RETIRED, AT LAST?

THE ROLE OF RETIREMENT ON HEALTH STATUS IN FRANCE

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Abstract: Reforms of the French *pay-as-you-go* pension system relies on increases in the contribution period, gradually postponing legal retirement ages. Several works analyse the effect of these reforms on employment rate or the financial equilibrium of pension scheme. The effect of transitioning into retirement on health status has not received the same attention. In order to assess the role of retirement on physical and mental health status, we use data coming from the French Health and Professional Route survey (Sip, "Santé et itinéraire professionnel") and address the methodological issues (endogeneity biases such as reverse causality and unobserved characteristics) by setting up an instrumental variables method relying on discontinuities induced by legal ages of retirement. Unaccounting for endogeneity biases, we do not find any significant effect of retirement on health status as a whole. When instrumenting by legal ages of retirement, we find consistent and large effects on activity limitations, anxiety disorders and depressive episodes. We also find that these effects are heterogeneous according to gender, education levels and past exposures to detrimental working conditions during the entire career. Finally, mechanisms such as social activities, sport and health-related risky behaviours may be able to explain such a positive effect on health status.

JEL: I14, J26, C35, C36

Keywords: Retirement; Physical health; Mental health; Mechanisms; Instrumental variables

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Introduction

Traditional structural reforms for a *pay-as-you go* pension system in deficit rely on lower pensions, higher contributions or increases in retirement age. The latter was favoured by the indirect means of increases in the contribution period required to obtain a full rate pension (Balladur 1993 and Fillon 2003 reforms) or by the direct increase in the legal age of retirement (Fillon 2010 reform) including a gradual transition from 60 to 62. However, the issue of funding pensions occults other specifics of the pension system that may play a role on health status and ultimately on the finances of the health insurance branch and the management of long-term care. Exposure to harsh working conditions and the impact of ill health on the employment of older workers, notably, are already well documented in France.

The effect of transitioning into retirement has not received the same attention in the French economic literature (besides Blake and Garrouste, 2012). Retirement in France mostly remains an absorbing state (relatively few employment situations of individuals cumulating retirement benefits and paid jobs). It can thus be seen in many cases as an irreversible shock. The sharp transition into retirement can often affect perceived health status, but the nature of the causal relationship between retirement and health can also be bidirectional due to retirement endogeneity.

Before retirement, health status already appears as one of the most important non-monetary drivers in the trade-off between work and leisure in older workers (Barnay, 2016; Lindeboom, 2006). Although the nature of the relationship between health and employment appears obvious, studying causal impacts is complex (Strauss and Thomas, 1998). The retirement decision may free individuals from a job strain situation. By examining the relationship between work and health, the first can indeed be beneficial to the latter, but the arduous nature of certain working conditions may also deteriorate health.

The retirement decision is indeed partly motivated by health status, healthier individuals tending to remain in employment. In contrast, a poor health condition reduces labour supply and causes early exit from the labour market. Many studies have highlighted the existence of a *healthy worker effect* testifying of the selection on the labour market of the most resilient workers. A poor health status may speed up the retirement decision (Alavinia and Burdorf, 2008; Jones *et al.*, 2010): notably, Dwyer and Mitchell (1999) show that sick workers can advance from one or two years their plan to retire. From ECHP (European Community Household Panel), García-Gómez (2011) studies the effect of a health shock on employment

in nine European countries. The results obtained from a matching method suggest that health shocks have a negative causal effect on the probability of being employed. People with health problems are more likely to leave employment and transit to situations of disability.

Moreover, it is difficult to isolate the health-related effects of retirement from those of the natural deterioration rate related to ageing, and many unobservable individual characteristics are also able to explain not only the retirement decision behaviours, but also health status indicators (subjective life expectancy, risk aversion behaviours or the labour supply disutility). Finally retirement, considered as non-employment may be the cause of a feeling of social utility loss which can lead to declining cognitive functions and a loss in self-esteem.

In this paper, we study the role of retirement on several physical and mental health status indicators. In order to take care of the inherent endogeneity biases, we set up an instrumental variable approach relying on discontinuities in the probability to retire generated by legal incentives at certain ages as a source of heterogeneity. Thanks to the Health and Professional Path survey (*Santé et Itinéraire Professionnel* – Sip) dataset, we are able to control for a variety of covariates, including exposures to detrimental working conditions throughout the whole career. We also acknowledge the likely heterogeneity of the effect of retirement and the possible mechanisms explaining its effects on health status. To our knowledge, no study evaluates the effect of the retirement decision on the physical and mental health conditions of retirees, after taking into account biases associated with this relationship as well as exposures to working conditions and the nature of the entire professional career.

The paper is organized as follows. Section 1 is dedicated to an empirical literature review of relationships between retirement and health status. Section 2 and Section 3 then describes the database, Section 4 describes the empirical strategy. Section 5 then presents the results and Section 6 concludes.

1. Background and literature

French retirees have a rather advantageous relative position compared with other similar countries. The retirement age is comparatively lower (62 years while the standard is 65 in most other countries like Japan, Sweden, the U.K., the U.S. or Germany). The share of public expenditures devoted to the pension system is 14%, with only Italy devoting a superior part of its wealth. The net replacement rate is 68%, which places it among the most generous countries with Italy and Sweden. In contrast, the Anglo-Saxon countries relying on funded schemes have lower replacement rates and the share of individual savings in retirement is

much higher than in countries where pension systems are of the pay-as-you go type. This position is convergent when considering life expectancy indicators at 65 or poverty levels. The life expectancy of a 65 year-old or more French countryman is systematically higher than the one observed in other countries (except for Japanese women, who can expect to live 24 years compared to 23.6 years in France). The poverty rate among the elderly is the lowest among all the countries mentioned here (3.8% in France compared to 12.6% on average for the OECD).

Even though the issue of the links between health and work has many microeconomic and macroeconomic implications, the French economic literature is still relatively scarce compared to the number of international studies on the subject (Barnay, 2016). The deterioration of health status contributes first to change the preferences for leisure and decreases individuals' work capacity or productivity. The Grossman (1972, 2000) model indicates that each individual has a health capital that depreciates with age. Any health event affects the career path *via* the potential stock effects (instant exogenous shock) and the depreciation rate of this health capital but also, more generally, on future investments in human capital (primary or secondary prevention actions in health). Disease can lead individuals to include a reallocation of time spent between work and leisure times. Alteration of the health condition therefore reduces the labour supply. Conversely, poor working and employment conditions can affect health status and generate costs for the company (related to absenteeism). Stressful work situations can also generate an increase in healthcare consumptions and the number of daily allowances for illness.

The specific relationship between non-employment and health has received very little attention in France unlike in Europe (Barnay, 2016). In general, job loss is associated with a deterioration of well-being. Persistent unemployment and recurrent forms of non-employment have a deleterious effect on health, for example overweight and alcohol consumption (Deb *et al.*, 2011). Unemployment and inactivity, happening early in the professional life, can promote the onset of depressive symptoms thereafter, as shown by Mossakowski in 2009 on U.S. longitudinal data. Furthermore, job loss increases mortality (Sullivan and Wachter, 2009). Finally, many studies agree on a negative effect of unemployment on health (Böckerman and Ilmakunnas, 2009; Browning and Heinesen, 2012; Eliason and Storrie, 2009a, 2009b; Kalwij and Vermeulen, 2008).

The effects of retirement on health status are not trivial. Two competing hypotheses can be advanced. Retirement can first free individuals from job strain situations and may improve

their health condition in the short run. This virtuous circle will be sustainable provided that individuals have a capacity to invest in their health (income effect). Many international empirical studies show that retirement is beneficial to health status (Blake and Garrouste, 2012; Charles, 2002; Coe and Zamarro, 2011; Grip *et al.*, 2012; Insler, 2014; Neuman, 2008). Coe and Zamarro (2011) measure the health effect of retirement and conclude that it decreases the likelihood of reporting poor perceived health (35%) after controlling for reverse causality. However, this effect is not observed with the two depression indicators. In the U.K., Bound and Waidmann (2007) found a positive but transitory health effect of retirement, only in men. The retirement decision can also generate a loss of social role (Kim and Moen, 2002), a reduction of social capital and therefore a deterioration in mental health, strengthened in the case of a negative impact on the living standards. Other studies also reach opposite results including mental health (cognitive abilities) (Behncke, 2012; Bonsang *et al.*, 2012; Dave *et al.*, 2008; Mazzonna and Peracchi, 2009; Rohwedder and Willis, 2010). Overall, the positive effect of retirement on health status seems to prevail, except for cognitive abilities.

To our knowledge, only very few studies tried to work out the effect of transitioning into retirement on health in France and show that retirement decision improves physical health for non-qualified people.

2. Data

The *Santé et Itinéraire Professionnel* survey (Sip) used in this study provides access to particularly detailed individual descriptions. Besides the usual socioeconomic variables (age, sex, activity sector, professional category, educational level, marital status), specific items are provided about physical and mental health. The survey was designed jointly by the French Ministries in charge of Healthcare and Labour and includes two waves (2006 and 2010), conducted on the same sample of people aged 20-74 years living in private households in metropolitan France. The 2010 wave was granted with an extension to better assess psychosocial risk factors. Two questionnaires are available: the first one is administered by an interviewer and accurately informs the individual and job characteristics and the current health status of the respondents. It also contains a biographical lifegrid to reconstruct individual careers and life events: childhood, education, health, career changes, working conditions and significant life events. The second one is a self-administered questionnaire targeting risky health behaviours (weight, cigarette and alcohol consumption). It notably

informs the current or past tobacco and alcohol consumption (frequency, duration, *etc.*). A total of 13,648 people were interviewed in 2006, and 11,016 of them again in 2010.

We make use of the biographic dimension of the 2006 survey by reconstructing workers' careers yearly. We are therefore able to know, for each individual, his/her employment status and working conditions every year from their childhood to the date of the survey (2006). As far as work strains are concerned, the survey provides information about ten indicators of exposure: night work, repetitive work, physical load and exposure to toxic materials, full skill usage, work under pressure, tensions with the public, reward, conciliation between work and family life and relationships with colleagues. The intensity of exposure to these work strains is also known.

In our sample, we only retain individuals present in both the 2006 and 2010 waves, *i.e.* 11,016 individuals. In order to avoid too heterogeneous samples, we select individuals aged 50-69 in 2010 for whom we benefit from all the information needed in terms of pension and health status. Thus, we work on a sample of 4,610 individuals. 2,071 of them are retired.

3. Descriptive statistics

The general descriptive statistics on the 50-69 year-old sample are available in Table 1. First four columns grant information about the whole sample, fifth column (N) gives the number of individuals belonging to the category in row and last three columns respectively give the average in the retired or non-retired populations and the significance of the difference between the two.

The most important element to notice in these simple descriptive statistics is that retirees apparently systematically self-report a worse general health condition and a better mental health status than non-retirees. Obviously these raw statistics do not account for other characteristics, notably the 8-year difference in age between the two populations. Yet, 38% of the retired population declare poor levels of self-assessed health against 36% in the non-retired population, 50% a chronic disease (against 40%) and 26% being limited in daily activities *(vs.* 24%). These findings are not quite similar for mental health indicators, which indicate that the retired population suffers from less anxiety disorders (5%) and depressive episodes (6%) than the control group *(resp.* 8% and 9%). Exposure to harsh physical and psychosocial working conditions is much higher among retirees than among non-retirees as it is likely that the last years of professional life are marked by greater exposures. Finally, retirees are more prone to having social activities such as associations, unions, religious or

artistic activities (48% *vs.* 38%), have more physical activities (45% *vs.* 40%), are less often smokers (16% *vs.* 27%, most likely at least partly indicating a selection effect, the most heavy smokers having a shorter life expectancy) but are more overweight (60% *vs.* 52%) than the rest of the population.

Table 1: General descriptive statistics

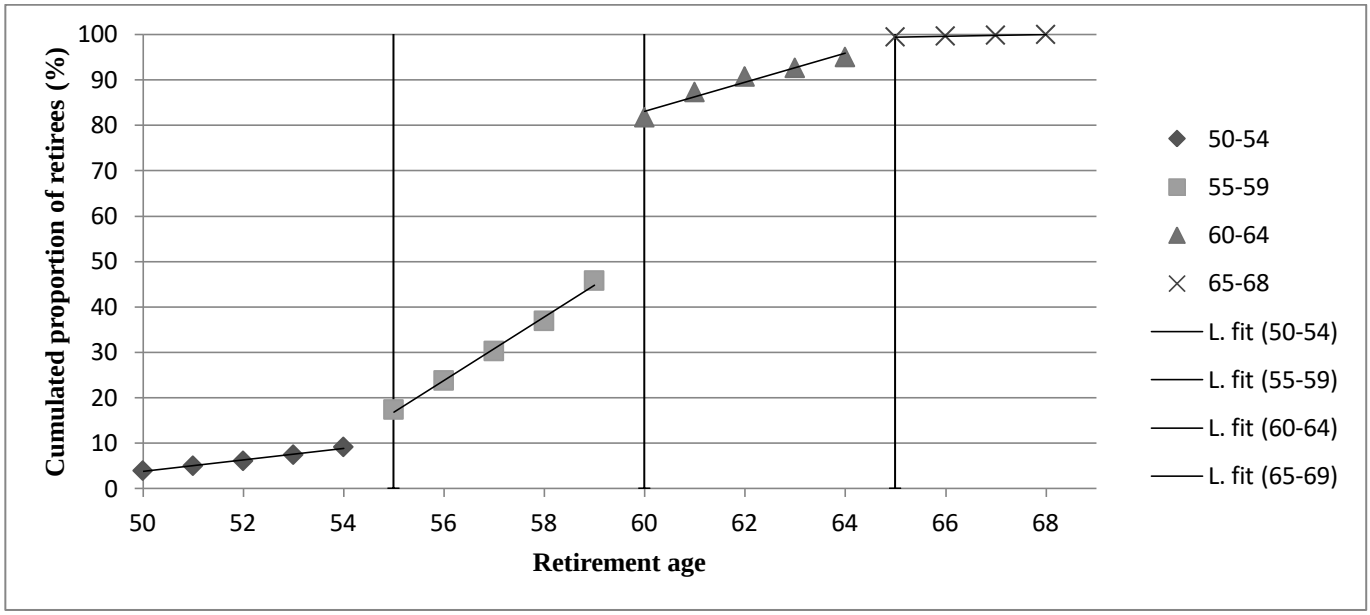
Variable	Mean	Std. error	Min.	Max.	N	Mean Retirees	Mean non-retirees	Diff.
Retirement								
Retired	.42	*.49*	0	1	2071	-	-	-
Aged 55 or more	.74	*.44*	0	1	3629	.98	.55	-.44***
Aged 60 or more	.45	*.50*	0	1	2235	.90	.13	-.77***
Aged 65 or more	.18	*.38*	0	1	876	.40	.01	-.39***
Health status								
Poor perceived health	.37	*.48*	0	1	1802	.38	.36	-.02*
Chronic diseases	.45	*.50*	0	1	2200	.50	.40	-.10***
Activity limitations	.25	*.43*	0	1	1219	.26	.24	-.02*
Anxiety disorder	.07	*.25*	0	1	321	.05	.08	.02***
Depressive episode	.08	*.27*	0	1	380	.06	.09	.03***
Demographics								
Men	.46	*.50*	0	1	2254	.51	.42	-.08***
Age	58.79	*.40*	50	69	4932	63.47	55.40	-8.06***
No education	.09	*.28*	0	1	421	.08	.09	.01
Primary/secondary	.56	*.50*	0	1	2782	.62	.52	-.09***
Equivalent to French BAC	.14	*.34*	0	1	679	.12	.15	.04***
Superior	.19	*.40*	0	1	957	.17	.21	.04***
One or more children	.91	*.29*	0	1	4466	.91	.90	-.01
Employment								
Public sector	.18	*.39*	0	1	898	.12	.23	.11***
Private sector	.36	*.48*	0	1	1772	.20	.47	.26***
Self-employed	.07	*.26*	0	1	348	.04	.10	.06***
Career in long-term jobs	.79	*.41*	0	1	3881	.84	.75	-.10***
Stable career	.59	*.49*	0	1	2887	.53	.62	.10***
Poor physical working cond.	.22	*.41*	0	1	1010	.29	.17	-.12***
Poor psychosocial working cond.	.16	*.37*	0	1	731	.20	.13	-.07***
Mechanisms								
Daily social activities	.42	*.49*	0	1	2088	.48	.38	-.10***
Sport	.42	*.49*	0	1	2063	.45	.40	-.05***
Tobacco consumption	.22	*.42*	0	1	1034	.16	.27	.11***
Risky alcohol consumption	.24	*.42*	0	1	1085	.25	.23	-.02
Overweight	.56	*.50*	0	1	2540	.60	.52	-.09***

Note: ****: significant at 1%, **: significant at 5%, *: significant at 10%.*
Reading: *Retirees are 38% to report poor perceived health and 36% of non-retirees are in good perceived health. This difference of -2 percentage points is significant at the 10% level.*
Field: *Santé et Itinéraire Professionnel survey, individuals aged 50-69 in 2010.*

Figure I shows the evolution of the proportion of retirees in the sample, depending on age. Each point represents the proportion of retirees in the sample at a given age (starting from less than 5% of retirees at age 50 to 100% at age 69). Each 5-year category from age 50 to 69 has been considered and fitted separately in order to identify eventual discontinuities in the growth of the proportion at specific ages. As expected for the French case, three retirement

ages seem to emerge as the most common, hence being the most effective cut points: age 55, 65 but mostly age 60, which corresponds to the legal threshold for full-rate pension. Thus, when the proportion of pensioners is only of about 45% of the sample's total at age 59, it amounts to more than 80% of the total number only a year later. Similar graphs specifically for men and women are available in Appendix 1 (Figure III and Figure IV).

Figure I: Proportion of retirees in the sample according to age



Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

4. Empirical strategy

4.1. Biases

As evidenced in the literature, determining the effect of the retirement decision on retirees' health condition is not trivial. In fact, besides taking into account the natural deterioration rate of the *health capital* related to ageing, estimates are subject to biases due to the endogeneity of the relationship between health status and retirement. Thus, two major sources of endogeneity may be raised. The first is the existing two-way relationship between retirement and health status. In particular, the decision to retire taken by individuals depends on their initial health condition, leading to a health-related selection bias. The second is the unobserved factors influencing not only health status but also retirement. To the extent that individuals have different characteristics, notably in terms of subjective life expectancy, risk aversion preferences or disutility at work, then the estimates are at risk of being biased.

4.2. Identifying variables approach

4.2.1. Advantages

To address these methodological difficulties, we set up an identifying variable method, the objective being to determine the causal effect of retirement decision on retirees' health condition. The identification strategy of this method relies on the use of legal norms following which individuals undergo a change (decision to retire) or not, norms therefore regarded as sources of exogeneity (Coe and Zamarro, 2011). The general idea of this method lies in the exploitation of discontinuities in the allocation of a *treatment* (the retirement decision) related to laws granting incentives to retire at a certain age. To the extent that a full rate legal retirement age in France exists (60 years-old for this study, before the implementation of the Fillon reform in 2010), we use this indicator as the identifying variable for the retirement process. However, it is noteworthy that age, and more importantly reaching a certain age, is not the only element predicting the retirement decision. Using a minimum age as a source of exogeneneity, the instrumental variable method is relatively close to a Regression Discontinuity Design method (RDD) on panel data, the major difference between instrumental variables and RDD being that it is possible with the latter to establish different trends before and after reaching the threshold, which is not possible with a conventional instrumental variables method (Eibich, 2015). Nevertheless, instrumental variables allow greater flexibility in estimations and do not focus exclusively on very short-term effects of retirement on health.

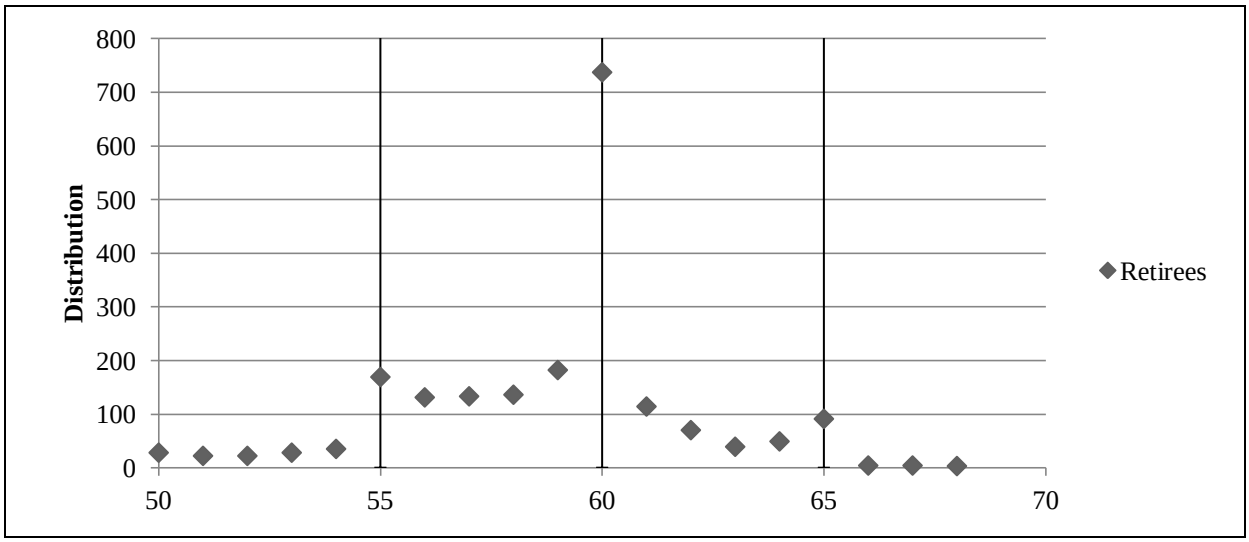
4.2.2. Hypotheses

The use of instrumental variable methods is based on two assumptions widely discussed in the literature. The first, called the relevance assumption induces that the identifying variable is correlated with the endogenous variable. In our case, the identifying variable being the legal age of retirement at full rate, it appears intrinsically relevant to explain the decision to retire. The second, called the validity assumption, assumes that the identifying variable is not correlated with the error term. To the extent that the legal age of retirement is decided at the level of the state and is not conditioned by health status, this hypothesis, although not directly testable, does not appear as particularly worrying especially considering this empirical strategy is very widely used in the literature. It is also to be noted that reaching a certain particular age (for instance age 60) should not specifically generate a discontinuity in the age-related health status degradation trend.

4.2.3. Identifying variables

We consider, in the French context, three possible significant ages of retirement suggested by the legislation and by the data itself: age 55, 60 and 65. 55 is the first significant age inducing early retirements. Before the Fillon 2010 reform, age 60 is the legal age for a full pension and has the greatest discontinuity in the number of retirees. Finally, we also test age 65 to account for late retirement decisions. As evidenced in Figure II below, 37% of retirees have done so precisely at age 60, 9% at 55 and 5% at age 65. Note that, for the rest of the paper, only the fact of being aged 60 and older will be used as an identifying variable except in some specific robustness checks.

Figure II: Distribution of retirement ages



Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

4.3. Estimation

We consider first a simple specification relying on a binomial probit model, explaining health status in 2010 (vector $y_{k,i}$, for health indicator k and individual i) by the self-declared retirement status (R_i), controlling the model by a vector of other explanatory variables (C_i'):

$$y_{k,i}^{*} = \alpha + \beta R_i + \gamma C_i' + \varepsilon_i$$
$$y_{k,i} = \begin{cases} 1 \; if \; y_{k,i}^{*} > 0 \\ 0 \; if \; y_{k,i}^{*} \leq 0 \end{cases} \quad (1)$$

However, for the reasons mentioned above, this specification (1) does not appear satisfying enough to determine a causal effect of retirement on health status. This relationship is characterised by endogeneity biases related to reverse causality and unobserved heterogeneity. Formally, our identification strategy is then based on the fact that, even if achieving or

exceeding a certain age $\overline{Age}$ does not fully determine the retirement status, it causes a discontinuity in the probability of being retired at a certain age. Therefore, in order to exploit this discontinuity, we also estimate the following equation (2):

$$R_i^* = \alpha' + \theta\, \mathbf{1}_{(Age_i \geq \overline{Age})} + \gamma' C_i' + \varepsilon_i' \qquad (2)$$

$$R_i = \begin{cases} 1 \; if \; R_i^* > 0 \\ 0 \; if \; R_i^* \leq 0 \end{cases}$$

The dummy variable $\mathbf{1}_{(Age_i \geq \overline{Age})}$ takes the value 1 when individual i is at least $\overline{Age}$ years-old. Consequently, we estimate simultaneously a system of two equations (3):

$$\begin{cases} y_{i,k}^* = \alpha + \beta R_i + \gamma C_i' + \varepsilon_i \\ R_i^* = \alpha' + \theta\, \mathbf{1}_{(Age_i \geq \overline{Age})} + \gamma' C_i' + \varepsilon_i' \end{cases} \qquad (3)$$

$$y_{i,k} = \begin{cases} 1 \; if \; y_{i,k}^* > 0 \\ 0 \; if \; y_{i,k}^* \leq 0 \end{cases} \qquad R_i = \begin{cases} 1 \; if \; R_i^* > 0 \\ 0 \; if \; R_i^* \leq 0 \end{cases}$$

Empirically, to estimate this simultaneous two-equation system, we set up a bivariate probit model, estimated by maximum likelihood. The use of such models is justified by the fact that both explained and explanatory variables are binary indicators (Lollivier, 2006). This method is equivalent to conventional two-stage methods in a linear case.

$$\begin{cases} y_{i,k}^* = \alpha + \beta R_i + \gamma C_i' + \varepsilon_i \\ R_i^* = \alpha' + \theta\, Ident_i' + \gamma' C_i' + \varepsilon_i' \end{cases} \qquad (4)$$

$$y_{i,k} = \begin{cases} 1 \; if \; y_{i,k}^* > 0 \\ 0 \; if \; y_{i,k}^* \leq 0 \end{cases} \qquad R_i = \begin{cases} 1 \; if \; R_i^* > 0 \\ 0 \; if \; R_i^* \leq 0 \end{cases}$$

We simultaneously explain the probability of being retired and health status. We introduce the vector $Ident_i'$ representing the identifying variables allowing the model's identification (4). These variables take the form of dummies, taking value 1 if individual i is at least $\overline{Age}$ years-old and 0 otherwise, the threshold depending on the legal retirement age considered. Taking the example of the full-rate age of retirement (60), the corresponding identifying variable will take value 1 if individual i is aged 60 or over, and 0 otherwise (other thresholds 55 and 65 are determined in the same manner). Bivariate probit models also assume the correlation between residuals ε_i and $\varepsilon_i^{'}$, *i.e.* $\rho = Corr(\varepsilon_i, \varepsilon_i' | C_i') \neq 0$. In addition, residuals of this model are expected to follow a bi-normal distribution[3]:

[3] *The data management has been done using SAS 9.4. The econometric strategy is implemented in Stata 11 using the "probit" and "biprobit" commands for the main results, as well as the "ivreg2" package for linear probability models used as robustness checks.*

$$\begin{bmatrix} \varepsilon_i \\ \varepsilon_i' \end{bmatrix} \rightarrow N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right]$$

4.4. Variables

Five health status indicators are used in this study. In order to acknowledge the effect of retirement decision on general health condition, we use three indicators coming from the Mini European Health Module (see Appendix 2): self-assessed health status (dichotomized to oppose *very good* and *good* perceived health conditions on the one hand and *fair*, *bad* and *very bad* on the other hand), chronic illnesses (binary) and limitations in daily activities (binary). We also use two mental health indicators: suffering from Generalised Anxiety Disorders (GAD) in the six previous months or Major Depressive Episodes (MDE) over the past two weeks (see Appendix 3 and Appendix 4).

Regarding our variable of interest, we use a question specifying the current occupation status at the time of the 2010 survey, and build a dummy variable equal to 1 if the individual has reported being retired or pre-retired at this date and 0 otherwise.

We control all our results by sex, age, age squared (age plays an important role in determining health status, and this role is not necessarily linear throughout the entire life), educational level in three dummies (the more educated individuals are generally better protected in terms of health status than the less educated), having had at least one child, activity sector (public, private or self-employed, when applicable) as it is likely that some sectors are more protective than others. Relying on the retrospective part of the data, we include indicators for having spent the majority of the career in long-term jobs of more than 5 years and finally an indicator for career fragmentation (these are especially important because of their influence not only on health status but also on the age of retirement). We are also able to reconstruct, year by year, the professional path (including working conditions) of individuals since the end of their initial studies to the end of their career. Exposure to physical and psychosocial working conditions during the whole career (the fact of having been exposed 20 years to single strains or 10 years to multiple simultaneous strains of the same type) are thus accounted for. The hypothesis behind it is that individuals having faced such strains at work should be even more relieved by retirement, hence inducing heterogeneity in the effect of retirement on health status.

The potential mechanisms explaining the role of retirement on health status will be assessed by daily social activities (associations, volunteering, unions, political, religious or artistic activities), physical activity and health-related risky behaviours (tobacco, alcohol and BMI).

5. Results

5.1. Main results

Table 2 below presents the econometric results for the five health indicators first displaying naive univariate probit models and then bivariate probit models accounting for endogeneity biases using the legal age of retirement at full rate (60) as source of exogeneity. The models for the probability to be retired (first step) are available in Table 13 (Appendix 5).

Naive univariate models indicate, whatever the health indicator considered, no effect of retirement on health status whatsoever. Yet, many expected results can be found: the deleterious effect of ageing (except for chronic diseases and anxiety disorders), a powerful protective effect of the level of education and from being self-employed. Having spent the majority of one's career on long-term jobs and having experienced a stable career path also play an important role. Exposures to detrimental working conditions during the whole career has an extremely strong influence on health, including higher impacts from physical constraints on perceived health status and activity limitations and larger amplitudes of psychosocial risks factors on anxiety disorders and depressive episodes. Finally, being a man appears to be very protective when considering anxiety disorders and depressive episodes.

Table 2: Retirement and health status

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	.00	-.07	.04	-.02	.00	-.09**	-.02	-.11***	-.01	-.10***
	.02	*.05*	*.02*	*.05*	*.02*	*.04*	*.01*	*.03*	*.01*	*.03*
Demographics										
Men (*ref.: women*)	.00	.00	-.00	-.00	.02	.02	-.04***	-.04***	-.03***	-.03***
	.01	*.01*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Age	.06**	.06**	.03	.02	.07***	.07***	.03	.03*	.03**	.04***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Age²	-.01**	-.01*	-.00	-.00	-.01**	-.01**	-.01*	-.00	-.01**	-.01*
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.01*
Children (*ref.: none*)	-.03	-.03	-.03	-.03	.01	.01	.03*	.03*	.03*	.03*
	.02	*.02*	*.03*	*.03*	*.02*	*.02*	*.01*	*.02*	*.02*	*.02*
Education										
< BAC (*ref.: no dipl.*)	-.11***	-.11***	-.03	-.03	-.04*	-.04*	-.02	-.02	-.04***	-.04***
	.02	*.02*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
= BAC (*ref.: no dipl.*)	-.14***	-.14***	-.03	-.03	-.04	-.04	-.01	-.00	-.04**	-.03**
	.02	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.02*	*.01*	*.02*
> BAC (*ref.: no dipl.*)	-.26***	-.26***	-.08***	-.08**	-.09***	-.09***	-.03**	-.04**	-.07***	-.07***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.02*	*.02*	*.02*
Employment										
Public sector (*ref.: private*)	-.02	-.02	-.01	-.01	-.05**	-.05**	.01	.01	.01	.01
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Self-employed (*ref.: private*)	-.07**	-.08***	-.04	-.05	-.05*	-.06**	-.02	-.04**	-.04*	-.05**
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Long-term jobs (*ref.: short term*)	-.12***	-.11***	-.08***	-.08***	-.10***	-.09***	-.02**	-.01	-.04***	-.03***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Stable career (*ref.: unstable*)	-.02	-.02	-.01	-.01	-.02*	-.02*	.00	.01	-.01*	-.01
	.01	*.01*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Physical strains	.11***	.12***	.07***	.07***	.09***	.10***	.02***	.03***	.02*	.02**
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Psycho. strains	.07***	.07***	.06***	.06***	.04**	.04**	.03***	.04***	.04***	.04***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Rho		.14		.10		.21**		.47***		.41***
		.09		*.08*		*.08*		*.10*		*.12*
Hausman test[4]	2.33		1.71		6.75***		10.13***		10.13***	
N	4610									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

[4] *The Hausman test has been calculated as follow:* $\frac{(\beta_{Biprobit}-\beta_{Probit})^2}{\sigma^2_{Biprobit}-\sigma^2_{Probit}}$*, followed by a Chi² test.*

When taking into account the endogenous nature of the retirement decision (*i.e.* reverse causality between health conditions and retirement as well as omitted variables related to these two dimensions), the results are thereby radically changed. Retirement indeed appears to have a fairly strong negative effect on the probability of reporting activity limitations (-9 percentage points – pp), anxiety disorders ($-11pp$) or depressive episodes ($-10pp$). Retirement yet seems to have no particular effect on perceived health status and chronic diseases. The effects of other control variables seem quite stable and are therefore confirmed. The bivariate probit's auxiliary models explaining the probability of retirement by being aged 60 or more is available in Appendix 5 (Table 13 column 2; column 1 is the univariate Probit equivalent for comparison purposes). As expected, the identifying variable appears to be strongly correlated with retirement (reaching age 60 induces a $16pp$ increase on the probability to retire) even after age and age-squared are introduced, inducing the instrument is relevant. A positive role of age ($+3pp$), of having a lower education ($+3pp$), of having been mainly in long-term jobs ($+12pp$) and of having had a stable career ($+3pp$) on the probability of being retired can also be noted. However, being self-employed seems to greatly reduce the probability of being retired ($-15pp$). Finally, having been exposed to physical strains at work also appears to accelerate the retirement process ($+3pp$).

Comparing the results of the bivariate probit models with their univariate equivalents (the latter assuming no correlation between residuals of the two models), there is a fairly high consistency of the results for all variables but the role of retirement in the determination of health status is changing dramatically between uni- and bivariate models.

5.2. Heterogeneity

This mean impact of retirement on health status is bound to be heterogeneous, notably according to sex (men and women have different types of career and declarative patterns), education levels (because of the protective role of education in terms of career and health outcomes) and more importantly past exposures to detrimental working conditions (retirement seen as a relief from possibly harmful jobs). We can therefore test these assumptions by seeking for heterogeneity in the effect by sex (Table 3 and Table 4), by education levels (Table 5 and Table 6) and possible past exposures to physically (Table 7 and Table 8) or psychosocially (Table 9 and Table 10) demanding jobs. The models have also been conducted on a subsample excluding civil servants (Appendix 6, Table 14 and Table 15). All the following models make use of the fact of being aged 60 or older as a source of exogeneity.

5.2.1. Sex

Because the determinants of men's and women's health status and career outcomes may differ and because health condition suffers from declarative social heterogeneity (Barnay, 2016; Devaux *et al.*, 2008; Shmueli, 2003), it is first interesting to assess the possible heterogeneity of the effect of retirement on health status according to sex. The results are hence stratified by sex (results for men are presented in Table 3 and for women in Table 4 below).

Table 3: Heterogeneity analysis – Male population

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	-.06	-.08	.01	-.04	-.04	-.11*	-.02	-.11***	-.02	-.13***
	.03	*.07*	*.03*	*.07*	*.03*	*.06*	*.01*	*.04*	*.02*	*.05*
Demographics										
Age	.13***	.14***	.08*	.08*	.09**	.10**	-.00	.02	.02	.06*
	.04	*.04*	*.05*	*.05*	*.04*	*.04*	*.02*	*.03*	*.02*	*.03*
Age²	-.01***	-.01***	-.00	-.00	-.01**	-.01**	.00	-.00	-.00	-.01*
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.00	-.00	-.05	-.05	.03	.03	.02	.03	.01	.01
	.03	*.03*	*.04*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Education										
< BAC (*ref.: no dipl.*)	-.10***	-.09***	.02	.02	-.03	-.03	-.01	-.01	-.04***	-.04***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.01*	*.01*	*.01*
= BAC (*ref.: no dipl.*)	-.22***	-.22***	-.01	-.01	-.08**	-.08**	-.03	-.04*	-.05***	-.06***
	.04	*.04*	*.04*	*.04*	*.04*	*.04*	*.02*	*.02*	*.02*	*.02*
> BAC (*ref.: no dipl.*)	-.27***	-.27***	-.04	-.04	-.13***	-.14***	-.02	-.03	-.06***	-.07***
	.04	*.04*	*.04*	*.04*	*.04*	*.04*	*.02*	*.02*	*.02*	*.02*
Employment										
Public sector (*ref.: private*)	-.07**	-.07**	-.05	-.05	-.06***	-.10***	-.01	-.01	-.00	-.01
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.02*	*.02*	*.02*
Self-employed (*ref.: private*)	-.11***	-.11***	-.07*	-.08*	-.06*	-.07**	.01	-.01	-.02	-.04
	.04	*.04*	*.04*	*.04*	*.03*	*.04*	*.02*	*.02*	*.02*	*.02*
Long-term jobs (*ref.: short term*)	-.15***	-.15***	-.12***	-.12***	-.10***	-.09***	-.02*	-.02	-.05***	-.04**
	.04	*.04*	*.04*	*.04*	*.03*	*.03*	*.01*	*.02*	*.01*	*.02*
Stable career (*ref.: unstable*)	-.03	-.03	-.02	-.02	-0.4**	-.04**	-.00	.00	-.01	-.00
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Physical strains	.09***	.09***	-.04	.04	-.07***	.07***	.02**	.03**	.01	.02
	.02	*.02*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Psycho. strains	.07***	.07***	.07**	.08**	-.04	-.04	.02*	.02*	.04***	.04***
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Rho		.05		.09		.17		.60***		.61***
		.13		*.11*		*.12*		*.15*		*.17*
Hausman test	.10		.63		1.81		5.40***		5.76***	
N	2140									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Men aged 50-69 in 2010.*

Table 4: Heterogeneity analysis – Female population

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	.04	-.08	.04	-.03	-.04	-.06	-.01	-.06**	-.01	-.09**
	.03	*.07*	*.03*	*.07*	*.03*	*.06*	*.02*	*.04*	*.02*	*.04*
Demographics										
Age	.01	-.00	-.01	-.02	.06*	.05	.05**	.04*	.05*	.04
	.04	*.04*	*.04*	*.04*	*.04*	*.04*	*.02*	*.03*	*.03*	*.03*
Age²	-.00	.00	*.00*	.00	-.01*	-.00	-.01**	-.00	-.01*	-.00
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.04	-.04	.01	.01	.01	-.01	.03	.04	.06**	.06**
	.03	*.03*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.03*	*.03*
Education										
< BAC (*ref.: no dipl.*)	-.13***	-.13***	-.09**	-.09**	-.05	-.04	-.03	-.02	-.03*	-.03
	.03	*.03*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
= BAC (*ref.: no dipl.*)	-.09**	-.09**	-.06	*-.06*	-.01	-.01	.01	.01	-.02	-.01
	.04	*.04*	*.04*	*.04*	*.05*	*.04*	*.02*	*.02*	*.02*	*.02*
> BAC (*ref.: no dipl.*)	-.27***	-.27***	-.12***	-.12***	-.07**	-.07*	-.04*	-.04*	-.06***	-.06***
	.04	*.04*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Employment										
Public sector (*ref.: private*)	.01	.01	.02	.01	-.02	-.02	.02	.02	.01	.01
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.02*	*.02*	*.02*
Self-employed (*ref.: private*)	-.01	-.03	-.00	-.01	-.04	-.05	-.09**	-.10**	-.06*	-.07**
	.05	*.05*	*.05*	*.05*	*.04*	*.04*	*.04*	*.04*	*.04*	*.04*
Long-term jobs (*ref.: short term*)	-.12***	-.10***	-.07***	-.06***	-.11***	-.10***	-.02*	-.01	-.04***	-.03**
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Stable career (*ref.: unstable*)	-.02	-.02	-.01	-.00	-.01	-.01	.01	.01	-.02	-.01
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Physical strains	.13***	.14***	-.10***	.10***	.11***	-11***	.02	.03	.02	.03
	.03	*.03*	*..03*	*.03*	*.02*	*.02*	*.02*	*.02*	*02*	*.02*
Psycho. strains	.07**	.07**	.05*	.05*	-.03	-.04	.05***	.05***	.04**	.04**
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*	*.02*	*.02*
Rho		.22**		.13		.20*		.34**		.30*
		.12		*.11*		*.12*		*.14*		*.15*
Hausman test	3.60		1.13		.15		2.08		5.33***	
N	2470									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Women aged 50-69 in 2010.*

In the male population, retirement reduces the probability to declare activity limitations, generalized anxiety disorders and major depressive episodes. No significant effect appears on self-assessed health and chronic diseases. Among women, retirement only seems favourable for GAD and MDE. In terms of magnitude, retirement decreases the probability of activity limitations and GAD by $11pp$ and of MDE by $13pp$ in men, when in women the decrease in GAD and MDE is of respectively $6pp$ and $9pp$.

5.2.2. Education

We then stratify our sample according to the level of education: on the one hand, we consider individuals with a primary or secondary education level (Table 5) and on the other hand, the ones that reached a level at least equivalent to the French *baccalaureat* (Table 6). It is to be noted that the sample sizes of the two populations are fairly different (*resp.* 3,045 and 1,497 individuals for the lowly and highly educated).

Table 5: Heterogeneity analysis – Low education attainment

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	-.01	-.08	.03	.02	-.01	-.13**	-.02	-.08**	-.01	-.07**
	.03	*.06*	*.03*	*.06*	*.03*	*.05*	*.01*	*.03*	*.02*	*.04*
Demographics										
Men (*ref.: women*)	.04**	.05**	.02	.02	.05***	.05***	-.03***	-.03***	-.03**	-.02**
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Age	.05	.05	.02	.03	.07**	.08**	.02	.02	.04*	.04*
	.04	*.04*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Age²	-.00	-.00	-.00	-.00	-.01**	-.01**	-.00	-.00	-.01*	-.01
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.01*
Children (*ref.: none*)	-.01	-.01	-.04	-.04	.03	.03	.03	.03*	.03	.04*
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Employment										
Public sector (*ref.: private*)	-.02	-.02	.01	.01	-.07***	-.07***	.01	.01	.01	.01
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*01*	*.01*	*.02*
Self-employed (*ref.: private*)	-.08**	-.09**	-.03	-.03	-.03	-.04	-.01	-.02	*-.02*	-.03
	.04	*.04*	*.04*	*.04*	*.04*	*.04*	*.02*	*.02*	*.02*	*.03*
Long-term jobs (*ref.: short term*)	-.15***	-.15***	-.12***	-.12***	-.13***	-.12***	-.03***	-.03**	*-.06***	-.06***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Stable career (*ref.: unstable*)	-.03*	-.03*	-.01	-.01	-.02	-.01	.00	.01	*-.02*	-.01
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.00*	*.01*	*.01*	*.01*
Physical strains	.13***	.13***	.05**	.05**	.10***	.10***	.03***	.03***	*.03****	.03***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Psycho. strains	.08***	.08***	.07***	.07***	.02	.02	.03**	.03**	*.04****	.04***
	.02	*.02*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Rho		.12		.03		.25**		.32**		.31**
		.10		*.09*		*.10*		*.14*		*.13*
Hausman test	1.81		.04		9.00***		4.50***		3.00	
N	3045									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field : *Santé et Itinéraire Professionnel survey. Low-educated individuals aged 50-69 in 2010.*

Table 6: Heterogeneity analysis – High education attainment

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	.02	-.03	.01	-.15*	.04	.03	-.01	-.14***	-.03	-.22***
	.03	*.09*	*.04*	*.09*	*.03*	*.08*	*.02*	*.05*	*.02*	*.06*
Demographics										
Men (*ref.: women*)	-.06**	-.06**	-.03	-.03	-.04*	-.04*	-.07***	-.07***	-.04***	-.05***
	.02	*.02*	*.03*	*.03*	*.02*	*0.2*	*.02*	*.02*	*.01*	*.02*
Age	.06	.05	*.01*	-.01	.05	.05	.04	.04	.02	.01
	.05	*.05*	*.05*	*.06*	*.04*	*.05*	*.03*	*.03*	*.03*	*.03*
Age²	-.00	-.00	*-.00*	.00	-.00	-.00	-.01*	-.00	-.00	.00
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.04	-.04	*-.01*	-.01	.00	.00	.03	.03	.02	.03
	.04	*.04*	*.04*	*.04*	*.03*	*.03*	*.02*	*.03*	*.02*	*.03*
Employment										
Public sector (*ref.: private*)	-.05*	-.05*	-.05*	-.05*	-.03	-.03	-.01	-.01	-.01	-.01
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Self-employed (*ref.: private*)	-.05	-.06	-.07	-.10*	-.04	-.06	-.03	-.07**	-.06**	-.12***
	.04	*.05*	*.05*	*.05*	*.03*	*.04*	*.03*	*.03*	*.03*	*.04*
Long-term jobs (*ref.: short term*)	-.09***	-.09***	-.00	.02	-.05**	-.04	-.00	.02	-.02	.00
	.03	*.03*	*.04*	*.04*	*.02*	*.03*	*.02*	*.02*	*.02*	*.02*
Stable career (*ref.: unstable*)	-.01	-.01	-.03	-.03	-.05**	-.05**	-.00	-.00	.01	-.01
	.02	*.02*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.02*
Physical strains	.07*	.08*	.15***	.17***	.06*	.07*	-.01	.01	-.03	-.01
	.04	*.04*	*.05*	*.05*	*.04*	*.04*	*.02*	*.03*	*.03*	*.03*
Psycho. Strains	.06*	.06*	.05	.05	.08**	.08**	.06***	.06***	.04**	.05**
	.03	*.03*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Rho		.10		.28*		.02		.57***		.77***
		.17		*.15*		*.17*		*.15*		*.14*
Hausman test	.35		3.94**		.02		8.05***		11.28***	
N	1565									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field : *Santé et Itinéraire Professionnel survey. High-educated individuals aged 50-69 in 2010.*

In the lower-educated population, retirement seems beneficial in terms of daily activity limitations ($-13pp$ on the probability to declare activity limitations), GAD ($-8pp$) and MDE ($-7pp$). In the higher-educated sample, the role of retirement is sensible on chronic diseases ($-15pp$) and even more important for mental health (*resp.* $-14pp$ and $-22pp$ for GAD and MDE). Other changes in the determinant of health status are noticeable between these two populations: having been in long term jobs as well as physical and psychosocial working conditions during the career do exhibit massive impacts on health status in 2010, when it is not as much the case in the higher-educated sample.

5.2.3. Past work strains

The beneficial effects of retirement on health status are often explained because retirement, seen as the fact of not working anymore, is considered as a relief from hard jobs in terms of working conditions. Here we test the hypothesis according to which retirement is even more beneficial on health if retirees were originally employed in harmful jobs. We stratify the sample respectively according to high and low physical exposures (Table 7 and Table 8) and high and low psychosocial exposures (Table 9 and Table 10) during the whole career.

Table 7: Heterogeneity analysis – Highly physically demanding career

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	-.08	-.08	-.10*	-.13*	-.09*	-.15*	-.08***	-.17**	-.04	-.11**
	.05	*.05*	*.05*	*.08*	*.05*	*.09*	*.03*	*.08*	*.03*	*.06*
Demographics										
Men (*ref.: women*)	-.02	-.02	-.02	-.02	-.01	-.01	-.04**	-.04**	-.03*	-.03*
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Age	.12*	.09	.13*	.14**	.11*	.12	-.04	-.02	.01	.02
	.07	*.07*	*.07*	*.07*	*.06*	*.07*	*.04*	*.04*	*.04*	*.04*
Age²	-.01*	-.00	-.01	-.01	-.01*	-.01*	.00	.00	-.00	-.00
	.00	*.00*	*.00*	*.00*	*.00*	*.01*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.01	-.00	-.02	-.02	.06	.06	.01	.01	.01	.01
	.06	*.06*	*.06*	*.06*	*.05*	*.05*	*.03*	*.03*	*.03*	*.04*
Education										
< BAC (*ref.: no dipl.*)	-.07	-.07	.02	.02	-.00	.00	-.02	-.02	-.03	-.03
	.04	*.04*	*.04*	*.04*	*.04*	*.04*	*.02*	*.02*	*.02*	*.02*
= BAC (*ref.: no dipl.*)	-.17**	-.18**	.03	.13*	-.01	-.01	-.05	-.04	-.10**	-.09**
	.07	*.07*	*.08*	*.07*	*.07*	*.07*	*.04*	*.04*	*.05*	*.05*
> BAC (*ref.: no dipl.*)	-.30***	-.30***	.03	.03	-.12	-.12	-.05	-.05	-.13**	-.13**
	.08	*.08*	*.08*	*.08*	*.08*	*.08*	*.05*	*.05*	*.06*	*.06*
Employment										
Public sector (*ref.: private*)	.03	.03	.01	.01	-.13**	-.13**	.03	.03	.05	.05
	.06	*.06*	*.06*	*.06*	*.06*	*.06*	*.03*	*.03*	*.03*	*.03*
Self-employed (*ref.: private*)	-.05	-.04	-.16*	-.16*	-.02	-.03	-.01	-.02	.02	.01
	.08	*.08*	*.08*	*.08*	*.08*	*.08*	*.05*	*.05*	*.05*	*.05*
Long-term jobs (*ref.: short term*)	-.10**	-.11**	-.10**	-.10**	-.12***	-.11***	-.04	-.03	-.06**	-.05**
	.05	*.05*	*.05*	*.05*	*.04*	*.04*	*.02*	*.02*	*.02*	*.02*
Stable career (*ref.: unstable*)	-.01	-.02	-.05	-.04	.01	-.01	-.03	-.04*	-.00	.00
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Rho		-.20		.06		.13		.41*		.31*
		.16		*.17*		*.17*		*.25*		*.17*
Hausman test	.00		.23		.64		1.47		1.81	
N	1010									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals who faced a highly physically demanding career, aged 50-69 in 2010.*

Table 8: Heterogeneity analysis – Lowly physically demanding career

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	.02	-.07	.07***	.02	.03	-.07	.00	-.08***	-.00	-.09**
	.02	*.06*	*.03*	*.06*	*.02*	*.05*	*.01*	*.03*	*.01*	*.04*
Demographics										
Men (*ref.: women*)	.00	.01	.00	.00	.02	.02	-.05***	-.05***	-.03***	-.03***
	.02	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Age	.05	.04	.00	.00	.06**	.06*	.05***	.05**	.05**	.04**
	.03	*.03*	*.03*	*.04*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Age²	-.00	-.00	.00	.00	-.01**	-.01*	-.01***	-.01**	-.01**	-.01**
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.01*	*.00*	*.00*
Children (*ref.: none*)	-.03	-.03	-.03	-.03	.00	.00	.03*	.03*	.03*	.04*
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.02*	*.02*	*.02*
Education										
< BAC (*ref.: no dipl.*)	-.14***	-.13***	-.06*	-.05*	-.06**	-.05**	-.00	-.01	-.04***	-.04***
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*
= BAC (*ref.: no dipl.*)	-.15***	-.14***	-.07*	-.07*	-.05*	-.05*	.00	.00	-.03*	-.03*
	.03	*.03*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
> BAC (*ref.: no dipl.*)	-.27***	-.27***	-.10***	-.10***	-.10***	-.10***	-.03*	-.03*	-.06***	-.06***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.01*
Employment										
Public sector (*ref.: private*)	-.03	-.03	-.02	-.02	-.04*	-.04*	.00	.00	-.00	-.00
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Self-employed (*ref.: private*)	-.07**	-.09***	-.03	-.04	-.05*	-.06**	-.03	-.04**	-.05**	-.06***
	.03	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*	*.0*
Long-term jobs (*ref.: short term*)	-.12***	-.10***	-.08***	-.07***	-.09***	-.08***	-.01	-.01	-.03***	-.02**
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Stable career (*ref.: unstable*)	-.03*	-.03	-.00	-.00	-.03**	-.03**	-.01	-.00	-.02*	-.02*
	.02	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Rho		.26**		.08		.23**		.43***		.39**
		.10		*.09*		*.10*		*.12*		*.15*
Hausman test	2.53		.93		4.76***		8.00***		5.40***	
N	3600									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals who faced a lowly physically demanding career, aged 50-69 in 2010.*

Despite the loss in accuracy of the estimations due to a significantly lower sample size, individuals having faced a physically strenuous career clearly experience the most positive effects of retiring on their health condition, as every indicators but self-assessed health status are impacted (*resp.* $13pp$, $15pp$, $17pp$ and $11pp$ decreases in the probability of declaring chronic diseases, activity limitations, GAD and MDE). When it comes to individuals with lower levels of physical exposures, only mental health is improved ($-8pp$ and $-9pp$ for GAD and MDE).

Table 9: Heterogeneity analysis – Highly psychosocially demanding career

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	-.12**	-.21**	-.15***	-.35***	-.11**	-.19*	-.04	-.34***	-.02	-.23**
	.05	*.11*	*.05*	*.12*	*.05*	*.12*	*.03*	*.10*	*.04*	*.09*
Demographics										
Men	.01	.01	.02	.02	.02	.02	-.06***	-.06**	-.03	-.03
(*ref.: women*)	*.04*	*.04*	*.04*	*.04*	*.03*	*.03*	*.02*	*.02*	*.03*	*.02*
Age	.24***	.26***	.23***	.25***	.24***	.25***	.01	.11	.10*	.16**
	.08	*.08*	*.08*	*.08*	*.07*	*.08*	*.05*	*.08*	*.06*	*.07*
Age²	-.01***	-.01***	-.01***	-.01***	-.01***	-.01***	-.00	-.00	-.01*	-.01**
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children	-.01	-.01	.03	.03	-.02	-.02	.05	.04	.02	-.02
(*ref.: none*)	*.06*	*.06*	*.07*	*.06*	*.06*	*.06*	*.05*	*.05*	*.05*	*.05*
Education										
< BAC	-.09	-.08	-.02	.01	-.00	.01	.02	.07	.01	.02
(*ref.: no dipl.*)	*.06*	*.06*	*.06*	*.06*	*.05*	*.06*	*.04*	*.05*	*.04*	*.04*
= BAC	-.19***	-.18**	.01	.03	-.00	.01	.05	.08*	-.01	.01
(*ref.: no dipl.*)	*.09*	*.07*	*.07*	*.07*	*.07*	*.07*	*.04*	*.05*	*.05*	*.05*
> BAC	-.32***	-.31***	-.09	-.08	-.06	-.05	-.00	.00	-.06	-.05
(*ref.: no dipl.*)	*.07*	*.07*	*.07*	*.07*	*.07*	*.07*	*.04*	*.05*	*.05*	*.05*
Employment										
Public sector	-.05	-.06	-.11*	-.14**	-.20***	-.21***	.00	-.04	-.03	-.07
(*ref.: private*)	*.06*	*.06*	*.06*	*.06*	*.06*	*.06*	*.04*	*.04*	*.04*	*.04*
Self-employed	-.09	-.07	-.14	-.14	-.01	-.01	.02	.03	.01	-.00
(*ref.: private*)	*.10*	*.10*	*.10*	*.10*	*.09*	*.09*	*.06*	*.06*	*.03*	*.03*
Long-term jobs	-.11**	-.10*	-.09	-.06	-.10**	-.09*	-.03	-.01	-.06*	-.04
(*ref.: short term*)	*.05*	*.05*	*.05*	*.05*	*.05*	*.05*	*.03*	*.03*	*.03*	*.03*
Stable career	.01	.02	-.04	-.03	.03	-.03	-.05	-.07***	.01	.02
(*ref.: unstable*)	*.04*	*.04*	*.04*	*.04*	*.04*	*.04*	*.02*	*.02*	*.03*	*.03*
Rho		.16		.38*		.16		.93***		.70**
		.21		*.21*		*.23*		*.20*		*.23*
Hausman test	.84		3.36		.54		9.89***		6.78***	
N	731									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals who faced a highly psychosocially demanding career, aged 50-69 in 2010.*

Table 10: Heterogeneity analysis – Lowly psychosocially demanding career

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	.03	-.08	.07***	.03	.03	-.09*	-.01	-.08***	-.01	-.09***
	.02	*.05*	*.02*	*.06*	*.02*	*.05*	*.01*	*.03*	*.01*	*.03*
Demographics										
Men (*ref.: women*)	.01	.02	-.00	.00	-.03*	.03**	-.04***	-.04***	-.03***	-.03***
	.02	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Age	.03	.03	.00	-.00	.05*	.04	.03*	.03	.02	.02
	.03	*.03*	*.00*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Age²	-.00	-.00	.00	-.00	-.00	-.00	-.01*	-.00	-.00	-.00
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.03	-.03	-.03	-.03	.02	.02	.02	.02	.03*	.03**
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.02*	*.02*	*.02*
Education										
< BAC (*ref.: no dipl.*)	-.13***	-.12***	-.04	-.04	-.05**	-.05**	-.03**	-.03**	-.05***	-.05***
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
= BAC (*ref.: no dipl.*)	-.16***	-.16***	-.05*	-.05	-.07**	-.07**	-.02	-.02	-.05***	-.02***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.02*	*.02*	*.02*
> BAC (*ref.: no dipl.*)	-.29***	-.29***	-.09***	-.09***	-.13***	-.13***	-.05***	-.05***	-.07***	-.08***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.02*	*.02*	*.02*
Employment										
Public sector (*ref.: private*)	-.03	-.02	-.01	-.01	-.03*	-.03*	.01	.01	.01	.01
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Self-employed (*ref.: private*)	-.07**	-.09***	-.03	-.04	-.05*	-.07**	-.03	-.04**	-.02	-.03*
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Long-term jobs (*ref.: short term*)	-.11***	-.10***	-.09***	-.08***	-.10***	-.08***	-.02**	-.01	-.04***	-.03***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.011*
Stable career (*ref.: unstable*)	-*.03***	-.03*	-.00	-.01	-.04**	-.03**	-.01	-.00	-.02**	-.02*
	.02	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Rho		.20**		.07		.26***		.39***		.36**
		.09		*.09*		*.09*		*.12*		*.14*
Hausman test	5.76***		.50		6.86***		6.13***		8.00***	
N	3879									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals who faced a lowly psychosocially demanding career, aged 50-69 in 2010.*

Again, despite precision-losses related to sample sizes, the most psychosocially exposed individuals during their career also experience massive improvements in all aspects of their health status (*resp.* $-21pp$, $-35pp$, $-19pp$, $-34pp$ and $-23pp$ for self-assessed health, chronic diseases, activity limitations, GAD and MDE). In the less exposed individuals, only GAD ($-8pp$) and MDE ($-9pp$) are affected. The massive impacts in the psychosocial subgroup specifically on self-assessed health and mental health indicators can be explained by

the relief from a very stressful work-life. The impact on chronic diseases most likely depicts the role of retirement on long-term mental health deterioration as a consequence.

5.2.4. Civil servants

Because civil servants (who are included in our sample) are likely to be specific in terms of retirement requirements, we test whether or not the results vary if we only consider individuals who are/were not civil servants (it is impossible to run the regressions on civil servants only, because of sample sizes). The results indicate no major changes, and the effect of retirement on health status is confirmed by these regressions (Appendix 6, Table 14 and Table 15).

5.3. Mechanisms

We investigate several possible reasons (mechanisms) as of why retirement appears to have such a positive impact on retirees' health. In section 5.3.1, we acknowledge the effects of retirement on daily activities and then, in section 5.3.2, on health-related risky behaviours. All the following models make use of the fact of being aged 60 or older as a source of exogeneity.

5.3.1. Daily activities

Table 11: Mechanisms – The effect of retirement on daily activities

Variable	Social activities		Sport	
	Probit	**Biprobit**	**Probit**	**Biprobit**
Retired	.10***	.10**	.07***	.10*
	.02	*.04*	*.02*	*.05*
Demographics				
Men (*ref.: women*)	-.01	-.01	.00	.01
	.02	*.02*	*.02*	*.02*
Age	-.00	-.01	-.04	-.04
	.03	*.03*	*.03*	*.03*
Age²	.00	.00	.00	.00
	.00	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.00	-.00	.01	.01
	.02	*.02*	*.02*	*.02*
Education				
< BAC (*ref.: no dipl.*)	.11***	.11***	.11***	.12***
	.03	*.03*	*.03*	*.03*
= BAC (*ref.: no dipl.*)	.21***	.21***	.20***	.20***
	.03	*.03*	*.03*	*.03*
> BAC (*ref.: no dipl.*)	.34***	.34***	.31***	.31***
	.03	*.03*	*.03*	*.03*
Employment				
Public sector (*ref.: private*)	.05**	.05**	.03	.02
	.02	*.02*	*.02*	*.02*
Self-employed (*ref.: private*)	.02	.01	-.08***	-.09***
	.03	*.03*	*.03*	*.03*
Long-term jobs (*ref.: short term*)	-.01	-.00	.06***	.07***
	.02	*.02*	*.02*	*.02*
Stable career (*ref.: unstable*)	.01	.01	.02*	.03*
	.01	*.03*	*.01*	*.02*
Physical strains	-.05***	-.05***	-.04**	-.04**
	.02	*.02*	*.02*	*.02*
Psycho. strains	.04**	.04**	.01	.01
	.02	*.02*	*.02*	*.02*
Rho		.05		.10
		.08		*.08*
Hausman test	.00		.43	
N	4610			

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

5.3.2. Health-related risky behaviours

Table 12: Mechanisms – The effect of retirement on health-related risky behaviours

Variable	Tobacco		Alcohol		Overweight	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	-.04**	-.08**	.04**	.08**	.05**	.12**
	.02	*.04*	*.02*	*.04*	*.02*	*.05*
Demographics						
Men (*ref.: women*)	.08***	.09***	.26***	.26***	.19***	.19***
	.01	*.01*	*.01*	*.01*	*.01*	*.01*
Age	.01	.00	.05**	.05**	.05*	.06*
	.03	*.03*	*.03*	*.03*	*.03*	*.03*
Age²	-.00	-.00	-.01**	-.01**	-.00	-.01*
	.00	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.01	-.01	.00	.00	.01	.01
	.02	*.02*	*.02*	*.02*	*.03*	*.03*
Education						
< BAC (*ref.: no dipl.*)	-.03	-.03	.04	.04	-.01	-.01
	.02	*.02*	*.02*	*.02*	*.03*	*.03*
= BAC (*ref.: no dipl.*)	-.02	-.02	.04	.03	-.07**	-.07**
	.03	*.03*	*.03*	*.03*	*.03*	*.03*
> BAC (*ref.: no dipl.*)	-.06**	-.06**	.04	.03	-.15***	-.15***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*
Employment						
Public sector (*ref.: private*)	.00	.00	-.01	-.01	-.04*	-.04*
	.02	*.02*	*.02*	*.02*	*.02*	*.02*
Self-employed (*ref.: private*)	-.01	-.01	.02	.03	-.02	-.01
	.03	*.03*	*.02*	*.02*	*.03*	*.03*
Long-term jobs (*ref.: short term*)	-.05***	-.05**	-.03*	-.04**	-.02	-.03
	.02	*.02*	*.02*	*.02*	*.02*	*.02*
Stable career (*ref.: unstable*)	-.02	-.01	.01	.01	.01	.01
	.01	*.01*	*.01*	*.01*	*.02*	*.02*
Physical strains	.03**	.04**	-.00	-.00	.07***	.07***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*
Psycho. strains	.02	.02	.00	.00	-.02	-.02
	.02	*.02*	*.02*	*.02*	*.02*	*.02*
Rho		.07		-.09		-.13
		.10		*.09*		*.08*
Hausman test	1.33		1.33		2.33	
N	4610					

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Retirement has a positive role on the probability of having daily social activities as well as on the probability to have physical activities ($+10pp$), which is in line with the literature (Eibich, 2015) (Table 11). Even though it is not possible to say for sure this may causally explain why retirees have a better health condition, daily social activities and sport are bound

to be correlated with better health status and well-being (Ho, 2016; Ku *et al.*, 2016; Sarma *et al.*, 2015). Retiring is also found to decrease the probability of smoking ($-8pp$) which is also in line with a general health status improvement and makes sense, because of the relief retirement generates from the stress of the work-life for instance. Yet, most likely because of the increase in spare time and despite the fact that retirees do sport more often, they are also more numerous to have a risky alcohol consumption ($+8pp$) and to be overweight ($+12pp$) (Table 12). These results are congruent with the literature, which notably shows that quitting smoking involves higher BMI levels (Courtemanche *et al.*, 2016), just like the fact of retiring (Godard, 2016).

5.4. Robustness checks

First, we test other retirement thresholds, as three different thresholds are potentially relevant in the French case: years 55, 60 and 65 (see Figure I as well as Figure III and Figure IV in Appendix 1). We estimate bivariate Probit models, this time including these three thresholds in the retirement models. The main results are unchanged, and the auxiliary models show no effect of the 55-year threshold, while a strong effect can be found for the 60 and 65 thresholds, this potentially rendering them useful as identifying variables (Appendix 7, Table 16 and Table 17).

We then put our results to the test of linear probability models (LPM), estimated by the generalized method of moments (GMM) with heteroscedasticity-robust standard errors, in order to take advantage of the possibility of using our two relevant identifying variables (60 and 65 years-old thresholds) by initiating different tests. The type of modelling also allows for several tests, as well as for a better handling of unobserved heterogeneity (Angrist and Pischke, 2009). It also allows relaxing the hypothesis of the residuals following a bi-normal distribution (which is the case of bivariate probits). The results of the models (Appendix 7, Table 18) are resilient to LPM modelling. It is the same for the results of auxiliary retirement models, which are also stable (Appendix 7, Table 19). We performed Sargan-Hansen tests for over-identification, which show that the null hypothesis of correctly excluded instruments is never rejected in our case. Moreover, the Kleibergen-Paap test statistics are consistently well above the arbitrary critical value of 10, indicating that, with no surprise, our instruments seem relevant to explain the retirement decision.

Finally, we test whether the results hold up when not controlling for several, endogenous covariates, related to the professional career. What can be noted is that the results appear as

robust to this new specification, indicating that the effect of retirement was not driven by endogenous relationships with such variables (Appendix 7, Table 20 and Table 21).

6. Discussion

This study measures the causal effect of retirement on health status by mobilizing an econometric strategy allowing to take into account the endogenous nature of the retirement-health relationship (*via* instrumental variables) and retrospective panel data on individual careers. We find that retirement has an average positive effect on activity limitations, GAD and MDE after controlling for reverse causality and unobserved heterogeneity. No significant effect can be found on self-assessed health and chronic diseases. It is also the case in the male population when in women, retirement benefits appear only on GAD and MDE and no effect is to be measured on physical health status. These results are particularly strong in the less educated and in the most exposed individuals to physical and psychosocial working conditions during their career, while also partly holding for the rest of the population to a lesser extent. We also find that this positive effect on health status might be explained by a greater ability for retirees to have more social and physical daily activities and smaller tobacco consumption (even though we cannot be certain of the causal relationship between these mechanisms and health status in our study). Yet, retirees are also found to be significantly more at risk for alcohol consumption and overweight. To our knowledge, this is the first study to give insights on the average effect of retirement on the whole population in France and on the mechanisms which could explain its health effects as well as describing heterogeneous impacts according to sex, education levels and past exposures to two types of working conditions during the entire career, while addressing the endogeneity biases inherent to this type of study.

Yet, several limitations can be noted. As we do not rely on panel data *per se*, we do not have the possibility to account systematically for individual unobserved heterogeneity. Even though this should not matter because of our instrumental variables framework, panel data would have enabled RDD methods allowing the implementation of differentiated trends left and right of the thresholds, at the cost of temporal distance and sample sizes. Also, in the case of unobserved characteristics correlated with both the probability to be retired and health status, an endogeneity issue cannot be excluded, which can render our identification strategy doubtful in that respect. Another main limit lies in the fact that we cannot determine if the mean effect of retirement on health status differs according to the distance with the retirement

shock. We do not know, because of our data, if this effect is majorly led by short-, mid- or long-run consequences, neither can we determine if the impact on health status happens right after retirement or in a lagged fashion. There are also several missing variables, such as the professional status before retirement and standards of living as well as elements related to retirement reforms. It is also to be noted that comparisons between stratified samples are complicated because the results hold on different samples.

Some perspectives also remain to be tested. An initial selection of the sample taking into account the fact that individuals have worked during their careers or even a selection of individuals who have worked after reaching 50 would probably grant a greater homogeneity in the sample. Finally, the potentiality of some individuals being impacted by pension reforms will be assessed and further robustness checks accounting for this possibility will be conducted if necessary.

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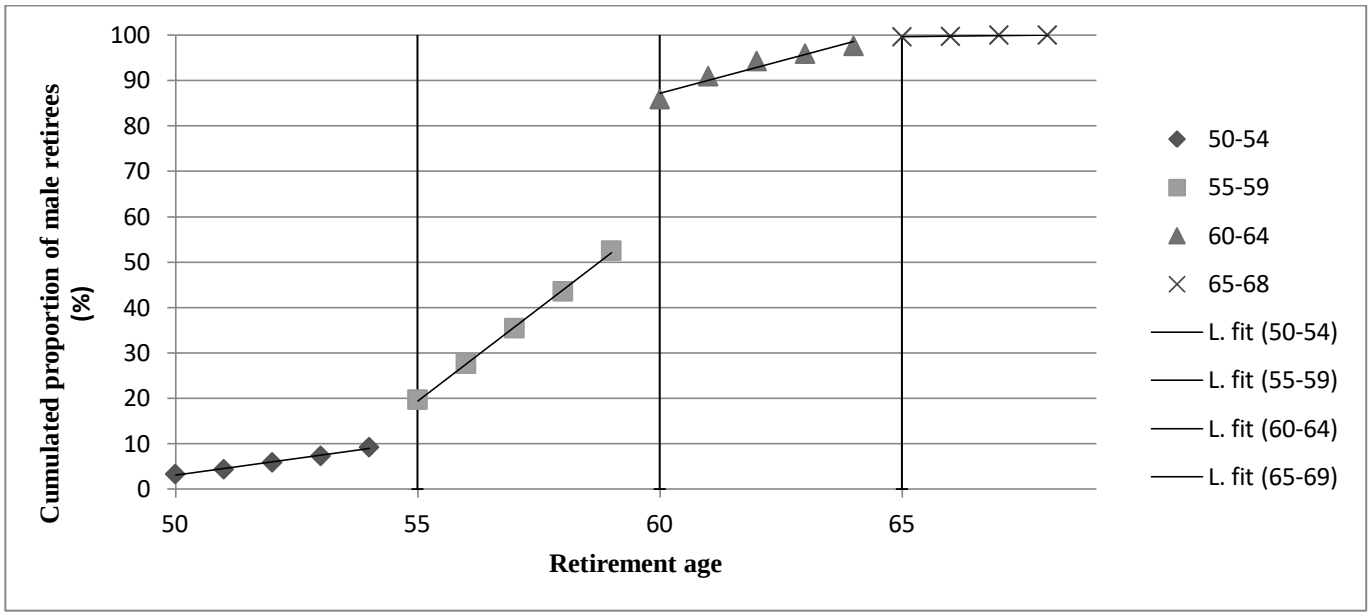
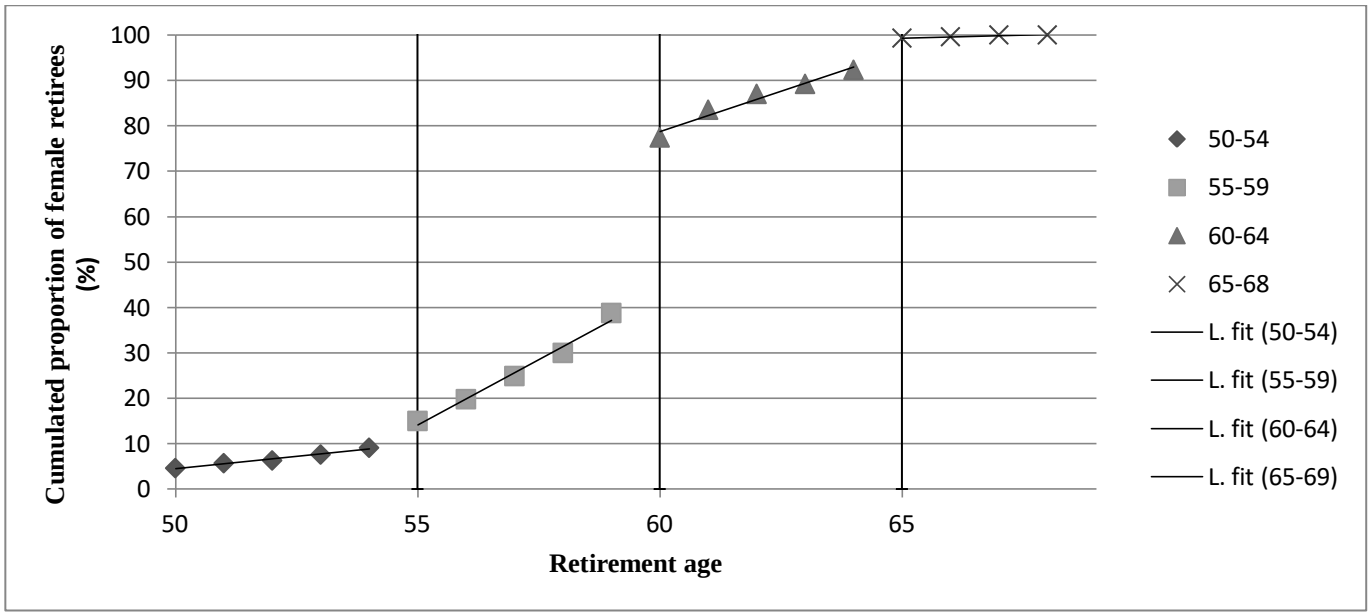
Appendix 1: Proportion of retirees, male and female samples

Figure III: Proportion of retirees in the male sample, according to age



Field: *Santé et Itinéraire Professionnel survey. Men aged 50-69 in 2010.*

Figure IV: Proportion of retirees in the female sample, according to age



Field: *Santé et Itinéraire Professionnel survey. Women aged 50-69 in 2010.*

Appendix 2: The Mini European Health Module

The Mini European health module is intended to give a uniform measure of health status in European countries by asking a series of three questions apprehending perceived health, the existence of chronic diseases and activity limitations.

It is based on Blaxter's model (1989) which identifies three semantic approaches to health:

- The subjective model based on the overall perception of the individual, "How is your overall health? *Very Good/Good/Average/Bad/Very bad*";
- The medical model, based on disease reporting, "Do you currently have one or more chronic disease(s)? *Yes/No*";
- The functional model which identifies difficulties in performing frequent activities: "Are you limited for six months because of a health problem in activities people usually do? *Yes/No*".

Appendix 3: Major Depressive Episodes (MDE)

The MDE are identified in two stages. First, two questions making use of filters are asked:

- Over the past two weeks, have you felt particularly sad, depressed, mostly during the day, and this almost every day? *Yes/No*
- Over the past two weeks, have you almost all the time the feeling of having no interest in anything, to have lost interest or pleasure in things that you usually like? *Yes/No*

Then, if one of the two filter questions receives a positive response, a third question is then asked, in order to know the specific symptoms: Over the past two weeks, when you felt depressed and/or uninterested for most things, have you experienced any of the following situations? *Check as soon as the answer is "yes", several possible positive responses*.

- Your appetite has changed significantly, or you have gained or lost weight without having the intention to (variation in the month of +/- 5%)
- You had trouble sleeping nearly every night (sleep, night or early awakenings, sleep too much)
- You were talking or you moved more slowly than usual, or on the contrary you feel agitated, and you have trouble staying in place, nearly every day

- You felt almost tired all the time, without energy, almost every day
- You feel worthless or guilty, almost every day
- You had a hard time concentrating or making decisions, almost every day
- You have had several dark thoughts (such as thinking it would be better be dead), or you thought about hurting yourself

Using the responses, two algorithms are then implemented in accordance with the criteria of the Diagnostic and Statistical Manual (DSM-IV). An individual suffers from MDE if:

- A positive response to two filter questions and four symptoms are listed
- Two positive answers to two filter questions and three symptoms are listed

Appendix 4: Generalized Anxiety Disorder (GAD)

GAD are identified using a similar filter questions system.

Three questions are asked:

- Over the past six months, have you felt like you were too much concerned about this and that, have you felt overly concerned, worried, anxious about life's everyday problems, at work/at school, at home or about your relatives? *Yes/No*

In case of positive answer:

- Do you have such concerns almost every day? *Yes/No*

In case of positive answer:

- Is it difficult to control these concerns or do they prevent you to focus on what you have to do? *Yes/No*

If the interviewee responds positively to the three filter questions, another question is asked in order to know the specific symptoms: "Over the last six months, when you felt particularly concerned, worried, anxious, you often happened:

- To feel restless, tense, the edgy nerves?
- To have tense muscles?
- To feel tired, weak or exhausted easily?
- To have trouble concentrating or vacuum passages?
- To be particularly irritable?

- To have sleep problems (difficulty falling asleep, waking in the middle of the night, waking early or sleeping too much)?

For a person to suffer from generalized anxiety disorder, he/she must respond positively to the three filter questions, then three out of six symptoms described later. This protocol is consistent with that used by the DSM-IV.

Appendix 5: Main auxiliary models

Table 13: Auxiliary models of the probability of being retired

	Probit	**Biprobit**
Aged 60 or more	.16***	.16***
	.01	*.01*
Demographics		
Men (*ref.: women*)	.03***	.03***
	.01	*.01*
Age	.02	.02
	.03	*.03*
Age²	.00	.00
	.00	*.00*
Children (*ref.: none*)	.01	.01
	.02	*.02*
Education		
< BAC (*ref.: no dipl.*)	.03**	.03**
	.02	*.01*
= BAC (*ref.: no dipl.*)	.02	.02
	.02	*.02*
> BAC (*ref.: no dipl.*)	-.01	-.01
	.02	*.02*
Employment		
Public sector (*ref.: private*)	.01	.01
	.01	*.01*
Self-employed (*ref.: private*)	-.15***	-.15***
	.02	*.02*
Long-term jobs (*ref.: short term*)	.11***	.12***
	.01	*.01*
Stable career (*ref.: unstable*)	.03***	.03***
	.01	*.01*
Physical strains	.04***	.03***
	.01	*.01*
Psycho. strains	.01	.01
	.01	*.01*
N	4610	

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Appendix 6: Civil servants

Table 14: Retirement and health status – No civil servants

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	.01	-.05	.03	-.01	.00	-.08**	-.01	-.09***	-.02	-.08***
	.02	*.05*	*.03*	*.05*	*.02*	*.04*	*.01*	*.03*	*.01*	*.03*
Demographics										
Men (*ref.: women*)	.01	.01	.01	.01	.03*	.03*	-.04***	-.04***	-.03***	-.03***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Age	.08**	.08**	.02	.02	.08***	.08***	.02	.02	.04**	.04**
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Age²	-.01**	-.01**	-.00	-.00	-.01**	-.01**	-.00	-.00	-.01**	-.01**
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.02	-.03	-.01	-.01	.03	.03	.03*	.03*	.04**	.04**
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Education										
< BAC (*ref.: no dipl.*)	-.13***	-.13***	-.03	-.03	-.05**	-.05**	-.02	-.02	-.04***	-.04***
	.02	*.02*	*.03*	*.03*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
= BAC (*ref.: no dipl.*)	-.16***	-.16***	-.03	-.03	-.06**	-.06**	-.01	-.01	-.04**	-.04**
	.02	*.02*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
> BAC (*ref.: no dipl.*)	-.28***	-.28***	-.06**	-.06**	-.11***	-.11***	-.03*	-.03*	-.06***	-.06***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Employment										
Self-employed (*ref.: private*)	-.07**	-.07**	-.04	-.04	-.05*	-.05*	-.02	-.02	-.04**	-.04**
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Long-term jobs (*ref.: short term*)	-.12***	-.12***	-.09***	-.09***	-.10***	-.10***	-.02**	-.02**	-.04***	-.04***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Stable career (*ref.: unstable*)	-.02*	-.02*	-.02	-.02	-.03*	-.03*	.00	.00	-.01	-.01
	.01	*.01*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Physical strains	.10***	.10***	.06***	.06***	.09***	.09***	.02*	.02*	.01	.01
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Psycho. strains	.07***	.07***	.07***	.07***	.04**	.04**	.03***	.03***	.04***	.04***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Rho		.13		.09		.20**		.41***		.34***
		.09		*.07*		*.08*		*.11*		*.12*
N	3810									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Table 15: Auxiliary models of the probability of being retired – No civil servants

	Probit	Biprobit
Aged 60 or more	.17***	.17***
	.01	*.01*
Demographics		
Men (*ref.: women*)	.04***	.04***
	.01	*.01*
Age	.05	.05
	.03	*.03*
Age²	-.00	-.00
	.00	*.00*
Children (*ref.: none*)	-.00	-.01
	.02	*.02*
Education		
< BAC (*ref.: no dipl.*)	.02	.02
	.02	*.02*
= BAC (*ref.: no dipl.*)	.01	.01
	.02	*.02*
> BAC (*ref.: no dipl.*)	-.03	-.03
	.02	*.02*
Employment		
Self-employed (*ref.: private*)	-.14***	-.14***
	.02	*.02*
Long-term jobs (*ref.: short term*)	.10***	.10***
	.01	*.01*
Stable career (*ref.: unstable*)	.02**	.02**
	.01	*.01*
Physical strains	.02**	.02**
	.01	*.01*
Psycho. strains	.02	.02
	.01	*.01*
N	3810	

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Appendix 7: Robustness checks

Table 16: Tests with three instruments (age 55, 60 and 65)

Variable	Poor SAH	Chronic diseases	Activity limitations	GAD	MDE
	Biprobit	**Biprobit**	**Biprobit**	**Biprobit**	**Biprobit**
Retired	-.08	-.02	-.10**	-.11***	-.11***
	.05	.05	.04	.03	.03
Demographics					
Men (*ref.: women*)	.00	-.00	.02	-.04***	-.03***
	.01	.02	.01	*.01*	.01
Age	.06**	.02	.07***	.03*	-.04**
	.03	.03	.03	.01	.02
Age²	-.01*	-.00	-.01**	-.00	-.01*
	.00	.00	.00	.00	.00
Children (*ref.: none*)	-.03	-.03	.01	.03*	.03*
	.02	.03	.02	.02	.02
Education					
< BAC (*ref.: no dipl.*)	-.11***	-.03	-.04*	-.02	-.04***
	.02	.03	.02	.01	.01
= BAC (*ref.: no dipl.*)	-.04***	-.03	-.04	-.00	-.03**
	.03	.03	.03	.02	.02
> BAC (*ref.: no dipl.*)	-.26***	-.08**	-.09***	-.04**	-.07***
	.03	.03	.03	.02	.02
Employment					
Public sector (*ref.: private*)	-.02	-.01	-.05**	.01	.01
	.02	.02	.02	.01	.01
Self-employed (*ref.: private*)	-.08***	-.05	-.06**	-.04**	-.05**
	.03	.03	.03	.02	.02
Long-term jobs (*ref.: short term*)	-.11***	-.08***	-.09***	-.01	-.03***
	.02	.02	.02	.01	.01
Stable career (*ref.: unstable*)	-.02	-.01	-.02*	.01	-.01
	.01	.02	.01	.01	.01
Physical strains	.12***	.07***	.10***	.03***	.02**
	.02	.02	.02	.01	.01
Psycho. strains	.06***	.06***	.04**	.04***	.04***
	.02	.02	.02	01	.01
Rho	.15*	.10	.22***	.47***	.43***
	.09	.08	.08	.10	.12
N	4610				

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Table 17: Auxiliary models of the probability of being retired (age 55, 60 and 65)

	Probit	Biprobit
Aged 55 or more	-.00	-.00
	.03	*.03*
Aged 60 or more	.18***	.18***
	.02	*.02*
Aged 65 or more	.09***	.09***
	.03	*.03*
Demographics		
Men (*ref.: women*)	.03***	.03***
	.01	*.01*
Age	.10**	.10**
	.05	*.05*
Age²	-.00	-.00
	.00	*.00*
Children (*ref.: none*)	.01	.01
	.02	*.02*
Education		
< BAC (*ref.: no dipl.*)	.03**	.03**
	.02	*.02*
= BAC (*ref.: no dipl.*)	.02	.02
	.02	*.02*
> BAC (*ref.: no dipl.*)	-.01	-.01
	.02	*.02*
Employment		
Public sector (*ref.: private*)	.01	.01
	.01	*.01*
Self-employed (*ref.: private*)	-.15***	-.14***
	.02	*.02*
Long-term jobs (*ref.: short term*)	.12***	.12***
	.01	*.01*
Stable career (*ref.: unstable*)	.03***	.03***
	.01	*.01*
Physical strains	.04***	.04***
	.01	*.01*
Psycho. strains	.01	.01
	.01	*.01*
N	4610	

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Table 18: Estimation of linear probability models (LPM) using the generalized method of moments (GMM) with two instruments (60 and 65)

Variable	Poor SAH	Chronic diseases	Activity limitations	GAD	MDE
	LPM (GMM)	LPM (GMM)	LPM (GMM)	LPM (GMM)	LPM (GMM)
Intercept	-1.16	-.38	-1.76**	-.62	-.86*
	.85	*0,89*	*.77*	*0,44*	*.47*
Retired	-.06	-.02	-.09**	-.08***	-.09***
	.06	*.06*	*.04*	*.03*	*.03*
Demographics					
Men (*ref.: women*)	.02	.01	.02	-.04***	-.03***
	.01	*.01*	*.01*	*.01*	*.01*
Age	.06*	.02	.07**	.02	.03**
	.02	*.03*	*.03*	*.01*	*.02*
Age²	-.01*	-.01	-.01**	-.00	-.01*
	.00	*.01*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.02	-.03	.01	.02**	.02**
	02	*.03*	*.02*	*.01*	*.01*
Education					
< BAC (*ref.: no dipl.*)	-.12***	-.03	-.04*	-.02	-.05***
	.03	*.03*	*.02*	*.01*	*.02*
= BAC (*ref.: no dipl.*)	-.15***	-.03	-.04	-.01	-.04**
	.03	*.03*	*.03*	*.01*	*.02*
> BAC (*ref.: no dipl.*)	-.26***	-.07**	-.09***	-.03**	-.07***
	.03	*.03*	*.03*	*.02*	*.02*
Employment					
Public sector (*ref.: private*)	-.02	-.01	-.04***	.01	.01
	.02	*.02*	*.02*	*.01*	*.01*
Self-employed (*ref.: private*)	-.07***	-.04	-.06**	-.03**	-.04***
	.03	*.03*	*0,02*	*.01*	*.01*
Long-term jobs (*ref.: short term*)	-.11***	-.08***	-.10***	-.01	-.04***
	.02	*.02*	*.02*	*.01*	*.01*
Stable career (*ref.: unstable*)	-.02	-.01	-.02*	-.00	-.01*
	.01	*.02*	*.01*	*.00*	*0,00*
Physical strains	.12***	.07***	.11***	.03***	-.02**
	.02	*.02*	*.02*	*.01*	*.01*
Psycho. strains	.07***	.06***	.04**	.04***	.04***
	.02	*.02*	*.02*	*.01*	*.01*
Hansen's J stats.	.03	1.12	.63	.26	.36
Kleibergen-Paap F stat.	249.78	249.75	250.63	249.75	249.76
N	4610				

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Table 19: Auxiliary models of the probability of being retired – LPM (GMM)

	LPM (GMM)
Intercept	-.59
	.365
Aged 60 or more	.50***
	.02
Aged 65 or more	.06**
	.02
Demographics	
Men	.03***
(*ref.: women*)	.01
Age	-.01
	.02
Age²	.00
	.00
Children	.01
(*ref.: none*)	.01
Education	
< BAC	.03**
(*ref.: no dipl.*)	.01
= BAC	.03
(*ref.: no dipl.*)	.02
> BAC	-.02
(*ref.: no dipl.*)	.02
Employment	
Public sector	.01
(*ref.: private*)	.01
Self-employed	-.15***
(*ref.: private*)	.02
Long-term jobs	.12***
(*ref.: short term*)	.01
Stable career	.02***
(*ref.: unstable*)	.01
Physical strains	.04***
	.01
Psycho. strains	.01
	.01
N	4610

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Table 20: Retirement and health status – No endogenous covariates

Variable	Poor SAH		Chronic diseases		Activity limitations		GAD		MDE	
	Probit	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**	**Probit**	**Biprobit**
Retired	-.01	-.05	.02	-.03	-.02	-.09**	-.02	-.10***	-.02*	-.09***
	.02	*.05*	*.02*	*.05*	*.02*	*.04*	*.01*	*.03*	*.01*	*.03*
Demographics										
Men (*ref.: women*)	-.01	-.01	-.02	-.02	-.01	-.01	-.04***	-.04***	-.04***	-.04***
	.01	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*	*.01*
Age	.06**	.06**	.03	.03	.07***	.07***	.02	.03*	.03*	.03*
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.01*	*.02*	*.02*	*.02*
Age²	-.01**	-.01**	-.00	-.00	-.01**	-.01**	-.00	-.00	-.01*	-.01*
	.00	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*	*.00*
Children (*ref.: none*)	-.01	-.01	-.01	-.01	.02	.02	.03*	.03*	.03**	.03**
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.02*	*.01*	*.01*
Education										
< BAC (*ref.: no dipl.*)	-.15***	-.15***	-.06**	-.06**	-.07***	-.07***	-.02*	-.02	-.05***	-.05***
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
= BAC (*ref.: no dipl.*)	-.20***	-.20***	-.06**	-.06**	-.09***	-.09***	-.01	-.00	-.05***	-.05***
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.02*	*.01*	*.01*
> BAC (*ref.: no dipl.*)	-.33***	-.33***	-.12***	-.12***	-.15***	-.15***	-.04***	-.04**	-.08***	-.08***
	.03	*.03*	*.03*	*.03*	*.02*	*.02*	*.01*	*.02*	*.01*	*.01*
Employment										
Public sector (*ref.: private*)	-.06***	-.06***	-.04**	-.04**	-.08***	-.08***	-.00	.01	-.01	-.01
	.02	*.02*	*.02*	*.02*	*.02*	*.02*	*.01*	*.01*	*.01*	*.01*
Self-employed (*ref.: private*)	-.11**	-.11**	-.06**	-.06**	-.08***	-.08***	-.03**	-.04**	-.05***	-.05***
	.03	*.03*	*.03*	*.03*	*.03*	*.03*	*.02*	*.02*	*.02*	*.02*
Rho		.11		.08		.16**		.38***		.34***
		.08		*.08*		*.07*		*.11*		*.11*
N	4932									

Reading: *Marginal effects. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*

Table 21: Auxiliary models of the probability of being retired – No endogenous covariates

	Probit	Biprobit
Aged 60 or more	.17***	.17***
	.01	*.01*
Demographics		
Men	.06***	.06***
(*ref.: women*)	*.01*	*.01*
Age	.06**	.06**
	.03	*.03*
Age²	-.00	-.00
	.00	*.00*
Children	.01	.01
(*ref.: none*)	*.01*	*.01*
Education		
< BAC	.06***	.06***
(*ref.: no dipl.*)	*.01*	*.01*
= BAC	.04**	.04**
(*ref.: no dipl.*)	*.02*	*.02*
> BAC	.01	.01
(*ref.: no dipl.*)	*.02*	*.02*
Employment		
Public sector	.04***	.04***
(*ref.: private*)	*.01*	*.01*
Self-employed	-.15***	-.15***
(*ref.: private*)	*.02*	*.02*
N	4932	

Reading: *Coefficients. Standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey. Individuals aged 50-69 in 2010.*