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Inequality of opportunity for healthy aging in Europe

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Abstract

This study quantifies the inequality of opportunity (IOp) for healthy aging in Europe. Unlike earlier studies, an objective health indicator, grip strength, is used as an outcome. Using the longitudinal data from the Survey of Health, Aging and Retirement in Europe (Wave 1-5), I introduce a general model where explanatory variables portray individual lifetime trajectory. All predictors are disentangled into illegitimate and legitimate components. The Hausman-Taylor (1981) estimator is employed to deal with the presence of unobserved heterogeneity and endogeneity of time-variant lifestyle. Both upper and lower bounds of IOp are considered by incorporating different sets of illegitimate factors under six scenarios. Parallel results based on self-reported health are provided. We find that IOp in a subjective measure is less sensitive to age, but more to unobserved factors. Finally, the magnitude of IOp is compared between men and women as well as across ten states—Denmark, Sweden, Switzerland, Austria, Germany, France, the Netherlands, Belgium, Spain and Italy. Overall, the results are sensitive to the choice in health indicator.

Keyword: healthy aging, inequality of opportunity, direct unfairness, fairness gap

1 Introduction

This study quantifies the inequality of opportunity (IOp) for health among heterogeneous groups of the elderly population in Europe. Our goal is to disentangle ethically unacceptable inequality from the overall disparity. Therefore, all predictors are classified as either an illegitimate or legitimate factor, which is coined as "circumstance (C)" and "effort (E)" respectively. Broadly speaking, the distinction between two components is often made according to "individual responsibility" (Fleurbaey and Schokkaert, 2009). In this study, we introduce a general model that incorporates various determinants of health, which sketch individual lifetime trajectories from childhood to late adulthood. Various distinctions between C and E are considered under six scenarios.

The contribution of this study is twofold. First, I use an objective indicator of health as an outcome instead of self-reported health, which has been widely used in earlier studies on a similar subject (e.g. Bricard et al., 2013). A subjective indicator might be incomparable across heterogeneous groups due to their different thresholds or rating scales. For example, Jürges (2007) shows that the Danish and Swedish are more optimistic about own health, and Germans are less so compared to other European counterparts. Bago d'Uva et al. (2011) also find that highly educated people tend to assess their health more negatively. I attempt to deal with the issue of reporting heterogeneity by introducing an objective measure, grip strength, as a primary dependent variable. In addition, self-reported health is also used as a secondary variable for comparison.

Secondly, while most existing studies focus on the lower bound of IOp, this paper also addresses its upper bound by taking unobserved individual heterogeneity into account. In earlier investigation, partial observability of circumstance/effort and the presence of unobserved heterogeneity were often neglected. Omitted variables may contain not only unmeasured circumstance and effort, but also luck-related components. By excluding these factors from computation, we always obtain the lower bound of IOp. In addition, without controlling for unobserved heterogeneity, we encounter a problem of endogeneity regarding some key variables, which is lifestyle in our case. To deal with these issues, I apply a panel data technique to gauge the contribution of unobserved heterogeneity to health disparity rather explicitly. More specifically, the Hausman-Taylor (1981)'s approach is applied on the random effect model, which also allows for the estimation of coefficients of endogenous time-varying and invariant factors consistently by letting other exogenous regressors (or their deviations from the mean) serve as instrument variables (IV).

In many empirical studies on IOp, childhood backgrounds are often considered the most illegitimate determinant for adulthood outcomes. The Survey of Health, Aging and Retirement in Europe (SHARE) provides an adequate source of data for this purpose. While exclusively targeting people above age 50, its third wave is uniquely designed for surveying respondents' childhood retrospectively. There are five waves that are available to date. Our model uses lagged values for lifestyle variables as covariates to avoid the problem of reverse causality. As a result, I consider the outcome variables from Wave 2, 4 and 5 and analyze ten countries that appear through Wave 1-5. Our sample contains 21,530 observations which are collected from Denmark, Sweden, Switzerland, Austria, Germany, France, the Netherlands, Belgium, Spain and Italy.

As mentioned above, I impose various normative positions regarding the scope of individual responsibility in terms of late adulthood health. To quantify the upper bound of IOp, if both time-varying and invariant unobserved heterogeneities are classified as illegitimate factors, C, the unfair inequality takes on more than 90% of the overall inequality unless age is standardized. That is, young adulthood outcomes (including education and occupational status) and late adulthood lifestyle seem to play a limited role in equalizing the distribution of health. Even when all variance due to unobserved factors is standardized, however, we still observe 10-40% of IOp in grip strength, which is attributed to demographic characteristics and childhood backgrounds. When self-reported health is used instead, this magnitude falls to 5-25%. These results indicate the lower bound of IOp.

Furthermore, our results suggest that age-related variation is slightly larger in grip strength, especially among men relative to women. On the other hand, the variation driven by unobserved heterogeneity is more pronounced in self-assessed health, especially among women relative to men. Fixing time-invariant unobserved heterogeneity at zero, two indicators consistently suggest that elderly people in France, Belgium and Germany face relatively high IOp in health, while their counterparts in Denmark enjoy low IOp. Nonetheless, we find little consistency in other cases, which sometimes conflict between indicators. This study demonstrates the importance of a careful choice in outcome indicator as well as a normative position when measuring IOp in health status.

2 Data

SHARE is the European longitudinal study on the population over 50 years old. SHARE provides detailed information about individuals' socioeconomic status, human capital, family, health, lifestyles, social networks, beliefs/values, etc. The initial survey was launched in eleven European countries and Israel in 2004. New waves have been added every two years. To date, five waves have been released, where eight countries additionally joined. The third sweep (SHARE LIFE) was specially added to investigate respondents' childhood and young adulthood situations retrospectively. The data also contains a small fraction of participants' younger partners. We consider only the observations over age 50 in each sweep.

I construct panel data consisting of three periods ($t = 1, 2, 3$). The structure is illustrated in Table 1. Time-invariant variables (i.e. adulthood height, education, etc.) are mainly collected from Wave 1. If they are missing, I refer to the corresponding variables in following waves. Information on childhood backgrounds is retrieved from Wave 3, or from a mini childhood module in Wave 5. The data also contains lagged lifestyle variables retrieved from the previous wave to rule out reverse causality. Accordingly, our analysis is restricted to ten countries that participated in all waves, such as Denmark (DK), Sweden (SE), Switzerland (CH), Austria (AT), Germany (DE), France (FR), the Netherlands (NL), Belgium (BE), Spain (ES), and Italy (IT).

Table 1: Structure of the data used in the analysis

	Year	t	Used information	Retrieved Information	Observations
Wave 1	2004/2005				(dropped)
Wave 2	2006/2007	1	health status	adulthood height from w1, childhood from w3 & 5, job at age 35 from w3, lifestyle from w1	7,418
Wave 3	2008/2009				(dropped)
Wave 4	2011/12	2	health status	adulthood height from w1, childhood from w3 & 5, job at age 35 from w3, lifestyle from w2	7,170
Wave 5	2013	3	health status	adulthood height from w1, childhood from w3, job at age 35 from w3, lifestyle from w4	6,942

2.1 Dependent Variable

Compared to other European surveys such as the European Community Household Panel (ECHP) and the European Union Statistics on Income and Living Conditions (EU-SILC), SHARE provides the widest range of health indicators. O'Donnell (2009) enumerates available variables in SHARE from subjective to objective measures: self-assessed health, chronic condition, activity limitations, health-related symptoms, depression scale, diagnosed condtions, body mass index, physical measurements (e.g. grip strength and walking speed), and mortality. First, I choose a relatively objective indicator as a dependent variable to assure international and interpersonal comparability. Mortality is left out because the cause-of-death is unknown for some cases. Accordingly, I consider physical performance test scores. I choose maximum grip strength instead of walking speed due to a large number of missing cases in the latter.

Abundant evidence suggests that hand grip is a valid predictor for overall health outcomes. For example, Bohannon (2008) finds 24 articles that investigate its association with mortality/survival, 9 articles with disability, and 12 articles with complications and/or increased length of hospitalization. Most studies he reviews focus on older subjects. There are additional findings proving the correlation between hand grip and the risk of diabetes (Wander et al., 2011) and dementia/Alzheimer (Boyle et al., 2009). Furthermore, even compared to chronological age, grip strength is found to be a "more useful single marker of frailty for older people" (Syddall et al., 2003)[1].

Second, concerning the fact that grip strength might be a narrow measure, self-rated global health is considered as another dependent variable. To make results more comparable between indicators as well as across countries, the ordinal variable is converted into a continuous one with the same scale as grip strength (1 to 100) after being regressed on other sub-indicators of health. I consider that this procedure helps reduce country-specific reporting heterogeneity, which is hinted by dissimilar distributions of the original variable in Appendix A.

The detailed procedure is as follows. The original five categories of self-assessed health are dichotomized to 0 for fair/poor health and 1 for excellent/very good/good health. This binary variable is regressed on a set of other self-reported indicators which focus on more details of physical condition, such as limitations with general/instrumental/daily activities

[1] They compared hand grip and chronological age in terms of predicting decreased cognitive function, increased lens opacity, higher hearing threshold, poorer visual acuity, lower hemoglobin, higher alkaline phosphatase, fewer teeth, increased risk of walking problems, self-reported generalized arthritis and fracture.

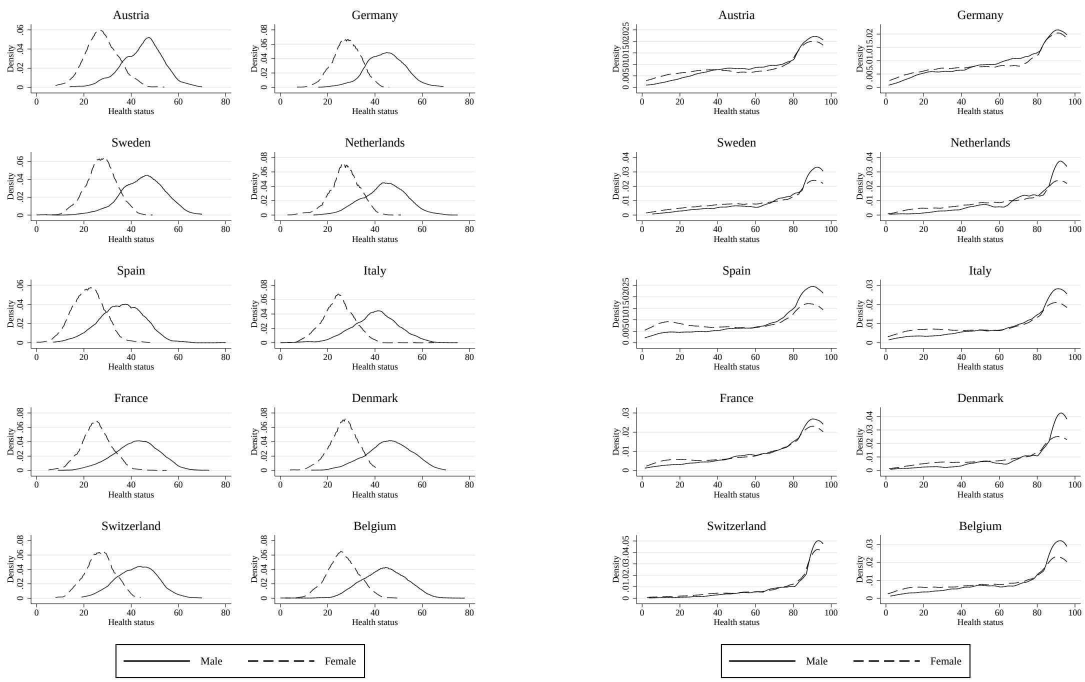
(0 none, 1 more than one), chronic condition (0 none or one, 1 more than two), mobility limitations (scale between 0 and 10), long-term illness (0 none, 1 yes), and body mass index (1 underweight, 2 normal, 3 overweight, 4 obese). Using probit estimation, I compute a predicted probability of each individual reporting good health status, and multiply these values by 100. This transformation is conducted based on a pooled sample. An alternative method based on separate samples from each country is also applied, which is used for sensitivity analysis in Section 6.

Figure 1 illustrates that the distribution of grip strength substantially differs between men and women. This picture suggests that grip strength may be useful for comparing health status across population groups that are unlikely to diverge from each other biologically (e.g. country, education, etc.), but not based on other factors (e.g. gender, etc.). The gender difference is less pronounced in terms of self-assessed health. Overall, we observe higher dispersion of grip strength among males. Considering a large discrepancy in the distribution between gender as well as indicators, I analyze the samples of men and women separately and quantify IOp as a proportion of the illegitimate inequality in the overall disparity of each indicator.

Figure 1: Distribution of health status

(a) Grip strength

(b) Self-reported health



2.2 Independent Variables

Our explanatory variables embody four life cycle stages—childhood, adolescence, early adulthood, and late adulthood. Our childhood-related covariates are the number of books at age ten and parental lifestyles such as drinking and smoking. The former is used as a proxy variable of socioeconomic status during childhood. Wickrama et al. (1999) demonstrate that family social status and lifestyles are important channels for the inter-generational transmission of health. We also include childhood residential area to control for regional gaps in the delivery of health care, neighborhood effect, environmental risk (i.e. pollutant), and so on.

As an adolescent factor, we include adult height[2] as a proxy for health investment during childhood (Case and Paxson, 2008). Considering gradual improvement of nutritional status

[2]This information is surveyed only in the first wave that each respondent joined.

among younger generations, height is transformed as deciles within age groups[3], gender and country. In addition, our model portrays early adulthood SES by educational attainment (e.g. years of schooling) and initial occupation at age 35.

While it is straightforward that childhood characteristics are considered illegitimate factors, it is less clear whether the influence of young adulthood outcomes can be legitimate or not. For example, at a glance, adult height seems to have nothing to do with individual responsibility, because it is an indicator of childhood living conditions as well as genetic endowment (Silventoinen, 2003). Nonetheless, recent evidence shows that lifestyle also contributes to height shrinkage in the aging process (Huang et al., 2013). Similarly, children's educational and occupational choices are affected by their own aspirations and endeavors in addition to parental support or inherited gifts (Diris and Ooghe, 2015). In a nutshell, these variables have two-sided features that are simultaneously related to illegitimate and legitimate factors. For notational simplicity, I name them mixed variables (M).

I attempt to disentangle C and E compounded in M. Following Roemer (1998)'s view, I deem that any correlation between two factors in M is considered to be illegitimate (C) (Trannoy et al., 2010). Accordingly, a residual approach is employed to purge the influence of childhood in M. To elaborate further, I regresses M on childhood background and obtain its residuals. We apply OLS regression for continuous variables such as adult height and years of schooling. For a categorical variable, the initial occupational status, we operate the ordered probit regression and compute generalized residuals (Gourieroux et al., 1987).

Finally, late adulthood characteristics are captured by lifestyles such as smoking, drinking, exercising, and a high level of cholesterol diagnosed by a medical doctor. The last factor is assumed to partially inform about dietary habit. As mentioned earlier, its lagged value is used, considering reverse causation between lifestyle and health.

2.3 Descriptive Statistics

The summary statistics of all variables are provided in Appendix B. On average, Spain and Italy show lower maximum grip strength as well as lower self-reported health. The standard deviation of grip strength is relatively high in Denmark, as well as that of self-reported health in Spain and Italy. The mean age is around 67 years old, but samples from Austria, Sweden and Spain are one or two years older. The proportion of females is about 55% in all samples, on average, yet it diverges slightly in Danish and Austrian

[3] Age is divided into 7 groups such as 50-54, 55-59, 60-64, 65-69, 70-74, 75-79 and 80-102.

samples. Between-country variation is more pronounced in terms of the number of books during childhood. While 26% of the Swedish sample had books that were enough to fill two shelves, this was only 4-6% for Spanish and Italian samples. In all samples, more than half had a smoking parent. Nonetheless, the prevalence of parental smoking is even higher than 70% in Danish, Belgian, and Dutch samples. Less than 15% had a heavily drinking parent, which is relatively consistent across countries, except for the Dutch sample that records only 4%.

Concerning adolescent and young adulthood characteristics, we observe a clear divergence in southern Europe. For example, the average years of schooling are much lower in Spain and Italy. Moreover, the proportion of non-manual job holders—such as professionals, technicians, and service employees/office clerks—is lower, and that of the inactive or unemployed population is relatively higher in these countries.

Drinking and smoking behavior somehow reflects social and cultural norms present in the society. In all samples, around 20% of respondents smoke. We observe a slightly higher smoking rate in Denmark. In southern Europe, nearly half of respondents are alcohol abstainers. The rate of daily drinking is approximately 40% in Italy and France, and 30% in the Netherlands, Denmark, Switzerland, and Belgium. We find more physically inactive elderly people in Spain and Italy, which is around 10-15%. The incidence of high cholesterol is higher in Spain and Belgium (30-34%) compared to other countries.

3 Method

Partial observability of individual characteristics and the presence of unobserved heterogeneity are commonly addressed challenges in empirical investigations of equality of opportunity. Using limited information provided by survey-based data, many studies focus on the correlation between observed circumstances (or effort) and the outcome of interest (See Lefranc et al., 2009; Rosa Dias, 2010 for further discussions), resulting in the lower bound of IOp. Endogeneity of a variable is another concern related to unobserved heterogeneity. For instance, if lifestyle is endogenous to past illness and/or sudden shocks that are not surveyed, we hardly identify independent contribution of individual effort to health maintenance (See García-Gómez et al., 2015).

To overcome these shortcomings, this study employs a panel data technique, namely the Hausman-Taylor (1981) estimator based on the random effect model, in order to identify not only a causal effect of past lifestyle but also the role of unobserved heterogeneity explicitly.

Note that a linear model is applicable to both indicators of health, which range between 1 and 100.

3.1 Estimation strategy

We consider the following base model with Z_i and X_{it}, denoting vectors of time-invariant and variant variables respectively. We are concerned with the situation where $Cov(X_{it}, u_i) \neq 0$, or endogenous lifestyle in other words.

$$y_{it} = \alpha + \beta_1 Z_i + \gamma X_{it} + u_i + e_{it} \tag{1}$$

Although we can obtain consistent estimates of γ through the fixed effect model, time-invariant factors such as Z_i are removed by within-transformation; hence, β is not estimable. Therefore, I adopt the Hausman-Taylor (1981)'s approach (HT) which involves the following steps.

First, we sub-divide X_{it} into exogenous and endogenous factors, denoted as X_{1it} and X_{2it} respectively.

$$y_{it} = \alpha + \beta Z_i + \gamma_1 X_{1it} + \gamma_2 X_{2it} + u_i + e_{it} \tag{2}$$

As a result, our model considers three groups of variables as follows.

- Z_i: A vector of time-invariant variables that are considered to be uncorrelated with u_i (e.g. childhood condition, mixed factors)
- X_{1it}: A vector of time-varying variables that are uncorrelated with u_i (e.g. current age)
- X_{2it}: A vector of time-varying variables that are correlated with u_i (e.g. lifestyle)

Through a within-transformation (eq. 3), we obtain consistent estimates of the coefficients of all time-varying factors, namely γ_1 and γ_2. In addition, the variance of the residuals, σ_e^2, is also consistently estimated using the residuals from this stage.

$$(y_{it} - \overline{y}_i) = \gamma_1(X_{1it} - \bar{X}_{1i}) + \gamma_2(X_{2it} - \bar{X}_{2i}) + (e_{it} - \overline{e}_i) \tag{3}$$

$$where \quad \overline{y}_i = \frac{1}{T_i}\sum_{t=1}^{T_i} y_{it}, \quad \overline{x}_{Ji} = \frac{1}{T_i}\sum_{t=1}^{T_i} x_{Jit}(J = 1, 2) \quad and \quad \overline{e}_i = \frac{1}{T_i}\sum_{t=1}^{T_i} e_{it}.$$

Using $\hat{\gamma}_1$ and $\hat{\gamma}_2$ estimated from the first stage, we get the group-mean of the residuals, $\bar{\varepsilon}_i$ (eq. 4).

$$\bar{\varepsilon}_i = \overline{y}_i - \hat{\gamma}_1 \bar{X}_{1i} - \hat{\gamma}_2 \bar{X}_{2i} \tag{4}$$

Next, we regress $\bar{\varepsilon}_i$ on Z_i. If Z_i is endogenous, Hausman and Taylor (1981) propose to use $\bar{X}_{1it}$ and other exogenous time-invariant variables as IV. In our case, all time-invariant factors are assumed to be exogenous; hence, Z_i is used as IV for itself in eq. (5).

$$\bar{\varepsilon}_i = \beta Z_i + u_i + \overline{e}_i \tag{5}$$

The variance of the total residuals in eq. (5), σ^{*2}, can be re-expressed in eq. (6).

$$\sigma^{*2} = \sigma_u^2 + \frac{\sigma_e^2}{T_i} \tag{6}$$

By using σ_e^2, which is computed in eq. (3), we can estimate σ_u^2 via eq. (7).

$$\sigma_u^2 = \sigma^{*2} - \frac{\sigma_e^2}{T_i} \tag{7}$$

Finally, we compute θ_i, the coefficient to be used for GLS transformation (eq. 9), and get β, γ_1 and γ_2.

$$\theta_i = 1 - \frac{\sigma_u}{\sqrt{\sigma_e^2 + T_i \sigma_u^2}} \tag{8}$$

$$y_{it} - \theta_i \overline{y}_i = \alpha(1-\theta_i) + \beta Z_i (1-\theta_i) + \gamma_1 (X_{1it} - \theta_i \bar{X}_{1it}) + \gamma_2 (X_{2it} - \theta_i \bar{X}_{2it}) \tag{9}$$

$$+ u_i(1-\theta_i) + (e_{it} - \theta_i \overline{e}_i) \tag{10}$$

In Appendix C, I compare $\hat{\gamma}_2$ obtained from various estimating methods such as fixed effect (FE), random effect (RE), and a pooled OLS (OLS) estimation. In addition, the correlated random effect model with Mundlak-specification (ML) is also considered, which assumes eq. (11) and transform the model to eq. (12).

$$u_i = \eta_2 \overline{X}_{2it} + \epsilon_i \tag{11}$$

$$y_{it} = \alpha + \beta Z_i + \gamma_1 X_{1it} + \gamma_2 X_{2it} + \eta_2 \overline{X}_{2it} + \epsilon_i + e_{it} \tag{12}$$

Overall, the statistical importance of $\hat{\gamma_2}$ is either absent or weak across all specifications. In terms of economic importance, $\hat{\gamma_2}$ obtained from HT is similar to that of FE and ML, but substantially different from that of RE or OLS. Although an ML approach can be used alternatively, HT is still preferred because it does not require additional regressors such as $\overline{X}_{1it}$ and $\overline{X}_{2it}$, making our model more parsimonious[4]. However, we still use the results from ML for robustness check in Section G.

3.2 Responsibility cut

After estimating all coefficients, all predictors are partitioned into two components, C and E, where C is a vector of (illegitimate) circumstance variables, and E is a vector of (legitimate) effort variables. The borderline between the two is coined a "responsibility cut", whose location depends on a researcher's normative judgment. I consider six possible scenarios (Table 2).

Under Scenario I, individual responsibility is defined as what is fully controlled by an individual (e.g. control approach). Under this position, only late adulthood lifestyle can be considered as E. Nevertheless, one may argue that individuals decide their health-promoting behavior based on given constraints (i.e. time, economic resource, environment, etc.). It is also empirically proven that lifestyles are significantly correlated with individual socioeconomic status (SES) (Contoyannis and Jones, 2004; Balia and Jones, 2008; Govil et al., 2009; Paulik et al., 2010). Nevertheless, our model posits that past lifestyles are time-varying factors, where people are free to choose whether to maintain or adjust in each period. Furthermore, using the Hausman-Taylor estimator, we restrict lifestyle to explain the within-individual variation of health status only, which equally applies to all individuals regardless of their heterogeneous backgrounds.

Under Scenario II, I postulate that individuals are responsible for their actions after the age of consent (Roemer and Trannoy, 2013). Accordingly, residuals of M are additionally classified as E. The next scenario III relates ethical concern regarding demographic disparity. Although aging is inescapable and thus beyond individual control, one may argue that its influence on physical strength is rather biological, and hence not to be ethically illegitimate. In this view, age can be sorted as E instead.

[4]In our study, it is assumed that individuals are fully responsible for the consequence of their lifestyle, as far as the effect is independent of any kind of individual characteristics including unobserved heterogeneity (See Section 3.2). Therefore, our normative position is incompatible with ML specification, which assumes individual mean lifestyle, $\overline{X}_{2it}$, to be correlated with individual random effects.

The following scenarios are motivated to grasp the importance of unobserved heterogeneity. However, it is difficult to classify unobserved terms into either factor without a strong assumption. For instance, a time-invariant heterogeneity, u_i, may indicate genetic endowment and environmental factors that have a latent effect on health. Using this interpretation, u_i can be considered as C. Nevertheless, u_i also conveys unmeasured health-related preferences, which suggests its classification as E.

Concerning e_{it}, idiosyncratic shocks, more explicit interpretation is possible by introducing an additional factor, luck (L), in addition to C and E. That is, disparity in an outcome due to e_{it} is ethically unacceptable if we assume that it represents brute luck. It relates to the event that an individual has no reasonable influence on a probability of its occurrence. On the other hand, it can be legitimated if e_{it} is viewed as option luck. It requires other conditions such as "the risk is taken deliberately, is calculated, isolated, anticipated and avoidable" (Dworkin, 1981, retrieved from Vallentyne, 2002 and Lefranc et al., 2009).

Instead of interpreting these factors arbitrarily, we consider all possible scenarios depending on the identification of each. Scenario IV classifies u_i as an illegitimate factor and e_{it} as a legitimate one. Scenario V does vice versa. In the final scenario, all unobserved factors are considered to be legitimate factors.

Table 2: Responsibility cut according to various scenarios

Scenario	Illegitimate	Legitimate	Note
I	age, childhood, M, u_i, e_{it}	lifestyle	Upper bound of IOp
II	age, childhood, u_i, e_{it}	M, lifestyle	
III	childhood, u_i, e_{it}	age, M, lifestyle	
IV	age, childhood, u_i	e_{it}, M, lifestyle	
V	age, childhood, e_{it}	u_i, M, lifestyle	
VI	age, childhood	u_i, e_{it}, M, lifestyle	Lower bound of IOp

3.3 Standardization

I use Fleurbaey and Schokkaert (2009)'s framework of "direct and indirect standardization" to quantify the illegitimate inequality in health. The direct standardization produces direct unfairness by fixing all individuals' effort variables at reference values: $y^*(C, E^*)$. The DU satisfies the reward principle, which states that differences in outcome due to efforts are equitable; hence better effort should be rewarded. However, under the artificial situation where everyone makes the same effort, there is "no influence of legitimate difference". Therefore, any health disparities after the direct standardization are considered illegitimate.

On the other hand, the indirect standardization computes the fairness gap (FG). It refers to the difference between a health status that is predicted by actual variables and a hypothetical counterpart that assumes identical circumstances for all individuals: $y(C, E) - y^*(C^*, E)$. The FG satisfies the compensation principle, which means that the health status of two individuals making the same efforts should be equal, since a fair society compensates the worse-off between them.

The detailed procedure for commutating DU and FG under each scenario is displayed in Appendix D using the following values as references.

- Childhood: having the largest number of books, no parental smoking or heavy drinking, and having lived in town
- Age: being aged 50
- M: zero for residualized height, zero for residualized occupational choices, three for residualized years of schooling (roughly leading to one level higher educational degree)
- Lifestyle: drinking monthly, non smoking, exercising, and absence of high cholesterol
- u_i and e_{it}: zero

In general, the principles of reward and compensation are incompatible when the effects of efforts and circumstances are not independent of one another. Accordingly, none of the direct and indirect methods satisfy both principles simultaneously. However, within an additively separable model, which is our case, two methods yield the same outcome. This fact provides another rationale for our approach that converts an ordinal variable of self-reported health into a continuous indicator and applies a linear model. Consequently, our measures of IOp using DU and FG are equivalent to each other as expressed in eq. (13).

$$IOp(\%) = \frac{Var(DU)}{Var(y_{it})} \times 100 = \frac{Var(FG)}{Var(y_{it})} \times 100 \tag{13}$$

4 Estimation results

This section provides an overview on the relationship between each of the regressors and two indicators of health based on a pooled analysis (Table 3). However, in the next section, IOp is computed based on the estimation using country-specific samples. The results are presented in Appendix E. In terms of the sign of coefficients, the results between pooled and separate analyses are mostly consistent.

All results are presented according to the timing of events in one's life course. The first set of variables portrays childhood backgrounds. Childhood SES is positively correlated with both indicators, which is proxied by the number of books at age ten. On the other hand, parental lifestyle plays a different role in explaining each indicator. For males, parental smoking is insignificantly correlated with both indicators of health. For females, it is positively correlated with women's grip strength, but negatively with their self-reported health. However, the statistical significance of such correlations is weak ($P < 0.1$). Relative to smoking, parental alcohol consumption is more closely related to a descendent's health status in late adulthood. If a parent was a heavy drinker, the probability of reporting good health is likely to decrease by 4.43 percentage points for sons and 6.06 percentage points for daughters. On the other hand, its correlation with children's grip strength is statistically insignificant.

Although a positive contribution from parental smoking is counter-intuitive, I attempt to provide some possible explanations. First of all, it could simply be attributed to imprecise measurement. In SHARE data, most of the childhood information relies on elderly participants' retrospect; hence, it is hard to account for detailed features (i.e. frequency or amount) of parental smoking behavior. Moreover, during their parents' young adulthood, cigarette smoking began to spread widely, especially at the outbreak of the World Wars, yet the public awareness of its hazards was not well established. As a consequence, tobacco usage can misrepresent parental health practice if it merely signals a temporary attempt to follow a fashion of that time.

In addition, we should not neglect the fact that the social gradient on tobacco consumption has varied over time. A number of studies claim that cigarette smoking was initially adopted by people in a privileged position who were more opt to or able to accept innovative lifestyles. When such upstream practice was diffused to other segments of society, however, the high status initiators began to turn away from smoking. The reason is that, by this period, health concern emerged as a more innovative idea in life (Ferrence, 1989; Pettit and Griswold, 1995 retrieved from Pampel, 2005; Escobedo and Peddicord, 1996; Graham, 1996). To conclude, if smoking status misinforms about parental unhealthy behavior, or its correlation with other unobserved factors (i.e. social status) plays a greater role, it is not striking to observe such a result that is in discord with our conventional belief.

The different roles of parental lifestyle regarding objective and subjective indicators can be partly attributed to reporting bias. Supporting this hypothesis, Bertoni (2015) documents the long-term impact of childhood deprivation on individual perception of subjective well-being. The author reports that childhood starvation tends to lower standards of life satisfaction later in life. In our case, the influence of parental risky behavior seems to be opposite, if it exists, which induces children to use higher thresholds in their diagnosis of overall health, and thus report a worse condition. One of the possible relevant mechanisms is exposure to parental disease (e.g. cancer) which could have been directly or indirectly caused by their unhealthy behavior. While facing an adverse situation followed by parental illness, children may have not only learned the cost of risky lifestyles but could have also been motivated to adjust their expectations about health. In addition, it is also plausible that self-assessment reflects a broader aspect of overall health compared to grip strength, which helps reveal further association with parental behavior.

Compared to those who lived in an urban area during childhood, people who lived either in a town or a rural area tend to show higher grip strength. However, for males, childhood residence does not play a role in determining subjective health. Next, we consider a number of outcomes that are attained shortly after the age of consent, namely height, as a proxy for initial health, education, and occupation during young adulthood. In most cases, adulthood height and education are positively correlated with better health. In addition, from the male sample only, we find a negative correlation between higher tendency to hold a manual job and both health indicators. On the other hand, presumably due to women's low participation in the labor market, this variable has minimal predictive power regarding women's health.

Table 3: Estimation result: pooled sample across ten countries

	Male				Female			
	Grip strength		SRH		Grip strength		SRH	
Book at age 10 (ref. few)								
: One shelf	1.59***	(0.32)	0.94	(1.00)	0.87***	(0.21)	4.97***	(1.05)
: One bookcase	1.67***	(0.33)	2.88**	(1.03)	0.66**	(0.22)	6.23***	(1.09)
: Two bookcases	1.35***	(0.39)	2.35+	(1.20)	1.11***	(0.26)	5.72***	(1.28)
Parent smoked	0.22	(0.26)	-0.38	(0.79)	0.29+	(0.16)	-1.57+	(0.82)
Parent drank heavily	-0.26	(0.44)	-4.43**	(1.36)	-0.41	(0.27)	-6.06***	(1.33)
Childhood residence (vs. City)								
: Town	1.16***	(0.32)	-1.06	(1.00)	0.39+	(0.22)	2.45*	(1.09)
: Rural area	1.73***	(0.32)	-0.85	(0.99)	1.09***	(0.22)	3.38**	(1.07)
Height decile_residuals	1.99***	(0.12)	0.99**	(0.37)	1.33***	(0.08)	0.29	(0.38)
Education_residuals	0.03	(0.03)	0.63***	(0.11)	0.10***	(0.02)	0.72***	(0.12)
Job at age 35_residuals	-0.28*	(0.12)	-1.60***	(0.38)	-0.12	(0.08)	-0.60	(0.40)
Drank at $t-1$ (ref. Daily)								
: Weekly	-0.01	(0.19)	-0.19	(0.64)	-0.25	(0.16)	0.90	(0.77)
: Monthly	0.04	(0.26)	-0.34	(0.87)	-0.16	(0.18)	-0.02	(0.88)
: Never	0.01	(0.28)	-0.18	(0.94)	0.01	(0.19)	-0.52	(0.91)
Smoked at $t-1$	0.20	(0.27)	0.82	(0.92)	0.03	(0.23)	1.28	(1.08)
Exercised weekly at $t-1$	0.15	(0.22)	0.75	(0.73)	0.25+	(0.14)	0.04	(0.65)
Had high cholesterol at $t-1$	0.08	(0.19)	1.28*	(0.62)	0.08	(0.13)	0.58	(0.63)
Country (ref. Switzerland)								
: Austria	3.53***	(0.75)	-11.93***	(2.31)	2.07***	(0.47)	-8.81***	(2.35)
: Germany	3.10***	(0.67)	-13.97***	(2.07)	1.56***	(0.45)	-11.96***	(2.23)
: Sweden	3.88***	(0.64)	-6.08**	(1.97)	1.57***	(0.42)	-7.42***	(2.06)
: Netherlands	2.38***	(0.64)	-5.62**	(1.97)	1.17**	(0.42)	-6.66**	(2.09)
: Spain	-4.14***	(0.68)	-10.70***	(2.10)	-3.43***	(0.46)	-14.47***	(2.26)
: Italy	-0.45	(0.64)	-8.06***	(1.97)	-1.58***	(0.42)	-10.19***	(2.11)
: France	0.83	(0.65)	-9.92***	(2.00)	-0.43	(0.42)	-7.55***	(2.11)
: Denmark	3.45***	(0.65)	-5.70**	(2.01)	0.67	(0.44)	-5.59**	(2.17)
: Belgium	2.31***	(0.59)	-8.98***	(1.82)	0.38	(0.39)	-9.64***	(1.95)
Age	-0.55***	(0.01)	-0.80***	(0.04)	-0.31***	(0.01)	-0.81***	(0.04)
σ_u	6.25		19.11		4.51		22.57	
σ_e	4.46		15.04		3.39		16.12	
N	9,760				11,770			

Note: Constant terms are omitted. Standard errors are in parentheses. (+ p$<$ 0.1, * p $<$ 0.05, ** p $<$ 0.01, *** p $<$ 0.001)

The following variables provide insights into the health-related lifestyle of late adulthood. Exercising helps increase women's physical strength, which is measured objectively. Unexpectedly, we find a positive correlation between high cholesterol and males' self-reported health only. It may be partly attributed to reporting heterogeneity unless two measures capture different aspects of health condition. That is, those who exert a less healthy lifestyle that leads to a high level of cholesterol may be more optimistic when rating own health status[5].

Dummies for country of residence are introduced next to control for the country-fixed effect. The different signs of their coefficients between two indicators suggest the presence of country-specific reporting heterogeneity. Compared to Switzerland, for instance, people from most countries tend to perceive their health less optimistically, even if their physical strength is similar or higher, except for Spain and Italy. The chronological age follows next, which provides indications of biological deterioration of health due to aging. We find a slightly larger health penalty of aging among men. On the other hand, the gender discrepancy in aging is less pronounced concerning self-assessed health. The final two rows show the standard deviations of residuals, u_i and e_{it}. Both σ_u and σ_e are larger for self-assessed health. This result is plausible because error terms include (unobserved) reporting bias.

5 Comparison of Inequality of opportunity (IOp)

5.1 Across normative positions

In this section, we compare the magnitude of IOp across different normative positions as well as measures of health status. Let us begin the discussion with the case of males presented in Figure 2. As mentioned in Section 3.3, IOp is measured in a relative term, namely its proportion to the overall inequality. Based on an objective measure for health, as presented in Figure 2(a), IOp takes up almost 100% when only the lifestyle-related inequality is considered to be legitimate (Scenario I). Even if we consider that the disparity explained by intermediate adulthood outcomes (including SES) is also legitimate, a decrease

[5]In country-specific analyses (Appendix C), we observe a substantial variation in health returns to drinking behavior across countries. In Germany (among females), the Netherlands, and Belgium (among females), less frequent drinking negatively affects physical health. On the other hand, a positive role is found in Sweden (among males), Italy (among females) and Switzerland (among females). To some extent, this divergence can be attributed to cultural or societal backgrounds that determine preferred type of alcohol, drinking context or amount, and so on. For instance, in some societies, non-frequent drinking behavior may reflect limited social interactions, which can aggravate physical health (Cornwell and Waite, 2009).

of IOp in Scenario II is less than 5 percentage points in most cases. However, a visible drop (by 5-15 percentage points) is found in Scenario III, where age difference is additionally standardized. This change captures the contribution of biological aging to the inequality in health. Under this scenario, IOp in grip strength is still higher than 80%.

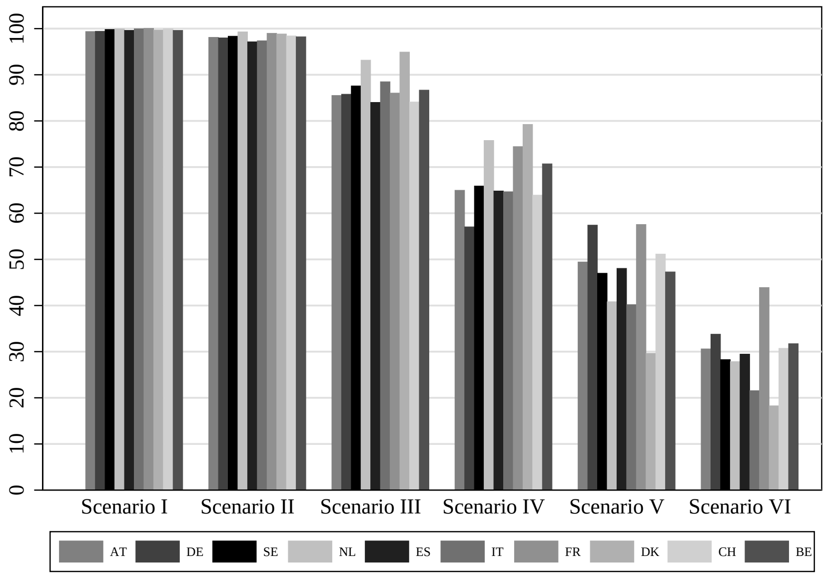
A further drop is observed in Scenario IV that standardizes an idiosyncratic shock, e_{it}, which is defined as option luck. Compared to that in the first two scenarios, IOp in grip strength decreases by more than 30 percentage points in most countries except for the Netherlands, France, Denmark, and Belgium. Under Scenario V that presumes u_i to mostly reflect unobserved efforts, we find that its contribution to IOp outweighs that of e_{it} in most cases. Germany is an exception, where time-variant and invariant unobserved heterogeneities are equivalently important for a disparity in (objective) health of the elderly population. In Scenario VI, when both types of unobserved factors are considered as legitimate components, the magnitude IOp falls to around 30% or below in most countries except for France (about 45%). The lowest IOp is found in Italy and Denmark, which amounts to 20%.

When a subjective measure is used (Figure 2b), the picture changes drastically from Scenario III onwards. We find a smaller contribution of age-related heterogeneity to IOp[6]. The results from Scenario IV-V suggest a larger importance of unobserved factors to self-assessed health. When either term is identified as an legitimate factor, IOp falls below 50% in most cases except for Germany, France, Denmark and Belgium. Under Scenario VI, which suggests the lower bound of IOp, less than 15% of inequality is considered to be unfair in most countries except for Germany and France.

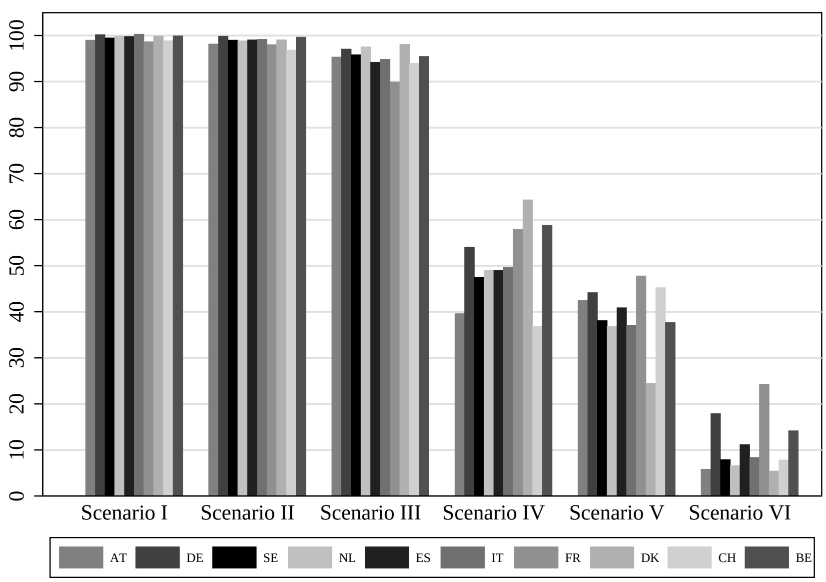
[6] This result seems contrary to earlier results in Table 3, which shows larger coefficients of age with respect to self-rated health. Nonetheless, what is compared in this section is the contribution of age to the overall variance of each indicator expressed in a relative term, rather than its absolute importance to the mean.

Figure 2: Inequality of opportunity for health among males (%)

(a) Grip strength



(b) Self-reported health



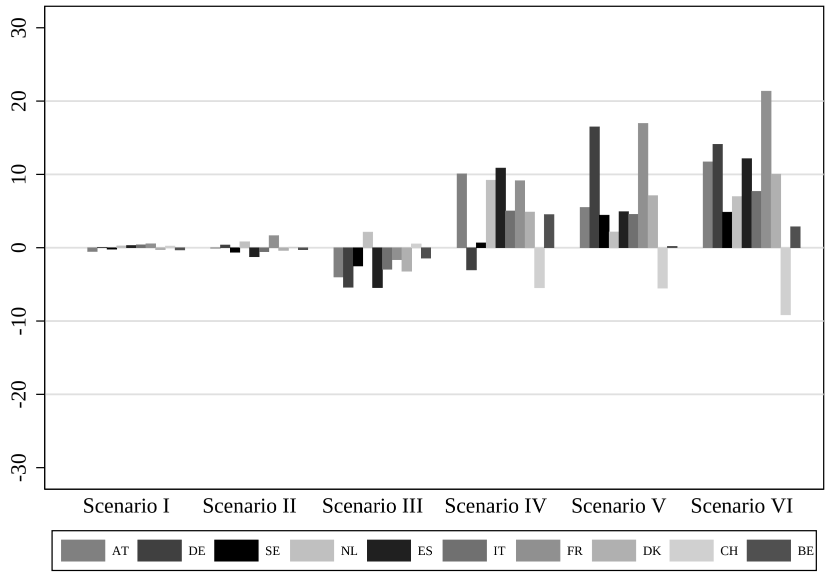
5.2 Between gender

The results are compared between gender in this section. The parallel results from the female sample are provided in Appendix F. The overall picture is mostly consistent with the result from their male counterparts. For an easier comparison, Figure 3 highlights the gender gap in terms of IOp by subtracting the IOp of females from that of males under each scenario.

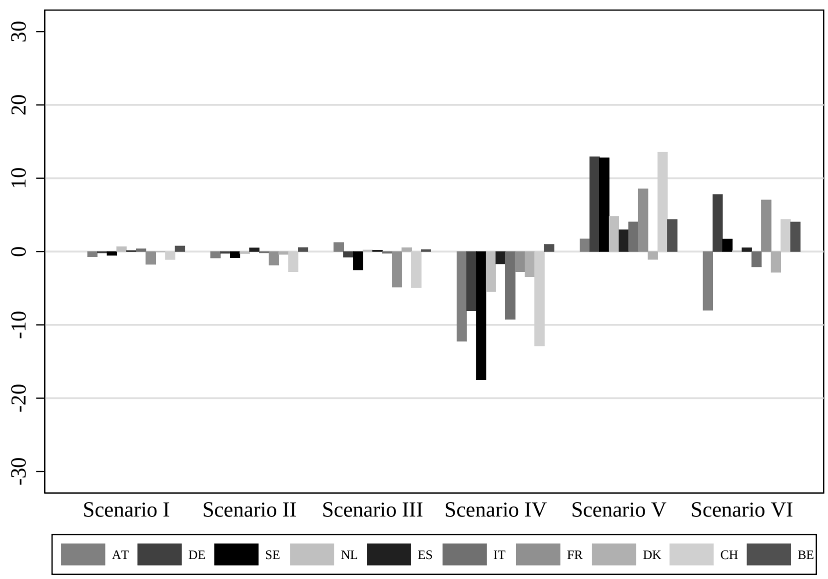
While there is a minimal difference between gender under the first two scenarios, some visible discrepancies appear from the third scenario onwards. Under Scenario III, for example, women show a slightly higher IOp (5 percentage points). Except for France and Switzerland, however, the gender gap is less pronounced in terms of a subjective indicator. Under Scenario IV, women show a smaller IOp in grip strength, but a larger one in self-assessed health. Phrasing differently, e_{it} is more important to females than to males in terms of objective health, but vice versa in terms of subjective health. The results from Scenario V show that women's IOp is more sensitive to u_i regardless of an indicator of health. The gender gap is largest under the final scenario in terms of grip strength. Except for Switzerland and Belgium, IOp of women's grip strength is around 20% or below (Appendix F), which is approximately 10 percentage point lower than that of males'. Nonetheless, we find a smaller gender difference in terms of a subjective indicator under the same scenario.

Figure 3: Gender difference in IOp (percentage points)

(a) Δ IOp in grip strength



(b) Δ IOp in self-reported health



Note: Δ is computed by subtracting the results of females from that of males.

To summarize, major implications vary with not only normative positions but also health indicators. Overall, based on an objective measure, the gender gap ranges between 5-20 percentage points. According to Scenario IV-VI, it is suggested that the female elderly populations enjoy better equality of opportunity for health. Our results imply that women and men can enjoy an equivalent level of equity in health, if interventions successfully mitigate the larger role of aging for male populations or that of unobserved heterogeneity for female counterparts. However, if the different roles of these factors are mainly related to their biological distinction, the gender gap in IOp is unlikely to be closed. Based on a subjective measure, the gender difference is less profound.

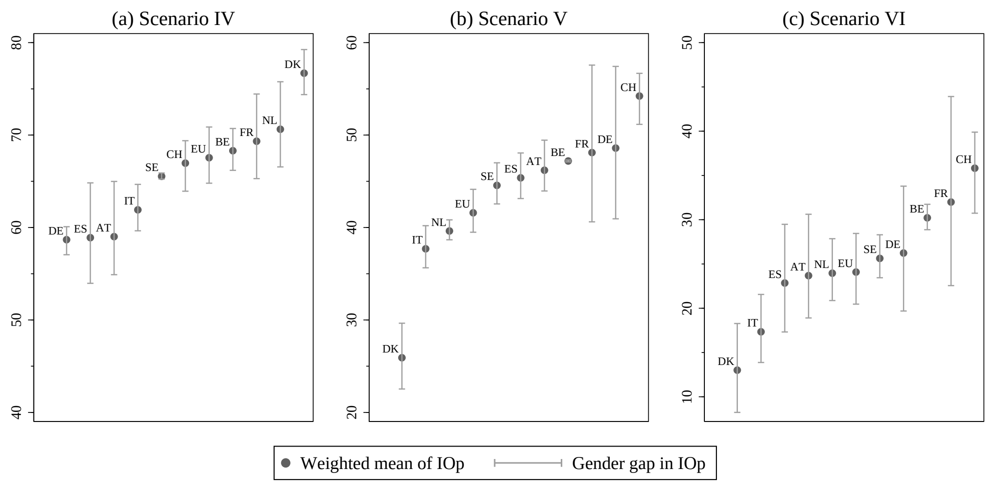
5.3 Across countries

Finally, the results are also compared across countries. Figures 4-5 exhibit international ranks of IOp with respect to each of the scenarios and measures. The cross-country comparison is conducted based on a weighted mean of IOp of men and women within a country, which is calculated using each group's sample size. As a reference, IOp obtained from a pooled sample is added, which is marked as EU[7]. We can neglect the first three scenarios, of which results suggest an excessive IOp of above 80% in all countries. In this situation, IOp should be a concern in all societies, and hence comparing relative ranks may not be useful for policy guidance.

First, let us discuss the results based on grip strength that are assumed to be more comparable across countries. Under Scenario IV, we find the highest IOp in Denmark. the Netherlands, Belgium and France follow next. Among these countries, Denmark and the Netherlands switch their relative position substantially under Scenario VI (or V). This change indicates that their policy makers can effectively lower IOp in health by equalizing u_i. Therefore, particularly in these countries, further investigation considering a wider set of covariates is needed to reveal what u_i actually captures. Except for these countries, plus Italy, the IOp in most countries remains above 40% under Scenario V, but falls below under Scenario VI. These results suggest that IOp can be reduced through policies that enable people to be better insured against their brute luck.

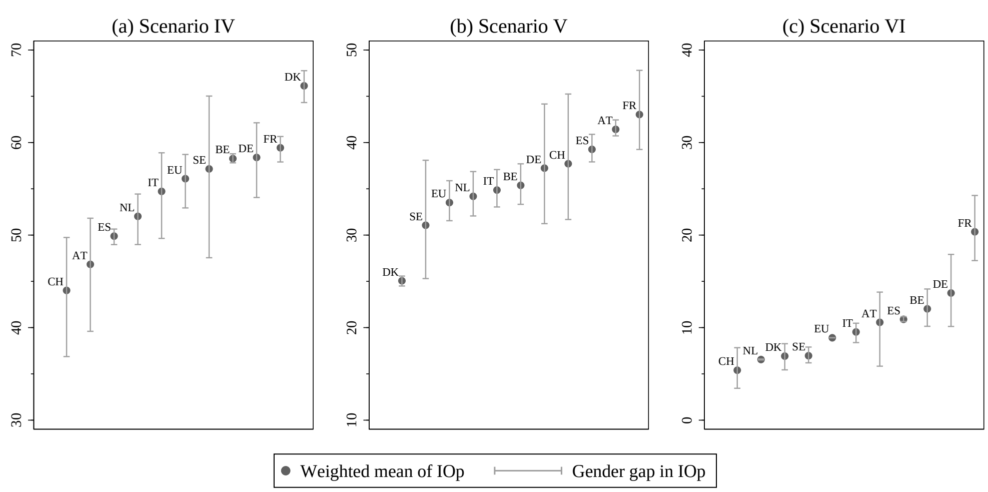
[7]When computing IOp of EU, the same set of covariates is included without country dummies, equivalently to the case of estimation on individual countries.

Figure 4: Cross-country comparison of IOp based on grip strength (%)



Special attention should be given to Belgium and France, which are constantly ranked relatively high for Scenarios IV-VI, as well as Switzerland, which also exhibits a relatively high IOp under Scenario VI, the scenario defining circumstances most restrictively. Our results imply that the link between childhood circumstances and late adulthood health, as well as between age and late adulthood health, is stronger in these three countries.

Figure 5: Cross-country comparison of IOp based on self-reported health



When self-reported health is used as an outcome, most results and policy implications change substantially, but with a few exceptions (e.g. Denmark, Belgium and France). For instance, Germany shows high IOp under Scenario IV, which contrasts to the earlier outcome. On the other hand, the situation in Switzerland under Scenario VI is no longer as problematic as the earlier results. Again, our results imply the importance of the choice of an indicator.

In addition, to stress the importance of controlling for unobserved heterogeneity on IOp, we compare our results with an earlier finding based on a cross-sectional analysis. For instance, Bricard et al. (2013) evaluate the IOp in self-reported health using the third wave of SHARE. They reveal a relatively high importance of circumstances in the Czech Republic, Greece, France and Austria (70-80%), and a lower importance in Germany, Italy, Switzerland, the Netherlands and Belgium (about 30-50%), regardless of assumed scenarios[8]. Precisely speaking, their results are incomparable to any of ours due to the fact that they measure the relative importance of C to the variation in health explained by observed characteristics[9]. However, we assume that our exercise under Scenario VI somewhat resembles their approach in the sense that both concern the lower bound of the IOp. Under this final scenario, similar to their investigation, we find a high IOp in France and low IOp in Switzerland as well as the Netherlands. However, we also obtain some contrasting results such as a high IOp in Germany and Belgium as well as a middle-ranked IOp for Austria and Italy.

6 Sensitivity analysis

In this section, additional results are provided to check the robustness of our results. First, I introduce an alternative subjective indicator that takes country and gender-specific heterogeneities into account. The rational is that the prevalence of some health problems may differ across populations. For instance, depending on how rare (or common) obesity is in a society, obese people may perceive their general health differently. To capture such differences, self-reported health status is regressed on the same set of other health indicators,

[8]They consider two scenarios, namely Roemer (1998)'s scenario that defines any correlation between C and E as C, as well as Barry (2005)'s, which does not differentiate the role of E according to contamination of C. Their model considers more detailed childhood backgrounds such as the main breadwinner's occupation, number of books/rooms/facilities, parental lifestyle, economic hardship, experience of hunger, parental longevity, and regular dental check-ups. Due to missing information, however, many factors are ignored in this study in order to avoid losing a large number of observations in the longitudinal data. For lifestyle variables, they retrieve the information from the previous wave.

[9]On the other hand, we measure the importance of C in the overall variation of health.

but country and gender-specific samples are used in prediction instead of a pooled one.

The distribution of our initial and alternative subjective indicators of health differs (Appendix G). For instance, we find higher concentration in the upper end after using an alternative measure in Austria, Sweden, Denmark, Switzerland, and Belgium. An opposite pattern is observed in Germany (for males), Spain, Italy, and France. Nonetheless, using an alternative measure does not affect our results substantially as illustrated in Appendix H. The change is less than 5 percentage points in most cases. The most pronounced difference is found under Scenario VI where u_i is classified as an illegitimate factor.

Another robustness check is conducted using a different estimation strategy, namely a random effect model with Mundlak specification. Considering the fact that this approach uses individual average time-varying factors as IV for individual-specific heterogeneity, mean values of lifestyle are always classified in the same group with u_i throughout six scenarios. After using an alternative model specification, the change in IOp remains below 5 percentage points in most cases (Appendix I).

7 Conclusion

This study quantifies unfair health disparities in ten European countries—Denmark, Sweden, Switzerland, Austria, Germany, France, the Netherlands, Belgium, Spain and Italy – that have participated in SHARE from Wave 1 to 5. Using the framework of equality of opportunity, I attempt to identify unfairness from the overall disparity in health, by disentangling all covariates into illegitimate (e.g. circumstance) and legitimate (e.g. effort) parts. My model incorporates a rich set of explanatory variables that portrays individual life course, namely childhood, adolescence, early adulthood, and late adulthood. By employing the Hausman-Taylor (1981) estimators on the random effect model, we deal with the issue of endogeneity in lifestyle variables and characterize luck-related components in unobserved heterogeneity.

The classification between illegitimate and legitimate components varies with normative positions. In this study, six scenarios are considered in order to motivate further ethical considerations in future policy making processes. In a nutshell, we observe substantially different levels of IOp among the tested scenarios, comprising between 5% to 99% of the overall inequality. In general, the contribution of young adulthood investment or late adulthood lifestyle to reducing IOp seems minimal compared to that of time-invariant or variant heterogeneity.

In addition, we find that overall results change drastically according to the choice in health indicator. I use grip strength as an objective measure of physical health and (predicted level of) self-reported health as a subjective one. The impact of aging on IOp is more pronounced with the former, while IOp in the latter is more sensitive to unobserved factors. Consequently, under the scenario that assumes the role of unobserved heterogeneity to be legitimate, we obtain 10-40% of IOp in the former, but 5-25% in the latter.

We also observe some gender-related discrepancies. In terms of grip strength, standardizing age differences leads to a 5 percentage point larger drop of IOp among men. On the other hand, unobserved heterogeneities seem to be more important channels for mitigating IOp among women especially in terms of grip strength. Women enjoy up to a 20 percentage point better equality of opportunity once unobserved factors are standardized instead. Nonetheless, the gender gap in IOp is less pronounced when self-reported health is used as an outcome.

By comparing the results between scenarios, we obtain different policy lessons. For example, we learn that IOp can be lowered effectively by equalizing unobserved circumstances, u_i, in the Netherlands and Denmark. It is also suggested that IOp can be substantially reduced by better insuring people against brute luck, e_{it}, in most countries except for the Netherlands, Denmark and Italy. Furthermore, we find a stronger link between childhood circumstances and late adulthood health, as well as between age and late adulthood health, in France and Belgium.

In terms of cross-country comparison, we find diverging results between two indicators of health. For example, Switzerland is ranked high for IOp in terms of an objective indicator but low in terms of a subjective one, after standardizing all types of unobserved heterogeneities. Our results from the latter are compared with Bricard et al. (2013)'s cross-sectional study based on the third wave of SHARE. Consistently with their findings, we observe high IOp in self-assessed health in France and low IOp in Switzerland as well as the Netherlands. However, we also obtain contrasting results, such as a high level of IOp in Germany and Belgium. These varying results suggest the importance of unobserved heterogeneity.

In a nutshell, we find not only different magnitudes of IOp but also diverging policy implications from two indicators of health. However, it is hard to identify whether such a gap is due to a narrower reflection of health status in the former, or subjectivity in the latter. Therefore, further investigation is needed to construct alternative indicators of global health that are more comparable across heterogeneous groups.

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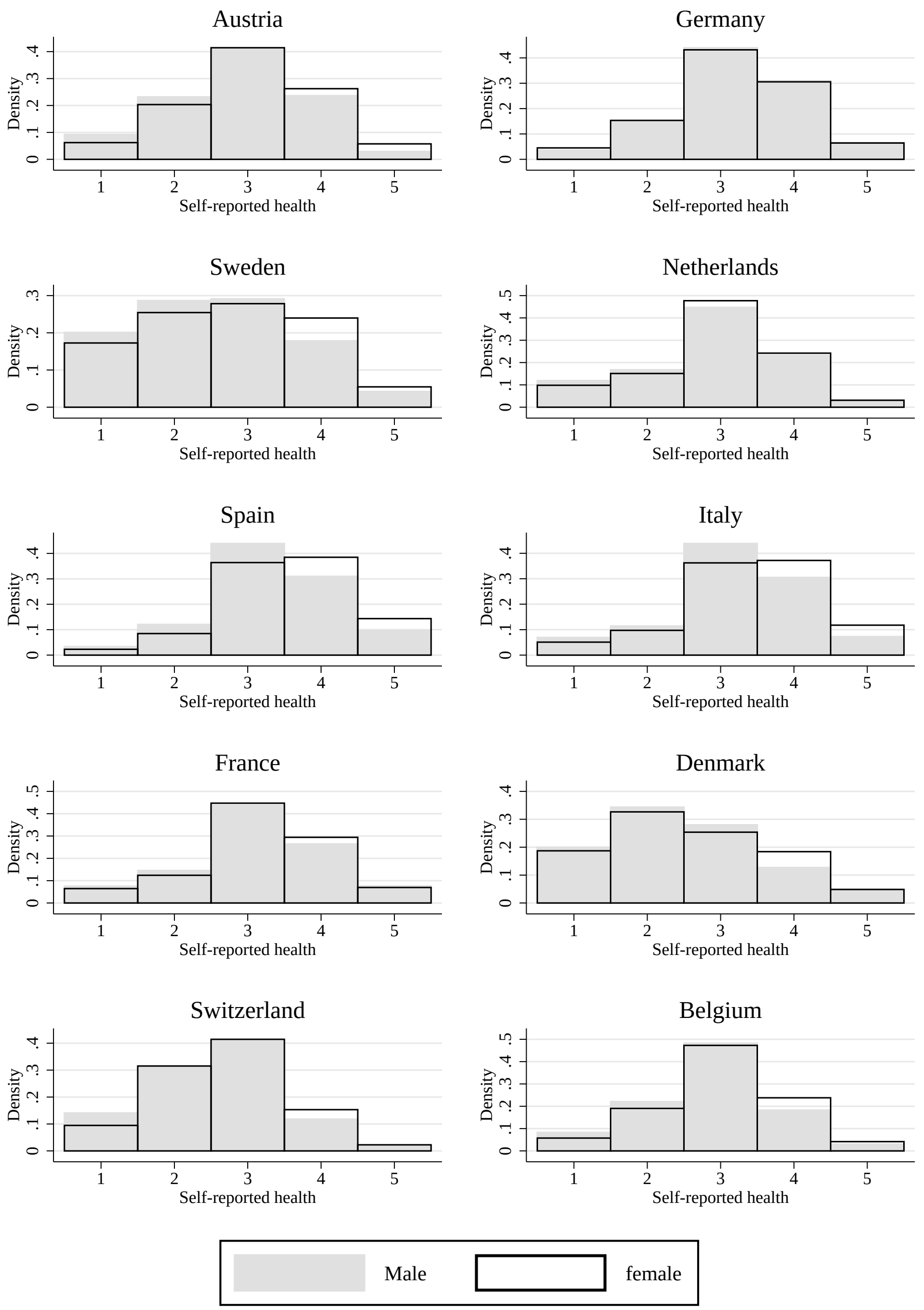
Health Economics, Management & Policy, the 2014 iHEA and ECHE joint congress, the 2015 CINCH Summer School in health economics, and the 15th World congress of social economics. I thank the audience for their useful discussions and comments, which definitely helped further improvement of my investigation.

Appendix

A Distribution of raw self-reported health



Note: 1 for excellent health, 2 for very good, 3 for good, 4 for fair and 5 for poor health.

B Summary statistics

	Austria		Germany		Sweden		Netherlands		Spain	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Grip strength	34.60	(11.50)	35.60	(10.70)	35.20	(11.70)	34.70	(11.20)	28.30	(10.70)
Self-assessed health	67.50	(28.00)	66.70	(27.60)	72.10	(25.30)	73.00	(24.30)	63.70	(30.60)
Age	68.70	(8.32)	67.00	(7.70)	68.70	(8.53)	67.20	(8.53)	69.10	(8.69)
Female	0.59	(0.49)	0.54	(0.50)	0.55	(0.50)	0.56	(0.50)	0.55	(0.50)
Book at age 10: None/few (ref.)	0.42	(0.49)	0.31	(0.46)	0.17	(0.37)	0.30	(0.46)	0.69	(0.46)
: One shelf	0.28	(0.45)	0.25	(0.43)	0.22	(0.42)	0.25	(0.43)	0.16	(0.37)
: One bookcase	0.21	(0.40)	0.29	(0.45)	0.34	(0.48)	0.30	(0.46)	0.10	(0.30)
: Two bookcases	0.09	(0.29)	0.16	(0.36)	0.26	(0.44)	0.15	(0.36)	0.06	(0.23)
Parent smoked	0.55	(0.50)	0.57	(0.50)	0.52	(0.50)	0.83	(0.37)	0.62	(0.49)
Parent drank heavily	0.12	(0.32)	0.07	(0.26)	0.08	(0.27)	0.04	(0.18)	0.08	(0.28)
Childhood residence : City (ref.)	0.21	(0.40)	0.22	(0.41)	0.22	(0.41)	0.39	(0.49)	0.13	(0.34)
: Town	0.24	(0.43)	0.35	(0.48)	0.46	(0.50)	0.30	(0.46)	0.69	(0.46)
: Rural area	0.55	(0.50)	0.43	(0.50)	0.32	(0.47)	0.31	(0.46)	0.18	(0.38)
Height decile	5.20	(2.78)	5.14	(2.88)	5.54	(2.88)	5.41	(2.84)	5.21	(2.74)
Education	10.60	(3.93)	14.10	(2.84)	11.10	(3.16)	12.00	(3.25)	6.57	(4.09)
Job at age 35 : Professional	0.12	(0.33)	0.12	(0.33)	0.28	(0.45)	0.18	(0.38)	0.05	(0.21)
: Technician	0.06	(0.24)	0.13	(0.33)	0.13	(0.34)	0.09	(0.29)	0.04	(0.20)
: Service/office clerk	0.26	(0.44)	0.31	(0.46)	0.26	(0.44)	0.18	(0.38)	0.10	(0.30)
: Farmer	0.05	(0.23)	0.04	(0.19)	0.03	(0.17)	0.03	(0.17)	0.07	(0.26)
: Skilled	0.13	(0.33)	0.17	(0.38)	0.11	(0.31)	0.13	(0.34)	0.15	(0.36)
: Unskilled	0.10	(0.29)	0.04	(0.20)	0.06	(0.23)	0.04	(0.20)	0.18	(0.38)
: Other	0.22	(0.42)	0.19	(0.39)	0.14	(0.35)	0.31	(0.46)	0.23	(0.42)
: Never worked	0.06	(0.23)	0.01	(0.10)	0.01	(0.09)	0.04	(0.18)	0.19	(0.39)
Drank at $t-1$: Daily (ref.)	0.17	(0.37)	0.22	(0.42)	0.10	(0.29)	0.34	(0.47)	0.23	(0.42)
: Weekly	0.30	(0.46)	0.35	(0.48)	0.49	(0.50)	0.31	(0.46)	0.13	(0.33)
: Monthly	0.27	(0.44)	0.26	(0.44)	0.30	(0.46)	0.14	(0.35)	0.10	(0.31)
: Never	0.25	(0.43)	0.16	(0.37)	0.12	(0.33)	0.20	(0.40)	0.51	(0.50)
Smoked at $t-1$	0.15	(0.36)	0.14	(0.35)	0.12	(0.33)	0.19	(0.39)	0.14	(0.35)
Exercised weekly at $t-1$	0.84	(0.37)	0.92	(0.27)	0.94	(0.24)	0.91	(0.28)	0.85	(0.36)
Had high cholesterol at $t-1$	0.20	(0.40)	0.19	(0.39)	0.18	(0.39)	0.18	(0.38)	0.29	(0.45)
N	1088		1655		2361		2479		1839	

	Italy		France		Denmark		Switzerland		Belgium	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Grip strength	31.53	(11.31)	32.77	(11.50)	35.70	(12.31)	33.63	(10.63)	34.55	(11.85)
Self-assessed health	67.91	(28.39)	69.87	(26.56)	73.88	(25.12)	80.94	(20.23)	69.30	(27.45)
Age	67.89	(7.77)	67.94	(9.08)	67.42	(9.26)	68.38	(9.04)	67.67	(9.01)
Female	0.55	(0.50)	0.56	(0.50)	0.52	(0.50)	0.56	(0.50)	0.53	(0.50)
Book at age 10: None/few (ref.)	0.76	(0.43)	0.45	(0.50)	0.22	(0.41)	0.30	(0.46)	0.46	(0.50)
: One shelf	0.13	(0.33)	0.21	(0.41)	0.23	(0.42)	0.20	(0.40)	0.21	(0.41)
: One bookcase	0.07	(0.26)	0.20	(0.40)	0.29	(0.45)	0.30	(0.46)	0.20	(0.40)
: Two bookcases	0.04	(0.19)	0.14	(0.34)	0.27	(0.44)	0.21	(0.41)	0.12	(0.33)
Parent smoked	0.62	(0.48)	0.50	(0.50)	0.81	(0.39)	0.55	(0.50)	0.72	(0.45)
Parent drank heavily	0.11	(0.32)	0.09	(0.29)	0.10	(0.30)	0.09	(0.28)	0.09	(0.28)
Childhood residence : City (ref.)	0.09	(0.29)	0.21	(0.41)	0.28	(0.45)	0.18	(0.39)	0.20	(0.40)
: Town	0.29	(0.45)	0.38	(0.48)	0.25	(0.44)	0.23	(0.42)	0.27	(0.45)
: Rural area	0.62	(0.49)	0.41	(0.49)	0.47	(0.50)	0.58	(0.49)	0.52	(0.50)
Height decile	5.09	(2.82)	5.48	(2.81)	5.28	(2.87)	5.24	(2.80)	5.29	(2.86)
Education	7.21	(4.14)	9.44	(5.12)	12.60	(3.36)	11.81	(4.20)	10.46	(3.75)
Job at age 35 : Professional	0.05	(0.23)	0.16	(0.36)	0.12	(0.33)	0.12	(0.33)	0.14	(0.35)
: Technician	0.07	(0.26)	0.16	(0.37)	0.13	(0.34)	0.11	(0.31)	0.10	(0.30)
: Service/office clerk	0.15	(0.36)	0.22	(0.41)	0.31	(0.46)	0.32	(0.47)	0.17	(0.37)
: Farmer	0.08	(0.27)	0.05	(0.21)	0.06	(0.24)	0.05	(0.21)	0.03	(0.17)
: Skilled	0.12	(0.32)	0.09	(0.29)	0.14	(0.35)	0.10	(0.30)	0.10	(0.30)
: Unskilled	0.21	(0.41)	0.10	(0.30)	0.08	(0.28)	0.04	(0.19)	0.21	(0.41)
: Other	0.17	(0.37)	0.18	(0.39)	0.13	(0.34)	0.24	(0.43)	0.19	(0.39)
: Never worked	0.15	(0.36)	0.04	(0.20)	0.01	(0.08)	0.02	(0.14)	0.06	(0.25)
Drank at $t-1$: Daily (ref.)	0.41	(0.49)	0.38	(0.48)	0.30	(0.46)	0.27	(0.45)	0.30	(0.46)
: Weekly	0.09	(0.28)	0.24	(0.43)	0.44	(0.50)	0.40	(0.49)	0.33	(0.47)
: Monthly	0.06	(0.24)	0.21	(0.41)	0.22	(0.41)	0.21	(0.41)	0.20	(0.40)
: Never	0.39	(0.49)	0.18	(0.39)	0.06	(0.23)	0.13	(0.34)	0.18	(0.38)
Smoked at $t-1$	0.17	(0.37)	0.13	(0.34)	0.23	(0.42)	0.20	(0.40)	0.15	(0.35)
Exercised weekly at $t-1$	0.78	(0.41)	0.87	(0.34)	0.93	(0.25)	0.90	(0.30)	0.88	(0.32)
Had high cholesterol at $t-1$	0.23	(0.42)	0.25	(0.43)	0.20	(0.40)	0.15	(0.36)	0.34	(0.47)
N	0.23		(0.42)		0.25		(0.43)		0.20	

C Model comparison

(a) Male	Grip strength					Self-reported health				
	FE	HT	ML	RE	OLS	FE	HT	ML	RE	OLS
Drink: Weekly (vs. Daily)	0.009	-0.011	0.009	0.182	0.488+	0.017	-0.192	0.065	-0.259	0.061
	(0.193)	(0.192)	(0.193)	(0.168)	(0.188)	(0.652)	(0.643)	(0.654)	(0.552)	(0.574)
: Monthly	0.071	0.038	0.068	0.302	0.792+	0.004	-0.343	-0.136	-1.236+	-1.675+
	(0.262)	(0.260)	(0.262)	(0.224)	(0.247)	(0.884)	(0.871)	(0.886)	(0.734)	(0.752)
: Never	0.052	0.010	0.044	-0.191	-0.392	0.264	-0.179	-0.156	-2.304+	-3.603+
	(0.284)	(0.281)	(0.283)	(0.237)	(0.250)	(0.957)	(0.943)	(0.958)	(0.769)	(0.763)
Currently smoking	0.244	0.197	0.252	-0.219	-0.499+	1.302	0.819	1.708+	-0.738	-1.310+
	(0.277)	(0.274)	(0.276)	(0.212)	(0.201)	(0.934)	(0.919)	(0.934)	(0.676)	(0.611)
Exercising weekly	0.139	0.153	0.143	0.841+	2.452+	0.599	0.747	0.836	6.082+	14.994+
	(0.220)	(0.218)	(0.219)	(0.204)	(0.262)	(0.741)	(0.731)	(0.742)	(0.682)	(0.798)
High cholesterol	0.088	0.083	0.086	0.187	0.322+	1.332+	1.282+	1.257+	-2.341+	-6.451+
	(0.188)	(0.186)	(0.188)	(0.163)	(0.181)	(0.633)	(0.624)	(0.634)	(0.536)	(0.552)
σ_u	7.442	6.252	6.001	6.001		21.252	19.106	16.513	16.513	
σ_e	4.463	4.461	4.463	4.463		15.051	15.043	15.051	15.051	
N	9,760					9,760				

Note: + p< 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

(b) Female	Grip strength					Self-reported health				
	FE	HT	ML	RE	OLS	FE	HT	ML	RE	OLS
Drink: Weekly (vs. Daily)	-0.239	-0.251	-0.239	-0.088	0.221	1.022	0.899	1.010	0.302	0.058
	(0.163)	(0.161)	(0.163)	(0.140)	(0.153)	(0.777)	(0.767)	(0.775)	(0.673)	(0.730)
: Monthly	-0.152	-0.157	-0.152	-0.147	-0.038	0.025	-0.024	0.011	-2.550+	-4.917+
	(0.187)	(0.184)	(0.187)	(0.153)	(0.158)	(0.889)	(0.878)	(0.888)	(0.736)	(0.755)
: Never	0.012	0.010	0.012	-0.215	-0.298+	-0.493	-0.524	-0.576	-4.130+	-7.156+
	(0.193)	(0.191)	(0.193)	(0.153)	(0.154)	(0.921)	(0.909)	(0.919)	(0.737)	(0.732)
Currently smoking	0.069	0.028	0.071	0.192	0.311+	1.695	1.278	1.844+	-0.780	-2.176+
	(0.230)	(0.227)	(0.230)	(0.164)	(0.148)	(1.095)	(1.079)	(1.092)	(0.788)	(0.704)
Exercising weekly	0.235+	0.247+	0.236+	0.723+	1.610+	-0.083	0.038	0.043	5.770+	16.097+
	(0.138)	(0.137)	(0.138)	(0.124)	(0.150)	(0.659)	(0.650)	(0.657)	(0.600)	(0.714)
High cholesterol	0.089	0.082	0.087	0.213+	0.319+	0.650	0.580	0.430	-1.955+	-5.631+
	(0.133)	(0.132)	(0.133)	(0.112)	(0.120)	(0.635)	(0.626)	(0.631)	(0.541)	(0.571)
σ_u	5.318	4.514	4.262	4.262		24.824	22.566	19.916	19.916	
σ_e	3.388	3.387	3.388	3.388		16.130	16.122	16.130	16.130	
N			11,770					11,770		

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D Direct and indirect standardization under Scenario I-VI

Scenario	Illegitimate	Legitimate	Direct unfairness	Fairness gap
I	age, childhood, M, u_i, e_{it}	lifestyle	$\widehat{X^*_{it}\beta} + \hat{u}_i + \hat{e}_{it}$	$y_{it} - \widehat{X^*_{it}\beta}$ $(u_i = 0, e_{it} = 0)$
II	age, childhood, u_i, e_{it}	M, lifestyle	$\widehat{X^*_{it}\beta} + \hat{u}_i + \hat{e}_{it}$	$y_{it} - \widehat{X^*_{it}\beta}$ $(u_i = 0, e_{it} = 0)$
III	childhood, u_i, e_{it}	age, M, lifestyle	$\widehat{X^*_{it}\beta} + \hat{u}_i + \hat{e}_{it}$	$y_{it} - \widehat{X^*_{it}\beta}$ $(u_i = 0, e_{it} = 0)$
IV	age, childhood, u_i	e_{it}, M, lifestyle	$\widehat{X^*_{it}\beta} + \hat{u}_i$ $(e_{it} = 0)$	$y_{it} - (\widehat{X^*_{it}\beta} + \hat{e}_{it})$ $(u_i = 0)$
V	age, childhood, e_{it}	u_i, M, lifestyle	$\widehat{X^*_{it}\beta} + \hat{e}_{it}$ $(u_i = 0)$	$y_{it} - (\widehat{X^*_{it}\beta} + \hat{u}_i)$ $(e_{it} = 0)$
VI	age, childhood	u_i, e_{it}, M, lifestyle	$\widehat{X^*_{it}\beta}(u_i = 0, e_{it} = 0)$	$y_{it} - (\widehat{X^*_{it}\beta} + \hat{u}_i + \hat{e}_{it})$

The computation proceeds as follows. Let us consider DU under Scenario I as an example. First, the observed legitimate factors, lifestyle, are placed with their reference values. In this study, the most beneficial behavior is considered those references such as drinking monthly, not smoking, exercising weekly, and not being diagnosed with high cholesterol. On the other hand, original values remain with respect to other observed characteristics that are classified as illegitimate factors. In the case of unobserved illegitimate factors, u_i and e_{it}, we take their predicted values, $\hat{u}_i$ and $\hat{e}_{it}$ since their original values are unknown. Finally, DU is computed by adding these predicted residuals to a linear prediction of the outcome after converting some observed covariates (eq. 14).

$$DU_{ScenarioI} = y^*(C, E^*) = \widehat{X^*_{it}\beta} + \hat{u}_i + \hat{e}_{it} \tag{14}$$

To compute FG under Scenario I, we need to set C at the reference values. First, the observed illegitimate factors, namely age, childhood condition and M, are replaced with their reference values. It is assumed that all individuals are 50 years old, have had the largest number of books and non-smoking/heavily drinking parents, and have lived in a town during their childhood. Regarding M, residualized height and occupational choices are replaced with zero, but residualized years of schooling is converted to three. Second, the unobserved illegitimate terms, u_i and e_{it}, are standardized as zero.

$$FG_{ScenarioI} = y(C, E) - y^*(C^*, E) = y_{it} - \widehat{X^*_{it}\beta} \tag{15}$$

E Estimation based on country-specific samples

(a) Male	Austria		Germany		Sweden		Netherlands		Spain	
	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH
Book at age 10 : One shelf (ref. None/few)	1.76	2.71	-1.10	1.45	2.85*	6.69*	0.84	-2.14	0.89	-2.59
: One bookcase	3.61*	1.80	-1.63	6.51+	1.30	7.58*	2.86**	1.60	3.26*	6.00
: Two bookcases	1.58	4.10	-0.22	15.63***	1.49	8.86**	1.31	-8.64**	0.10	-7.13
Parent smoked	0.55	0.14	0.06	-0.76	-1.02	-1.88	-0.80	-5.29+	1.34	-2.53
Parent drank heavily	-1.47	-6.26	-3.41*	-2.03	-1.37	-3.14	-2.14	0.31	1.65	2.27
Childhood residence : Town (vs. City)	1.25	4.22	-0.16	-8.85*	1.17	-1.61	2.32**	0.59	1.76	-2.55
: Rural area	0.14	-2.52	1.15	-3.67	1.42	-1.14	4.06***	0.57	3.91*	-3.95
Height decile_residuals	1.10*	0.87	1.49***	-0.28	1.99***	1.47	1.69***	-0.15	2.43***	1.54
Education_residuals	-0.06	1.10+	-0.22	1.18*	-0.21	0.58	0.11	1.19***	0.24*	0.90*
Job at age 35_residuals	-1.69**	-0.23	0.19	-0.88	-0.45	-1.12	-0.04	-0.86	-0.66	-0.58
Drank at $t-1$: Weekly (vs. Daily)	-0.67	-4.21	0.17	0.12	1.20	-0.02	-0.94+	0.80	-0.21	-3.61
: Monthly	-0.98	0.77	0.00	-1.38	1.75+	-3.81	-1.89*	0.53	-0.17	3.70
: Never	-1.50	-3.17	0.91	5.35	2.07	-1.79	0.55	-3.24	-0.75	-1.42
Smoked at $t-1$	-1.97	2.07	-3.20**	-3.90	0.87	5.22+	1.68+	0.35	-0.68	3.58
Exercised weekly at $t-1$	0.74	1.87	0.38	-0.88	0.14	0.55	-0.31	-1.16	0.31	-1.54
Had high cholesterol at $t-1$	0.95	0.64	0.85	1.28	0.15	1.56	-0.43	0.46	0.14	4.85*
Age	-0.54***	-0.61*	-0.61***	-1.12***	-0.56***	-0.58***	-0.48***	-0.51***	-0.61***	-1.04***
σ_u	5.94	20.62	5.09	19.45	6.28	16.55	6.60	17.04	6.28	21.78
σ_e	4.34	18.21	4.72	16.04	4.65	14.54	3.88	13.67	4.80	17.85
N	444		768		1,064		1,096		836	

Note: Constant terms and standard errors are omitted. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(b) Male_continued	Italy		France		Denmark		Switzerland		Belgium	
	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH
Book at age 10 : One shelf (ref. None/few)	2.88*	6.10+	3.81***	6.32*	2.56+	2.76	0.86	-0.47	0.49	-3.20
: One bookcase	0.15	2.24	2.79**	4.34	3.77**	5.24	0.33	7.13*	0.64	-2.91
: Two bookcases	3.76+	6.97	2.09+	-0.10	2.45+	7.77*	1.53	4.91	0.15	-2.75
Parent smoked	1.56*	-0.33	-0.71	1.12	2.36*	5.05	-0.06	-1.14	0.17	1.13
Parent drank heavily	1.52	-0.11	1.53	-3.94	0.71	-2.19	-1.53	-2.28	-1.19	-11.83***
Childhood residence : Town (vs. City)	2.53+	-1.53	1.07	0.24	-1.09	-1.30	2.08	-1.27	1.46+	2.20
: Rural area	3.99**	1.92	-0.67	1.82	-1.21	1.37	2.81*	-0.80	1.74**	-2.29
Height decile_residuals	2.89***	3.06**	1.77***	0.84	2.00***	0.29	1.56***	1.05	2.13***	0.87
Education_residuals	0.20*	0.91**	0.07	0.58*	-0.13	-0.30	0.16	0.38	-0.06	0.32
Job at age 35_residuals	0.51	0.82	-0.68+	-2.27+	-0.89*	-4.46***	-0.71	-3.25**	0.13	-2.18*
Drank at $t-1$: Weekly (vs. Daily)	0.55	-2.77	-0.52	1.95	0.20	-1.14	-0.90	-1.56	0.54	1.18
: Monthly	0.60	-2.66	-0.55	0.92	0.05	-2.86	-0.16	2.85	0.77	0.83
: Never	0.86	0.04	-1.19	4.90	-2.06	-6.05	-1.44	2.51	-0.29	-1.02
Smoked at $t-1$	1.05	-1.75	-0.03	5.11+	0.67	2.64	1.29	0.91	0.61	-4.24+
Exercised weekly at $t-1$	-1.13+	0.12	-0.01	5.16*	1.40*	1.15	0.93	5.04*	0.57	-0.12
Had high cholesterol at $t-1$	0.27	2.30	-0.36	-0.58	0.06	1.25	0.47	-0.09	-0.26	0.68
Age	-0.55***	-0.90***	-0.65***	-1.29***	-0.37***	-0.36**	-0.57***	-0.37**	-0.58***	-1.02***
σ_u	6.59	18.72	6.25	19.26	7.20	18.69	5.25	11.22	5.97	20.68
σ_e	4.92	15.99	4.25	14.54	3.79	11.78	4.40	12.58	4.32	14.61
N	1,209		968		896		533		1,946	

Note: Constant terms and standard errors are omitted. + p < 0.1 * p < 0.05, ** p < 0.01, *** p < 0.001

(c) Female	Austria		Germany		Sweden		Netherlands		Spain	
	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH
Book at age 10 : One shelf (ref. None/few)	-0.07	2.82	-0.76	5.81	1.51*	5.71	1.18+	3.67	1.76*	4.45
: One bookcase	-1.50	3.96	-0.88	5.12	0.38	4.48	0.67	3.86	2.21*	9.59+
: Two bookcases	1.32	-1.04	1.11	6.06	1.05	5.26	0.01	-2.78	3.09*	11.33+
Parent smoked	0.62	0.92	0.13	-3.45	-0.11	-2.64	0.51	1.14	-0.12	-3.68
Parent drank heavily	-0.22	-14.79**	-0.95	-4.87	-0.51	-6.04	-0.48	-8.83+	-1.30	-7.05
Childhood residence : Town (vs. City)	0.91	7.70	-1.14	3.41	-0.27	-2.00	0.57	1.88	2.49**	1.30
: Rural area	1.22	4.98	-0.05	7.27+	0.56	-3.57	0.33	4.68+	3.47**	-2.64
Height decile_residuals	1.47***	0.33	1.29***	-1.00	1.17***	0.58	1.30***	-0.14	1.03***	0.90
Education_residuals	0.07	1.01*	-0.06	0.88	-0.02	0.73+	0.08	0.24	0.12	1.54***
Job at age 35_residuals	0.06	-1.44	-0.49+	2.15	-0.19	-1.01	0.22	-0.62	0.04	0.29
Drank at $t-1$: Weekly (vs. Daily)	0.15	3.24	-0.33	-2.10	-0.31	-0.28	-0.76+	-2.64	0.07	-0.42
: Monthly	0.14	0.65	-1.21+	-0.53	-0.04	-0.31	-0.37	-4.53	-0.45	4.08
: Never	0.23	3.08	-1.14	-1.12	0.10	-0.72	-0.15	-5.54+	0.16	0.35
Smoked at $t-1$	-1.35	-1.91	0.26	-0.53	-0.19	3.63	-0.11	2.05	2.63*	3.43
Exercised weekly at $t-1$	0.05	2.25	0.64	-3.56	0.49	-2.13	0.73+	4.70*	-0.35	-1.75
Had high cholesterol at $t-1$	1.40*	0.85	-0.63	3.14	0.10	-1.02	0.12	1.22	-0.42	-1.64
Age	-0.34***	-1.04***	-0.31***	-0.98***	-0.35***	-0.64***	-0.31***	-0.62***	-0.27***	-1.00***
σ_u	4.75	22.11	4.24	23.74	4.43	22.45	4.45	21.45	4.81	23.60
σ_e	4.13	18.12	3.22	15.97	3.26	14.06	3.07	15.63	4.02	19.88
N	644		887		1,297		1,383		1,003	

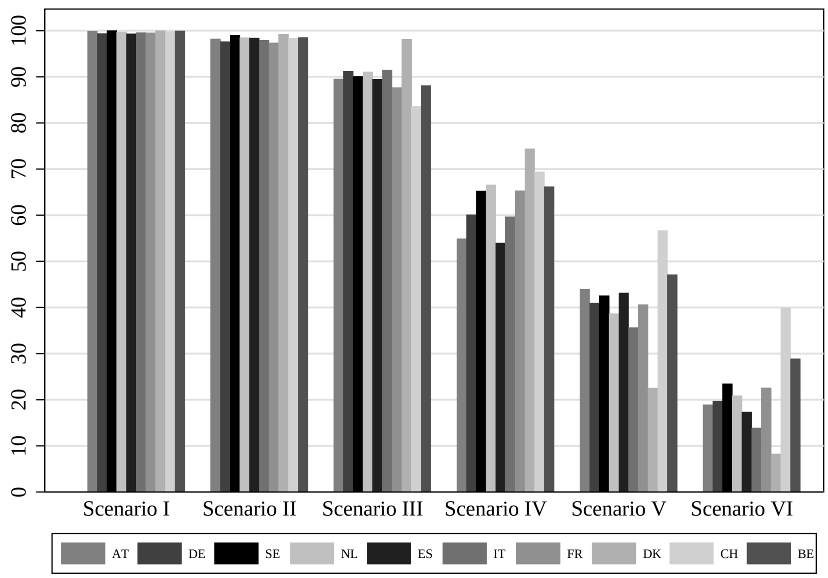
Note: Constant terms and standard errors are omitted. + $p < 0.1$ * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(d) Female_continued	Italy		France		Denmark		Switzerland		Belgium	
	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH	Grip	SRH
Book at age 10 : One shelf (ref. None/few)	1.73**	10.22**	0.77	4.54	0.69	1.88	-1.16	-3.32	0.54	3.24
: One bookcase	1.17	11.69**	0.32	12.68***	2.53**	8.55*	0.65	3.98	-0.05	-0.49
: Two bookcases	1.44	12.55*	0.16	13.74***	2.36**	3.78	-0.19	4.38	0.88	2.40
Parent smoked	0.58	-1.34	0.49	-2.44	1.21	-2.39	-0.08	-0.31	0.44	-1.44
Parent drank heavily	0.26	-1.59	0.37	-4.31	1.34	-3.04	-0.88	-7.08+	-1.95**	-7.37*
Childhood residence : Town (vs. City)	0.73	10.26*	0.09	-0.78	-0.26	-0.33	0.12	2.54	1.18*	2.76
: Rural area	1.69*	6.76+	0.10	6.84*	0.68	0.77	1.13	3.18	1.81***	3.61
Height decile_residuals	1.40***	1.56	1.48***	0.51	1.27***	-0.85	1.39***	0.22	1.40***	0.13
Education_residuals	0.16*	1.00**	0.19***	0.41	0.05	1.21**	-0.04	0.32	0.06	0.37
Job at age 35_residuals	-0.24	-1.21	0.08	-3.26**	-0.35	-1.57	-0.03	2.00	-0.17	0.15
Drank at $t-1$: Weekly (vs. Daily)	0.29	3.92	-0.31	0.68	-0.35	0.59	0.80	2.63	-0.97**	2.67
: Monthly	0.61	-4.79+	-0.36	-1.24	-0.08	1.02	1.31*	2.41	-0.91*	-0.04
: Never	0.83*	0.23	-0.67	0.33	-0.34	-2.51	0.18	4.18	-0.67	-4.09+
Smoked at $t-1$	0.30	-0.21	0.57	1.23	-0.67	3.59	0.09	-1.53	0.10	0.42
Exercised weekly at $t-1$	0.96**	1.27	-0.02	-1.62	-0.07	0.37	-0.16	-3.64	0.03	1.12
Had high cholesterol at $t-1$	0.59	0.03	-0.74+	2.34	1.08**	1.35	0.87	-0.55	-0.28	0.18
Age	-0.28***	-0.96***	-0.33***	-0.96***	-0.10***	-0.70***	-0.40***	-0.17	-0.37***	-0.94***
σ_u	4.72	22.84	4.46	22.70	5.23	22.15	3.92	17.07	4.48	23.21
σ_e	3.61	16.78	3.23	15.57	2.69	13.35	2.94	13.54	3.31	16.45
N	1,471		1,223		989		666		2,207	

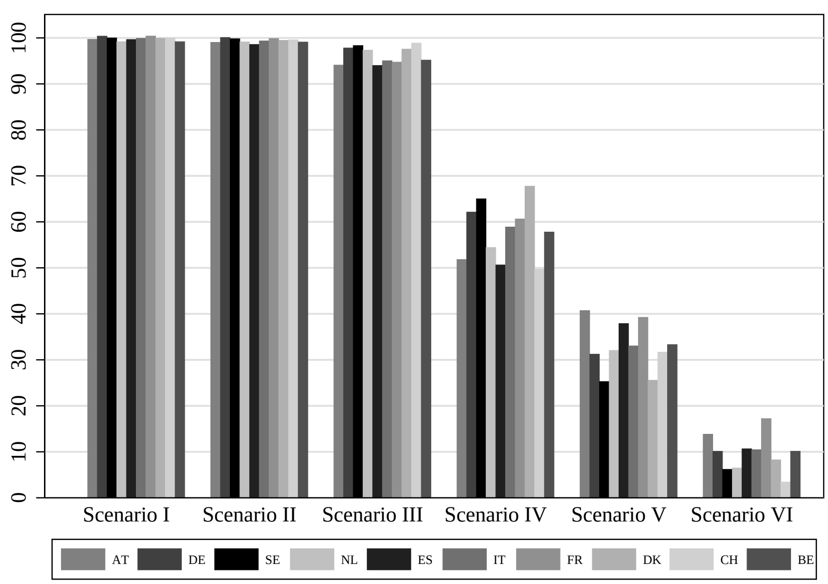
Note: Constant terms and standard errors are omitted. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

F Inequality of opportunity for health among females

(a) IOp in grip strength

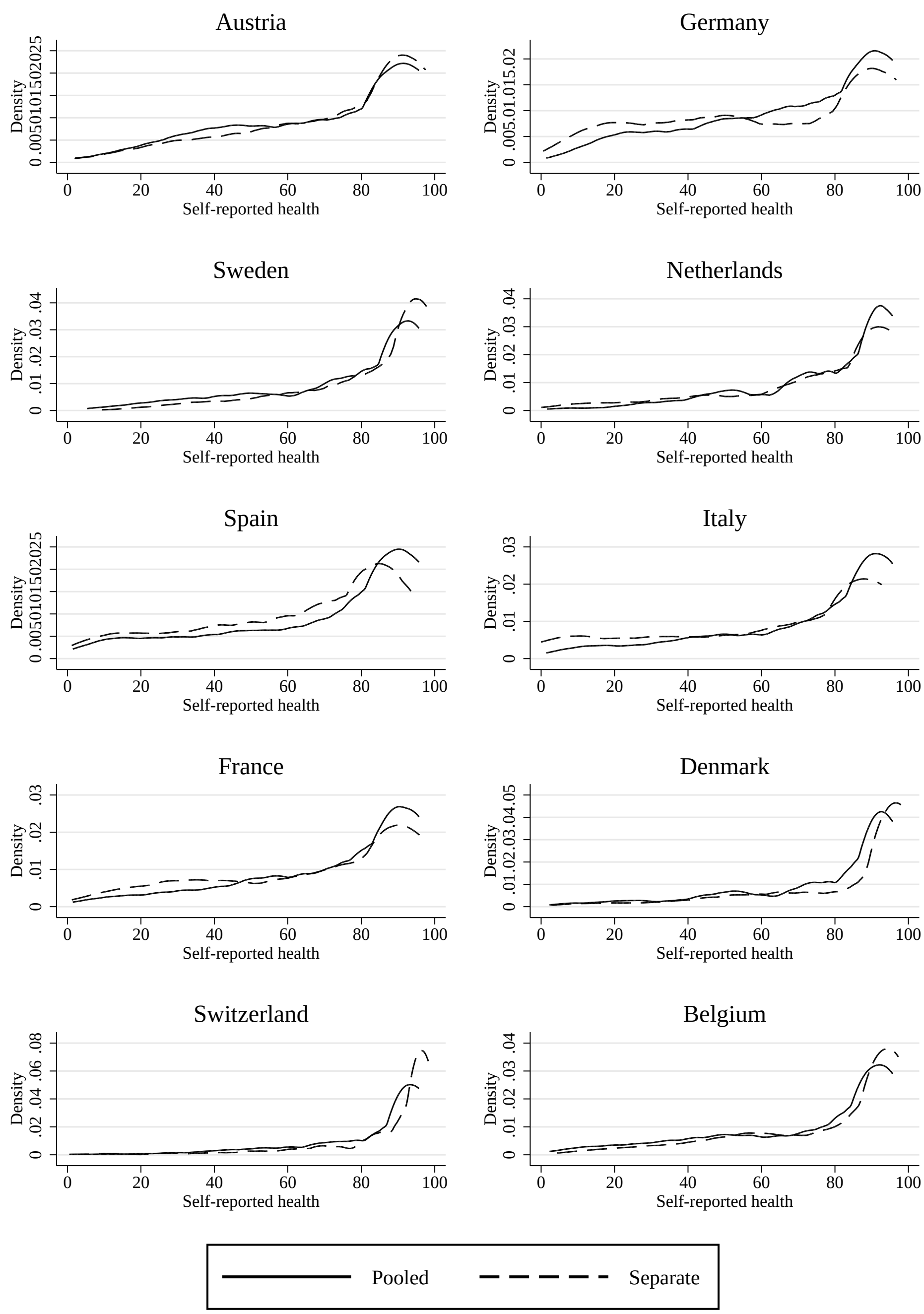


(b) IOp in self-reported health

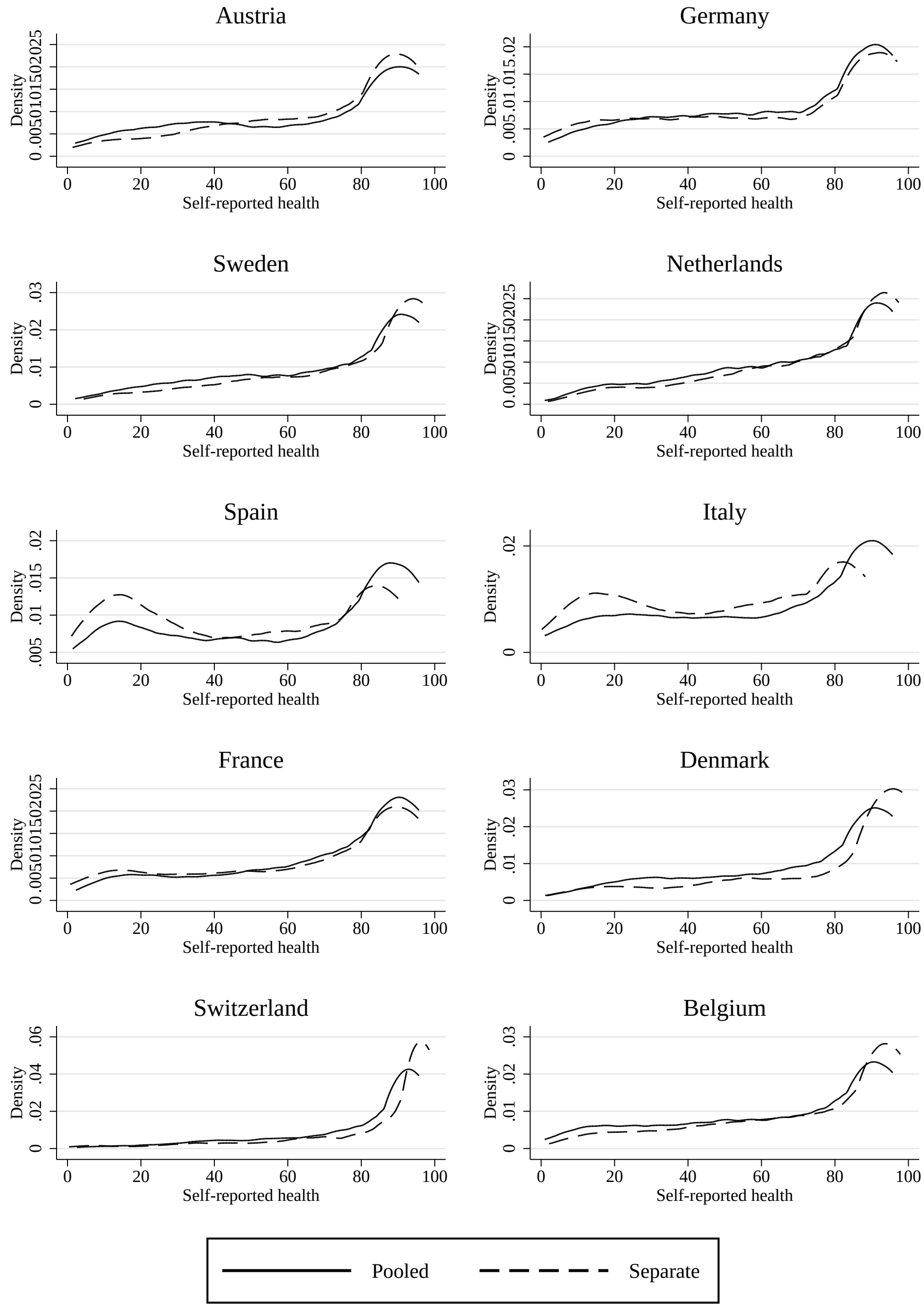


G Self-reported health based on pooled vs. separated prediction

(a) Male



(b) Female

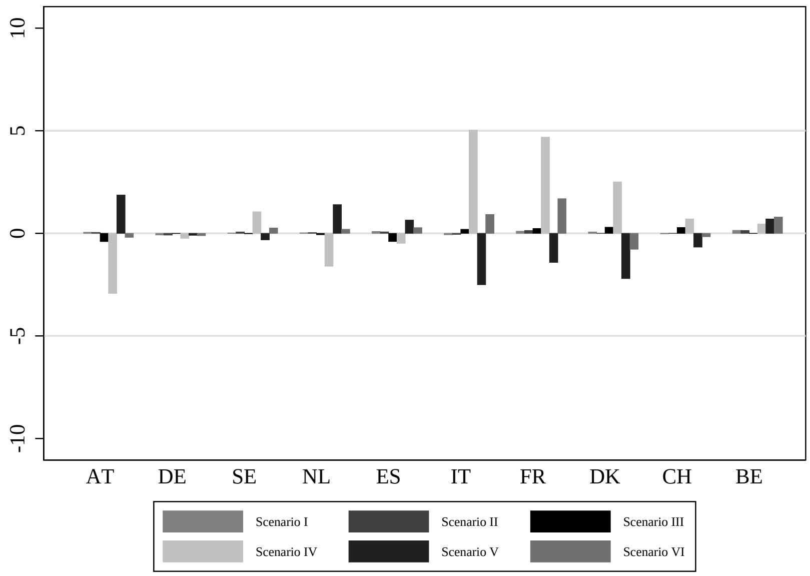


Austria
Germany
Sweden
Netherlands
Spain
Italy
France
Denmark
Switzerland
Belgium
Density
Self-reported health
Pooled
Separate

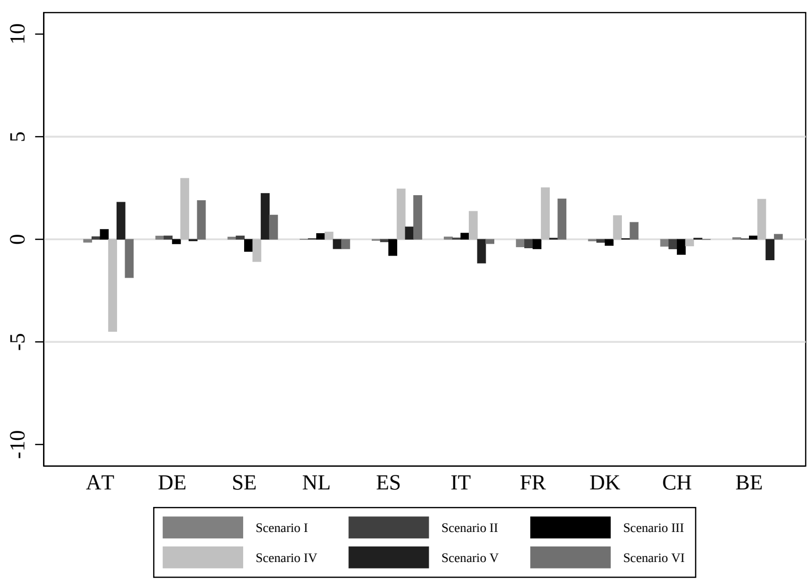
H Robustness to alternative subjective measure

$IOp_{initial} - IOp_{alternative}$(percentage point)

(a) Male



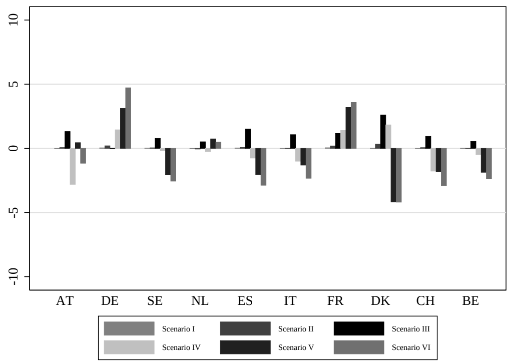
(b) Female



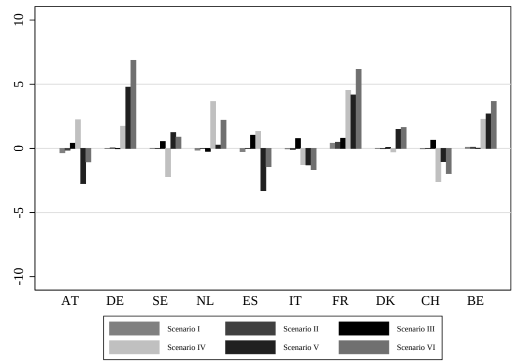
I Robustness to alternative specification

$IOp_{initial} - IOp_{alternative}$(percentage point)

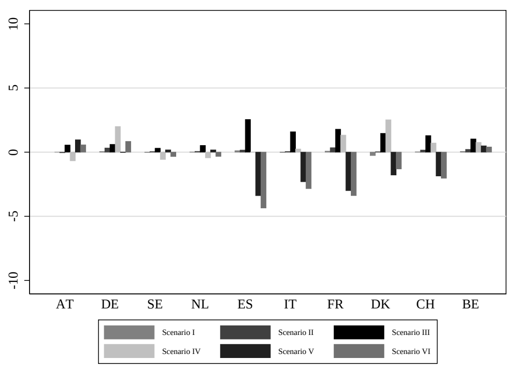
(a) Male : grip strength



(b) Male : self-reported health



(a) Female : grip strength



(b) Female : self-reported health