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Health and Aging before and after Retirement

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Abstract. In this paper, we investigate health and aging before and after retirement for specific occupational groups. We use five waves of the Survey of Health, Aging, and Retirement in Europe (SHARE) dataset and construct a frailty index for elderly men and women from 10 European countries. We classify occupation by low vs. high education, blue vs. white collar color, and by high vs. low physical or psychosocial job burden. Controlling for individual fixed effects, we find that, regardless of the used classification, workers from the first (low status) group display more health deficits at any age and accumulate health deficits faster than workers from the second (high status) group. We instrument retirement by statutory retirement ages ("normal" and "early") and find that the health of workers in low status occupations benefits greatly from retirement, whereas retirement effects for workers in high status occupations are small and frequently insignificant. We also find that workers from low status occupations accumulate health deficits faster after retirement, i.e. we find evidence for an occupational health gradient that widens with increasing age, before and after retirement.

Keywords: health deficits; occupation; retirement; frailty index; Europe.
JEL: I10, I19, J13.

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1. Introduction

Some occupations exert a higher toll on human health than others. In this paper, we investigate in a unified framework how job characteristics affect health and aging before and after retirement. The related literature (discussed below) usually focuses on health status and addresses these problems separately, i.e. there exists a literature on the impact of job characteristics on the health status of workers and a literature on the impact of retirement on health. Here we focus on the dynamic aspect of health, i.e. biological aging, expressed by the process of health deficit accumulation before and after retirement of individuals from different occupational groups.

Controlling for individual fixed effects and instrumenting for entry into retirement, we find that individuals in low status occupations display more health deficits at any age before and after retirement. This difference is observed for low- vs. high-skilled individuals, individuals in blue- vs. white-collar occupations, individuals in occupations of high- vs. low physical burden, and for individuals in occupations of high- vs. low psychosocial burden. We also find that retirement leads to a reduction of health deficits, which is statistically significant and large for individuals from low-status occupations and small and frequently insignificant for individuals from high-status occupations. Most importantly, we find that individuals in low-status occupations develop new health deficits faster before *and* after retirement. In other words, we find evidence for diverging aging processes across occupational groups.

These findings contribute to a better understanding of human aging and how it is shaped by occupational health burdens. Specifically, divergence of health deficits across occupational groups suggests that human aging is a self-productive process (Dragone and Vanin, 2020), which means that existing health deficits are conducive to the development of more health deficits during the next time increment (e.g. the next year). Ceteris paribus, unhealthy persons age faster than healthy persons. The health capital model, in contrast, predicts the opposite, namely that healthy persons (endowed with much health capital) age faster in the sense of greater loss of health capital due to depreciation during the next time increment (Grossman, 1972). If occupation exerts a level effect on health, the health capital model predicts that health differences among workers converge (Case and Deaton, 2005) and if occupation exerts a rate effect on health, the health capital model predicts that the health of workers after retirement converges (see Section 2 for details).

A widening occupational health gradient is predicted by the health deficit model, developed by Dalgaard and Strulik (2014) based on aging processes modeled in gerontology (Gavrilov and Gavrilova, 1991; Mitnitski et al., 2001, 2002, 2006, Mitnitski et al, 2017). This is so, because, according to the health-deficit model, existing health deficits are conducive to the development of further health deficits. The only case for which the health deficit model could predict convergence is if the health gain from retirement were so large that the level of health of workers in high-burden occupations returns to the level of those in low-burden occupations, which seems to be not the case, empirically.

In order to measure biological aging and how it is affected by retirement, we follow Mitnitski et al. (2001, 2002) and construct a frailty index (health deficit index). The index counts the number of health deficits that a person has at a given age relative to the number of potential health deficits. Health deficits include serious disabilities as well as mild illnesses. We then use information on retirement to construct a dummy variable that indicates whether an individual is retired or not. For this purpose, we employ the Survey of Health, Aging, and Retirement in Europe (SHARE) which contains health-related information, as well as retirement and the life-history of individuals.

We follow the empirical strategy of Abeliansky and Strulik (2018a, 2018b, 2019, 2020) and use as dependent variable the log of the frailty index and age and retirement as the explanatory variables. In order to assess occupation-specific health effects that operate independently of the personal characteristics of the workers, we exploit the panel dimension of the data and control for individual fixed effects. In order to account for the potential endogeneity of retirement we instrument it with two dummy variables that takes the value of one if the individual has reached the statutory early or normal retirement ages, in a similar vein as Mazzona and Peracchi (2012, 2017). We first split the sample according to the educational level of the individuals (11 years of schooling as the threshold). We next consider the last job as reported in the SHARE dataset and following Mazzona and Peracchi (2017) we classify jobs as being demanding or not in three different ways: overall job burden; physical job burden; and psychosocially burdensome. Finally, we classify occupations into white and blue collar jobs. We consistently observe for both men and women diverging health deficits across occupational groups and greater benefits from retirement for low-status workers. The only "anomaly" is that we also obtain large health benefits from retirement for women in white-collar occupations.

Our study has been inspired by the work of Case and Deaton (2005) who also emphasize the dynamic process of aging and investigate the health of workers of all ages but mainly focus on their work-life. Using self-reported health from the National Health Interview Surveys (NHIS), Case and Deaton observe a health-cost especially of low-paid or manual work such that these workers have both lower health and more rapidly deteriorating health, at least when they are working. They conclude that the observation of a widening occupational health gradient as workers become older is hard to reconcile with Grossman's (1972) health capital model. In their cross-sectional study, Case and Deaton control for a host of potentially confounding variables and argue that, thus, they provide "prima facie evidence for the existence of occupational specific health effects that operate, at least in part, independently of the personal characteristics of the workers" (p. 199). We try to improve on this state of affairs by using panel data and controlling for individual fixed effects, i.e. we investigate the individual aging process of workers in specific occupational groups. We also try to improve on the health metric by replacing the crude measure of self-reported health by the gerontologically founded frailty index.

Our study is also related to the influential work of Michael Marmot (and coauthors). Initially based on longitudinal studies of British civil servants and then extended in other directions, Marmot argues that occupational status is mainly associated with health status because of occupational stress, social position, and sense of being in control of one's life (e.g. Marmot et al., 1991, 1997, Marmot, 2005). We contribute to this line of research by investigating the impact of psychosocial job burden on health deficit accumulation and by showing that it is as large, if not larger, as the impact of physical job burden.

More recent work by Fletcher et al. (2011) constructs measures of physical demands and environmental stress of job characteristics for a sample of US households and finds negative effects on self-reported health for individuals working in jobs with high physical demands or harsh conditions, in particular for women and older workers. Gueorguieva et al. (2009) investigate self-rated health for a sample of older workers from seven waves of the Health and Retirement Survey (HRS) and find health effects of occupation on the level of health but not on the speed of aging. Kelly et al (2014) investigate occupational effects on health behavior and find that blue collar work early in life is associated with increased probabilities of obesity and smoking, and decreased physical activity later in life. Ravesteijn et al. (2016) investigate health satisfaction in a panel of German workers. Controlling for selection by lagged health, they find level and rate effects on health of blue collar work as well as of physical strain and low job control. Morefield et al. (2011) investigate health transitions and observe that workers in physically more demanding jobs are more likely to transit from good to bad health but do not have different probabilities of health improvements. The results thus provide indirect support for the self-productive nature of the health deficit model stratified by occupation. The Markovian nature of health deficit accumulation has been established in Mitnitski et al.(2006) and has recently been refined by Hosseini et al. (2019).

There exists a rich literature on the effects of retirement on health and many but not all studies suggest that retirement improves health. Coe and Zamarro (2011) are perhaps the first who exploit statutory retirement age as an instrument for retirement. Using data for a sample of countries from the first wave of SHARE, they find a large positive impact of retirement on self-reported health as well as on an index of objective health measures. They also find, surprisingly, that age has only a small effect on health and no evidence for a non-linear age-health relationship. A limitation of the cross-sectional study is certainly that it cannot consider the aging process of individuals by inclusion of individual fixed effects. Behncke (2012) uses data for England and a propensity score method and finds that retirement significantly increases the risk for suffering from chronic conditions such as cardiovascular disease and cancer as well as self-assessed health. Insler (2014) uses panel data from the HRS and self-reported predictions of working past ages 62 and 65 as instrument. He observes a large positive impact of retirement on individual health measured by a health index comprising objective and subjective health indicators. Eibich (2015) uses a regression discontinuity design and financial incentives in the German pension system and finds that retirement improves subjective health status at the individual level, which is particularly strong for low-skilled individuals. The study also suggests several channels of health behavior by showing that retirement leads to less smoking, more physical activity, and more sleep.

Mazzonna and Perarchi (2017) take the first two waves of SHARE data and construct indices of physical and psychosocial burden of the individuals' last occupation, i.e. the indices that we will also employ in our study. In first-difference regressions and instrumenting by statutory retirement age, the study finds a positive effect of retirement on a health index of male workers in physically demanding jobs but no such effect for women or individuals in jobs with low or median physical burden. Gorry et al. (2018) use panel data from the HRS, instrument by eligibility for several measures of social security, and find that retirement improves self-reported health but not the number of diagnosed health conditions. Leimer (2017) uses fives waves of the SHARE data, instruments by statutory retirement age, and finds a positive impact of retirement on self-assessed health as well as on other health indicators. Workers in blue collar or in physically demanding jobs, however, are not found to benefit more from retirement in terms of self-assessed health (albeit in terms of mobility limitations and grip strength). We aim to contribute to this literature by using the frailty index as an encompassing measure of health and aging established in the gerontological literature, by exploiting the panel dimension of the SHARE data, by a unified analysis of aging during the work-life and after retirement, and by addressing the question of whether the state of health converges or diverges with age across occupations, before and after retirement.

The remainder of the paper is organized as follows. In the next section we provide the theoretical background for the discussion of occupational effects on aging before and after retirement. In Section 3, we describe the dataset and the empirical method. Section 4 provides the results. Section 5 concludes the paper.

2. Aging Before and After Retirement: Theory

In order to theoretically identify the impact of occupations on aging it is useful to impose a *ceteris paribus* assumption and consider two individuals of the same age and state of health at the time of entry into the workforce. Suppose that the state of health depends only on the age and the physical or mental burden of the occupation. In order to derive a testable hypothesis from a theoretical background we consider stylized versions of the health capital model (Grossman, 1972) and the health deficit model (Dalgaard and Strulik, 2014). Following Case and Deaton (2005) we show two alternative ways that explain how occupation may affect health: level effects and rate effects.

The health capital model (Grossman, 1972) conceptualizes aging as loss of health capital, which depreciates at a certain rate (δ) as individuals grow older such that $H(t+1) = (1-\delta(t))H(t)$, in which $H(t)$ is the health capital stock at age t. The depreciation rate $\delta(t)$ may be constant or increasing in age. The health deficit model captures a stylized fact from gerontology, namely that individuals accumulate health deficits as they grow older: $D(t+1) = (1+\mu)D(t)$, in which $D(t)$ are health deficits at age t, and μ is the rate of aging. In both types of health models it is additionally assumed that the evolution of health depends on behavior (health investments, consumption of unhealthy goods etc), a feature which is omitted subsequently. By controlling for health behavior, we isolate the direct effect from occupation.

Suppose first that the health-burden of occupation exerts a level effect. According to the health capital model this implies that health differences across occupations are largest at young ages. This features has first been emphasized by Grand and Muurinen (1985) with respect to social classes. Intuitively, the argument is that the component of health decline that reflects biological aging is small for young workers and large for old workers (Case and Deaton, 2005). Formally, consider two individuals who enter the workforce at age t with health capital $\bar{H}$. Worker A experiences no health damage from work, while worker B suffers from the health burden $b > 0$ of the occupation. As a level effect, job-burden reduces health capital by factor $(1 - b)$. Suppose, for simplicity that δ is constant. The difference of health capital stocks at age T is then given by $H_A(T) - H_B(T) = (1 - \delta)^{T-t}\bar{H} - (1 - \delta)^{T-t}\bar{H}(1 - b) = (1 - \delta)^{T-t}b$. The health difference is initially largest and then depreciates as both individuals grow older and suffer from "normal" aging. If health depreciation were age-dependent, the depreciation effect of a level effect would be smaller at young ages and even greater at old ages. Case and Deaton (2005) refute the prediction of converging health capital with age using self-reported health for manual vs. non-manual workers.

The health deficit model, in contrast, predicts that initial health differences become larger as workers grow older. To see this, consider two workers, A and B, with health deficits $\bar{D}$ before entry into the workforce and a level effect on health deficits of size b only for worker B. Health deficits of worker B are thus shifted upwards by factor b and given by $\bar{D}(1+b)$. The difference in health deficits at age T is then computed as $D_B(T) - D_A(T) = (1+\mu)^{T-t}\bar{D}(1+b) - (1+\mu)^{T-t}\bar{D} = (1 + \mu)^{T-t}b$, i.e. the model predicts that occupational health differences become larger with increasing age T of the workers.

These distinctive features of the two models have been discussed in a general context and identified as self-depleting (health capital) and self-productive (health deficits) dynamic processes (Dragone and Vanin, 2020). Almond and Currie (2011) and Dalgaard et al. (2019) analyze level effects in the context of early-life health shocks. The self-depleting health capital model predicts that early life health shocks are depreciated away as individuals grow older while the self-productive health deficit model predicts that initial shocks are amplified as individuals grow older such that small shocks in utero or early childhood can have severe effects on late-life health. Abeliansky and Strulik (2018b, 2020) provide an empirical test of the health deficit model in the context of early-life health shocks.

Suppose now that the occupational health burden has rate effects rather than level effects. Then, naturally, both types of models predict that health differences grow during employment. Distinctive predictions, however are obtained for life after retirement. For the health capital model suppose that the health capital depreciates at rate δ without health-burden from occupation and at rate $\delta + \delta_b$ in health-demanding occupations. Health capital at the age of retirement R can be written as $H_A(R) = (1-\delta)^{R-t}\bar{H}$ without health-burden and $H_B(R) = (1-\delta-\delta_b)^{R-t}\bar{H}$ with health burden, in which $\bar{H}$ denotes the level of initial health capital. Individuals exposed to health-burden in their occupation face a larger rate of work-related depreciation and thus exhibit less health capital at retirement.

After retirement, the job related depreciation δ_b is no longer present and the self-depleting guarantees that health differences between retirees converge as they grow older. To see this, we can re-iterate the computation from above. The health difference between the two individuals at age $T > R$ is $H_A(T) - H_B(T) = (1-\delta)^{T-R}H_A(R) - (1-\delta)^{T-R}H_B(R) = (1-\delta)^{T-t}(H_A(R) - H_A(R))$. The health difference is largest at retirement age and depreciates away as individuals grow older. The health capital model predicts convergence of the state of health after retirement.

For health deficit accumulation, assume analogously that health burden from occupation increases the natural rate of aging, which is μ without burden (individual A) and $\mu + \mu_b$ with burden (individual B) and that there are no level effects. Then, health deficits at retirement are $D_A(R) = (1+\mu)^{T-t}\bar{D}$ and $D_B(R) = (1+\mu+\mu_b)^{T-t}\bar{D}$. The individual in unhealthy occupation has accumulated more health deficits at retirement. After retirement, $\mu_b = 0$ and individuals accumulate new health deficits at the same rate. The difference in health deficits at age $T > R$ is obtained as $D_B(T) - D_A(T) = (1+\mu)^{T-R}(D_B(R) - D_A(R))$ and it becomes larger as individuals grow older. The model predicts divergence of occupational health differences before *and* after retirement.

In this study, we investigate both level and rate effects in context of the health deficit model. In our baseline specification we consider level effects where health deficits at age t are given by

$$D(t) = \bar{D}\mathrm{e}^{\mu t}\mathrm{e}^{-(1_{[t \geq R]}b)}, \tag{1}$$

in which $\mathbb{1}_{[j=R]}$ is an indicator function that attains a value of one for retired individuals. We thus identify the occupational health burden b as the downward shift of health deficits at the age of retirement. In the level specification, we allow the rate of aging μ to differ across occupational classes but not within classes before and after retirement. The latter feature is captured by the rate-model where

$$D(t) = \bar{D}e^{\mu t}e^{1_{[t\geq R]}\mu_b t}, \tag{2}$$

in which $\mu + \mu_b$ is the rate of health deficit accumulation after retirement. If there is a rate effect from occupation, we expect μ_b to be negative such that individuals age at lower rate after retirement. It will turn out that, perhaps surprisingly, the prediction of the level- and rate-model are quite similar. The main reason for this is that the rate model also involves a level effect because, if $\mu_b < 0$, health deficits shift down by factor $e^{\mu_b R}$ at the point of retirement. For this reason, and to save space, we confine most of the robustness checks to the level model.

We do not explicitly test the health capital model. Nevertheless, inferences about the health capital model are feasible if there is a monotonous negative association of health capital and health deficits. In contrast to health deficits, the literature has never developed a standardized metric for health capital but empirical attempts to measure health capital are frequently based on the absence of health deficits (e.g. Wagstaff, 1993) or on self-evaluated health (e.g. Grossman, 2000). In the latter case, we need to assume that individuals with less health deficits evaluate their health better, which seems to be a plausible assumption. Under these restrictions, empirical support of the health deficit model in terms of divergence of health deficits during or after retirement implies that the health capital model might not be the best tool to study these issues. This is so because, in the terminology of Dragone and Vanin (2020), the process of human aging can only be either self-depleting or self-productive, but not both at the same time.

3. Empirical Method and Data

3.1. **Data.** In order to study aging before and after retirement, we use the Survey of Health, Aging, and Retirement in Europe (SHARE dataset release 7.0.0) and the Job Episodes Panel (release 7.0.0).[1] We use five waves from SHARE that provide health-related information (wave 1, 2, 4, 5 and 6); for methodological details, see Börsch-Supan et al. (2013) and Brugiavini et

[1]DOIs: 10.6103/SHARE.w1.700, 10.6103/SHARE.w2.700, 10.6103/SHARE.w4.700, 10.6103/SHARE.w5.700, 10.6103/SHARE.w6.700, and 10.6103/SHARE.jep.700)

al. (2019). Wave 1 took place in the year 2004, wave 2 in 2006/7, wave 4 in 2011 (in 2012 for Germany) wave 5 in 2013, and wave 6 in 2015[2]. We considered adults aged 50 and above in 10 countries that participated in the survey: Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Italy, Netherlands and Sweden. We focussed on these countries because their relevant statutory ages do not depend on individual characteristics (other than age) as in other countries like, for example, the Czech Republic where the number of children is also decisive for the statutory retirement age. We also omit Israel and Greece because they participated in the survey less often than the other countries. We only used observations of individuals aged 85 and below because several very old people show "super healthy" characteristics (likely because of selection effects).[3]

For each observation of each surveyed individual we constructed a frailty index following Mitnitski et al. (2002) and Searle et al. (2006). We took into consideration 38 symptoms, signs, and disease classifications, which can be found in Table A.1 in the Appendix. We followed Mitnitski et al. (2002) and coded multilevel deficits using a mapping to the Likert scale within the interval 0-1. Details on the construction of each variable are available in Table A.2 in the Appendix. We then obtained the frailty index as an individual's ratio of deficits. If information on specific deficits was not there for an individual, we instead calculated the index based on the information which was available about potential deficits (i.e. if data was not available for x potential health deficits, the observed health deficits were divided by $38-x$). From the surveyed people, we retained only those with information on at least 30 health deficits for at least 2 waves and also removed individuals younger than 50 since this was not the targeted population of the survey (and this group very likely represented partners of the actual targeted people). We further cleaned the data removing individuals with a frailty index of zero because we use the logarithm of health deficits. We arrived at a sample of 83,659 observations, which corresponds to 28,664 individuals.

We then continue with the sample split by educational level. We took 11 years of schooling as the threshold for high-and low-educational levels since this was the mean value. The second

[2]Wave 3 was not included given that it does not report health-related variables (it is a retrospective wave). Wave 7, although available, lacks the whole module on mental health for those who have been surveyed in the past so it could not be included in the analysis.

[3]Despite the fact that the survey is intended for adults aged 50 or above (ideally making it representative of the non-institutionalized population of age 50+), people aged below 50 years are also in the original data set since partners are also interviewed. Since they are not from the representative sample they were removed.

sample split refers to the level of job burden (high/low) that each individual had in their last job. Each person was asked in wave 1 which was their last job, and the answer was coded following the ISCO-88 classification. Since this information is only available for wave 1, the sample for this analysis only includes individuals that were present in wave 1 (and onwards). The ISCO-88 code on the last job is used to match it with the classification from Kroll (2011), also used by Mazzona and Peracchi (2015) (we did the match at the 4 digit-level). Kroll (2011) classified the jobs according to their overall intensity, which is comprised of physical and mental strain, and assigned a value from 1 to 10 to each job in the ISCO-88 classification. Mazzonna and Peracchi (2017, p.135) define a physical burdensome job as one with high environmental pollution and ergonomic stress and a psychosocially burdensome job as one with high level of "mental stress, social stress, and temporal loads". We follow Mazzona and Peracchi (2015) and use the interval [1,5] to classify an individual whose last job is/was low in intensity, while all whose index is above 5 as strenuous ("high intensity"). Finally, we also use the reported last job with its ISCO-88 classification and assign it the category of "blue" or "white collar" using the classification of Eurofund (2020).

We recorded individuals as "retired" when they replied "retired' to "In general, how would you describe your current situation?". Following the literature, we omitted those individuals who answered "Permanently sick or disabled" since this group could benefit from early retirement benefits due to disability and because their aging process could be different. Moreover, we erased those individuals who refused to provide an answer. We also complimented this information with that of the Job Episode Panel, provided by SHARE in another dataset. In the robustness analysis we only kept individuals who are retired, employed or unemployed. Facing the problems of endogeneity of retirement and of reverse causality, we use an instrumental variable approach. We take the "normal" and "early" statutory retirement ages as external instruments, since individuals do not choose these themselves and have no power to change these. The SHARE dataset provides the "normal" statutory retirement age for most individuals and the "early" one for a very reduced group. Because using the "early" information from SHARE would reduce our sample size considerably, we have complemented it with information on early retirement provided in Leimer (2017).

Table 1 shows the summary statistics of the samples used for the educational split, job intensity splits as well as for the collar split. Females have, on average, more health deficits than men.

Table 1. Summary Statistics

Variable s	Females Mean	Females Std. Dev.	Males Mean	Males Std. Dev.	Females Mean	Females Std. Dev.	Males Mean	Males Std. Dev.
	High Education				Low Education			
Frailty index	0.130	0.097	0.097	0.086	0.185	0.132	0.130	0.110
Age	63.154	8.306	64.237	8.405	67.364	8.837	67.536	8.729
Retired	0.504	0.500	0.585	0.493	0.600	0.490	0.758	0.428
Statutory retirement age	63.755	2.083	64.463	1.610	63.167	2.382	64.499	1.574
(Early) Statutory retirement age	60.135	1.940	60.749	2.096	59.940	1.903	60.709	2.175
	Overall Job Burden: Low Burden				Overall Job Burden: High Burden			
Frailty index	0.168	0.114	0.127	0.105	0.201	0.128	0.155	0.123
Age	69.541	7.849	71.385	7.149	69.592	7.826	71.315	7.139
Retired	0.849	0.358	0.967	0.178	0.787	0.410	0.967	0.179
Statutory retirement age	63.185	2.276	64.282	1.733	63.075	2.361	64.514	1.499
(Early) Statutory retirement age	59.565	2.005	60.216	2.175	59.629	1.924	60.248	2.056
	Physical Job Burden: Low Burden				Physical Job Burden: High Burden			
Frailty index	0.170	0.115	0.130	0.108	0.199	0.127	0.154	0.121
Age	69.766	7.788	71.502	7.076	69.382	7.881	71.187	7.213
Retired	0.865	0.342	0.971	0.167	0.774	0.418	0.963	0.190
Statutory retirement age	63.185	2.263	64.297	1.715	63.072	2.372	64.514	1.505
(Early) Statutory retirement age	59.543	2.032	60.253	2.171	59.644	1.901	60.211	2.051
	Psychosocial Job Burden: Low Burden				Psychosocial Job Burden: High Burden			
Frailty index	0.168	0.111	0.139	0.114	0.197	0.128	0.144	0.116
Age	69.307	7.976	71.477	7.008	69.739	7.739	71.211	7.287
Retired	0.824	0.381	0.966	0.181	0.811	0.392	0.968	0.176
Statutory retirement age	63.232	2.273	64.346	1.679	63.058	2.350	64.459	1.558
(Early) Statutory retirement age	59.592	2.048	60.220	2.162	59.603	1.906	60.246	2.064
	White Collar				Blue Collar			
Frailty index	0.169	0.116	0.123	0.104	0.218	0.142	0.159	0.127
Age	69.748	7.647	71.435	7.104	70.005	8.109	71.677	7.246
Retired	0.872	0.334	0.970	0.170	0.751	0.433	0.961	0.193
Statutory retirement age	63.336	2.246	64.282	1.734	62.818	2.449	64.531	1.489
(Early) Statutory retirement age	59.659	1.939	60.271	2.142	59.549	1.852	60.198	2.025

This is line with Abeliansky and Strulik (2018a, 2018b, 2019, 2020). We also observe that individuals with higher educational levels have, on average, less deficits (as previously shown by Harttgen et al, 2013). The mean age of females and males is similar, individuals are, on average, 3 to 4 years younger in the high education group. In line with this observation, the percentage of observations of retired individuals is somewhat lower among the highly educated. As expected, the mean early statutory retirement age is lower than the statutory retirement age. With respect to the sample splits according to job burden, we observe that within burden-classes men are, on average, about 1.5 years older than women but across burden classes there are only small age differences. Men and women in high burden occupations display on average more health deficits. This difference is most pronounced for men in occupations of high physical burden who display about 20 percent more health deficits than their counterparts in low-burden occupations. Occupational differences are greatest across collar groups. Men and women in blue collar occupations display on average almost 30% more health deficits than their counterparts in white collar occupations.

3.2. **Model Specification.** As our baseline specification, we log-linearize equation (1) and estimate the following relationship between the frailty index, age, and retirement:

$$\ln D_{iw} = \mu \cdot age_{iw} + \gamma \cdot retirement_{iw} + \lambda_i + \epsilon_{iw}, \tag{3}$$

where D is the frailty index, i represents the individual, w the wave, *age* represents the age at the interview, *retirement* is a dummy that takes the value of one if the individual is retired, λ_i are individual fixed effects and ϵ is the error term. Standard errors are clustered at the year-of-birth level.[4] Equation (1) implies that health deficits grow exponentially with age akin to the Gompertz law of mortality. When individuals retire, there is a shift in the health-deficit accumulation curve.

Alternatively, we consider that occupational factors affect the rate of aging when working. After log-linearizing (2), we estimate the following econometric model:

$$\ln D_{iw} = \mu \cdot age_{iw} + \omega \cdot age_{iw} \cdot retirement_{iw} + \lambda_i + \epsilon_{iw}. \tag{4}$$

We also tried to implement both level- and rate effects. This, however, led to less consistent results, most likely due to the collinearity of both effects since, as shown below, level and rate effects of retirement transform the age-trajectory of health deficit accumulation in a very similar way.

We estimate (3) and (4) separately for men and women since previous studies have shown that males and females accumulate health deficits at different rates and levels (e.g. Mitnitski et al., 2002, Abeliansky and Strulik, 2018a, 2019). Most importantly, we estimate (3) and (4) for different occupational groups, i.e. we consider sample splits according to education, different characteristics of job burden, and collar-color in order to obtain occupational differences of aging before and after retirement. In IV regressions we control for the potential endogeneity of individual retirement status by instrumenting it with the statutory retirement age.

[4]We have also conducted the analysis using two-way clustering at the country and year-of-birth level. We refrained from reporting these results since the command *xtivreg2* would not report the Hansen test due to few observations in some clusters. The conclusions derived from using these alternative standard errors are the same. Results are available upon request.

4. Results

Table 2 shows the results of estimating Equation (1) for men and women, according to their educational level. On average, individuals develop about 2 percent more health deficits from one birthday to the next. We see that elderly women start from a higher level of initial health deficits than men (larger constant) and that men, as they age, accumulate health deficits at a greater speed than women, in line with past literature (i.e. Mitnitski et al., 2002; Abeliansky and Strulik, 2018). Columns (1), (4), (7) and (10) show the baseline results when the retirement dummy is not included. We see that within-gender groups, individuals with low education age faster. While this result is, in principle known from the literature (e.g. Harttgen et al., 2013), we here show that it holds true when controlling for individual characteristics by individual fixed effects in the regression.

In columns (2), (5), (8), and (11) we include the retirement dummy in the OLS regressions. We observe a statistically significant effect of retirement only for women with low education and for men with high education. The results, however, are likely driven by endogeneity-bias. This view is confirmed when we consider the results from instrumental variable regression in columns (3), (6), (9), and (12). The first stage results are shown in Table C.1 in the Appendix. The instruments are valid according to the Kleinbergen Paap Wald F-statistic (above the threshold of 10) and in most of the cases the Hansen statistic fails to reject the null hypothesis that the over-identifying restrictions are valid. We now observe that retirement has a significant effect on health deficits. For all four gender-occupation groups, the switch to retirement contributes to a downward shift of the age-deficit trajectory. Among women, the point estimate is marginally higher (in absolute value) for women with low education. Among men, we observe that men with low education age more rapidly but benefit more from retirement than those with higher education.

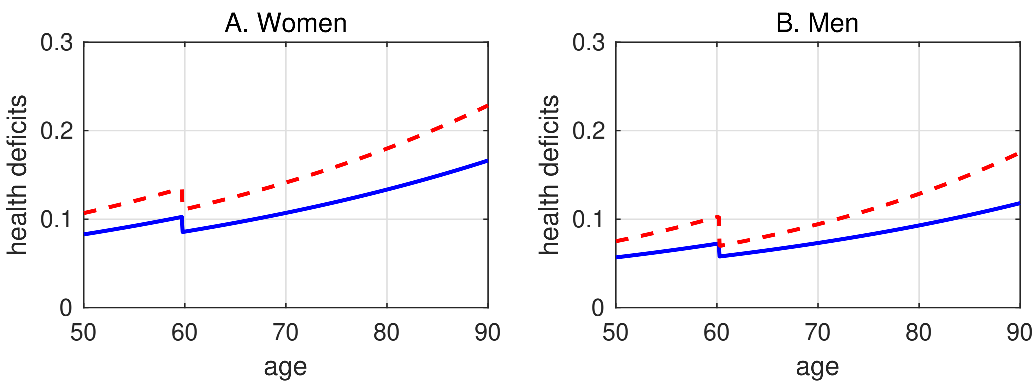
Since the introduction of the retirement shifter also affects the rate of aging (as well as the initial value), the aggregate educational effects on health deficit accumulation before and after retirement are hard to discern from the estimated coefficients. In particular, the issue of convergence or divergence motivated in the theory section is hard to resolve from inspection of Table 2. To alleviate inferences, we thus use the point estimates from the IV regressions for a graphical representation of biological aging of men and women distinguished by educational class. These results are shown in Figure 1. We took the gender-specific average retirement age

TABLE 2. Health Deficits and Retirement - Education Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.015***	0.016***	0.022***	0.019***	0.020***	0.024***	0.016***	0.019***	0.024***	0.021***	0.022***	0.031***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)
Retired		-0.029	-0.183***		-0.037*	-0.200***		-0.071***	-0.228**		-0.056	-0.392***
		(0.025)	(0.058)		(0.020)	(0.065)		(0.023)	(0.093)		(0.033)	(0.077)
Constant	-3.256***	-3.310***	-3.591***	-3.231***	-3.269***	-3.436***	-3.683***	-3.803***	-4.068***	-3.758***	-3.812***	-4.139***
	(0.139)	(0.153)	(0.185)	(0.135)	(0.132)	(0.130)	(0.188)	(0.194)	(0.257)	(0.196)	(0.195)	(0.179)
Obs.	19,583	19,583	19,583	25,485	25,485	25,485	19,232	19,232	19,232	19,359	19,359	19,359
Ind.	6,750	6,750	6,750	8,601	8,601	8,601	6,707	6,707	6,707	6,606	6,606	6,606
Educ.	High	High	High	Low	Low	Low	High	High	High	Low	Low	Low
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	282.64	-	-	206.44	-	-	117.12	-	-	181.87
H-Test	-	-	0.088	-	-	0.707	-	-	0.260	-	-	0.480

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the frailty index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap Wald F-statistic and H-test for Hansen test (p-value).

Figure 1: Health Deficits by Age: High vs. Low Education



Predictions for estimates from IV-regression, columns (3),(6), (9), and (12) from Table 2. Retirement at the average gender-specific retirement age. Blue (solid) lines: high education; red (dashed) lines: low education.

as the shift point. Women are represented in panel A on the left-hand side and men are shown in panel B. Health deficits by age are represented by blue (solid) lines for high-educated individuals and by red (dashed) lines for low educated individuals.

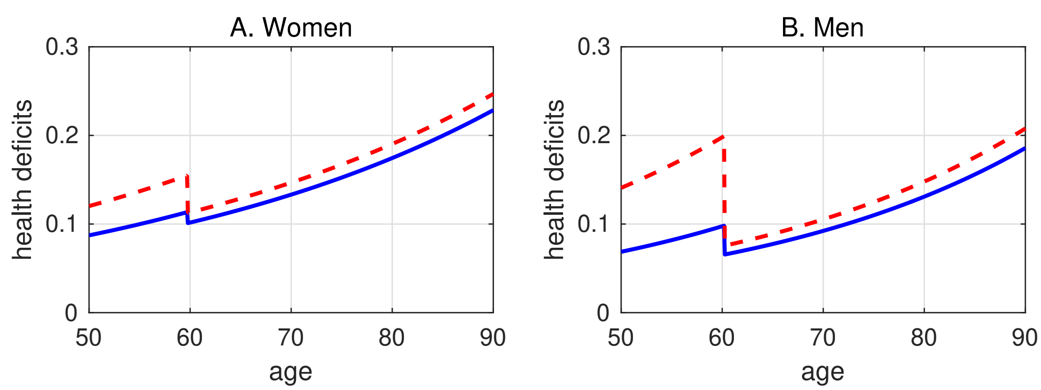
The results from Figure 1 show that low educated individuals have at any age accumulated more health deficits and that the distance between health deficits by skill-group gets larger with increasing age, before and after retirement. Thus there is divergence of health deficits as predicted by the health deficit model (and in disagreement with the health capital model). Divergence after retirement follows from the feature that health deficit is a self-productive process (cf. theory section) together with the result that the age-coefficient is larger for low-educated individuals at all ages. This particular result could be an artifact. We thus check below whether it is robust when we allow retirement to have an impact on the rate of aging. The results in

Figure 1 also show that the retirement effect on health recovery is economically significant. It takes five to ten years of biological aging after retirement to return to the health deficit level reached just before retirement.

While it is reasonable that part of the effect of education on aging works through the selection of occupation, it is well known that education effects health also through other pathways (e.g. Grossman, 2006; Strulik, 2018; Galama and Van Kippersluis, 2019). With our next sample split we thus focus on the physical and psychosocial burden of occupation, classified to be either high or low (see Data section). By including individual fixed effects in the regression, we control for education as a selection device since it can reasonable be argued that education is finished at the age of 50 (the youngest age in our sample). A shortcoming of these regressions is that job burden refers to the current job or the last job that retired individuals had. If individuals, as they age, move from health-demanding occupations to less health-demanding occupations, we do not capture the job burden of the whole work-life correctly and the regressions tend to overestimate the health toll of low-burden jobs, i.e. to underestimate the occupational differences of aging and retirement.

Table 3 shows the results for aggregate job burden, as well as separated by physical burden and psychosocial burden. Focusing on the IV regressions, we observe a statistically significant impact of retirement only for men and women in high burden occupations. For both men and women the age coefficient is similar across burden levels but the constant is significantly larger in high burden occupations. Retirement causes a particularly large reduction of health deficits for men in high-burden occupations, regardless of the dimension of burden.

Figure 2: Health Deficits by Age: Low vs. High Physical Burden



Predictions for estimates from IV-regression, columns (3),(6), (9), and (12) from Table 3.B. Retirement at the average gender-specific retirement age. Blue (solid) lines: low physical burden; red (dashed) lines: high physical burden.

Table 3. A. Health Deficits and Retirement - Overall Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.024***	0.024***	0.024***	0.023***	0.024***	0.029***	0.032***	0.032***	0.034***	0.030***	0.031***	0.035***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Retired		0.004	0.024		-0.053	-0.413**		0.014	-0.453		-0.229**	-0.967***
		(0.071)	(0.126)		(0.044)	(0.171)		(0.132)	(0.376)		(0.108)	(0.335)
Constant	-3.696***	-3.696***	-3.695***	-3.418***	-3.428***	-3.498***	-4.644***	-4.653***	-4.341***	-4.318***	-4.176***	-3.719***
	(0.182)	(0.182)	(0.185)	(0.202)	(0.196)	(0.171)	(0.251)	(0.258)	(0.380)	(0.297)	(0.303)	(0.325)
Obs.	3,501	3,501	3,501	3,885	3,885	3,885	3,270	3,270	3,270	3,361	3,361	3,361
Ind.	958	958	958	1,079	1,079	1,079	940	940	940	931	931	931
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	60.56	-	-	52.00	-	-	11.21	-	-	12.23
H-Test	-	-	0.294	-	-	0.047	-	-	0.729	-	-	0.964

B. Health Deficits and Retirement - Physical Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.025***	0.027***	0.022***	0.023***	0.026***	0.033***	0.033***	0.035***	0.029***	0.030***	0.034***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Retired		0.050	-0.117		-0.078*	-0.321**		0.033	-0.405		-0.240**	-0.971***
		(0.075)	(0.162)		(0.044)	(0.145)		(0.139)	(0.370)		(0.090)	(0.351)
Constant	-3.791***	-3.792***	-3.789***	-3.342***	-3.360***	-3.418***	-4.709***	-4.732***	-4.428***	-4.234***	-4.091***	-3.660***
	(0.234)	(0.238)	(0.229)	(0.174)	(0.170)	(0.149)	(0.293)	(0.302)	(0.380)	(0.265)	(0.267)	(0.329)
Obs.	3,439	3,439	3,439	3,961	3,961	3,961	3,463	3,463	3,463	3,182	3,182	3,182
Ind.	949	949	949	1,091	1,091	1,091	994	994	994	882	882	882
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	43.45	-	-	64.36	-	-	9.84	-	-	16.27
H-Test	-	-	0.442	-	-	0.058	-	-	0.488	-	-	0.605

C. Health Deficits and Retirement - Psychosocial Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.023***	0.023***	0.025***	0.024***	0.024***	0.028***	0.032***	0.032***	0.034***	0.030***	0.031***	0.035***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Retired		-0.023	-0.093		-0.034	-0.375*		-0.021	-0.307		-0.240***	-1.342***
		(0.072)	(0.106)		(0.050)	(0.193)		(0.126)	(0.325)		(0.063)	(0.448)
Constant	-3.603***	-3.609***	-3.626***	-3.513***	-3.515***	-3.529***	-4.592***	-4.579***	-4.402***	-4.352***	-4.190***	-3.449***
	(0.140)	(0.135)	(0.142)	(0.216)	(0.213)	(0.202)	(0.266)	(0.271)	(0.309)	(0.297)	(0.285)	(0.425)
Obs.	2,925	2,925	2,925	4,461	4,461	4,461	3,460	3,460	3,460	3,171	3,171	3,171
Ind.	801	801	801	1,236	1,236	1,236	976	976	976	895	895	895
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	60.56	-	-	52.00	-	-	11.21	-	-	12.23
H-Test	-	-	0.294	-	-	0.049	-	-	0.729	-	-	0.964

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the frailty index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap Wald F statistic and H-test for Hansen test (p-value).

In Figure 2 we illustrate aging by occupational class for the case of physical burden. For the illustration, we use again the point estimates of the IV regressions and the average gender-specific retirement age. The age-profiles reveal that men and women in high-burden occupations develop health deficits faster although the estimated age coefficient is slightly lower than for individuals with low burden. The reason is the higher level of initial deficits in conjunction with the self-productive nature of deficit accumulation. We thus observe divergence, in particular during during working age, as predicted by the health deficit model (and in disagreement with the health capital model). The results resemble those from Figure 1 although predicted health deficits for men in high-burden occupation appear to be very high. One explanation of this phenomenon could be that many of these workers retire earlier than the average and have thus accumulated less deficits than predicted at the point of retirement.

Finally, Table 4 shows the results using a different categorization: whether the last job was classified either as "white" or "blue" collar. In the case of men we observe the familiar pattern: the health of men with blue collar jobs benefits more from retirement. For women, we observe a new and perhaps surprising pattern: women in white collar jobs benefit more in terms of health deficit reduction from retirement than those in blue collar jobs. The point estimates, however, are quite close and the occupational differences in the benefit from retirement are no longer statistically significant when we remove home-makers and individuals having reported "other" as their last occupation (Table D.5 in the Appendix). Figure 3 shows the predicted gender- and occupation specific aging. For men, we observe again divergence of health deficits, before and after retirement. For women, we observe that a larger age-coefficient for white collar women is not sufficient to produce convergence of health deficits across occupational groups, although, in this case, divergence is hardly discernible with the naked eye. Algebraically, however we confirm that health deficits diverge as blue and white collar women grow older.

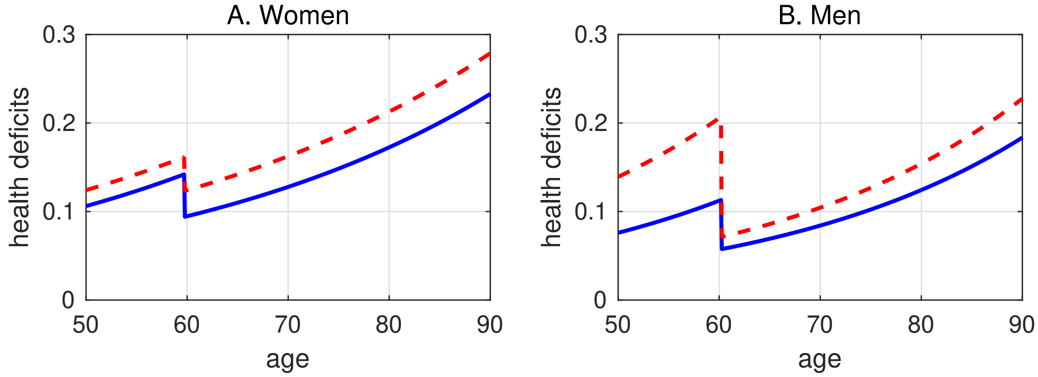
Table 4. Health Deficits and Retirement - White/Blue Collar Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.026***	0.030***	0.023***	0.025***	0.027***	0.036***	0.036***	0.039***	0.034***	0.035***	0.039***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Retired		-0.007	-0.414***		-0.116***	-0.271**		0.047	-0.678*		-0.195***	-1.068***
		(0.079)	(0.147)		(0.040)	(0.134)		(0.163)	(0.372)		(0.051)	(0.294)
Constant	-3.829***	-3.828***	-3.743***	-3.369***	-3.397***	-3.436***	-4.996***	-5.028***	-4.527***	-4.553***	-4.438***	-3.922***
	(0.199)	(0.198)	(0.166)	(0.175)	(0.175)	(0.179)	(0.225)	(0.259)	(0.345)	(0.272)	(0.254)	(0.298)
Observations	3,442	3,442	3,442	3,864	3,864	3,864	4,174	4,174	4,174	4,379	4,379	4,379
Individuals	955	955	955	1,104	1,104	1,104	1,235	1,235	1,235	1,240	1,240	1,240
Collar	White	White	White	Blue	Blue	Blue	White	White	White	Blue	Blue	Blue
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	45.68	-	-	100.55	-	-	13.83	-	-	56.82
H-Test	-	-	0.213	-	-	0.786	-	-	0.381	-	-	0.589

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the frailty index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap Wald F statistic and H-test for Hansen test (p-value).

The first stages from the instrumental variable regressions are available in the Appendix, Tables C.1, C.2 and C.3. Moreover, in the Appendix-Tables D.1, D.2, D.3, D.4 and D.5 we replicate the above models but now changing the control group. We now keep in the analysis

Figure 3: Health Deficits by Age: White vs. Blue Collar Occupation



Predictions for estimates from IV-regression, columns (3),(6), (9), and (12) from Table 4. Retirement at the average gender-specific retirement age. Blue (solid) lines: white collar; red (dashed) lines: blue collar.

those who are employed, unemployed and retired. The statistical significance of the point estimates remains fairly stable, as well as the sizes of the coefficients. As another robustness test we merged the burden indicator at the two-digit ISCO-level. The benefit of this approach is that we gain in sample size, but given the high aggregation level we lose the difference between the general burden index and the physical burden index. Overall, the aging pattern for high burden individuals remains the same in terms of statistical significance and similar in size (see Tables E.1 and E.2). A robust result of all performed tests is that individuals who are or were in high burden occupations benefit from retirement in terms of health deficit reduction, although in some specifications also individuals with low burden benefit.

We next turn to the analysis of rate effects of retirement by estimating specification (4). Results are summarized in Table 5. Focusing on the IV regressions, we observe the following regularities. Men and women with low education, or in blue collar work, or in occupations with high physical or psychosocial burden age faster when working (larger age coefficient) and the pace of aging slows down by more in retirement (the negative coefficient for age-retirement interaction is larger in absolute terms). Individuals in high burden occupations always benefit significantly from retirement in terms of a reduction of the rate at which health deficits accumulate; while in most cases, individuals with low job burden do not significantly benefits from retirement. The exception from theses regularities is, again, the case of white-collar women who benefit strongly from retirement and more so than their blue-collar counterparts.

Table 5. Rate Effects of Retirement

A. Education Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.015***	0.016***	0.022***	0.019***	0.020***	0.025***	0.016***	0.019***	0.024***	0.021***	0.023***	0.035***
	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)	(0.003)	(0.005)
Age * Retired		-0.000	-0.002**		-0.000	-0.003**		-0.001**	-0.003		-0.001	-0.006***
		(0.000)	(0.001)		(0.000)	(0.001)		(0.000)	(0.002)		(0.001)	(0.001)
Constant	-3.256***	-3.298***	-3.601***	-3.231***	-3.274***	-3.517***	-3.683***	-3.801***	-4.065***	-3.758***	-3.839***	-4.415***
	(0.139)	(0.159)	(0.222)	(0.135)	(0.135)	(0.165)	(0.188)	(0.204)	(0.333)	(0.196)	(0.209)	(0.245)
Obs.	19,583	19,583	19,583	25,485	25,485	25,485	19,232	19,232	19,232	19,359	19,359	19,359
Ind.	6,750	6,750	6,750	8,601	8,601	8,601	6,707	6,707	6,707	6,606	6,606	6,606
Educ	High	High	High	Low	Low	Low	High	High	High	Low	Low	Low
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	239.54	-	-	245.94	-	-	135.97	-	-	190.82
H-Test	-	-	0.619	-	-	0.072	-	-	0.156	-	-	0.174

B. Physical Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.024***	0.029***	0.022***	0.023***	0.030***	0.033***	0.032***	0.041***	0.029***	0.034***	0.050***
	(0.003)	(0.004)	(0.006)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.009)	(0.004)	(0.004)	(0.009)
Age * Retired		0.001	-0.002		-0.001	-0.005**		0.001	-0.006		-0.004**	-0.016***
		(0.001)	(0.003)		(0.001)	(0.002)		(0.002)	(0.007)		(0.001)	(0.006)
Constant	-3.791***	-3.750***	-3.907***	-3.342***	-3.406***	-3.645***	-4.709***	-4.693***	-4.814***	-4.234***	-4.319***	-4.596***
	(0.234)	(0.233)	(0.269)	(0.174)	(0.183)	(0.179)	(0.293)	(0.299)	(0.321)	(0.265)	(0.262)	(0.307)
Obs.	3,439	3,439	3,439	3,961	3,961	3,961	3,463	3,463	3,463	3,182	3,182	3,182
Ind.	949	949	949	1,091	1,091	1,091	994	994	994	882	882	882
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	37.47	-	-	40.91	-	-	9.00	-	-	13.02
H-Test	-	-	0.501	-	-	0.053	-	-	0.526	-	-	0.453

C. Psychosocial Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.023***	0.024***	0.026***	0.024***	0.024***	0.033***	0.032***	0.033***	0.038***	0.030***	0.034***	0.057***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)	(0.009)	(0.004)	(0.005)	(0.011)
Age * Retired		-0.000	-0.002		-0.000	-0.006*		-0.000	-0.005		-0.003**	-0.023***
		(0.001)	(0.002)		(0.001)	(0.003)		(0.002)	(0.006)		(0.001)	(0.008)
Constant	-3.603***	-3.630***	-3.726***	-3.513***	-3.531***	-3.825***	-4.592***	-4.600***	-4.696***	-4.352***	-4.411***	-4.754***
	(0.140)	(0.138)	(0.193)	(0.216)	(0.213)	(0.228)	(0.266)	(0.273)	(0.307)	(0.297)	(0.304)	(0.346)
Obs.	2,925	2,925	2,925	4,461	4,461	4,461	3,460	3,460	3,460	3,171	3,171	3,171
Ind.	801	801	801	1,236	1,236	1,236	976	976	976	895	895	895
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	32.06	-	-	36.99	-	-	9.52	-	-	19.66
H-Test	-	-	0.568	-	-	0.109	-	-	0.525	-	-	0.566

D. White/Blue Collar Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.026***	0.038***	0.023***	0.026***	0.031***	0.036***	0.035***	0.049***	0.034***	0.038***	0.057***
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.009)	(0.004)	(0.004)	(0.008)
Age * Retired		-0.000	-0.008***		-0.001**	-0.005**		0.001	-0.011*		-0.003***	-0.018***
		(0.001)	(0.003)		(0.001)	(0.002)		(0.003)	(0.007)		(0.001)	(0.005)
Constant	-3.829***	-3.838***	-4.160***	-3.369***	-3.461***	-3.652***	-4.996***	-4.974***	-5.177***	-4.553***	-4.620***	-4.958***
	(0.199)	(0.206)	(0.229)	(0.175)	(0.182)	(0.234)	(0.225)	(0.228)	(0.253)	(0.272)	(0.272)	(0.282)
Obs.	3,442	3,442	3,442	3,864	3,864	3,864	4,174	4,174	4,174	4,379	4,379	4,379
Ind.	955	955	955	1,104	1,104	1,104	1,235	1,235	1,235	1,240	1,240	1,240
Collar	White	White	White	Blue	Blue	Blue	White	White	White	Blue	Blue	Blue
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	44.47	-	-	76.02	-	-	12.76	-	-	44.40
H-Test	-	-	0.407	-	-	0.984	-	-	0.299	-	-	0.753

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the frailty index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap Wald F statistic and H-test for Hansen test (p-value).

We use these results to take up again the question of convergence/divergence. Since the rate of aging declines by more after retirement for individuals in high burden occupations and for low-skilled/blue collar workers, there is, in principle, potential for convergence of health deficits across occupations after retirement. A necessary, not sufficient condition for convergence is that the rate of aging gets smaller after retirement, i.e. the sum of age coefficient plus age-retirement coefficient is smaller for individuals in high burden occupations after retirement. The condition is not sufficient because initial values matter as well. In order to clarify the convergence question, we visually inspect the aging patterns predicted by the point estimates from the IV regressions in Table 5.

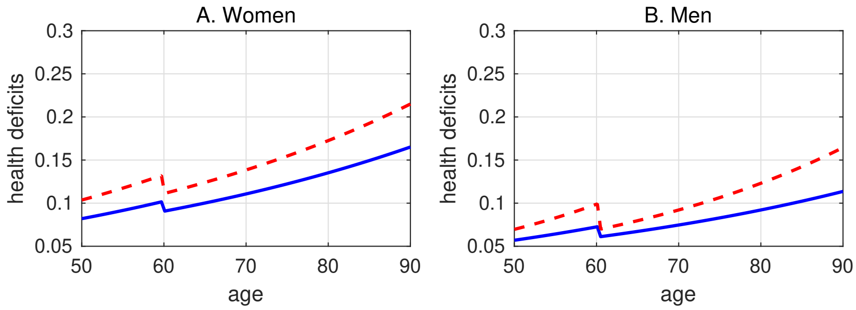
Results are shown in Figure 4, Panel A-C. As explained in the theory section, the age-retirement interaction also causes a drop of health deficits at entry into retirement. It turns out that this drop is of similar magnitude as the one predicted by the level-model (Figure 1-3). In fact, aging before and after retirement is predicted to be strikingly similar in the rate-model and in the level-model. For men, the divergence of health deficits with age across occupational groups is clearly discernible. For women, divergence is much smaller and can be identified only by computing analytically the occupational difference of health deficits. From age 60 to 90, the deficits difference between women in occupations of high vs. low physical burden increases from 1.5 to 1.9 percent and the deficits difference between blue and white collar women increases from 2.9 to 3.7 percent. Summarizing, we find no support for convergence of the state of health between occupational groups and, in particular for men, the results strongly suggest divergence before and after retirement, interrupted by a marked relief from health deficits with entry into retirement.

5. Conclusion

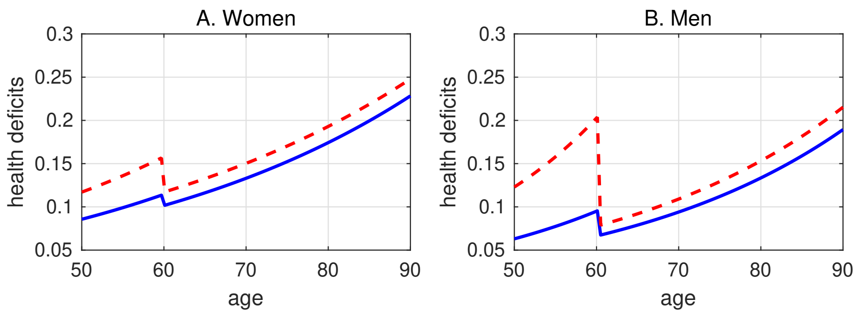
In this study we provide evidence for occupational health effects before and after retirement. Using the frailty index, an encompassing measure of health and aging developed in gerontology, and panel data for 10 European countries we find that, controlling for individual fixed effects, individuals with low education, in blue collar jobs, and in physically or psychosocially demanding occupations develop new health deficits faster than individuals in the corresponding higher status group. We instrument for retirement by statutory retirement age and find that retirement provides a strong relief from health deficits for individuals in low status occupations but leads

Figure 4: Rate Effects of Retirement

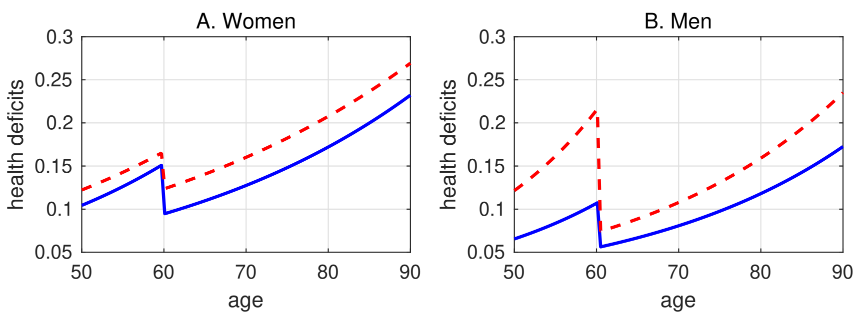
A. High vs. Low Education



B. Low vs. High Physical Burden



C. White vs. Blue Collar



Predictions for estimates from IV-regression, columns (3),(6), (9), and (12) from Table 4. Retirement at the average statutory retirement age from Table1. Blue (solid) lines: A. high education; B. low physical burden; C. white collar. Red (dashed) lines: A. low education; B. high physical burden, C. blue collar.

not to a complete reset of health deficits to the corresponding level in high status occupations. Consequently, individuals in low status occupations develop health deficits faster also after retirement. In other words, we observe a widening occupational health gradient not only during the work-life but also in retirement, which is particularly large for men. Diverging states of health for given are hard to square with predictions of the convergence-generating health capital model. They are supportive of the self-productive nature of health deficit accumulation according to the health deficit model.

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Appendix A. Data construction

Table A.1. Items of the Health Deficit Index

Arthritis	Difficulties concentrating
Stroke	Difficulties shopping
Parkinson	Difficulties lifting 5kg
Diabetes	Difficulties pulling/pushing object
Cholesterol	Less enjoyment
Asthma	Difficulties managing money
Depressed	Difficulties joining activities
High blood pressure	Difficulties bathing
Cataracts	Difficulties dressing
Pain	Difficulties doing housework
Difficulties seeing arm length	Difficulties walking across house
Difficulties seeing across street	Difficulties eating
Difficulties sitting long	Difficulties getting out of bed
Difficulties walking 100mt	Difficulties using the toilet
Difficulties getting out chair	Difficulties using map
Difficulties climbing stairs	Walking speed (only in wave 1 and 2)
Difficulties kneeing	BMI
Difficulties picking an object	Grip strength
Difficulties extending arms	Mobility

Table A.2. Variables from the SHARE data.

Dimension	Variable	Coding in SHARE dataset
Arthritis	ph006d8	yes=1, no=0
Stroke	ph006d4	yes=1, no=0
Parkinson	ph006d12	yes=1, no=0
Diabetes	ph006d5	yes=1, no=0
Cholesterol	ph006d3	yes=1, no=0
Asthma	ph006d7	yes=1, no=0
Depressed	mh002_	yes=1, no=1
High blood pressure	ph006d2	yes=1, no=0
Cataracts	ph006d13	yes=1, no=0
Pain	ph010d1	yes=1, no=0
Difficulties seeing arm length	ph044_	none=0, mild=0.25, moderate=0.5, bad=0.75, very bad=1
Difficulties seeing across street	ph043_	none=0, mild=0.25, moderate=0.5, bad=0.75, very bad=1
Difficulties sitting long	ph048d2	yes=1, no=0
Difficulties walking 100mt	ph048d1	yes=1, no=0
Difficulties getting out chair	ph048d3	yes=1, no=0
Difficulties climbing stairs	ph048d5	yes=1, no=0
Difficulties kneeing	ph048d6	yes=1, no=0
Difficulties picking an object	ph048d10	yes=1, no=0
Difficulties extending arms	ph048d7	yes=1, no=0
Difficulties concentrating	mh014_	yes=1, no=0
Difficulties shopping	ph049d9	yes=1, no=0
Difficulties lifting 5kg	ph048d9	yes=1, no=0
Difficulties pulling/pushing object	ph048d8	yes=1, no=0
Less enjoyment	mh016_	yes=1, no=0
Difficulties managing money	ph049d13	yes=1, no=0
Difficulties joining activities (because of health)	ph005_	not limited=0, limited, not severely=0.5, severely limited=1
Difficulties bathing	ph049d3	yes=1, no=0
Difficulties dressing	ph049d1	yes=1, no=0
Difficulties doing housework	ph049d12	yes=1, no=0
Difficulties walking across the house	ph049d2	yes=1, no=0
Difficulties eating	ph049d4	yes=1, no=0
Difficulties getting out of bed	ph049d5	yes=1, no=0
Difficulties using the toilet	ph049d6	yes=1, no=0
Difficulties using map	ph049d7	yes=1, no=0
Walking Speed (only available wave 1 and wave 2)	wspeed and wspeed2	no problem if: aged<75 (by construction);(wspeed>=0.4 or wspeed2==0); problem if: wspeed<=0.4 or wspeed2==1
BMI	bmi	(bmi<=18.5 or bmi>=30) =1; (bmi>=25 and bmi<30)=0.5; bmi>18.5 and bmi<25)=0
Grip strength	maxgrip and bmi	it is recorded as frail for women if (maxgrip<=29 & bmi<=24); (maxgrip<=30 & (bmi>=24.1 & bmi<=28)); (maxgrip<=32 & bmi>28); for men if : (maxgrip<=29 & bmi<=24); (maxgrip<=30 & (bmi>=24.1 & bmi<=28)); (maxgrip<=32 & bmi>28)
Mobility	mobility	(mobility>=3)=1; (1>=mobility<3)=0.5 and mobility=0

Appendix B. Frailty at age 65

Table B.1. Mean frailty index at age 65

Sample	Gender	Mean Frailty	Sample	Gender	Mean Frailty
High Education	Females	0.126	Low Education	Females	0.165
	Males	0.095		Males	0.114
White Collar	Females	0.143	Blue Collar	Females	0.188
	Males	0.106		Males	0.133
OJI: Low	Females	0.148	OJI: High	Females	0.176
	Males	0.112		Males	0.128
OPI: Low	Females	0.147	OPI: High	Females	0.175
	Males	0.113		Males	0.129
OSI: Low	Females	0.146	OSI: High	Females	0.173
	Males	0.118		Males	0.122

Notes: OJI stands for overall job burden index, OPI for overall physical job burden index and OSI for overall psychosocial job burden index.

Appendix C. First Stages

Table C.1. Education Split

	(1)	(2)	(3)	(4)
Age	0.014***	0.008***	0.015***	0.009***
	(0.002)	(0.001)	(0.003)	(0.003)
Ret. Age	0.295***	0.272***	0.220***	0.192***
	(0.016)	(0.014)	(0.019)	(0.015)
Early Ret. Age	0.198***	0.162***	0.229***	0.239***
	(0.028)	(0.015)	(0.028)	(0.019)
Constant	-0.646***	-0.281***	-0.624***	-0.186
	(0.139)	(0.081)	(0.168)	(0.159)
Obs.	19,583	25,485	19,232	19,359
Ind.	6,750	8,601	6,707	6,606
Education	Low	High	Low	High
Gender	Female	Female	Male	Male

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations and Ind. for individuals. Ret. Age is a dummy variable that takes the value of one if the person has the same or is older than the statutory retirement age, zero otherwise; and Early Ret. Age takes the value of one if the person has the same or is older than the statutory early retirement age, zero otherwise.

Table C.2. Job Intensity Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.004***	0.003***	-0.000	0.000	0.003***	0.004***	0.000	0.000	0.004***	0.002***	0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Ret. Age	0.150***	0.234***	0.050***	0.061**	0.165***	0.221***	0.039***	0.070**	0.217***	0.183***	0.062***	0.048**
	(0.024)	(0.036)	(0.015)	(0.025)	(0.027)	(0.029)	(0.013)	(0.027)	(0.036)	(0.027)	(0.018)	(0.019)
Early Ret. Age	0.194***	0.162***	0.157***	0.138***	0.188***	0.166***	0.157***	0.139***	0.169***	0.179***	0.182***	0.115***
	(0.031)	(0.019)	(0.037)	(0.028)	(0.039)	(0.020)	(0.037)	(0.025)	(0.036)	(0.026)	(0.048)	(0.016)
Constant	0.309***	0.261***	0.787***	0.758***	0.378***	0.206***	0.787***	0.757***	0.202**	0.333***	0.741***	0.798***
	(0.071)	(0.062)	(0.035)	(0.035)	(0.067)	(0.063)	(0.034)	(0.032)	(0.077)	(0.062)	(0.047)	(0.030)
Obs.	3,501	3,885	3,270	3,361	3,439	3,961	3,463	3,182	2,925	4,461	3,460	3,171
Ind.	958	1,079	940	931	949	1,091	994	882	801	1,236	976	895
Burden	OJI	OJI	OJI	OJI	OPI	OPI	OPI	OPI	OSI	OSI	OSI	OSI
Level	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Gender	Female	Female	Male	Male	Female	Female	Male	Male	Female	Female	Male	Male

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations and Ind. for individuals. Ret. Age is a dummy variable that takes the value of one if the person has the same or is older than the statutory retirement age, zero otherwise; and Early Ret. Age takes the value of one if the person has the same or is older than the statutory early retirement age, zero otherwise.

Table C.3. Collar Split

	(1)	(2)	(3)	(4)
Age	0.002**	0.004***	0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Ret. Age	0.144***	0.265***	0.036***	0.073***
	(0.021)	(0.039)	(0.011)	(0.026)
Early Ret. Age	0.156***	0.139***	0.164***	0.153***
	(0.044)	(0.038)	(0.035)	(0.021)
Constant	0.492***	0.162*	0.760***	0.744***
	(0.065)	(0.080)	(0.037)	(0.028)
Obs.	3,442	3,864	4,174	4,379
Ind.	955	1,104	1,235	1,240
Sample	White Collar	Blue Collar	White Collar	Blue Collar
Gender	Female	Female	Male	Male

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations and Ind. for individuals. Ret. Age is a dummy variable that takes the value of one if the person has the same or is older than the statutory retirement age, zero otherwise; and Early Ret. Age takes the value of one if the person has the same or is older than the statutory early retirement age, zero otherwise.

Appendix D. Reduced Sample - Sample Split

Table D.1. Health Deficits and Retirement - Education Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.013***	0.014***	0.019***	0.019***	0.020***	0.023***	0.016***	0.019***	0.024***	0.021***	0.022***	0.030***
	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)
Retired		-0.023	-0.163**		-0.066**	-0.190***		-0.083***	-0.253***		-0.056*	-0.389***
		(0.029)	(0.072)		(0.026)	(0.056)		(0.023)	(0.091)		(0.033)	(0.078)
Constant	-3.174***	-3.215***	-3.469***	-3.255***	-3.318***	-3.436***	-3.655***	-3.790***	-4.066***	-3.748***	-3.801***	-4.111***
	(0.155)	(0.169)	(0.201)	(0.146)	(0.143)	(0.136)	(0.199)	(0.204)	(0.261)	(0.196)	(0.196)	(0.179)
Obs.	15,761	15,761	15,761	15,244	15,244	15,244	18,449	18,449	18,449	18,780	18,780	18,780
Ind.	5,473	5,473	5,473	5,227	5,227	5,227	6,466	6,466	6,466	6,416	6,416	6,416
Educ.	High	High	High	Low	Low	Low	High	High	High	Low	Low	Low
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	163.97	-	-	354.48	-	-	141.80	-	-	176.69
H-Test	-	-	0.091	-	-	0.212	-	-	0.173	-	-	0.530

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table D.2. Health Deficits and Retirement - Overall Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.025***	0.025***	0.025***	0.024***	0.025***	0.027***	0.033***	0.033***	0.035***	0.031***	0.032***	0.035***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Retired		-0.078	-0.129		-0.131	-0.628***		0.086	-0.708		-0.246	-1.015**
		(0.083)	(0.229)		(0.100)	(0.233)		(0.136)	(0.708)		(0.151)	(0.407)
Constant	-3.702***	-3.661***	-3.634***	-3.542***	-3.461***	-3.154***	-4.728***	-4.795***	-4.175***	-4.371***	-4.203***	-3.677***
	(0.240)	(0.237)	(0.249)	(0.248)	(0.242)	(0.291)	(0.271)	(0.291)	(0.674)	(0.303)	(0.324)	(0.380)
Observations	2,450	2,450	2,450	2,323	2,323	2,323	3,092	3,092	3,092	3,259	3,259	3,259
Individuals	667	667	667	642	642	642	893	893	893	903	903	903
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	41.24	-	-	25.23	-	-	4.14	-	-	7.42
H-Test	-	-	0.209	-	-	0.520	-	-	0.849	-	-	0.746

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, E. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table D.3. Health Deficits and Retirement - Physical Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.027***	0.028***	0.023***	0.023***	0.025***	0.034***	0.034***	0.036***	0.030***	0.031***	0.034***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
Retired		-0.087	-0.261		-0.118	-0.479**		0.065	-0.640		-0.237*	-1.039**
		(0.094)	(0.234)		(0.098)	(0.204)		(0.145)	(0.691)		(0.132)	(0.426)
Constant	-3.816***	-3.768***	-3.672***	-3.415***	-3.346***	-3.132***	-4.799***	-4.851***	-4.292***	-4.278***	-4.121***	-3.586***
	(0.267)	(0.260)	(0.270)	(0.200)	(0.198)	(0.244)	(0.312)	(0.332)	(0.646)	(0.272)	(0.295)	(0.396)
Obs.	2,493	2,493	2,493	2,294	2,294	2,294	3,290	3,290	3,290	3,075	3,075	3,075
Ind.	682	682	682	630	630	630	947	947	947	854	854	854
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	28.91	-	-	25.41	-	-	3.88	-	-	9.90
H-Test	-	-	0.133	-	-	0.863	-	-	0.615	-	-	0.875

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, E. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table D.4. Health Deficits and Retirement - Psychosocial Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.024***	0.024***	0.026***	0.025***	0.025***	0.027***	0.033***	0.033***	0.034***	0.031***	0.032***	0.037***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Retired		-0.079	-0.264		-0.124	-0.446		-0.013	-0.399		-0.288**	-1.989***
		(0.092)	(0.195)		(0.087)	(0.275)		(0.123)	(0.401)		(0.114)	(0.707)
Constant	-3.646***	-3.610***	-3.526***	-3.608***	-3.528***	-3.320***	-4.621***	-4.612***	-4.350***	-4.456***	-4.230***	-2.894***
	(0.182)	(0.190)	(0.209)	(0.260)	(0.265)	(0.299)	(0.278)	(0.290)	(0.370)	(0.313)	(0.303)	(0.620)
Obs.	1,930	1,930	1,930	2,843	2,843	2,843	3,325	3,325	3,325	3,026	3,026	3,026
Ind.	528	528	528	781	781	781	939	939	939	857	857	857
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	38.86	-	-	52.89	-	-	6.77	-	-	7.66
H-Test	-	-	0.233	-	-	0.393	-	-	0.347	-	-	0.423

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table D.5. Health Deficits and Retirement - White/Blue Collar Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.027***	0.027***	0.028***	0.027***	0.028***	0.028***	0.037***	0.037***	0.040***	0.034***	0.035***	0.040***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Retired		-0.022	-0.469		-0.266***	-0.243		-0.002	-1.076*		-0.187**	-1.236***
		(0.110)	(0.438)		(0.080)	(0.191)		(0.142)	(0.569)		(0.073)	(0.380)
Constant	-3.873***	-3.856***	-3.519***	-3.666***	-3.516***	-3.528***	-5.044***	-5.042***	-4.186***	-4.599***	-4.476***	-3.783***
	(0.230)	(0.224)	(0.412)	(0.244)	(0.244)	(0.236)	(0.240)	(0.268)	(0.513)	(0.275)	(0.267)	(0.372)
Obs.	2,606	2,606	2,606	2,028	2,028	2,028	3,972	3,972	3,972	4,219	4,219	4,219
Ind.	706	706	706	586	586	586	1,175	1,175	1,175	1,195	1,195	1,195
Collar	White	White	White	Blue	Blue	Blue	White	White	White	Blue	Blue	Blue
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	4.37	-	-	16.39	-	-	6.15	-	-	16.85
H-Test	-	-	0.011	-	-	0.030	-	-	0.552	-	-	0.560

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

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Table E.1. Health Deficits and Retirement - Overall Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.025***	0.025***	0.027***	0.022***	0.023***	0.027***	0.035***	0.035***	0.037***	0.033***	0.034***	0.038***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Retired		0.006	-0.102		-0.077**	-0.346***		0.004	-0.612		-0.184***	-1.118***
		(0.063)	(0.143)		(0.033)	(0.116)		(0.154)	(0.400)		(0.051)	(0.333)
Constant	-3.795***	-3.795***	-3.787***	-3.324***	-3.340***	-3.398***	-4.893***	-4.896***	-4.462***	-4.514***	-4.401***	-3.825***
	(0.192)	(0.193)	(0.186)	(0.151)	(0.146)	(0.140)	(0.222)	(0.260)	(0.376)	(0.249)	(0.231)	(0.309)
Obs.	4,530	4,530	4,530	6,214	6,214	6,214	4,640	4,640	4,640	4,933	4,933	4,933
Ind.	1,276	1,276	1,276	1,770	1,770	1,770	1,372	1,372	1,372	1,385	1,385	1,385
Sample	Low Burden	Low Burden	Low Burden	High Burden	High Burden	High Burden	Low Burden	Low Burden	Low Burden	High Burden	High Burden	High Burden
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
Method	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV	FE	FE	FE-IV
F-test	-	-	36.86	-	-	128.24	-	-	11.90	-	-	58.76
H-Test	-	-	0.764	-	-	0.360	-	-	0.720-	-	0.428	

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table E.2. Health Deficits and Retirement - Psychosocial Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.025***	0.025***	0.025***	0.022***	0.023***	0.028***	0.037***	0.038***	0.041***	0.030***	0.030***	0.034***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Retired		-0.038	0.024		-0.058	-0.427***		-0.203	-0.734***		0.026	-1.026***
		(0.047)	(0.101)		(0.046)	(0.131)		(0.131)	(0.260)		(0.056)	(0.355)
Constant	-3.691***	-3.694***	-3.690***	-3.419***	-3.425***	-3.464***	-4.959***	-4.827***	-4.480***	-4.379***	-4.396***	-3.697***
	(0.142)	(0.143)	(0.144)	(0.178)	(0.173)	(0.161)	(0.222)	(0.242)	(0.231)	(0.266)	(0.253)	(0.327)
Obs.	4,006	4,006	4,006	6,738	6,738	6,738	5,299	5,299	5,299	4,274	4,274	4,274
Ind.	1,113	1,113	1,113	1,933	1,933	1,933	1,546	1,546	1,546	1,211	1,211	1,211
Sample	Low Burden	Low Burden	Low Burden	High Burden	High Burden	High Burden	Low Burden	Low Burden	Low Burden	High Burden	High Burden	High Burden
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	55.29	-	-	76.70	-	-	16.69	-	-	32.44
H-Test	-	-	0.617	-	-	0.327	-	-	0.897	-	-	0.653

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Appendix F. Retirement as an Interaction

Table F.1. Health Deficits and Retirement - Education Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.015***	0.016***	0.022***	0.019***	0.020***	0.025***	0.016***	0.019***	0.024***	0.021***	0.023***	0.035***
	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)	(0.003)	(0.005)
Age * Retired		-0.000	-0.002**		-0.000	-0.003**		-0.001**	-0.003		-0.001	-0.006***
		(0.000)	(0.001)		(0.000)	(0.001)		(0.000)	(0.002)		(0.001)	(0.001)
Constant	-3.256***	-3.298***	-3.601***	-3.231***	-3.274***	-3.517***	-3.683***	-3.801***	-4.065***	-3.758***	-3.839***	-4.415***
	(0.139)	(0.159)	(0.222)	(0.135)	(0.135)	(0.165)	(0.188)	(0.204)	(0.333)	(0.196)	(0.209)	(0.245)
Obs.	19,583	19,583	19,583	25,485	25,485	25,485	19,232	19,232	19,232	19,359	19,359	19,359
Ind.	6,750	6,750	6,750	8,601	8,601	8,601	6,707	6,707	6,707	6,606	6,606	6,606
Educ	High	High	High	Low	Low	Low	High	High	High	Low	Low	Low
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	239.54	-	-	245.94	-	-	135.97	-	-	190.82
H-Test	-	-	0.619	-	-	0.072	-	-	0.156	-	-	0.174

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table F.2. Health Deficits and Retirement - Overall Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.024***	0.024***	0.024***	0.023***	0.024***	0.033***	0.032***	0.031***	0.041***	0.030***	0.035***	0.051***
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)	(0.009)	(0.004)	(0.005)	(0.010)
Age * Retired		-0.000	0.000		-0.001	-0.006**		0.001	-0.007		-0.004*	-0.016***
		(0.001)	(0.002)		(0.001)	(0.003)		(0.002)	(0.007)		(0.002)	(0.006)
Constant	-3.696***	-3.700***	-3.689***	-3.418***	-3.451***	-3.796***	-4.644***	-4.634***	-4.772***	-4.318***	-4.392***	-4.659***
	(0.182)	(0.191)	(0.254)	(0.202)	(0.200)	(0.208)	(0.251)	(0.259)	(0.267)	(0.297)	(0.295)	(0.352)
Obs.	3,501	3,501	3,501	3,885	3,885	3,885	3,270	3,270	3,270	3,361	3,361	3,361
Ind.	958	958	958	1,079	1,079	1,079	940	940	940	931	931	931
Sample	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	49.16	-	-	30.98	-	-	10.70	-	-	9.96
H-Test	-	-	0.285	-	-	0.040	-	-	0.784	-	-	0.879

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table F.3. Health Deficits and Retirement - Physical Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.024***	0.029***	0.022***	0.023***	0.030***	0.033***	0.032***	0.041***	0.029***	0.034***	0.050***
	(0.003)	(0.004)	(0.006)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.009)	(0.004)	(0.004)	(0.009)
Age * Retired		0.001	-0.002		-0.001	-0.005**		0.001	-0.006		-0.004**	-0.016***
		(0.001)	(0.003)		(0.001)	(0.002)		(0.002)	(0.007)		(0.001)	(0.006)
Constant	-3.791***	-3.750***	-3.907***	-3.342***	-3.406***	-3.645***	-4.709***	-4.693***	-4.814***	-4.234***	-4.319***	-4.596***
	(0.234)	(0.233)	(0.269)	(0.174)	(0.183)	(0.179)	(0.293)	(0.299)	(0.321)	(0.265)	(0.262)	(0.307)
Obs.	3,439	3,439	3,439	3,961	3,961	3,961	3,463	3,463	3,463	3,182	3,182	3,182
Ind.	949	949	949	1,091	1,091	1,091	994	994	994	882	882	882
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	37.47	-	-	40.91	-	-	9.00	-	-	13.02
H-Test	-	-	0.501	-	-	0.053	-	-	0.526	-	-	0.453

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table F.4. Health Deficits and Retirement - Psychosocial Job Burden Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.023***	0.024***	0.026***	0.024***	0.024***	0.033***	0.032***	0.033***	0.038***	0.030***	0.034***	0.057***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)	(0.009)	(0.004)	(0.005)	(0.011)
Age * Retired		-0.000	-0.002		-0.000	-0.006*		-0.000	-0.005		-0.003**	-0.023***
		(0.001)	(0.002)		(0.001)	(0.003)		(0.002)	(0.006)		(0.001)	(0.008)
Constant	-3.603***	-3.630***	-3.726***	-3.513***	-3.531***	-3.825***	-4.592***	-4.600***	-4.696***	-4.352***	-4.411***	-4.754***
	(0.140)	(0.138)	(0.193)	(0.216)	(0.213)	(0.228)	(0.266)	(0.273)	(0.307)	(0.297)	(0.304)	(0.346)
Obs.	2,925	2,925	2,925	4,461	4,461	4,461	3,460	3,460	3,460	3,171	3,171	3,171
Ind.	801	801	801	1,236	1,236	1,236	976	976	976	895	895	895
Burden	Low	Low	Low	High	High	High	Low	Low	Low	High	High	High
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	32.06	-	-	36.99	-	-	9.52	-	-	19.66
H-Test	-	-	0.568	-	-	0.109	-	-	0.525	-	-	0.566

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).

Table F.5. Health Deficits and Retirement - White/Blue Collar Split

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Age	0.026***	0.026***	0.038***	0.023***	0.026***	0.031***	0.036***	0.035***	0.049***	0.034***	0.038***	0.057***
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.009)	(0.004)	(0.004)	(0.008)
Age * Retired		-0.000	-0.008***		-0.001**	-0.005**		0.001	-0.011*		-0.003***	-0.018***
		(0.001)	(0.003)		(0.001)	(0.002)		(0.003)	(0.007)		(0.001)	(0.005)
Constant	-3.829***	-3.838***	-4.160***	-3.369***	-3.461***	-3.652***	-4.996***	-4.974***	-5.177***	-4.553***	-4.620***	-4.958***
	(0.199)	(0.206)	(0.229)	(0.175)	(0.182)	(0.234)	(0.225)	(0.228)	(0.253)	(0.272)	(0.272)	(0.282)
Obs.	3,442	3,442	3,442	3,864	3,864	3,864	4,174	4,174	4,174	4,379	4,379	4,379
Ind.	955	955	955	1,104	1,104	1,104	1,235	1,235	1,235	1,240	1,240	1,240
Collar	White	White	White	Blue	Blue	Blue	White	White	White	Blue	Blue	Blue
Gender	Female	Female	Female	Female	Female	Female	Male	Male	Male	Male	Male	Male
F-test	-	-	44.47	-	-	76.02	-	-	12.76	-	-	44.40
H-Test	-	-	0.407	-	-	0.984	-	-	0.299	-	-	0.753

Notes: standard errors are clustered at the year-of-birth level. One asterisk indicates significance at the 10-percent level, two asterisks indicate significance at the 5-percent level, and three asterisks indicate significance at the 1-percent level. The dependent variable is the log of the health deficit index. FE stands for fixed effects and IV for instrumental variables regression, Obs. for observations, Ind. for individuals, Educ. for education, F-test is the Kleinbergen Paap rk Wald F statistic and H-test for Hansen test (P-value).