforts despite the link with children's efforts. Conversely, if you give precedence to the past generation in the application of the principle of natural reward, then that parental efforts must be respected whatever its consequences to the next generation will be. This latter position corresponds to Swift's viewpoint (Swift, 2005; Sørensen, 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'.[10] In effect, from Swift's point of view, the family is an association, and in Rawls' justice theory, the 'basic

[6]See page 22 in Roemer (1998).
[7]See page 15 in Roemer (1998).
[8]Transcription of Barry's position according to Roemer (1998), p.21.
[9]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 such as Arneson (1989) and Cohen (1989) support the view that individuals should be held responsible for factors that are within their own control, whereas for instance, Dworkin (1981) thinks that individuals should be held responsible for their preferences. In that interpretation, Barry would endorse the preference viewpoint and Roemer the control opinion.
[10]See page 271 in Swift (2005).

DOI: 10.1002/hec

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 efforts. In what we call Barry's view, circumstances are past variables and efforts are the variable, 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 efforts 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 efforts. In other terms, the vector of circumstances must be cleaned from any correlation with child's efforts.[11] 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, if the correlation is of the same sign between circumstances and health, and circumstances and effort. The question whether it matters empirically is the goal of the paper.

3. DATA

The French Health, Health Care and Insurance Survey (ESPS) 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 older. We included in the 2006 survey 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 6074 individuals (2485 men and 3589 women) having self-assessed health (SAH). 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.

Health status is viewed as a function of three sets of variables: circumstances as measured by family background, efforts as measured by lifestyles and demographic characteristics. Summary statistics of the main variables used in the paper are presented in Table I.

3.1. Health

The variable of interest is health in adulthood as measured by 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 despite being subjective, it 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). SAH has been found to suffer from individual reporting heterogeneity (Bago d'Uva *et al*., 2008). Nevertheless, a French study shows that SAH is the least biased health indicator as compared with several other indicators (Devaux *et al*., 2008).

We initially carried out ordered Probit models using the full information provided by SAH in five categories. However, the proportional odds assumption across the five response categories of SAH appeared not to hold, and so an ordered Probit model was found not suitable for the analysis. Therefore, we will consider health status as a binary variable grouping good and very good health against fair, poor and very poor health as it is usually carried out in the literature and estimate a Probit regression model (for the estimation strategy, see Section 4). More than 70% of the respondents reported that they had good or very good health.

[11] 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.

DOI: 10.1002/hec

Table I. Descriptive statistics

	Frequency	Percentage		Frequency	Percentage
Sex			Adverse life experiences		
Men	2485	40.91	No adverse life experience	5361	88.26
Women	3589	59.09	During childhood	351	5.78
Age			Non-response	362	5.96
Less than 30 years	842	13.86	Financial situation		
30–39 years	1226	20.18	Very comfortable	294	4.84
40–49 years	1280	21.07	Comfortable	2929	48.22
50–59 years	1119	18.42	Difficult	2249	37.03
60–69 years	698	11.49	Very difficult	507	8.35
More than 70 years	909	14.97	Non-response	95	1.56
Self-assessed health			Mother's occupation		
Very good	1177	19.38	Farmer	551	9.07
Good	3279	53.98	Craftmen	360	5.93
Fair	1351	22.24	Manager	126	2.07
Poor	211	3.47	Associate prof.	440	7.24
Very poor	56	0.92	Office worker	1914	31.51
Health-related behaviours			Elementary jobs	956	15.74
Non-smoker	4444	73.16	Inactive	1547	25.47
Daily vegetable consumption	4691	77.23	Non-response	180	2.96
Non-obese	5305	87.34	Father's occupation		
Childhood circumstances			Farmer	761	12.53
Mother's self-assessed health			Craftsmen	492	8.1
Very good	2273	37.42	Manager	617	10.16
Good	2698	44.42	Associate prof.	718	11.82
Fair	736	12.12	Office worker	574	9.45
Poor, very poor and deceased	314	5.17	Elementary jobs	2593	42.69
Non-response	53	0.01	Non-response	319	5.25
Father's self-assessed health			Mother's education level		
Very good	2470	40.67	Drop out	448	7.38
Good	2331	38.38	Primary school	3178	52.32
Fair	601	9.89	Secondary school 1	980	16.13
Poor, very poor and deceased	388	6.39	Secondary school 2	482	7.94
Non-response	284	4.68	University degree	380	6.26
Mother's longevity			Non-response	606	9.98
Short longevity	1044	17.19	Father's education level		
High longevity	1012	16.66	Drop out	336	5.53
Alive	3851	63.4	Primary school	2822	46.46
Non-response	167	2.75	Secondary school 1	1036	17.06
Father's longevity			Secondary school 2	371	6.11
Short longevity	1358	22.36	University degree	570	9.38
High longevity	1606	26.44	Non-response	939	15.46
Alive	2725	44.86	Total sample	6074	100
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			
Total sample	6074	100			

3.2. Circumstances

Because of 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 was measured by both professional status and education level and was available for both parents. Professional status was measured in six categories for the father, namely, farmer,

DOI: 10.1002/hec

craftsman, manager, associate professional, office worker and elementary occupation. A seventh category was added for mothers, being homemaker. Five levels were available for education: dropped out, primary school, secondary school 1, secondary school 2 and university degree.

Parents' health was measured in two different ways. On one hand, the descendant retrospectively self-assessed 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 were summarised in a single category in the model estimation. In addition, the respondent reports parents' date of birth, whether they were still alive at the time of the survey and their date of death, if applicable. Using these variables, we identified parents with high longevity (i.e. parents who died older than the median age at death of their generation) and parents with 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 was composed of three different categories: being alive, having had a high longevity and having had a short longevity. The proportion of alive parents was 63.4% for mothers and 44.9% for fathers.

Two parental health-related behaviours were available in the survey: smoking and alcohol consumption. The descendant reported whether the father, the mother or someone else was currently smoking in the household when they were 12 years old and whether the father, the mother or someone else in the household was having problems with alcohol. Three binary indicators were 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 were reported as smokers.

Finally, the descendant retrospectively reported whether he considered that the financial situation of his family was very comfortable, comfortable, difficult or very difficult when he was 12 years old. 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 were also considered.[12] The respondent reported 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 were then asked whether they had suffered sustained social isolation because of adverse life events happened to them or their relatives (war, migration, incarceration. . ..) during childhood. The analysis included a single indicator identifying whether the individual had experienced economic hardships or/and isolation during childhood (Cambois and Jusot, 2011). This was positive in 6% of the study sample.

There were missing values for parental characteristics coming from the usual causes of non-response in survey data such as weakened family bonds or non-nuclear family structure. For the sake of sample size, an additional 'non-response' category was added for the share of respondents having missing values.

3.3. Efforts

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 being a smoker or not[13]; the second effort variable categorises people as non-obese or obese – BMI greater than or equal to 30.[14] BMI was calculated using self-reported height and weight. Beyond the role of genes in the explanation of individual variance in BMI, obesity results from an imbalance between energy intake – diet – and energy expenditure (Case *et al*., 2005; Bleich *et al*., 2008; Etilé, 2011). The last effort variable categorises people as reporting eating vegetables everyday or not.

[12]The 5% non-response rate for this indicator is explained by the fact that questions on adverse life experiences during childhood were asked during another stage of the survey and were not asked to all individuals included in this study.
[13]In the survey, the question regarding smoking is the following: 'Do you smoke regularly?' (yes/no)
[14]BMI in kg/m^2 = weight/height^2

DOI: 10.1002/hec

A substantial majority of the sample reported healthy lifestyles; 73% were currently non-smoker, 87% were non-obese and 77% reported that they ate vegetables everyday.

We cannot claim that we have a complete description of efforts in health; therefore, we will cope with this potential underestimation of the contribution of efforts to health inequality and provide a set of robustness checks in the results section.

4. METHOD

We propose a two-step methodology to assess if Roemer's, Barry's and Swift's respective view empirically matters for the measurement of inequalities of opportunity in health. The authors do not clearly state whether they refer to causality or more broadly to correlation between the efforts and circumstances; we here consider the most loose interpretation, and the chief aim of the analysis is the assessment of the practical relevance of the debate about the correlation between circumstances and efforts. The estimation models and the quantification of inequality of opportunity according to diametrically opposed normative views serve the purpose of illustrating this debate. In the first step, a reduced model is estimated to measure the association between health status and, respectively, circumstances and efforts. In the second step, the predictions of the model are used to measure the magnitude of health inequalities and the respective contributions of circumstances and efforts.

4.1. Estimation strategy

In contrast to Fleurbaey and Schokkaert (2009) who propose to focus on a structural model to distinguish the mechanisms through which circumstances and efforts may impact health status, our aim was to assess empirically the relevance of the normative debate about the correlation existing between efforts and circumstances. Therefore, we are exclusively interested in capturing correlations between health, efforts and circumstances, respectively. This shortcut is endorsed by the ethical position that every unobservable variable linked to circumstances is considered as a circumstance and the same goes for efforts. For example, at the current state of science, the genes of individuals, whether they are parents or children, are not observed in most survey data. Let us assume that a given gene is associated with an addictive behaviour. This gene will be assimilated to efforts because it is an unobservable variable correlated to effort variable. Then the only ethical issue, which is not settled, is the status of the correlation between circumstances and efforts. In the framework of a reduced form, we can offer an econometric transcription of the three positions described in Section 2, which is straightforward to estimate as there are only three possible groups of determinants of inequalities in health: circumstances, efforts and demographic characteristics.

Let us assume that individual latent 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:

$$H = f(C, E, D, u) \tag{1}$$

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; Rosa-Dias, 2009; Lindeboom *et al.*, 2009; Trannoy *et al.*, 2010). 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; Rosa-Dias, 2009; Balia and Jones, 2011).

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. It could also be argued that health differences by age classes reflect

DOI: 10.1002/hec

the human destiny, and everyone will experiment them soon or later over the life cycle. Whether this makes health differences due to biological factors legitimate is a philosophical issue that we will not investigate. We consider it is meaningful to distinguish their influence from the impact of usual circumstances in the framework of this paper, because the discussion opened by the three normative viewpoints solely concerns family and social circumstances. In addition, a large part of the health differences related to biological factors is probably recognised as inescapable in the sense that it would be very costly to neutralise inequalities due to age and, to some extent, those due to sex, in developed countries. Moreover, in a cross-sectional analysis, age also represents the cohort that each individual belongs to; therefore, health disparities between two age groups capture the medical and technological progress of health care as well. One may advocate that this progress-related cohort effect should be considered as a circumstance; however, it appears to be inescapable as well. All those arguments lead us to set age and sex apart from other circumstances.

If we assume that we have a complete description of all factors, then the residual term appeals to pure luck and to 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 (Lefranc *et al*., 2009).

Other outcome 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, the interpretation of health inequality related to education and socioeconomic status in the equality of opportunity framework is not straightforward: the education level achieved and career success are partly due to efforts made at school and on labour market, which are unobserved characteristics. However, education level and socioeconomic status 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*., 2010). In this paper, we are not interested in knowing the pathways through which a factor has an impact on the health outcome. Nevertheless, it is important to remember that the estimated coefficients of C, E and D on H 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 efforts will be recognised as legitimate.

The analysis of equality of opportunities becomes more difficult when we recognise that circumstance and efforts are not independent. For example, smoking initiation has been found to be related to mother's education and parents' smoking behaviour (Rosa-Dias, 2009; Göhlmann *et al*., 2010; 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*., 2010). 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, we have presented the three views in the literature with respect to what belongs to efforts and circumstances. 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. The methodology is initially presented in the linear case for the sake of pedagogy and to save notations. Then the more complex methodology using non-linear variables is presented.

DOI: 10.1002/hec

According to Barry, descendant's efforts have to be fully respected whatever the influence of past circumstances on efforts decisions will be. It allows directly regressing circumstances and effort 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:

$$H_i^B = \lambda^B + \alpha^B C_i + \beta^B E_i + \gamma^B D_i + u_i \tag{2}$$

Equation (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 efforts to be purged of any contamination coming from circumstances. This concept leads to estimate an auxiliary equation, which regresses E_i, the efforts of individual i, against C_i, the circumstances.

It allows isolation of a residual term e_i, the relative efforts, which represent individual efforts purged from circumstances[15]:

$$E_i = \lambda + \delta C_i + e_i \tag{3}$$

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

$$H_i^R = \lambda^R + \alpha^R C_i + \beta^R \hat{e}_i + \gamma^R D_i + u_i \tag{4}$$

Equation (4) allows testing the condition of equality of opportunity in Roemer's view by testing the equality of $\hat{\alpha}_R$ to zero, because C_i and e_i are independent. If we were in a linear model, then $\hat{\beta}^R$ would be exactly the same as $\hat{\beta}^B$ in Equation (2) according to the Frisch–Waugh–Lowell theorem. However, $\hat{\alpha}^R$ and $\hat{\alpha}^B$ are different because in Roemer's approach, the coefficient of circumstances incorporate the indirect effect of circumstances on efforts. This indirect term is the product of both the coefficient of efforts and the coefficient of circumstances in Barry's approach. Therefore, in a linear regression model, the coefficient of relative efforts (the purged efforts) is the same as the coefficient of efforts, whereas the coefficient of circumstances would be magnified if efforts improve health.

From Swift's viewpoint, parents' own efforts have to be fully respected in the application of the principle of natural reward to encourage parents to transmit a value on efforts 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's efforts. As a consequence, the vector of circumstances[16] must be cleaned from any correlations with efforts.

[15]The issue of purging effort from demographic variables in Roemer's perspective has both its pros and cons. It calls for a case by case discussion. Pure 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 times more obese people for the age group 60–70 years old than for 16–30 years old. It is clear that when becoming older, it becomes more difficult (costly) to fight against overweight. However, obesity represents a large deviation with respect to a fair balance between size and weight. It is likely to be 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. Similarly, physical exercise comes to mind as an example where it seems odd not to control for 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 exercise of individual responsibility with respect to smoking or other lifestyles.

[16]As a matter of fact, a strict version of this principle should only require purging the educational parental effort from its consequences on children's destiny. However, in our context, 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 so, we will obtain a kind of upper bound for Swift's approach.

DOI: 10.1002/hec

Therefore, it is necessary to estimate an auxiliary equation that aims at isolating a residual term, which represents circumstances purged from descendant's efforts. We regress circumstances C_i according to efforts E_i as follows[17]:

$$C_i = \tau E_i + c_i \tag{5}$$

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:

$$H_i^S = \lambda^S + \alpha^S \hat{c}_i + \beta^S E_i + \gamma^S D_i + u_i \tag{6}$$

Equation (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 because $\hat{c}_i$ and E_i are independent. Again, if we were in a linear model, then $\hat{\alpha}^S$ and $\hat{\alpha}^B$ would be exactly the same as in Equation (2) according to the Frisch–Waugh–Lowell theorem. However, $\hat{\beta}^S$ and $\hat{\beta}^B$ are different because in Swift's approach, the coefficient of efforts is magnified if efforts improve health.

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 efforts and circumstances.

Because of the qualitative nature of the data related to health, efforts and circumstances, both health equations and auxiliary equations have to be estimated by non-linear models. There is no theorem equivalent to the Frisch–Waugh–Lowell theorem for non-linear models. Therefore, we have to perform all estimations to see whether the coefficient of the purged variable is higher than the coefficient of the actual variable.

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

In the second set of analyses, three independent Probit models corresponding to the three individual efforts binary variables are estimated to explain the association between circumstances and efforts in Roemer's framework before estimating the health model.

In the third set of analyses, we consider Swift's concept of circumstances and efforts. Prior to measuring the association of circumstances and efforts on health, we estimate a set of 14 circumstances independent equations according to the three individual effort variables. Multinomial logit models are used for those circumstances equations, except parental health-related behaviours for which Probit models are used.

The non-linear specification used does not allow us to undertake a direct estimation of the relative efforts $\hat{e}_i$ and the relative circumstances $\hat{c}_i$. We thus compute generalised residuals (APPENDIX A), which correspond to the conditional expected value of the residuals given the outcomes (Dubin and McFadden, 1984; Gourieroux *et al*., 1987). Therefore, the equations presented in the previous section correspond to the latent variables underlying the binary indicators of SAH, tobacco non-smoking, avoidance of obesity and daily vegetable consumption, and each circumstance categories.

Finally, we identify and measure the magnitude of health inequalities and the respective contributions of efforts, circumstances and demographics in the three alternative viewpoints.

It is important to bear in mind at this stage that empirical applications are always restricted to the use of observed variables. Like any other empirical applications, unobserved variables will induce a less precise model specification, leading to a larger error term. The main interest of this paper is on the explained variance of health in the selected model specification; all the results will be reliable on the assumption that they are based on the model specification that is considered. We can nevertheless question whether unobserved variables are likely to jeopardise our empirical results. Unobserved circumstances could for example induce endogeneity. This would matter if we were interested in understanding causality links. However, this is not an issue in our context because we

[17]We consider that controlling for 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 efforts that are meaningful from an ethical point of view.

DOI: 10.1002/hec

are focusing on the analysis of the correlation of circumstances and efforts with health. The only genuine issue we are facing could be if the unobserved circumstance(s) (effort(s)) were correlated with the observed circumstances (effort). This is likely to induce that Barry's model is less pure than expected.[18]

4.2. Inequality measurement

Because the health status is assessed by a qualitative binary variable, 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 in each of the three frameworks as follows:

in Barry's context,

$$\hat{H}_{\mathrm{i}}^{B} = \hat{\alpha}^{B} C_{\mathrm{i}} + \hat{\beta}^{B} E_{\mathrm{i}} + \hat{\gamma}^{B} D_{\mathrm{i}} \tag{7a}$$

in Roemer's context,

$$\hat{H}_{\mathrm{i}}^{R} = \hat{\alpha}^{R} C_{\mathrm{i}} + \hat{\beta}^{R} \hat{e}_{\mathrm{i}} + \hat{\gamma}^{R} D_{\mathrm{i}} \tag{7b}$$

in Swift's context,

$$\hat{H}_{\mathrm{i}}^{S} = \hat{\alpha}^{S} \hat{c}_{\mathrm{i}} + \hat{\beta}^{S} E_{\mathrm{i}} + \hat{\gamma}^{S} D_{\mathrm{i}} \tag{7c}$$

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

Let us note that $\hat{H}_C$ represents the circumstances-related source of inequalities, $\hat{H}_E$ represents the effort-related source and $\hat{H}_D$ represents 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 and population symmetry). We argue in favour 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, that is, a measure invariant to a translation, then 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, that is, a scale invariant measure. Its decomposition by sources is the same as that of the variance. This index belongs to the entropy class.

The same relative decomposition[19] 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

$$\sigma^2(\hat{H}^j) = \mathrm{cov}(\hat{H}^j_C, \hat{H}^j) + \mathrm{cov}(\hat{H}^j_E, \hat{H}^j) + \mathrm{cov}(\hat{H}^j_D, \hat{H}^j) \tag{8}$$

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

$$\mathrm{cov}(\hat{H}^j_C, \hat{H}^j) = \sigma^2(\hat{H}^j_C) + \rho_{CD}\sigma(\hat{H}^j_C)\sigma(\hat{H}^j_D) \tag{9}$$

[18] If the unobserved circumstances and efforts are correlated with observed circumstances and efforts, the estimated coefficient of observed effort will capture the impact of the unobserved circumstances, as for the coefficients of circumstances, they will also measure the impact of unobserved efforts.

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

DOI: 10.1002/hec

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

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

$$\operatorname{cov}(\hat{H}^j_E, \hat{H}^j) = \sigma^2(\hat{H}^j_E) + \rho_{ED}\sigma(\hat{H}^j_E)\sigma(\hat{H}^j_D) \tag{10}$$

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

It should be noted 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, that is, the share of health inequalities due to efforts and demographic characteristics.[20] To obtain a precise definition, we need to define a reference level. The mean is an obvious candidate. One can easily show 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:

$$\Theta_{\mathrm{DU}} = \sigma^2(\hat{H}^j_C + (\mu(\hat{H}^j) - \mu(\hat{H}^j_C))1) \tag{11}$$

with 1 as the unit vector, $\mu(\hat{H}^j)$ as the mean of health status and $\mu(\hat{H}^j_C)$ as 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, that is, 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:

$$\Theta_{\mathrm{FG}} = \sigma^2(\hat{H}^j) - \sigma^2((\hat{H}^j - \hat{H}^j_C) + \mu(\hat{H}^j_C)1) \tag{12}$$

It can be readily established[21] that the contribution of circumstances-related source of health inequality with the natural decomposition of the variance is just half of the two previous interpretations for the three views:

$$\frac{1}{2}(\Theta_{\mathrm{DU}} + \Theta_{\mathrm{FG}}) = \operatorname{cov}(\hat{H}^j_C, \hat{H}^j) \tag{13}$$

5. RESULTS AND DISCUSSION

The main results of interest of the paper are the magnitude of health inequalities and the respective contributions of efforts, circumstances and demographics in the three alternative viewpoints; we will not extensively comment on the intermediate estimations (both auxiliary and health equations) used to provide the predicted health required to quantify inequality.[22] Tables of intermediate results are provided in APPENDIX B.

Table A.I in the APPENDIX B shows the marginal effects of efforts and circumstances on the probability of reporting good or very good health, computed at the means of the independent variables for each scenario.

[20]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.
[21]See for instance pages 209–210 in Shorrocks (1982).
[22]More discussion on the results of the auxiliary and health equations can be found in Jusot *et al.* (2010).

DOI: 10.1002/hec

As expected, the marginal effects differ across scenarios because variables in the models are different from a mathematical point of view: actual efforts are dummy variables in Barry's model, whereas relative efforts are continuous variables in Roemer's model, and the same applies for actual circumstances in Barry's model and relative circumstances in Swift's model. However, it remains meaningful to compare the signs of the marginal effects for a given model. Overall, the signs of the key regressors corroborate earlier literature: 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. A large set of circumstances is also significantly associated with good health: parents' health status, as measured by both longevity and self-perceived health status, mother's education level and professional status, financial situation and economic hardship during childhood and finally, father's smoking and alcohol problems. The results of the auxiliary effort equations from Roemer's approach and the auxiliary circumstances equations from Swift's approach are available in Table A.II and Table A.III, respectively. They confirm the intergenerational transmission of lifestyles in relation to smoking and diet.

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

Using the estimated coefficients of the health equations, we can assess how the magnitude of legitimate health inequalities and illegitimate health inequalities, namely, inequalities of opportunity in health changes with the three alternative views. Roemer's view would a priori maximise the magnitude of illegitimate inequality in health due to circumstances and minimise the magnitude of legitimate inequality due to efforts. Conversely, Swift's view would maximise the magnitude of legitimate inequalities and minimise the magnitude of illegitimate inequality.

The last column of Table II gives the magnitude of health inequalities, which is assessed using the variance of the predicted latent health status as defined in Equation 8. We notice that the magnitude of health inequalities is very similar across scenarios.

The second, third and fourth columns of Table II recapitulate the share of health inequalities explained by each source in the three frameworks. Concretely, the share of health inequalities explained by efforts (circumstances) is given by the ratio of the covariance of efforts (circumstances) with health to the variance of the predicted latent health. These shares vary from one scenario to the other for two reasons. First, the estimated coefficients related to each effort variable (circumstances variable) change with the way the correlation between efforts and circumstances is considered in each scenario. Second, the effort variables (the circumstance variables) are different in each scenario: they may be the actual variable or the variable obtained with generalised residuals.

The contribution of circumstances to inequalities in health ranges between 44.5% and 46.4% according to the scenario, whereas the contribution of efforts ranges between 6.1% and 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 the health inequalities.

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

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

Full model	Contribution of circumstances (%)	Contribution of effort (%)	Contribution of demographics (%)	Total inequality
Barry's scenario	45.69	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

DOI: 10.1002/hec

Inequalities of opportunities in health are the highest in Roemer's framework and represents 46.4% of health inequalities. 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 efforts to health inequalities in this framework[23] is 2 percentage points higher than in Roemer's framework. The discrepancy between the two estimations is surprisingly small.

All in all, the contribution of circumstances is 5.4 times higher than the contribution of efforts in Swift's scenario and, respectively, 7.6 times higher in Roemer's scenario.

Finally, the share represented by demographic variables is around half the magnitude of inequalities in health in the three scenarios. We have to be reminded that the decomposition is based on predicted health only because a Probit model considers health as a latent variable. Hence, we cannot observe the residual part. This unexplained part is therefore a mix of luck factors, unobserved circumstances and efforts and variables influencing individual SAH reports.[24]

5.2. Statistical inference

To test the robustness of the decomposition results, we performed statistical inference using a bootstrapping percentile method (Davison and Hinkley, 1997). We used 1000 replications of the analysis to obtain 1000 estimations of both the auxiliary equations (estimating generalised residuals beforehand) and the health equation so that we could estimate the related health inequality decomposition by sources. Standard errors and confidence intervals are presented in Table III for the variance of the latent health status and the contribution of each source of inequalities. The findings confirm the benchmark results showing that in all scenarios, the contribution of circumstances to health inequalities is significantly higher than the contribution of efforts. Moreover, even if the estimated contribution of efforts is the highest in Swift's view as is the estimated contribution of circumstances in the Roemer's view, differences between the contributions of each source to inequalities across scenarios are not found significant.

It is also noticeable that the standard error of the variance of latent health status is only slightly weaker in Barry's scenario as the health equation in this scenario does not use generalised residuals. However, the three estimated health variances in the benchmark case are all included in the respective confidence intervals obtained with the bootstraped procedure in each scenario. In addition, the confidence intervals are not wider for the contribution of circumstances and efforts in the Roemer and Swift's scenarios than in the Barry's one. This is reassuring and confirms that results in the Roemer's and Swift's scenarii are not affected by the supplementary uncertainty introduced into the model using generalised residuals. We supplement these statistical inference results with several sensitivity analyses.

5.3. Sensitivity analysis

As we mentioned previously, the contribution of circumstances to overall inequality appears to be much larger than the contribution of efforts. We want to test the robustness of this result. Indeed, it may the case that the estimated contribution of efforts is a lower bound because of the limited description of efforts in the analysis. Therefore, we carry out a series of sensitivity analyses to assess whether the limited number of effort variables

[23]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.

[24]We considered a health linear probability model to cast light on this issue. The health model would explain 20% of the total variance. The three main determinants have similar contributions to health inequality as in Probit models: the contribution of circumstances to the explained health inequality comprised between 39.74% and 41.75%, whereas the contribution of efforts is between 5.81% and 8.06%.

DOI: 10.1002/hec

Table III. Decomposition of inequalities in health according to the three sources, circumstances, effort and demographics (Benchmark case bootstrapped with 1,000 replications using percentiles methods)

Full model	Contribution of circumstances (SE)	95% confidence interval	Contribution of effort (SE)	95% confidence interval	Contribution of demographics (SE)	95% confidence interval	Total inequality (SE)	95% confidence interval
Barry's scenario	45.69% (4.233)	[38.91; 55.59]	6.71% (1.446)	[3.73; 9.67]	47.59% (4.126)	[38.13; 54.19]	0.435 (0.0292)	[0.413; 0.526]
Roemer's scenario	46.43% (3.980)	[41.04; 56.35]	6.14% (1.268)	[3.53; 8.48]	47.43% (3.999)	[37.79; 53.31]	0.435 (0.0299)	[0.415; 0.530]
Swift's scenario	44.54% (3.892)	[38.97; 54.17]	8.14% (1.660)	[4.71; 11.58]	47.32% (3.852)	[38.02; 53.00]	0.437 (0.0310)	[0.418; 0.536]

DOI: 10.1002/hec

in comparison with the large number of circumstances characteristics plays an important role in the result. To do so, we re-estimated the three health models with alternative reduced sets of circumstances as regressors. Of course, the variance of predicted latent health status is reduced as well as the share of health inequality explained by circumstances. Nevertheless, this exercise remains important to provide us with an estimate of the lowest bound of the contribution of circumstances to health inequalities comparable with what we view as a lowest bound of the efforts relative contribution. Results of the sensitivity analyses (SA1–SA5) are presented in Table IV. In the first sensitivity analysis scenario SA1, we only focused on the three circumstances being the most significant parameters in the benchmark model, namely, mother's health, father's longevity and mother's education. In this case, the total inequality is reduced to a variance of 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 remains very similar to the contribution of efforts in the benchmark model (8.4% in Swift's framework and 6.9% in Roemer's scenario). Because circumstances are less numerous in this restricted model, 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. The contribution of circumstances is now only four times higher than the contribution of efforts.

In SA2, we considered parental health status, longevity and health-related behaviours as sole circumstances in the models. The differences between contributions within the three scenarios are less marked, but a similar pattern applies: the contribution of efforts is maximised in Swift's scenario representing 9% of total inequality (8.4% in Roemer's scenario) and the contribution of circumstances is higher in Roemer's scenario with 35% of total inequality.

In SA3, we only retained parents' socioeconomic status (occupation and education level) and economic conditions during childhood as circumstances in the models. 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 SA3 with the results of SA2, it appears thus that circumstances related to parents' health explain a larger part of health inequalities than circumstances related to parents' socioeconomic status. This may come from the intergenerational transmission of health showed in the work of Trannoy *et al.* (2010).

Table IV. Decomposition of inequalities in health according to the three sources, circumstances, effort and demographics: sensitivity analyses (SA) based on estimations with different sets of regressors

	Contribution of circumstances (%)	Contribution of effort (%)	Contribution of demographics (%)	Total inequality
SA1 With three circumstances (mother's health, father's longevity, mother's education)				
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
SA2 With only parents' health status related circumstances				
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
SA3 With only parents' socioeconomic status related circumstances				
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
SA4 With only father's circumstances				
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
SA5 With only mother's circumstances				
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

DOI: 10.1002/hec

We finally restricted the set of circumstances to fathers' characteristics in SA4 and to mothers' characteristics in SA5. The level of circumstances-related inequalities is higher when we only consider mothers' characteristics in the regressors (SA5); this suggests that mother's characteristics explain more health heterogeneity than father's characteristics.

Regardless of the number of the circumstances used in the model, the contribution of circumstances is much higher than the contribution of efforts, and this is true for Barry, Roemer and Swift's scenarios. What is striking is that the contribution of efforts never is beyond 9.2% (in SA4) regardless of the specification and does not represent half of the contribution of circumstances in the most favourable scenario.

This sensitivity analysis enables us to conclude that the limited set of effort variables with comparison to the set of circumstances can partly explain that efforts play a small role in shaping health inequalities in France. Regardless of the number of circumstances introduced in the sensitivity analyses, the main share of health inequalities comes both from circumstances and demographics.

6. CONCLUSION

This paper offers an original discussion of the cut-point between legitimate and illegitimate inequalities according to three viewpoints from the literature on social justice on how the correlation between circumstances and efforts should be treated. The analysis sought to quantify the respective share of inequalities of opportunities and legitimate inequalities in overall inequality in health in France on the basis of these three views. We used a simple method firstly to measure the relative contributions of circumstances and efforts to inequalities in health and secondly to compare the findings obtained under the three different conceptions about the correlation within a reduced form. Under Barry's view, the correlation is split between efforts and circumstances 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 efforts. 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 efforts 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 (44.5–46.4%) according to the adopted definition of individual efforts and circumstances. Still, compared with Roemer's conception, Swift's conception leads to a 33% increase in the share of legitimate inequalities. This figure is all but negligible, but because efforts count little in our data set, it does not make a large difference to consider one view rather than another, and the contribution of efforts comprised between a lower bound of 6% and an upper bound of 11%. 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 efforts.

However, it would be useful to supplement our study in several directions. First, it would be interesting to replicate the methodology on different health variables, such as longevity and handicap. Our introduction has also opened the debate on individual efforts related to specific health conditions such as cirrhosis or lung cancer, whereas our empirical analysis focussed on general health status. We may wonder whether efforts could, on average, account for a relatively small share of health inequality in the present context and meanwhile be a key determinant in the occurrence of specific conditions. If we refer to medical literature, then the major contribution of efforts is not so clear. Sorensen *et al*. (1984) concluded that in alcohol-abusing man, a liver biopsy provides more information than alcoholic history about the likelihood of future cirrhosis, whereas a recent systematic review shows that alcohol consumption had a significantly higher impact on mortality of liver cirrhosis compared with morbidity (Rhems *et al*., 2010). A comprehensive evaluation of the importance of efforts along with other determinants in specific health conditions would require well-informed dataset that are not available. Finally, it would have been preferred to have additional measures of individual efforts such

DOI: 10.1002/hec

as eating breakfast, sleeping and physical exercise as in the work of Balia and Jones (2008). Looking at the results obtained from these authors,[25] it is doubtful that the magnitude of the contribution of efforts 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.

APPENDIX A: GENERAL RESIDUALS

The qualitative nature of effort and circumstances variables within the analysis does not allow us to undertake a direct estimation of relative effort $\hat{e}_i$ and relative circumstances $\hat{c}_i$, which respectively correspond to effort purged from any correlation with circumstances in Roemer's scenario and to circumstances purged from any correlation with effort in Swift's scenario. Therefore, we estimate the relative effort 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 that was a smoker in the case of circumstance, then 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:

$$Y^* = Xb + \eta \tag{A1}$$

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, then we use binary Probit models to regress binary outcomes and the generalised residual can be computed as follows:

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

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, then we use multinomial logit models (Dubin and McFadden, 1984) to purge those circumstances from any correlation with effort variable. When modelling, we assume the existence of K latent variables $Y^*(k = 1,\ldots K)$ corresponding to the K categories (including the reference category) of the observed qualitative variable Y.

Each latent variable Y^* 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:

$$Y_k = Xb_k + \eta_k \tag{A3}$$

For identification issue, the parameters b_k are assumed to equal zero for the reference category. The outcome variable Y is observed if and only if the category $j \in (k = 1, \ldots, K)$ is chosen, which happens when

$$Y_j^* > \max_{s \neq j} Y_s^* \tag{A4}$$

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

[25] See Table 1, results for Equation (2) p.22. It gives results from regressing SAH on lifestyles and socioeconomic variables. Only non-obese and exercise are statistically significant.

DOI: 10.1002/hec

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

$$E\left(\eta_j / Y_j^* > \max_{s\neq j} Y_s^*\right) = -lnP_j \frac{\sqrt{3}}{\pi} \tag{A5a}$$

$$E\left(\eta_s / Y_j^* > \max_{s\neq j} Y_s^*\right) = \frac{P_s ln(P_s)}{1-P_s}\frac{\sqrt{3}}{\pi}, \forall s \neq j \tag{A5b}$$

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

It should be noticed that the generalised residuals need not be equal to zero for the reference category.

The introduction of both the generalised residuals of effort 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 marginal 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 continuous 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 effort and relative circumstances remain interpretable and indicate whether the characteristics has a positive or a negative association with health status.

APPENDIX B

Table A.I. Marginal effects of effort 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 years old)							
Less than 30 years	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		

(*Continues*)

DOI: 10.1002/hec

Table A.I. Continued

	Barry's scenario		Roemer's scenario		Swift's scenario		
Regressors	(a)		(a) (b)		(a) (c)	(d)	(e)
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		
Craftsmen	−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		*
Craftsmen	−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		*

(*Continues*)

Table A.I. Continued

	Barry's scenario		Roemer's scenario		Swift's scenario		
Regressors	(a)		(a) (b)		(a) (c)	(d)	(e)
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 R^2	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 descendants' 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%.
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.

Table A.II. Results of the auxiliary estimation for Roemer's view: Marginal effects of circumstances on the probability of doing effort (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 (ref: 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 (ref: 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 (ref: none)						
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 (ref: elementary jobs)						
Farmer	0.0812	***	0.0014		0.0430	
Craftsmen	0.0481	*	0.0190		0.0792	***
Manager	−0.0481		0.0053		0.0557	

(*Continues*)

DOI: 10.1002/hec

Table A.II. Continued

	Non-smoker		Non-obese		Eating vegetables	
Regressors	(a)		(a)		(a)	
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 (ref: elementary jobs)						
Farmer	0.0749	***	−0.0075		0.0348	
Craftsmen	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 (ref: 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 (ref: 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 (ref: 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 R^2	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 A.III. 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	*
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	**

(*Continues*)

DOI: 10.1002/hec

Table A.III. Continued

Dependent variables	Non-smoker		Non-obese		Eating vegetables	
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	*
Craftsmen	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	***
Craftsmen	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	*

(*Continues*)

DOI: 10.1002/hec

Table A.III. Continued

Dependent variables	Non-smoker		Non-obese		Eating vegetables	
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's 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 parent's health-related behaviour using binary Probit models.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support of Health Chair – a joint initiative by PSL, Université Paris-Dauphine, ENSAE and MGEN under the aegis of the Fondation du Risque (FDR). We are also grateful to IRDES for the inclusion of our set of questions on childhood circumstances in the 2006 ESPS survey. This paper is part of the research programme 'Inégalités sociales de santé', supported by DREES-MiRe, Inserm, DGS, InVS, INCa and CANAM. Part of this work was carried out while Sandy Tubeuf was visiting the LEDa-LEGOS at Université Paris-Dauphine in 2009. We are very grateful to Damien Bricard for his research assistance and to Christopher McCabe and Erik Schokkaert for their comments and suggestions on a previous version of that paper. We thank Pierre Blanchard, Paul Contoyannis, Brigitte Dormont, Marc Fleurbaey, Michel Grignon, Christine Le Clainche, David Meads, John Roemer, Dirk Van de Gaer and all participants of the IRDES seminar on inequalities in health and health care (Paris, France), the 2009 Health, inequalities, risk and public policy workshop (CERSES, Paris, France), the 2009 CHEPA Health Equity workshop (McMaster University, Hamilton, Canada), the Joint Economics-HEDS seminar (University of Sheffield, UK), the PSE Health Economics Seminar (Paris, France), the Health Economics Seminar Series of Erasmus University (Rotterdam, The Netherlands), the JMA (Angers, France), the 2011 PhD Seminar on Health Economics and Policy (Grindelwald, Switzerland) and the Economic Studies seminar at the University of Dundee for their helpful comments.

REFERENCES

Adams P, Hurd M, Mc Fadden D, Merril A, Ribeiro T. 2003. Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status. *Journal of Econometrics* **112** (1): 3–56.

Adda J, Chandola T, Marmot M. 2003. Socioeconomic status and health: causality and pathways. *Journal of Econometrics* **112**: 57–63.

Agrawal A, Lynskey ML. 2008. Are there genetic influences on addiction: evidence from family, adoption and twin studies, *Addiction* **103**: 1069–1081.

Allonier C, Dourgnon P, Rochereau T. 2008. The 2006 Health, Health Care and Insurance Survey, a panel for health policies analysis, public health and health economics research. Questions d'économie de la santé ; **131**.

Anda RF, Whitfield CL, Felitti VJ, Chapman D, Edwards VJ, Dube SR, Williamson DF. 2002. Adverse childhood experiences, alcoholic parents, and later risk of alcoholism and depression. *Psychiatric Services* **53**(8): 1001–9.

Arneson RJ. 1989. Equality and equal opportunity of welfare. *Philosophical Studies* **56**: 77–93.

Bago d'Uva T, van Doorslaer E, Lindeboom M, O'Donnell O. 2008. Does heterogeneity bias the measurement of health disparities? *Health Economics* **17**(3): 351–375.

Balia S, Jones A. 2008. Mortality, lifestyle and socio-economic status. *Journal of Health Economics* **27**(1): 1–26.

Balia S, Jones A. 2011. Catching the habit: a study of inequality of opportunity in smoking-related mortality. *Journal of The Royal Statistical Society Series A, Royal Statistical Society* **174**(1): 175–194.
Barry B. 2005. *Why Social Justice Matters*. Cambridge: Polity Press.
Bleich S, Cutler D, Murray C, Adams A. 2008. Why is the developed world obese? *Annual Review of Public Health* **29**: 273–95.
Bramstedt KA, Jabbour N. 2006. When alcohol abstinence criteria create ethical dilemmas for the liver transplant team, *Journal of Medical Ethics* **32**: 263–265.
Brighouse H, Swift A. 2009. Legitimate parental partiality, *Philosophy and Public Affairs* **37**(1): 43–80.
Cambois E, Jusot F. 2011. Contribution of lifelong adverse experiences to social health inequalities: findings from a population survey in France, *European Journal of Public Health* **21**(5): 667–673.
Case A, Fertig A, Paxson C. 2005. The lasting impact of childhood health and circumstance. *Journal of Health Economics* **24**: 365–389.
Cohen GA. 1989. On the currency of egalitarian justice. *Ethics* **99**: 906–944.
Contoyannis P, Jones A. 2004. Socio-economic status, health and lifestyle. *Journal of Health Economics* **23**(5): 965–995.
Currie J, Stabile M. 2003. Socioeconomic status and child health: why is the relationship stronger for older children. *American Economic Review* **93**: 1813–1823.
Davison AC, Hinkley DV. 1997. *Bootstrap Methods and Their Application*. Cambridge University Press; Cambridge.
DeSalvo K, Fan VS, McDonnell MB, Fihn SD. 2005. Predicting mortality and healthcare utilization with a single question. *Health Services Research* **40**(4): 1234–1246.
Devaux M, Jusot F, Sermet C, Tubeuf S. 2008. Hétérogénéité sociale de déclaration de l'état de santé et mesure des inégalités de santé. *Revue Française des Affaires Sociales* **1**: 29–47.
Dubin JA, McFadden DL. 1984. An econometric analysis of residential electric appliance holding and consumption. *Econometrica* **52**: 345–362.
Dworkin R. 1981. What is equality? Part I: equality of welfare. *Philosophy and Public Affairs* **10**: 185–246.
Etilé F. 2007. Modes de vie et santé des jeunes. In Cohen D. (ed.) Une jeunesse difficile. *Portrait économique et social de la jeunesse française*. Editions Rue d'Ulm/Presses de l'Ecole Normale Supérieure: Paris.
Etilé F. 2011. Food consumption and health, in *Oxford Handbook of the Economics of Food Consumption and Policy* (Lusk J, Shogren J and Roosen J. (ed.) Oxford University Press: Oxford. Chapter 29.
Fleurbaey M. 2006. Health, equity, and social welfare. *Annales d'Économie et de Statistique* **83/84**: 21–59.
Fleurbaey M. 2008. *Fairness, Responsibility, and Welfare*. Oxford University Press: Oxford.
Fleurbaey M, Schokkaert E. 2009. Unfair inequalities in health and health care. *Journal of Health Economics* **28**(1): 73–90.
Francesconi M, Jenkins SP, Siedler T. 2010. The effect of lone motherhood on the smoking behavior of young adults, *Health Economics* **19**(11): 1377–1384.
Garcia Gomez P, Schokkaert E, Van Ourti T, Bago d'Uva T. 2012. Inequity in the face of death, CORE Discussion Paper 2012/24.
Göhlmann S, Schmidt CM, Tauchmann H. 2010. Smoking initiation in Germany: the role of intergenerational transmission. *Health Economics* **19**(2): 227–242.
Gourieroux C, Monfort A, Renault E, Trognon A. 1987. Generalised residuals. *Journal of Econometrics* **34**(1–2): 5–32.
von Hinke Kessler Scholder S. 2008. Maternal employment and overweight children: does timing matter? *Health Economics* **17**(8): 889–906.
Idler EL, Benyamini Y. 1997. Self-rated health and mortality: a review of twenty-seven community studies. *Journal of Health and Social Behaviour* **38**: 21–37.
Jusot F, Tubeuf S, Trannoy A. 2009. Tel père, tel fils: l'influence de l'origine sociale et familiale sur la santé des descendants en Europe. *Retraite et Société* **58**(2): 63–85.
Jusot F, Tubeuf S, Trannoy A. 2010. Effort or circumstances: does the correlation matter for inequality of opportunity in health? *Cahiers de la Chaire Santé* **8**.
Khlat M, Jusot F, Ville I. 2009. Social origins, early hardship and obesity: a strong association in women, but not in men? *Social Science & Medicine* **68**(9): 1692–1699.
Laitinen J, Power C, Marjo-Riitta J. 2001. Family social class, maternal body mass index, childhood body mass index, and age at menarche as predictors of adult obesity. *American Journal of Clinical Nutrition* **74**: 287–294.
Lefranc A, Pistolesi N, Trannoy A. 2009. Equality of opportunity and luck: definitions and testable conditions, with an application to income in France. *Journal of Public Economics* **93**(11–12): 1189–1208.
Lindeboom M, Llena-Nozal A, van der Klaauw B. 2009. Parental education and child health: evidence from a schooling reform. *Journal of Health Economics* **28**(1): 109–131.
Phillips A. 2006. Really equal: opportunities and autonomy. *The Journal of Political Philosophy* **14**(1): 18–32.
Power C, Graham H, Due P, Hallqvist J, Joung I, Kuh D, *et al*. 2005. The contribution of childhood and adult socioeconomic position to adult obesity and smoking behaviour: an international comparison. *International Journal of Epidemiology* **34**: 335–344.

DOI: 10.1002/hec

Rawls J. 1999. *A Theory of Justice* (Revised edition), **265** Harvard University Press: Cambridge.
Rhems J, Taylor B, Mohapatra S, Irving H, Baliunas D, Patra J, Roerecke M. 2010. Alcohol as a risk factor for liver cirrhosis: a systematic review and meta-analysis. *Drug and Alcohol Review* **4**: 437–445.
Roemer J. 1998. *Equality of Opportunity*. Harvard University Press: Cambridge.
Rosa-Dias PR. 2009. Inequality of opportunity in health: evidence from the UK cohort study. *Health Economics* **18**(9): 1057–1074.
Rosa-Dias PR. 2010. Modelling opportunity in health under partial observability of circumstances. *Health Economics* **19**(3): 252–264.
Rosa-Dias PR, Jones A. 2007. Giving equality of opportunity a fair innings. *Health Economics* **16**: 109–112.
Sen AK. 2002. Why health equity? *Health Economics* **11**: 659–666.
Shorrocks AF. 1982. Inequality decomposition by factor components. *Econometrica* **50**(1): 193–211.
Sørensen A. 2006. Welfare states, family inequality, and equality of opportunity. *Research in Social Stratification and Mobility* **24**(4): 367–375.
Sørensen TI, Orholm M, Bentsen KD, Høybye G, Eghøje K, Christoffersen P. 1984. Prospective evaluation of alcohol abuse and alcoholic liver injury in men as predictors of development of cirrhosis. *Lancet* **ii**: 241–4.
Swift A. 2005. Justice, luck and the family: normative aspects of the intergenerational transmission of economic status. In Bowles S, Gintis H, Osborne-Groves M (ed.), Unequal Chances: *Family Background and Economic Success*. Princeton University Press: Princeton, 256–76.
Trannoy A, Tubeuf S, Jusot F, Devaux M. 2010. Inequality of opportunities in health in France: a first pass. *Health Economics* **19**(8): 921–938.
Tubeuf S, Perronnin M. 2008. New prospects in the analysis of inequalities in health: a measurement of health encompassing several dimensions of health. HEDG W/P 08/01 University of York.
Tubeuf S, Jusot F, Bricard D. 2012. Mediating role of socioeconomic factors and lifestyles in the relationship between early-life conditions and health: evidence from the 1958 British cohort. *Health Economics* **21**(Issue Supplement S1): 129–150.
Webb K, Neuberger J. 2004. Transplantation for alcoholic liver disease. *British Medical Journal* **329**: 63–64.
Zhang L, Welte JW, Wieczorek WF. 1999. The influence of parental drinking and closeness on adolescent drinking. *Journal of Studies on Alcohol* **60**: 245–251.

DOI: 10.1002/hec