Disentangling occupational and health paths : employment, working conditions and health interactions

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DISENTANGLING OCCUPATIONAL AND HEALTH PATHS: EMPLOYMENT, WORKING CONDITIONS AND HEALTH INTERACTIONS

Sous la Direction du **Professeur Thomas BARNAY**

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Abstract – Occupational and Health Paths

The objective of this Ph.D. Dissertation is to disentangle some of the many interrelationships between work, employment and health, mostly in a longitudinal approach. Establishing causal relationships between these three concepts is not easy, as many statistical biases generally undermine estimates, including selection biases and the three classical sources of endogeneity. This thesis proposes in a first chapter to study the effect of a mental health shock on workers' ability to remain in employment. The second chapter explores the possible sources of heterogeneity in the role of working conditions on health status by examining the effects of variable early-career exposures in terms of intensity and nature on the onset of chronic diseases. Finally, the third chapter deals with the end of the career and the decision to retire. The French panel data from the Health and Professional Path (Sip, *Santé et Itinéraire Professionnel*) survey with more than 13,000 respondents is used in this work, as well as several methodologies in order to take into account endogeneity biases, in particular methods relying on instrumental variables and methods for public policy evaluation (matching and difference-in-differences). The results confirm that employment, health and work are intimately related, with clear consequences of health shocks on employment and, conversely, a preponderant role of work on the determination of health status.

Keywords: work; employment; working conditions; retirement; general health; mental health; depression; anxiety; chronic diseases; childhood; endogeneity; instrumental variables; matching; panel methods; difference-in-differences; France.

Résumé – Parcours Professionnel et de Santé

L'objectif de cette thèse est de démêler quelques-unes des nombreuses interrelations entre travail, emploi et état de santé, la plupart du temps dans une logique longitudinale. Établir des relations causales entre ces trois dynamiques n'est pas chose aisée, dans la mesure où de nombreux biais statistiques entachent généralement les estimations, notamment les biais de sélection ainsi que les trois sources classiques d'endogénéité. Cette thèse se propose dans un premier chapitre d'étudier l'effet de la santé mentale sur la capacité à se maintenir en emploi des travailleurs. Le deuxième chapitre explore les possibles sources d'hétérogénéité du rôle des conditions de travail sur la santé en s'intéressant aux effets d'expositions variables en termes d'intensité et de nature en début de carrière sur les maladies chroniques. Enfin, le troisième chapitre traite de la fin de carrière et de la décision de départ en retraite. L'enquête en données de panel françaises de l'enquête Santé et itinéraire professionnel (Sip) comptant plus de 13 000 est utilisée dans cette thèse. Plusieurs méthodologies sont mises en place dans ce travail de manière à prendre en compte les biais d'endogénéité, notamment des méthodes en variables instrumentales ainsi que des méthodes d'évaluation des politiques publiques (appariement et différence-de-différences). Les résultats confirment qu'emploi, santé et travail sont intimement liés, avec respectivement des conséquences avérées des chocs de santé sur la trajectoire professionnelle, et inversement un rôle prépondérant du travail sur la santé.

Mots-clés : travail ; emploi ; conditions de travail ; retraite ; santé générale ; santé mentale ; dépression ; anxiété ; maladies chroniques ; enfance ; endogénéité ; variables instrumentales ; appariement ; méthodes de données de panel ; différence-de-différences ; France.

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À mon père.

À ma mère.

Summary

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General introduction

1. Work evolution and health consequences

1.1. Moving work

The face of employment in Europe is changing. Stock-wise and on the extensive margin, employment rates in EU28 reached 70.1% in 2015, nearing the pre-crisis levels of 2008 (Eurostat). These employment rates know important variations between countries (going from 54.9% for Greece to 80.5% in Sweden). When men's employment rates remained relatively stable between year 2005 and year 2015 (75.9%), women's knew a sizeable increase (60.0% in 2005, 64.3% in 2015) and even though older workers' is still rather low (53.3%), it also went up considerably since 2005 (42.2%). Yet, an important education-related gradient still exists, as only 52.6% of the less educated population is employed, when employment rates amount to 82.7% in the more educated. The results for France are slightly below the average of developed countries, as 69.5% of the population aged 20-64 is in employment (73.2% in men, 66% in women), but know a particularly weak level of employment in older workers (48.7%) in 2015. On the intensive margin, weekly working times in Europe have known a slight and steady decreasing trend since 2005, going from 41.9 hours to 41.4 hours in 2015 with rather comparable amounts between countries. France ranks at 40.4 hours a week.

What is also noticeable is that workers' careers appear to be more and more fragmented. When the proportion of workers employed with temporary contracts globally remained constant over the last decade in Europe (14.1% in total with 13.8% of men and 14.5% of women, 16.0% total in France), resorting to part-time job becomes more and more common. 17.5% of workers worked part-time in 2005, when almost one fifth of them do in 2015 (19.6% and 18.4% in France). The sex differences are very important: in 2015, only 8.9% of men worked part-time, when 32.1% of women did. Almost 4% of EU28 workers resort to a second job (from 0.5% in Bulgaria to 9.0% in Sweden and 4.3% in France). At the same time, unemployment rates also increased in Europe, going from 7% of the active population in 2007 (before the crisis) to 9.4% in 2015, and from 4.6% in Germany to 24.9% in Greece (10.4% in France). Long-term unemployment, intended as individuals actively seeking for a job for at least a year, also drastically increased during this period, going from 3.0% in 2007 to 4.5% in 2015 (1.6% in Sweden, 18.2% in Greece and 4.3% in France).

1.2. Intensificating work

On top of these more fragmented career paths, European workers face growing pressures at work. Notably, Greenan *et al.*(2014) indicate that, between 1995 and 2005, European employees have faced a degradation of their working-life quality. There has been a growing

interest in the literature for the health-related consequences of detrimental working conditions and their evolution. In a world where the development of new technologies, management methods, activity controls (quality standards, processes rationalization, *etc.*) as well as contacts with the public confront employees with different and increased work pressures (Askenazy and Caroli, 2010), the question of working conditions indeed becomes even more acute. When the physical strains of work have been studied for a long time, it has only been the case later on for psychosocial risk factors. Notably, the seminal *Job demand – Job control* model of Karasek (1979) and its variations (Johnson *et al.*, 1989; Theorell and Karasek, 1996) introduced a theoretical approach for these more subjective strains. Other models later included the notion of reward as a modulator, with the *Effort-Reward Imbalance* model (Siegrist, 1996). Whatever the retained indicators for strenuous working conditions, their role on health status seems consensual (Barnay, 2016).

These exposures to detrimental working conditions too, beyond possible evolutions in workers' perceptions of their own conditions at work (Gollac, 1994; Gollac *et al.*, 2014), have known several changes. If exposures to physical strains have slightly declined with the years, psychosocial strains have grown massively within the same time span. Exposures to physical risks as a whole almost remained constant since 1991 (Eurofound, 2012). Some risks declined in magnitude, when some others increased: tiring and painful positions (46% of the workforce) and repetitive hand or arm movements for instance (being the most prevalent risk of all, with 63% of workers exposed). Men are the most exposed to these risks. At the same time, subjective measures for work intensity increased overall for the past 20 years. 62% of workers reported tight deadlines, 59% high speed work, with workers having potentially less opportunities to alter the pace of their work. The level of one's control on his/her job also seem to evolve in a concerning way: 37% of workers report not being able to choose their method of work; 34% report not being able to change the order of their tasks and 30% not being able to change their speed of work, among other indicators (Eurofound, 2012). The situation in France also appeared to deteriorate between 2006 and 2010, gradually linking high levels of physical strains with low levels of job autonomy: increases in exposures to high work intensity, emotional demands, lack of autonomy, tensions and especially lack of recognition (as measured in the *Santé et Itinéraire Professionnel* 2006 and 2010 surveys by Fontaine *et al.*, 2016).

1.3. Everlasting work

These evolutions are even more alarming that we work longer than we used to, and that we are going to work even longer in the future. Three major factors are in line to explain this situation. First, we live longer. Eurostat projections for the evolution of life expectancy in Europe indicate that, between 2013 and 2060, our life expectancy at age 65 will increase by 4.7 years in men and 4.5 years in women (European Commission, 2014). The regularly increasing life expectancy comes, as a consequence, with an increase in the retirement/work-life imbalance, inducing financing issues.

Second, despite the objective set at the Stockholm European Council to achieve an employment rate of 50% for those aged 55-64 years old by year 2010, the European average was still only 47.4% in 2011 (Barnay, 2016), and only reached 53.3% in 2015 (Eurostat 2016). These particularly low employment rates for senior workers can be explained by a number of factors (economic growth not producing enough new jobs, poor knowledge of existing retirement frameworks, unemployment insurance being too generous, insufficient training at work for older workers, *etc.*). Notably, even though workers may have the capacity to stay in employment longer (García-Gómez *et al.*, 2016), they can also be explained by the role of strenuous careers and degraded *Health Capital* (health status seen as a capital stock, producing life-time in good health – Grossman, 1972), increasing risks of job loss or sick leave take-ups (Blanchet and Debrand, 2005). The obvious consequence is that potentially too few older workers contribute to the pension system in comparison to the number of recipients.

Hence, because of these first two points, the third factor is that *pay-as-you-go* systems are more often than not facing growing deficits. To counter this phenomenon, European governments have progressively raised retirement ages and/or increased the contribution period required to access full pension rights. In France, increases in the contribution period required to obtain full-rate pensions (laws of July 1993 and August 2003) followed by gradual increases of the retirement age of 60 years-old for the generation born before July, 1st 1951 and 62 years-old for those born on or after January 1st 1955 (law of November 2010) have been introduced. The aim of these reforms was to compensate for longer life spans, ensuring an intergenerational balance between working- and retirement-lives, allowing “fair treatment with regard to the duration of retirement and the amount of pensions” (Article L.111-2-1 of the French Social Security Code). As a result of these reforms, the relationship between working lives and retirement has remained relatively constant for generations born between 1943 and 1990 (Aubert and Rabaté, 2014), inducing longer work lives.

1.4. Affordable work: what are the health consequences?

Unaccounting for the possible exposures to detrimental conditions faced by individuals at work, being in employment has overall favourable effects on health status. Notably being in employment, among various social roles (such as being in a relationship or being a parent) is found to be correlated with lower prevalence of anxiety disorders and depressive episodes (Plaisier *et al.*, 2008), beyond its obvious positive role on wealth and well-being. This link between health (especially mental health) and employment status is confirmed by more econometrically robust analyses, notably by Llena-Nozal *et al.* in 2004. This relationship appears to be different depending on sex, as it seems stronger in men. This virtuous relationship between health status and employment is corroborated by another part of the literature, focusing on job loss. When being employed seems to protect one's health capital, being unemployed is associated with more prevalent mental health disorders, especially in men again (Artazcoz *et al.*, 2004). Losing one's job is logically also associated with poorer levels of well-being (Clark *et al.*, 2008), even more so considering the first consequences may be observed before lay-off actually happens (Caroli and Godard, 2016). In any case massive and potentially recurring unemployment periods are notorious for their adverse effects on health status (Böckerman and Ilmakunnas, 2009; Haan and Myck, 2009; Kalwij and Vermeulen, 2008). Retirement also comes with likely negative health consequences (Coe and Zamarro, 2011).

Nevertheless, and even if health status seems to benefit from employment overall, exposures to detrimental conditions at work are a factor of health capital deterioration. Factually, close to a third of EU27 employees declares that work affects their health status. Among these, 25% declared a detrimental impact when only 7% reported a positive role (Eurofound, 2012). Thus, in a Eurofound (2005) report on health risks in relationship to physically demanding jobs, the results of two studies (one in Austria and the other in Switzerland) were used to identify the deleterious effects of exposures on health status. In Austria, 62% of retirements are explained by work-related disabilities in the construction sector. In Switzerland, significant disparities in mortality rates exist, depending on the activity sector. On French data, Platts *et al.* (2016) show that workers who have faced physically demanding working conditions have a shorter life expectancy, in the energy industry. In addition, Goh *et al.* (2015) determine that 10% to 38% of disparities in life expectancy between cohorts can be attributed to exposures to poor working conditions.

1.5. Which are the options?

Because careers are more fragmented than they used to (see Section 1.1) with at the same time increasing and more diversified pressures at work (Section 1.2) and because careers tend to be longer (Section 1.3), health consequences are or will be even more sensible (Section 1.4). From the standpoint of policy-makers, all of this comes as new challenges, with the objective being to ensure that employment in general and the work-life in particular remain sustainable (*i.e.* workers being able to remain in their job throughout their career). A lot of public policies are hence targeting this objective. In Europe, the European Union is competent in dealing with Health and Safety matters, which in turn is one of the main fields of European policies. The Treaty of Functioning of the European Union allows the implementation, by the means of directives, of minimum requirements regarding "improvement of the working environment to protect workers' health and safety". Notably, employers are responsible of adapting the workplace to the workers' needs in terms of equipment and production methods, as explicated in Directive 89/391/EEC (Barnay, 2016).

In France, the legislative approach is mostly based on a curative logic. As far as the consideration of work strains is concerned, a reform in 2003 introduced explicitly the notion of *Pénibilité* (work drudgery), through Article 12 (Struillou, 2003). This reform failed because of the difficulty to define this concept, and to determine responsibilities. A reform in 2010 followed by creating early retirement schemes related to work drudgery, with financial incentives. 3,500 workers in 2013 benefited from early retirement because of exposures to detrimental working conditions inducing permanent disabilities. Early 2014, a personal account for the prevention of work drudgery is elaborated, allowing workers to accumulate points related to different types of exposures during their career (focusing exclusively on physical strains). Reaching specific thresholds, workers are eligible to trainings in order to change job, to access part-time work paid at full rate or early retirement schemes. According to the Dares (*Direction de l'animation de la recherche, des études et des statistiques* – French ministry for Labour Affairs), 18.2% of employees could be affected by exposure to these factors (Sumer Survey 2010).

Whatever the scheme considered (account for work drudgery, dedicated early retirement schemes and/or compensation schemes for occupational accidents and illnesses), the curative logic of *ex post* compensation has for a long time prevailed almost exclusively. However, more recent plans highlight the importance of prevention in the relationship between health and work. In France, three successive Health and Work Plans (*Plan Santé Travail*) have been

instigated since 2005, with the latter (*Plan Santé Travail 2016-2020*) emphasising on primary prevention and work-life quality. The results of these successive plans are mixed. However, other strategies coexist, mostly focusing on reducing illness-induced inequalities on the labour market (see the *Troisième Plan Cancer* for an example on cancer patients), an easier insertion on the labour market of workers suffering from mental health disorders and greater support to help them remaining in their job (*Plan Psychiatrie et santé mentale 2011-2015*), or any other handicap (notably a law in 1987, reinforced in 2005, binds employers from both public and private sectors to hire a minimum of 6% of disabled workers in their workforce) (Barnay *et al.*, 2016).

2. Work-Health influences: the importance of the individual biography

On the side of theoretical and empirical research, relationships between health, work and employment are particularly difficult to disentangle, because every part of the health and work cycles are linked with each other, and because their initial determinants happen very early in one's life (a summary of these interrelationships can be found in Figure I, which also highlights the specific interactions that will be studied in this Ph.D. Dissertation). First, studying such relationships is rather demanding in terms of available data. Not so many international surveys or administrative databases allow researchers to get information on professional paths, employment status, working conditions as well as health status and individual characteristics, while allowing temporal analyses. This scarcity of available data is even more pronounced when considering the French case. The need for temporal data (panel data, cohorts, *etc.*) is particularly important, as the relationships existing between health and professional paths are imbricated, with the weight of past experiences or shocks having potentially sizeable consequences on the decisions and on the condition of an individual, at any given point in time.

Then, the first determinants of future health and professional cycles can be found as early as the childhood period. Beyond elements happening *in utero* (described in the *latency approach* – Backer, 1995), significant life events or health conditions happening during the early-life of individuals are able to explain, at least partly, later outcomes for health and employment. For instance, poor health levels or the presence of disability during childhood are found to induce detrimental consequences on mental health at older ages as well as the appearance of chronic diseases (Llena-Nozal *et al.*, 2004). The consequences are also sensible on career paths. Because healthier individuals are usually preferred at work, especially in demanding jobs, the

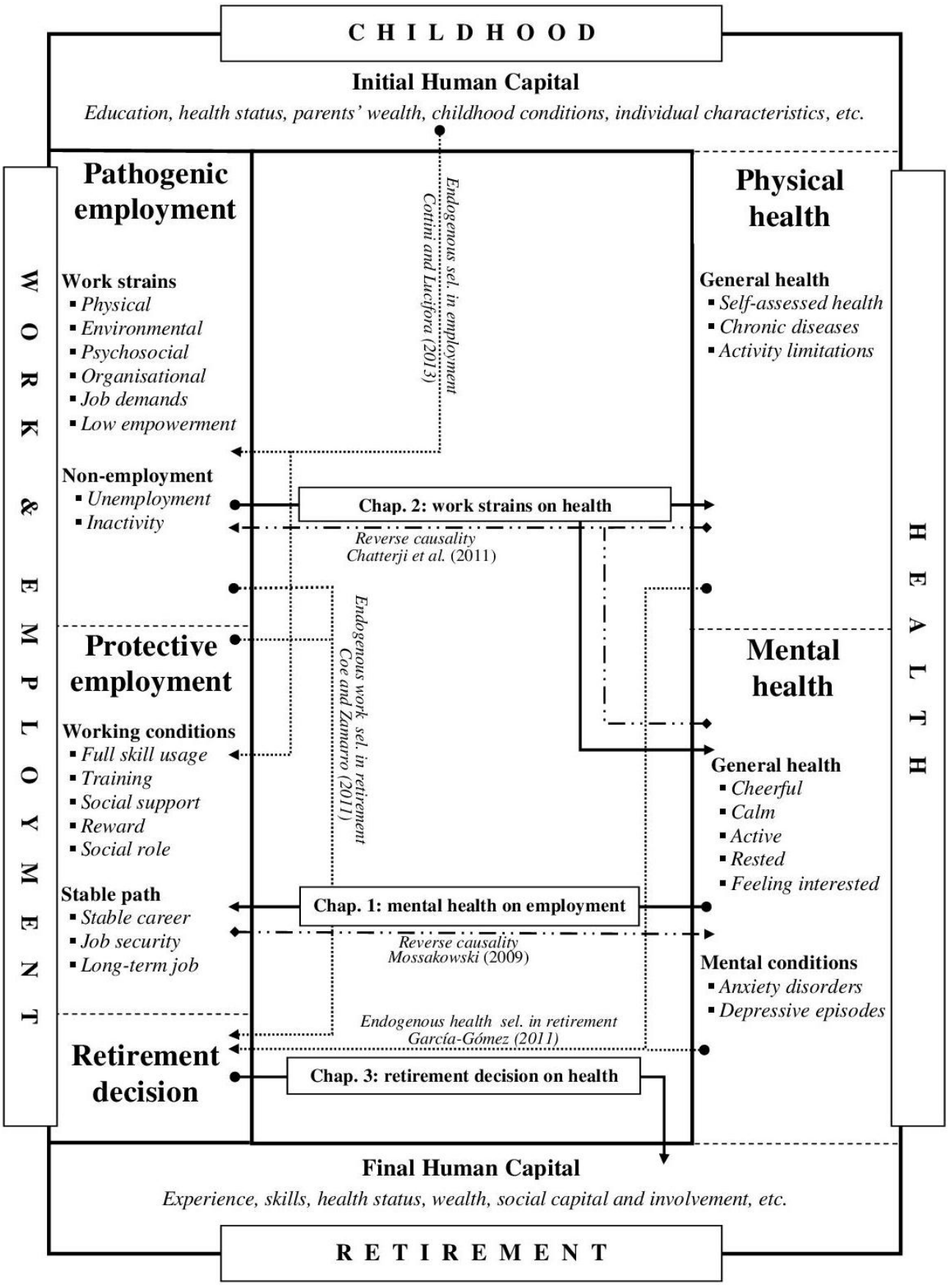
initial health capital is bound to play a major role in employability levels, at least during the first part of one's career (see the *Healthy Worker Effect*) (Barnay, 2016). Health status is not the only relevant determinant. Elements related to the socioeconomic background during childhood also benefited from several studies in the empirical literature. For instance, Lindeboom *et al.* (2002) demonstrated that one's environment during childhood impacts the likelihood to face, later on, occupational accidents and disabilities. Health consequences can also be expected in individuals who shortened their initial studies (Garrouste and Godard, 2016). Early conditions, unaccounted for, hence may very well generate methodological difficulties when assessing the impact of work on health, notably because of selection effects.

These initial circumstances indeed bear consequences over to the next part of one's life: the professional career and contemporary health status. Individuals facing poor conditions during childhood are then potentially more exposed to harder circumstances during their work life, for instance lower levels of employability when at the same time, facing unemployment early on in the career is found to generate ill-health. Low initial levels of *Human Capital* (intended as the stock of knowledge, habits, social and personality attributes that contributes to the capacity for one to produce – Becker, 1964), including health capital, impact all elements related to work and employment outcomes, ranging from increased exposures to certain types of detrimental working conditions (notably physical exposures in the lower-educated), greater probabilities to be employed part-time or in temporary contracts and overall more fragmented careers. Because of that, the health status of these originally disadvantaged individuals is likely to deteriorate even further. It is also true that contemporary health determines current employment outcomes, causing particularly detrimental *vicious circles* and inducing reverse causality issues. During this professionally active part of one's life, other shocks may happen. Illnesses or the death of a close relative or partner or marital separations, for instance, have a negative impact on health status (Dalgard *et al.*, 2006; Lindeboom *et al.*, 2002). Financial difficulties, are they current or older, are also often associated with the onset of common mental disorders (Weich and Lewis, 1998). When these shocks are unobserved, disentangling the role of the career on health status from other shocks appears as particularly tricky.

When considering the last part of one's career from the retirement decision onwards, the accumulation of all these circumstances throughout an individual's life cycle reinforce potential selection effects (Barnay, 2016). The decision to retire, because it is partly based on health status and the nature of the professional career, can possibly be massively altered, as much as later levels of human capital. Retirees who faced difficult situations at work in terms

of employment or working conditions are more likely to be in worst health conditions than others (Coe and Zamarro, 2011). Hence, originally because of poor initial life conditions (in terms of health or socioeconomic status), individuals may face radically changed professional and health paths. Moreover, at any time, elements of health status, employment or working conditions can also positively or negatively influence the rest of the life cycle, bearing repercussions until its end.

Figure I: Summary of Work-Health relationships in the Ph.D. Dissertation



3. Research questions

3.1. Health-Work causality: theoretical background

The theoretical relationships between work and health status can be analysed under the double expertise of health and labour economics.

The initial model of Grossman (1972) proposes an extension of the Human Capital theory developed by Becker (1964) by introducing the concept of Health Capital. Each individual possesses a certain level of health capital at birth. Health status, originally regarded as exogenous in the "demand for medical care" model by Newhouse and Phelpsen (1974), is supposed to be endogenous and can be both demanded (through demands for care) and produced by consumers (concept of investment in health). Individuals decide on the level of health that maximizes their utility and make trade-offs between time spent in good and poor health. In a later model for the demand of health, health capital is seen as an element allowing the output of *healthy time* (Grossman, 1999). This model offers a possibility for intertemporal analysis to study health both in terms of level and depreciation rate over the life cycle (Barnay, 2016). If the depreciation rate of health capital mostly refers to a biological process, health care consumption, health investment and labour market characteristics also influence this rate. The time devoted to work can increase (in the case of demanding work) or decrease (in case of a high quality work life) the rate of depreciation of health capital. Notably, in the case of an individual facing a very demanding job, the depreciation rate of his/her health capital over the life cycle is progressively rising, inducing an increasing price (or *shadow price* as it is hardly measurable) of health, just like for the ageing process. It is particularly the case in the less educated workers, who constitute a less efficient health-producing workforce (Grossman, 1999). Contradictory effects can then occur simultaneously as work can also be beneficial to health status (in comparison to non-employment), but the drudgery induced by certain working conditions can accelerate its deterioration (Strauss and Thomas, 1998).

In this context, exposure to past working conditions may partly explain the differential in measured health status. Notably, the differences in wages between equally productive individuals can be explained by differences in the difficulty of work-related tasks, meaning workers with poorer working conditions are paid more than others in a perfectly competitive environment (Rosen, 1974). In this framework, it is possible to imagine that health capital and wealth stock are substitutable, hence workers using their health in exchange for income (Muurinen and Le Grand, 1985). Individuals can therefore decide, depending on their utility function, to substitute part of their health capital in a more remunerative work, due to harmful

exposures. However, despite the hypothesis retained by Muurinen (1982) in an extension of Grossman (1972), working conditions are probably not exogenous. Several selection effects may exist, both in entering the labour market and in the capacity to occupy and remain in strenuous jobs for longer periods, thereby discrediting the hypothesis of exogeneity. These effects refer to characteristics of both the labour supply and demand. First, it can be assumed that the initial human capital (initial health status and level of education) of future workers will determine, in part, their entry conditions into the labour market but also the ability to "choose" a supposedly more or less strenuous job. Then, employers can also be the source of selection effects, based on criteria related to employees' health and their adaptability to demanding positions. Part of the empirical literature relying notably on testing methods testify of the existence of discriminations towards disabled individuals, including discriminations in employment (Bouvier and Jugnot, 2013). Thus, whether for health or for work, the hypothesis of exogeneity does not seem to be acceptable.

3.2. Health-Work causality: empirical resolution

If this exogeneity hypothesis does not seem trivial in a theoretical analysis, it is even more the case in an empirical framework.

First, selection biases are very common in the study of Health-Work relationships. For instance, one's health status may be determined by his/her former levels of human capital or past exposures to strenuous careers. Another example would be that the choice of a job is also made according to several characteristics, including constitutive elements of the initial human capital. Individuals may choose their job according to their own preferences, but also based on their education, health condition or childhood background. Thus, when unaccounted for, this endogenous selection may result in biased estimates in empirical studies. In particular, because healthier individuals may tend to prefer (self-selection) or to be preferred (discrimination) for more demanding jobs (Barnay *et al.*, 2015), researchers could face an overrepresentation of healthy yet exposed workers in their samples. In this case, the estimations are likely to be biased downwards because of individuals being both healthier and exposed to demanding jobs being overrepresented in the sample (inducing a *Healthy Worker Effect* – Haan and Myck, 2009). On the other hand, workers with lesser levels of initial health capital may benefit from fewer opportunities on the labour market and thus be restricted to the toughest jobs, leading in that case to an overrepresentation of initially unhealthy and exposed individuals, resulting in an upward bias of the estimates.

The Health-Work relationships are also more often than not plagued with reverse causality biases. The link between health status and employment is indeed bidirectional. When studying the role of a given health condition on one's capacity to be in employment for instance, it is quite easily conceivable that employment status is also able to partly determine current health status. A lot of empirical studies face this particular issue (see Chatterji *et al.*, 2011 for an example on mental health). In particular, being unemployed may impair individuals' mental health (Mossakowski, 2009). On the other hand, studying the role of employment on health status also suffers from this very same bias. In the literature, the causal role of retirement on health status has long been plagued with reverse causality, inducing that individuals with poorer levels of health capital were the ones to retire earlier. Again, most recent empirical works acknowledged this possibility (Coe and Zamarro, 2011).

The omission of variables leads to unobserved heterogeneity, which is also potentially a source of endogeneity when measuring such relationships. Some information is very rarely available on survey or administrative data, because of the difficulty to observe or quantify it. Among numerous others, family background or personality traits (Banerjee *et al.*, 2015), involvement and motivations (Nelson and Kim, 2008), risky health-related behaviours, subjective life expectancy, risk aversion preferences or disutility at work (Eibich, 2015) are mostly unobserved, thus omitted in most studies. Yet, these factors, remaining unobservable may therefore act as confounders, or as endogeneity sources when correlated with both the error term and observable characteristics. These unobserved individual or time-dependant heterogeneity sources may hence result in biased estimations (Lindeboom and Kerkhofs, 2009).

Finally, measurement errors or declarative biases can also be highlighted. When working on sometimes sensitive data like health-related matters or risky behaviours as well as some difficult work situations, individuals may be inclined to alter their declarative behaviours. For instance, individuals may alter their health status declarations in order to rationalize their choices on the labour market in front of the interviewer (Zhang *et al.*, 2009). Also, the non-participation to the labour market may be justified *ex-post* by the declaration of a worse health status. Lindeboom and Kerkhofs (2009) and Gannon (2009), showed that economic incentives are likely to distort health status declarations. There may also be declarative social heterogeneity in terms of health status, specifically related to sex and age (Devaux *et al.*, 2008; Shmueli, 2003). It is often argued that men have a tendency to under declare their

health condition when it is the contrary for women. Older individuals tend to consider their own health status relatively to their age, hence often overestimating their health condition.

3.3. Research questions and motivation

Do common mental health impairments (depression and anxiety) impact workers' ability to remain in employment (Chapter 1)? – Studies on the impact of mental health impairments on employment outcomes are numerous in the empirical literature, at an international level. This literature is diverse in its measurement of mental health: when many studies focus on heavy mental disorders such as psychoses or schizophrenia (Greve and Nielsen, 2013), a growing part of this literature is based on more common, less disabling disorders such as stress, anxiety or depression. This empirical literature has been focusing in more recent years on handling the inherent biases linked to the endogeneity of mental health indicators as well as declarative biases (Gannon, 2009; Lindeboom and Kerkhofs, 2009) in the study of the capacity of individuals suffering from mental health problems to find a job or to sustain their productivity levels. In particular, the relationship between mental health and employment appears to be bidirectional (Banerjee *et al.*, 2015; Chatterji *et al.*, 2011), and unobserved characteristics such as risk preferences, workers' involvement at work, personality traits, family background or risky behaviours are likely to induce biased estimates of the effect of mental health on employment (Nelson and Kim, 2008; Zhang *et al.*, 2009). In the economics literature accounting for these biases, it is found that mental health impairments do impact individuals' capacity to find a job. Banerjee *et al.* (2015), Chang and Yen (2011) and Chatterji *et al.* (2011) all find that individuals suffering from common mental health disorders are less likely to be in employment than others. This effect is found to vary among different groups, according to age (Zhang *et al.*, 2009) and more importantly to sex, with mixed evidence: Ojeda *et al.* (2010) and Zhang *et al.* (2009) find a stronger effect on men's employment outcomes when Frijters *et al.* (2014) on women's. Yet this literature, while mostly focusing on one's capacity to find a job, does not provide evidence on the role of mental health conditions in individuals already in employment, on their capacity to keep their job. The specific role of physical health status is also unaccounted for in most studies when it may act as a cofounding factor when analysing the specific effect of mental health on employment outcomes. Thus the first research question of this Ph.D. Dissertation will be to understand the role of common mental impairments in the ability to remain in employment.

Do varying levels of exposure to detrimental physical and psychosocial working conditions differently impact health status (Chapter 2)? – The role of working conditions on workers' health status has received considerable attention in the scientific literature, when it is not as much the case in the economic literature because of the biases it faces. First, the choice of a job by an individual is not made at random (Cottini and Lucifora, 2013), but the reasons and consequences of this selection bias are potentially contradictory. Healthier individuals may indeed prefer or be preferred for more arduous jobs, but it is also possible to imagine that individuals with a lesser initial health capital may be restricted to the toughest jobs. Then, unobserved characteristics (individual preferences, risk aversion behaviours, shocks, crises) may also induce biased estimates (Bassanini and Caroli, 2015). Because of the lack of panel data linking both working conditions and health status indicators on longer periods, few papers actually dealt with these methodological difficulties. The economic literature generally finds strong links between exposures to detrimental working conditions and poorer health conditions. Specifically, physical strains like heavy loads, night work, repetitive work (Case and Deaton, 2003; Choo and Denny, 2006; Debrand and Lengagne, 2008; Ose, 2005) as well as environmental exposures such as exposures to toxic or hazardous materials, extreme temperatures (Datta Gupta and Kristensen, 2008) and psychosocial risk factors like *Job strain* and social isolation do impact a variety of physical and mental health indicators (Cohidon *et al.*, 2010; Cottini and Lucifora, 2013; de Jonge *et al.*, 2000). This average instantaneous effect of exposures has been decomposed by Fletcher *et al.* (2011) in order to account for chronic exposures, and notably by the psychosocial literature in general to account for simultaneous exposures. More often than not, this literature is plagued with inherent issues coming from selection biases into employment and individual and temporal unobserved heterogeneity. On top of that, no study accounts for cumulative effects of strains due to both potentially simultaneous and chronic exposures, nor is the possibility of delayed effects on health status accounted for. The second research question is dedicated to the heterogeneous influence of varying levels of exposures (in terms of chronic or simultaneous exposures) to detrimental physical and psychosocial working conditions on health status.

What is the effect of retirement on general and mental health status in France (Chapter 3)? – Much has been said about the role of retirement on health conditions at the international level (Barnay, 2016). A big proportion of the studies in economics accounts for the endogeneity biases related to reverse causality (health status determines the decision to retire or not – García-Gómez, 2011, or the pace of this decision – Alavinia and Burdorf, 2008;

Jones *et al.*, 2010), unobserved heterogeneity and the specific role of ageing. The overall effect of retirement on health status differs greatly, depending on the outcome chosen. When the decision to retire appears beneficial to one's self-assessed health status and mental health indicators such as anxiety and depression (Blake and Garrouste, 2012; Coe and Zamarro, 2011; Grip *et al.*, 2012; Insler, 2014; Neuman, 2008), it seems to be the contrary for other mental health conditions, such as cognitive abilities (Behncke, 2012; Bonsang *et al.*, 2012; Dave *et al.*, 2008; Rohwedder and Willis, 2010). The reasons of the beneficial health effects of retirement have been studied more recently, notably by Eibich (2015), showing that retirement had a positive effect on being a non-smoker, a range of social and physical activities. Yet, the literature faces difficulties to accurately account for the nature of past professional careers of retirees, when it appears as one of the most important determinant of both the decision to retire and health status (Coe and Zamarro, 2011). It is indeed very likely that individuals relieved from arduous jobs will face the greatest improvements when it comes to their health condition after retirement. Generally speaking, single studies also rarely assess both potential heterogeneity sources and mechanisms simultaneously. This is even more the case for the French situation, where the literature on retirement and its impact on health status is very scarce. The third research question hence refers to the heterogeneous effect of retirement on general and mental health status in France.

4. Outline

My Ph.D. Dissertation relies on the use of a French panel dataset: the French Health and Professional Path survey ("*Santé et Itinéraire Professionnel*" – Sip). This survey was designed jointly by the French Ministries in charge of Healthcare and Labour. The panel is composed of two waves (one in 2006 and another one in 2010). Two questionnaires are proposed: the first one is administered directly by an interviewer and investigates individual characteristics, health and employment statuses. The second one is self-administered and focuses on more sensitive information such as health-related risky behaviours (weight, alcohol and tobacco consumption). Overall, more than 13,000 individuals are interviewed in 2006 and 11,000 of them in 2010 as well, making this panel survey representative of the French population. The main strength of this survey, on top of the wealth of individual data, is that it also contains a lifegrid allowing the reconstruction of a biography of individuals' lives: childhood, education, health, career and working conditions as well as major life events, from the beginning of one's life to the date of the survey. This allows for a great health and professional description, notably in terms of major work-related events.

Chapter 1 aims to measure, in 4,100 French workers aged 30-55 in 2006, the causal impact of self-assessed mental health in 2006 (in the form of anxiety disorders and depressive episodes) on employment status in 2010. In order to control for endogeneity biases coming from mental health indicators, bivariate probit models, relying on childhood events and elements of social support as sources of exogeneity, are used to explain simultaneously employment and mental health outcomes. Specifications control for individual, employment, general health status, risky behaviours and professional characteristics. The results show that men suffering from at least one mental disorder (depression or anxiety) are up to 13 percentage points (pp) less likely to remain in employment. Such a relationship cannot be found in women after controlling for general health status. Anxiety disorders appear as the most impactful on men's capacity to remain in employment, as well as being exposed to both mental disorders at the same time ($-14pp$), in comparison to only one ($-5pp$).

Chapter 2 estimates the causal impact of exposures to detrimental working conditions on self-declarations of chronic diseases. Using a rebuilt retrospective lifelong panel for 6,700 French individuals and defining indicators for physical and psychosocial strains, a mixed econometric strategy relying on difference-in-differences and matching methods taking into account for selection biases as well as unobserved heterogeneity is implemented. For men and women, deleterious effects of both types of working conditions on the declaration of chronic diseases after exposure can be found, with varying patterns of impacts according to the strains' nature and magnitude. In physically exposed men (*resp.* women), exposures are found to explain around 10% (*resp.* between 20% to 25%) of the total number of chronic diseases. Psychosocial exposures account, in men (*resp.* women), for 17% (*resp.* 21%) of the total number of chronic diseases.

Chapter 3 assesses the role of retirement on physical and mental health outcomes in 4,600 French residents, aged 50-69 in 2010. Methodological issues coming from endogeneity biases such as reverse causality and unobserved characteristics are addressed by an instrumental variables method relying on discontinuities induced by legal ages of retirement. Unaccounting for endogeneity biases, no significant effect of retirement on health status as a whole are found. When instrumenting by legal ages of retirement, consistent and large effects on activity limitations, anxiety disorders and depressive episodes are found. These effects are heterogeneous: men, low-educated workers and more exposed individuals to physical or psychosocial strains during the career appear as the most relieved after retirement. Such a positive effect of retirement on health status could be explained by mechanisms such as social

activities and the practice of sport (more frequent in retirees) and evolutions in health-related risky behaviours (retirees are less often smokers, but consume more alcohol and are more often overweight).

Chapter I: Mental health and job retention

THE INFLUENCE OF MENTAL HEALTH ON JOB RETENTION

This chapter is co-written with Thomas BARNAY (Paris-Est University)

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Introduction

Mental health (covering psychiatric disorders and psychotropic drug treatments without psychiatric pathologies identified in the health insurance database) accounts for 15% of the expenses of the CNAM-TS (National health insurance fund for salaried workers) in 2011, an expenditure superior to that of cancer treatment. More than seven million people are affected in France. Mental health problems are the cause of reduced work productivity and an increase in unemployment and sick-leaves, which would account for 3% to 4% of the GDP according to the International Labour Organisation (2000) and explain 40% of physical disabilities in high-income countries according to the World Health Organization (2010). In addition, the Psychiatry and Mental Health Plan 2011-2015 demonstrates the major role of mental health in current social issues. It explicitly states that access to – and retention in – employment for individuals with mental illnesses requires better support.

The issue of job retention for people with mental disorders appears to be essential for several reasons. It is established that overwork deteriorates both physical and mental health (Bell *et al.*, 2012). Moreover, the intensity of work (high pace and lack of autonomy) and job insecurity lead employees to face more arduous situations. In addition part-time jobs, when not chosen, affects mental health (Robone *et al.*, 2011).

The relationship between mental health and employment has been widely documented in the literature, establishing a two-way causalities between the two. A precarious job or exposure to detrimental working conditions can affect mental health. Self-reported health indicators are also characterized by justification biases and measurement errors as well as reporting social heterogeneity (Akashi-Ronquest *et al.*, 2011; Etilé and Milcent, 2006; Shmueli, 2003). Mental health, when subjective, is specifically associated with a measurement bias prompting to unravel the links between physical and mental health. Just like for physical health status, selection effects are also at work, an individual with mental disorders being found less often in employment. Mental health measurements are also potentially subject to a specific selection bias linked to the psychological inability to answer questionnaires.

Our goal is to establish a proper causality of mental health on job retention using French data. This study is inspired by Jusot *et al.* (2008) who measure the impact of physical health and risky behaviours on leaving employment four years later. While many studies focus on the role of mental health on employability, not a lot of them acknowledge its impact on workers' capacity to remain in their jobs. We also expend on the literature by considering the

endogeneity biases generated by reverse causality (effect of employment on mental health). Another addition is that we take into account for the role of physical health status which may very well act, when unaccounted for, as a cofounding factor when analysing the specific effect of mental health on employment outcomes. To our knowledge, no French study has empirically measured the specific effect of mental health on job retention while addressing these biases.

To do this, we use data from the Health and Professional Path survey (Sip, *Santé et Itinéraire Professionnel*), which allows the collection in 2006 of a set of indicators (socio-economic characteristics, health and risky behaviours), but also on the career characteristics from a complete retrospective questionnaire on employment and health events of more than 13,000 individuals. A temporal dimension is allowed by a second wave in 2010. The mental health indicators are based on self-reported measurements for generalized anxiety disorders (GAD) and major depressive episodes (MDE). Using bivariate probit models, we evaluate the causal effect of self-reported mental health in 2006 on employment in 2010 after controlling for reverse causality. The challenge is then to identify one or more instruments explaining mental health status in 2006 while meeting the validity assumption.

We articulate our article as follows. We expose in a literature review the main empirical results linking mental health and employment status. We then present the database and empirical strategy. A final section presents the results and concludes.

1. The links between mental health and employment

1.1. Mental health measurements

The economic literature establishing the role of mental health on employment mainly retains two definitions of mental health. The first one focuses on heavy mental disorders, such as psychoses (Bartel and Taubman, 1986). Notably, many studies evaluate the ability to enter the labour market for individuals with schizophrenia (Greve and Nielsen, 2013). The second one is based on more common but less disabling disorders such as stress or depression. Often used to assess mental health, these disorders are observed using standardized measures and are presented in the form of scores. Thus, the Kessler Psychological Distress Scale (K-10) allows, from 10 questions about the last 30 days, to evaluate individuals' overall mental state (Dahal and Fertig, 2013; Kessler *et al.*, 2001; Zhang *et al.*, 2009). Like in the K-10 questionnaire, the Short-Form General Health Survey (SF-36) evaluates mental health over the past four weeks with questions about how individuals feel (excitement, sadness, lack of energy, fatigue, ...)

(Frijters *et al.*, 2014). Another quite similar score was built, this time focusing on senior workers (age 50-64): the Center for Epidemiologic Studies Depression Scale (CES-D), with more specific questions such as isolation and self-esteem (Chang and Yen, 2011).

However the simplification risk linked to the aggregate nature of these scores justified the setup of other indicators to better approximate the true mental health diagnosis. Indicators of generalized anxiety disorders and major depressive episodes were then used, allowing a further analysis of mental health (Banerjee *et al.*, 2015; Chatterji *et al.*, 2011). They allow to identify the population suffering from these disorders and their symptoms (see Appendix 1 and Appendix 2). Despite their specificity and without being perfect substitutes to a medical diagnosis, these indicators prove robust to detect common mental disorders.

In addition, the subjective nature of the declaration of health in general and particularly of mental health, makes it difficult to make comparisons between two apparently similar declarations (Zhang *et al.*, 2009), notably due to reporting biases (Devaux *et al.*, 2008; Shmueli, 2003). Devaux *et al.* (2008) try to assess the importance of reporting biases in mental health and unveil that a *latent health condition* greatly contributes to mental health: two individuals may declare different mental health conditions depending on their general and physical health status. A person with a poor general condition will indeed be more likely to report a more degraded mental health status than a person in good general health. Leach *et al.* (2008) confirm these results and show a strong correlation between physical and mental health, particularly among women.

1.2. The influence of mental health on employment: a short literature review

1.2.1. Methodological difficulties

If the measurement of mental health from declarative data is not trivial, the relationship between mental health and employment is also tainted by endogeneity biases associated with reverse causality and omitted variables. From a structural point, we can quite easily conceive that if mental health and employment are observed simultaneously, the relationship will be bidirectional (Banerjee *et al.*, 2015; Chatterji *et al.*, 2011). In particular, being unemployed may impair individuals' mental health (Mossakowski, 2009).

The omission of variables leads to unobserved heterogeneity, which is also potentially a source of endogeneity when measuring the impact of mental health on employment. Risk preferences (Zhang *et al.*, 2009), workers' involvement at work and the ability to give satisfaction (Nelson and Kim, 2008), personality traits, family background (Banerjee *et al.*,

2015), risky behaviours (smoking, alcohol and overweight) are related to mental health as much as employment. These factors, remaining unobservable for some of them in household surveys, therefore act as confounders. Zhang *et al.* (2009) conclude, from Australian data (pooled data from the National Health Survey – NHS) and multivariate probit methods, that tobacco consumption in men and women as well as overweight in women increase the risk of reporting mental disorders. These behaviours are also shown to have a specific effect on the situation on the labour market (Jusot *et al.*, 2008).

Finally, it is possible to highlight some justification biases. Individuals may alter their health status declarations in order to rationalize their choices on the labour market in front of the interviewer (Zhang *et al.*, 2009). For example, the non-participation to the labour market can be justified *ex-post* by the declaration of a worse health status. Lindeboom and Kerkhofs (2009) showed on Dutch panel data using fixed effects models, that economic incentives are likely to distort health status declarations. This still seems to be the case on Irish panel data and after controlling for unobserved heterogeneity (Gannon, 2009).

1.2.2. Effects of mental health on employment

To address these methodological issues, the empirical literature makes use of instrumental variables and panel data models allowing to take care of unobserved heterogeneity by including fixed effects and reverse causality by a time gap between exogenous variables and the outcome.

Whatever the mental health indicators, the various studies appear to converge on a detrimental role of deteriorated mental health on employment outcomes. Thus, Banerjee *et al.* (2015) find, using bivariate Probit models and Two-Stage Least Squares (2SLS) performed on cross-sectional data, that people suffering from mental disorders (major depressive episodes and generalized anxiety disorders) in the 12 last months are much less likely to be in employment than others at the time of the survey. They do not find a significant effect of these mental conditions on the number of weeks worked and days of sick-leaves in individuals in employment after controlling for socioeconomic characteristics, chronic diseases and the area of residence in the U.S. territory. Chatterji *et al.* (2011) show, on cross-sectional data using two-stage (2SLS and bivariate probit) and Altonji Elder and Taber modelling (AET – Altonji *et al.*, 2005) and taking into account unobserved heterogeneity, that these mental disorders appearing in the last 12 months reduce by an average of 15% the likelihood to be in employment at the time of the survey. An American study, resorting in instrumental variable methods, found that most people with mental disorders are in employment, but more

pronounced symptoms reduce their participation to the labour market (Ojeda *et al.*, 2010). Finally, simultaneous modelling on Taiwanese pooled data confirms that a degraded mental health decreases the probability of working, while specifying that the prevalence of these disorders is lower among workers, thus inducing a protective effect of work on mental health (Chang and Yen, 2011). Cottini and Lucifora (2013) also confirm reverse causality in the relationship, using instrumental variables in three waves of the European Working Conditions Survey (EWCS), stressing the negative effects of poor working conditions on mental health.

These average effects are heterogeneous according to age and sex. Zhang *et al.* (2009) conducted stratified regressions on two age groups: the 18-49 years-old on the one hand and the 50-64 years-old on the other hand and find that mental health-related discriminations on the labour market are greater in middle-aged workers than for older workers. Sex effects are also important. The role of mental disorders on employment seems stronger in men (Ojeda *et al.*, 2010; Zhang *et al.*, 2009). However, there is no consensus on this fact in the literature. Frijters *et al.* (2014) show a stronger effect of mental health on women's employment, using Australian panel data (Household, Income and Labour Dynamics in Australia – HILDA) and several models, including bivariate Probit and fixed effects model.

1.3. What instrument(s) for mental health?

It is necessary to identify an instrument whose influence on mental health is established in the empirical literature (1.3.1) without being correlated with the error term (1.3.2).

1.3.1. The determinants of mental health

Determinants and other factors related to mental health are numerous in the literature and can be classified into three categories: social determinants, major life events and work-related factors.

Social factors refer to the society role of the individual and to his/her social relationships. Plaisier *et al.* (2008) identify three types of social roles being correlated with a better mental health condition: the roles of partner, parent and worker. Being in a relationship is associated with a stronger declaration of good mental health and a lower risk of depression and anxiety (Kelly *et al.*, 2011; Plaisier *et al.*, 2008). Endorsing the two roles of parent and partner seems linked to a better mental health. Professional activity can slow the depreciation rate of one's mental health capital, as shown by a study on panel data taking into account the endogenous nature of the relationship between health and employment (Llena-Nozal *et al.*, 2004). In contrast, Artazcoz *et al.* (2004) show that unemployment is often correlated with worse

mental health status among men and in women to a lesser extent. The combinations of these roles correspond to increased chances of reporting good mental health condition by 39% (Artazcoz *et al.*, 2004; Plaisier *et al.*, 2008).

Major life events also play a role in the determination of mental health. Unemployment and furthermore inactivity occurring during the beginning of professional life can induce the onset of depressive symptoms later on, as shown on U.S. panel data by Mossakowski (2009). Using a fixed effects framework on panel data, Lindeboom *et al.* (2002) establish that events such as illnesses or death of a close relative or partner impairs mental health. Moreover, marital separations and serious disputes within or outside the couple seem correlated with poorer mental health (Dalgard *et al.*, 2006; Kelly *et al.*, 2011). Past or present financial problems are also often associated with the occurrence of common mental disorders such as depression and anxiety (Laaksonen *et al.*, 2008; Weich and Lewis, 1998), as well as the deterioration of physical health (especially in women) (Leach *et al.*, 2008). A poor health status or the presence of disability during childhood also bears negative consequences on mental health at older ages and on the declaration of chronic diseases, regardless of the onset age (Llena-Nozal *et al.*, 2004).

Work-related factors may also have an effect on mental health. Atypical labour contracts such as part-time jobs increase the occurrence of depressive symptoms in employees (Santin *et al.*, 2009). Bildt and Michélsen (2002) show, using multivariate models, that exposure to detrimental working conditions can have a deleterious effect on mental health four years later, with sex-related differences. Men would be most affected by changes in tasks and a lack of recognition at work when in women, other specific conditions such as the role of the lack of training and lack of motivation and support at work are highlighted. Other factors linked to sex and associated with poorer mental health are found by Cohidon *et al.* (2010): the preponderance of work, contacts with the public, repetitive tasks and the lack of cooperation at work in men and the early beginning of career and involuntary interruptions in women.

1.3.2. Instruments in the literature and choices in our study

In the diversity of explanatory factors for mental health, only some of them have been retained in the economic literature as valid and relevant instruments. Frijters *et al.* (2014) used the death of a close friend intervened in the twelve months preceding the survey as an instrument for mental health. Hamilton *et al.* (1997) used the stressful events in life, the regularity of sport and a lagged mental health indicator, the latter being also used by Banerjee *et al.* (2015). The psychological status of parents (Ettner *et al.*, 1997; Marcotte *et al.*, 2000),

the one of children (Chatterji *et al.*, 2011; Ettner *et al.*, 1997), social support (Alexandre and French, 2001; Hamilton *et al.*, 1997; Ojeda *et al.*, 2010) were also frequently introduced. These factors were privileged because of them being valid determinants of mental health while meeting the exogeneity assumption, either because of their temporal distance from the other factors explaining employment or because of their absence of direct effects on employment. We make use of this literature by choosing proxies of mental health during childhood (violence suffered during this period and having been raised by a single parent) and an indicator for psychological status and social support during adult life (marital breakdowns), with a different approach according to sex, as suggested by the literature. Doing so, we put some temporal distance between these events and employment status (events occurring during childhood are observed up to 18 years-old whereas our working sample includes only individuals aged 30 and older; marital ruptures occur before 2006), and there is a low probability of direct effects of these instruments on the employment status of 2010, the professional route characteristics, employment at the time of the survey and risky behaviour being also controlled for.

2. Empirical analysis

2.1. The *Santé et Itinéraire Professionnel* survey

The *Santé et Itinéraire Professionnel* (Sip) used in this study provides access to a particularly detailed individual description. 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 conducted 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 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 informs 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.

In this study, we focus on people who responded to the survey both in 2006 and 2010, *i.e.* 11,016 people. We select individuals aged 30-55 years in employment in 2006 to avoid including students (see Appendix 3 and Appendix 4 for a discussion of the initial selection made on the sample in 2006 and a note on attrition between the two waves). The final sample thus consists of 4,133 individuals, including 2,004 men and 2,129 women.

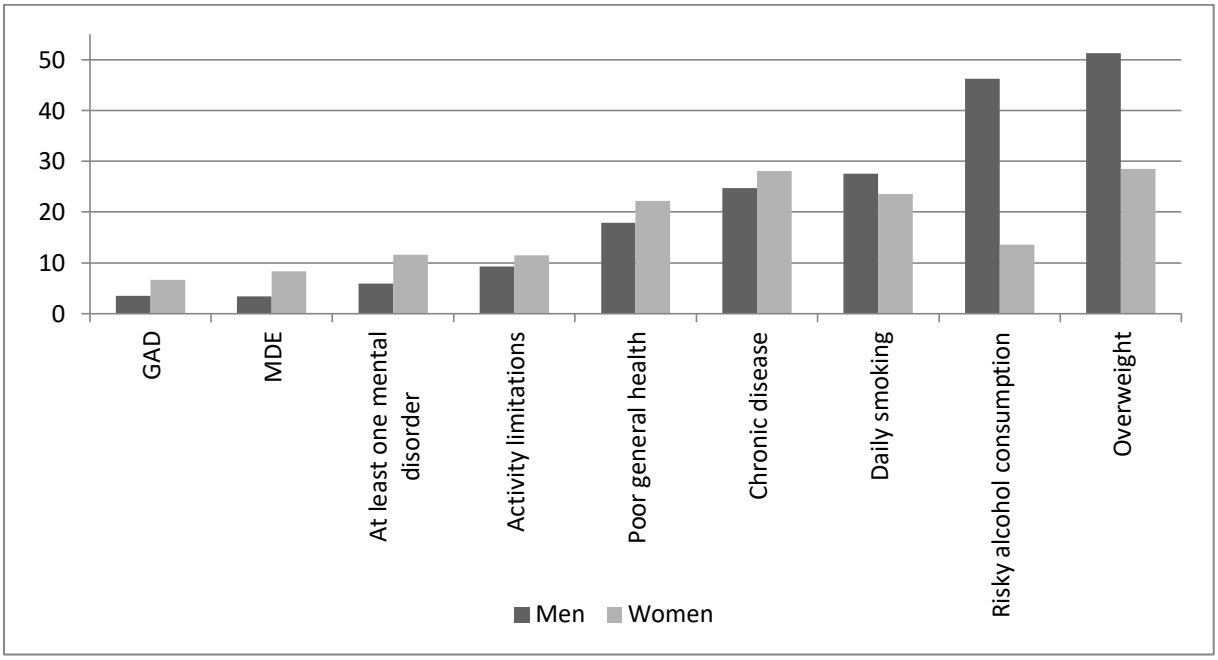
2.2. Descriptive statistics

2.2.1. Health status of the employed population in 2006

To broadly understand mental health, we use major depressive episodes (MDE) and generalized anxiety disorder (GAD), from the *Mini International Neuropsychatric Interview* (MINI), based on the *Diagnostic and Statistical Manual of Mental disorders* (DSM-IV). These indicators prove particularly robust in the Sip survey (see Appendix 5). Around 6% of men and 12% of women in employment in 2006 report having at least one mental disorder (Figure II).

The description of the general sample is presented in Table 29 (Appendix 6). Women report more frequent physical and mental health problems: anxiety disorders (7%), depressive episodes (8%), poor perceived health status (22%) and chronic illness (28%) are more widely reported by women than by men (*resp.* 4%, 3 %, 18% and 25%). These response behaviours are frequently raised by the literature and testify at least for some of them of the presence of reporting biases (rather downwards for men, and rather on the rise for women), as shown notably in Devaux *et al.* in 2008 or by Shmueli in 2003. Conversely, risky behaviours are substantially more developed in men. It is the case for daily smoking (28% in men *vs.* 24% in women) but it is even more acute for alcohol consumption (46% *vs.* 14%) and overweight (51% *vs.* 29%).

Figure II: Prevalence of health problems in the population in employment in 2006



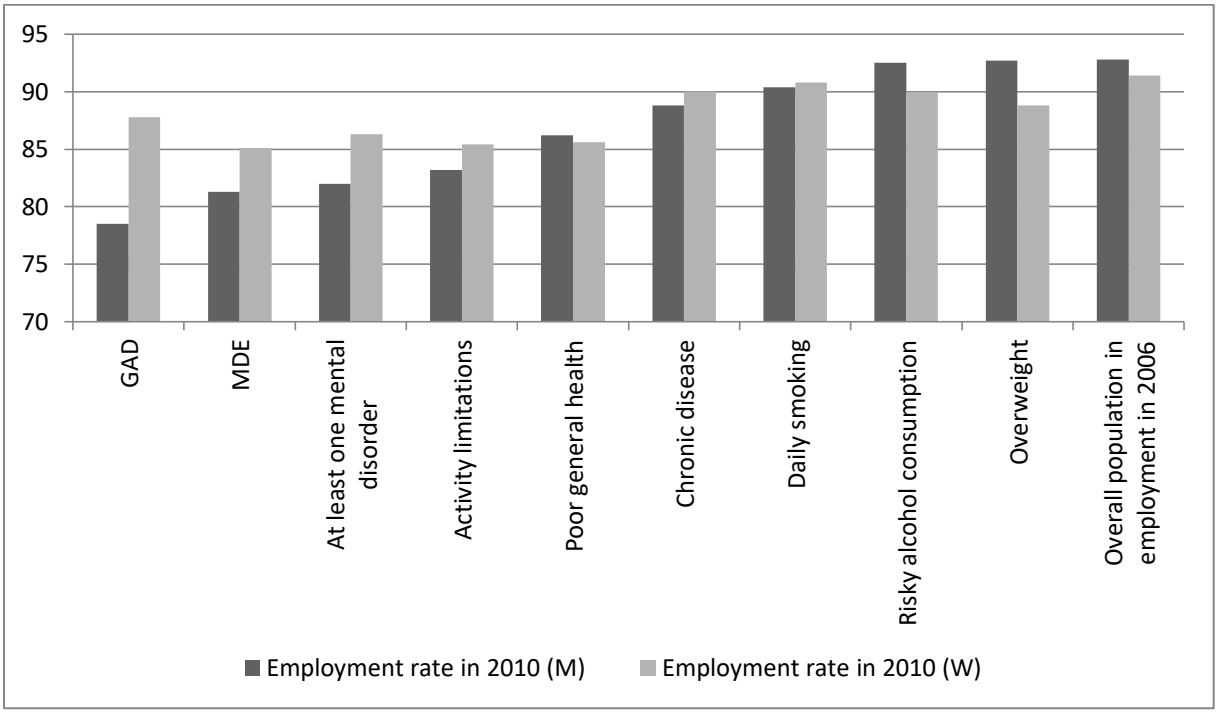
Reading: *6% of men and 12% of women report having at least one mental disorder (GAD or MDE) in 2006.*
Field: *individuals age 30-55 in employment in 2006.*
Source: *Sip (2006), weighted and calibrated statistics.*

2.2.2. Health problems and job retention

82% of men in employment and suffering from at least one mental disorder in 2006 are still in employment in 2010, against 86% of women[1]. Anxiety disorders have the biggest influence: 79% of men are employed (*vs.* 88% of women). General health status indicators show fairly similar results for men and women. For risky behaviours, daily tobacco consumption showed no significant difference in employment rates between men and women while alcohol (93% *vs.* 90%) and overweight (93% *vs.* 89%) are associated with comparatively lower employment rates for women than for men (Figure III).

[1] *Given the weakness of some of the subsample sizes, one must be cautious about the conclusions suggested by these descriptive statistics on mental disorders. GAD are faced by 88 men and 195 women and MDE respectively by 91 and 236. 150 men and 335 women declare suffering from at least one mental disorder.*

Figure III: Employment rates in 2010 according to self-reported health status in 2006

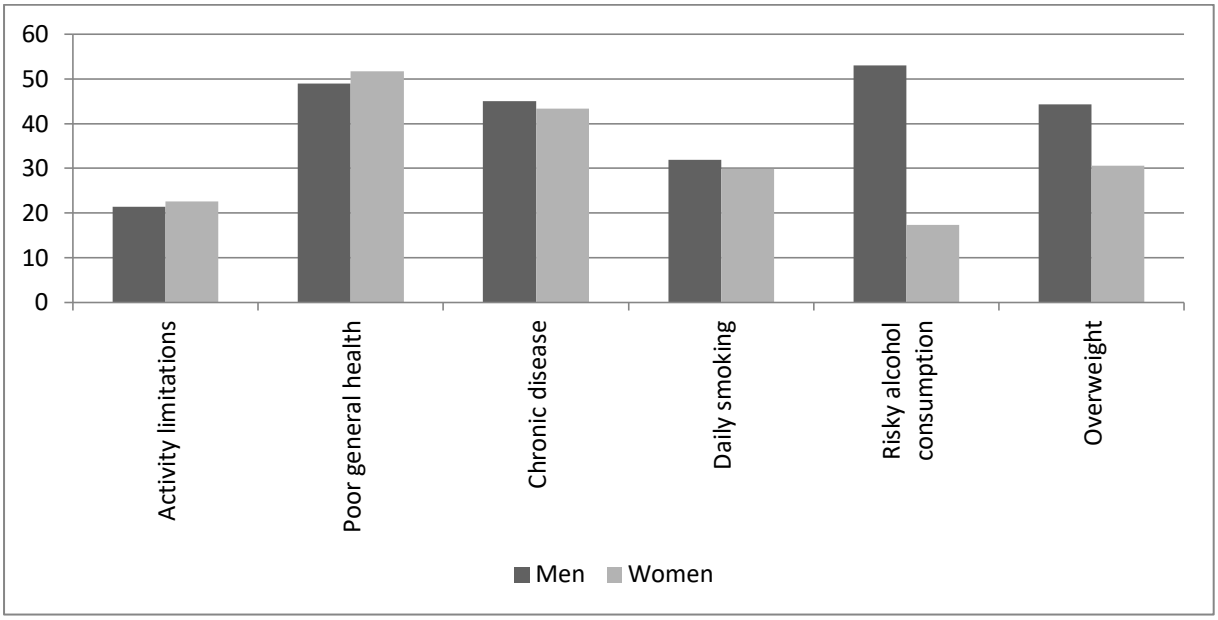


Reading: *82% of men in employment and suffering from at least one mental disorder (GAD or MDE) in 2006 are still in employment in 2010, against 86% of women.*
Field: *individuals age 30-55 in employment in 2006.*
Source: *Sip (2006), weighted and calibrated statistics.*

2.2.3. Mental health and general health status

A strong correlation between general and mental health status is observed in the sample. About 20% of men and women suffering from at least one mental disorder also reported activity limitations against 10% in the entire sample with normal mental health condition (see Figure II). Nearly 50% of them report poor perceived health (*vs.* 20% overall). Chronic diseases (45% *vs.* 25%) and daily tobacco consumption (30% *vs.* 25%) are also more common among these individuals. 53% of men and 17% of women with mental disorders declare risky alcohol consumption, against 46% and 13% *resp.* in the overall sample. Finally, overweight is declared by 44% of men and 31% of women with mental disorders, against *resp.* 51% and 29%. It is interesting to note that men with at least one mental disorder are less likely to report being overweight (Figure IV).

Figure IV: General health status of anxious and/or depressed individuals in 2006



Reading: *53% of men reporting mental disorders in 2006 also have risky alcohol consumption in 2006, against 17% of women.*
Field: *individuals age 30-55 in employment in 2006 who reported having at least one mental health disorder.*
Source: *Sip (2006), weighted and calibrated statistics.*

2.3. Econometric strategy

2.3.1. Univariate models

The econometric strategy is based on two steps to correct individual heterogeneity and the possibility of reverse causality.

In a first step, we initiate binomial univariate probit models to estimate, among people in employment in 2006, the effect of mental health in 2006 on the likelihood to remain in employment in 2010 (in employment *vs.* unemployed – dependent variable $y_{i,2010}$). Several specifications are tested and we stratify by sex for each one of them due to strong gendered differences in mental health linked to social heterogeneity in declarations (Artazcoz *et al.*, 2004; Devaux *et al.*, 2008; Leach *et al.*, 2008). We take a three-step strategy to gradually add relevant variable groups in the model and thus assess the robustness of the correlation between mental health in 2006 and employment in 2010 by gradually identifying confounders.

The first baseline specification (1) explains job retention by mental health status, controlling for a set of standard socioeconomic variables:

$$y^*_{i,2010} = \alpha + \beta MH_{i,2006} + \gamma SE'_{i,2006} + \varepsilon_i$$
$$y_{i,2010} = \begin{cases} 1 \; if \; y^*_{i,2010} > 0 \\ 0 \; if \; y^*_{i,2010} \leq 0 \end{cases} \quad (1)$$

Mental health in 2006 ($MH_{i,2006}$) is represented by a binary variable taking the value 1 when individual i is suffering from a generalized anxiety disorder or a major depressive episode, or both. Socio-economic variables are represented by the vector $SE'_{i,2006}$. They include age (in five-year increments from 30 to 55 years), marital status, presence of children, educational level, professional category, industry sector, type of employment (public, private, or independent) and part-time work. Age plays a major role on the employability of individuals and in the reporting of mental disorders (Devaux *et al.*, 2008; Shmueli, 2003). Current marital status and the presence of children in the household can also affect employability (especially in women) and reported mental health since people in a relationship with children turn out to be in better health status (Artazcoz *et al.*, 2004; Plaisier *et al.*, 2008). Work characteristics are also integrated (Llena-Nozal *et al.*, 2004).

An intermediate specification (2) is then performed with the addition of three variables from the European Mini-Module about individuals' general health status: their self-assessed health (taking the value 1 if it is good, and 0 for poor health), the fact that they suffer from chronic diseases or not and whether they are limited in their daily activities. These health status indicators are used in order to effectively isolate the specific effect of depression and anxiety on the position on the labour market (to disentangle it from the one of the *latent general health status* – Devaux *et al.*, 2008). This model also includes three variables of risky behaviours: being a daily smoker, a drinker at risk or overweight. The objective of these variables is to determine to which extent the role of mental health does not go partly through risky behaviours (Butterworth *et al.*, 2012; Jusot *et al.*, 2008; Lim *et al.*, 2000). Such behaviours are indeed known to affect the reporting of activity limitations in general (Arterburn *et al.*, 2012), employability (Paraponaris *et al.*, 2005), or the incidence of disease and premature mortality (Teratani *et al.*, 2012) as well as work-related accidents (Bourgkard *et al.*, 2008; Teratani *et al.*, 2012).

Finally, the last specification (3) adds two variables related to the professional route, reconstructed using retrospective information which is likely to play a role on the individual

characteristics in 2006 and employment transitions observed between 2006 and 2010. The objective is to control our results of potentially unstable careers (state dependence phenomenon), leading to a greater fragility on the labour market (Kelly *et al.*, 2011; Mossakowski, 2009). These variables include time spent in contracts of more than 5 years and the stability of the employment path, represented by the number of transitions made between jobs over 5 years, short periods of employment, periods of unemployment of more than one year and periods of inactivity.

$$y^*_{i,2010} = \alpha + \beta MH_{i,2006} + \gamma SE'_{i,2006} + \delta GH'_{i,2006} + \omega PR'_i + \varepsilon_i$$
$$y_{i,2010} = \begin{cases} 1 \; if \; y^*_{i,2010} > 0 \\ 0 \; if \; y^*_{i,2010} \leq 0 \end{cases} \quad (3)$$

General health status variables and risky behaviours in 2006 are presented in vector $GH'_{i,2006}$ and control variables on the professional route are included in the PR'_i vector. Thus, the relationship between the employment status of 2010 and mental health status in 2006 is controlled for general health status, health-related risky behaviours and elements linked to the professional route.

However, as widely explained in the literature, our mental health variable potentially suffers from endogeneity biases. Direct reverse causality is most likely ruled out since there is a time gap between our measure of mental health (2006) and that of employment (2010) and the fact that the nature of the past professional career (and status in employment in 2006 *de facto*) are taken into account. However, some individual characteristics (unobserved individual heterogeneity) linked not only to employment but also to mental health are not included in our model and the measurement of mental health is likely to be biased. We are in the presence of an endogenous mental health variable, due to omitted variables.

2.3.2. Handling endogeneity biases

In order to take into account this endogeneity issue, we set up a bivariate probit model. As suggested by the literature (Chatterji *et al.*, 2011; Frijters *et al.*, 2014; Ojeda *et al.*, 2010) dealing with biases related to mental health variables, we set up a methodology using bivariate probit modelling estimated by maximum likelihood. It is somewhat equivalent to the conventional linear two-stage approaches.

The two simultaneous equations to estimate can be written as follow:

$$y^*_{i,2010} = \alpha + \beta MH_{i,2006} + \gamma SE'_{i,2006} + \delta GH'_{i,2006} + \omega PR'_i + \varepsilon_i \quad (4)$$

$$MH^*_{i,2006} = \alpha' + \gamma' SE'_{i,2006} + \delta' GH'_{i,2006} + \omega' PR'_i + \varepsilon'_i \quad (5)$$

$$y_{i,2010} = \begin{cases} 1 \; if \; y^*_{i,2010} > 0 \\ 0 \; if \; y^*_{i,2010} \leq 0 \end{cases} \qquad MH_{i,2006} = \begin{cases} 1 \; if \; MH^*_{i,2006} > 0 \\ 0 \; if \; MH^*_{i,2006} \leq 0 \end{cases}$$

where ε_i and μ_i are the respective residuals for esquations (4) and (5). Despite the inclusion of these control variables, it is likely that the residuals of these two equations are correlated, inducing $\rho = Corr(\varepsilon_i, \varepsilon'_i | SE'_{i,2006}, GH'_{i,2006}, PR'_i) \neq 0$.

Several reasons can be stated. First, in the case of simultaneous observations of health status and employment outcomes, there is a high risk of reverse causality. In our case, to the extent that both are separated by several years, we limit this risk. However, it seems possible that there are unobserved factors that affect not only mental health condition but also the capacity to remain employed, such as individual preferences or personality traits. Notably, an unstable employment path before 2006 is one of the explanatory factors of the mental health of 2006 as well as of the employment status of 2010 (state dependence). Thus, only estimating equation (4) would result in omitting part of the actual model.

In such a case, a bivariate probit modelling is required in the presence of binary outcome and explanatory variables (Lollivier, 2006). A new specification (6) is therefore implemented, taking the form of a bivariate probit model using specification (3) as the main model and simultaneously explaining mental health by three identifying variables (vector $Ident'_i$):

$$\begin{cases} y^*_{i,2010} = \alpha + \beta MH_{i,2006} + \gamma SE'_{i,2006} + \delta GH'_{i,2006} + \omega PR'_i + \varepsilon_i \\ MH^*_{i,2006} = \alpha' + \theta Ident'_i + \gamma' SE'_{i,2006} + \delta' GH'_{i,2006} + \omega' PR'_i + \varepsilon'_i \end{cases} \quad (6)$$

$$y_{i,2010} = \begin{cases} 1 \; if \; y^*_{i,2010} > 0 \\ 0 \; if \; y^*_{i,2010} \leq 0 \end{cases} \qquad MH_{i,2006} = \begin{cases} 1 \; if \; MH^*_{i,2006} > 0 \\ 0 \; if \; MH^*_{i,2006} \leq 0 \end{cases}$$

We assume that the error terms follow a bivariate normal distribution:

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

In theory it is possible to estimate such a model without resorting to identifying variables (exclusion condition). However it is generally preferred, in the empirical literature, to base estimates on the exclusion criterion and use identifying variables. The identifying variables used in this study are chosen in line with the literature on the determinants of mental health

status and are taken from Sip's lifegrid: we use the fact of having been raised by a single parent, having suffered from violence during childhood from relatives or at school and finally having experienced many marital breakdowns. We differentiate our instruments by sex[2]: for men, we retain having suffered violence and marital breakdown; for women, having suffered violence and having been raised by a single parent.

Using a binary endogenous variable of mental health, there is no real specialized test to assess the validity of our identifying variables. However, correlation tests have been conducted (presented in Table 32 and Table 33, Appendix 7) to determine if they are likely to meet the validity and relevance assumptions. According to these limited tests, our three identifying variables are not likely to breach these assumptions. This intuition also tends to be confirmed by the estimates for ρ, the comparison of univariate and bivariate estimations for employment status (Table 1 and Table 2) and for mental health (Table 34, Appendix 7) (see section 3.2). On a more theoretical standpoint, because we only consider individuals aged 30 or more in 2006 (*i.e.* being in employment since some time in 2010) and because violence and the fact of being raised by a single parent relate to events occurring during childhood (before age 18), we are confident that these variables should not have a direct impact on employment status in 2010 (especially considering the stability of career paths are accounted for and because only individuals in employment are selected in our sample). On the other hand, marital breakdowns should not specifically be correlated with men's behaviour on the labour market[3].

3. Results

3.1. A poor mental health condition decreases the likelihood to remain in employment

We test three specifications of the probability of being employed in 2010 among people employed in 2006 in order to decompose the effect of mental health in 2006 but also to try taking into account for confounding factors.

The baseline model presented in Table 1 for men and Table 2 for women (specification 1) shows that men and women suffering from GAD and/or MDE in 2006 are less likely to remain in employment in 2010, after controlling for the individual and employment characteristics of 2006. Men in employment and declaring suffering from at least one mental

[2] *Following the dedicated literature indicating strong sex-linked relationships in the determinants for mental health, we decided to differentiate our instruments for men and women. Initial estimations including all three instruments (available upon request) have still been conducted, indicating similar yet slightly less precise results.*

[3] *The data management has been done using SAS 9.4. The econometric strategy is implemented in Stata 11 using respectively the "probit" and "biprobit" commands.*

disorder in 2006 are in average 9 percentage points (pp) less likely to remain in employment in 2010 ($5pp$ less likely in women). The other determinants of employment however differ between men and women in agreement with what other French studies have observed (Barnay, 2005). In addition to mental health, in women, the predictors of unemployment are age (over 45), the presence of children, agricultural or industrial sectors (*vs.* services), belonging to the private or public sectors (*vs.* self-employed) and part time work. It is interesting to note that within this selected population (*i.e.* in employment in 2006), professional categories have no role on employment trajectory between 2006 and 2010. In men, being 50 and over in 2006, the lack of education, celibacy and professional category (blue collars are most likely to leave the labour market) are all significant factors of poor labour market performance. The only common denominator between men and women appears to be the role of mental health and age.

In specification 2, we include general health status (self-assessed health, chronic diseases and activity limitations) and risky behaviours (daily tobacco consumption, risky alcohol drinking and being overweight). This new specification allows the assessment of potential indirect effects of mental health, transiting through the latent health status (Devaux *et al.*, 2008). In the male population, the coefficient associated with mental health declines slightly (the decline in the probability of remaining in employment falls from $9pp$ to $7pp$) but remains very significant. Activity limitations ($-3pp$) and daily tobacco consumption ($-4pp$) also play a role in job loss regardless of the effect of mental health. Being observed simultaneously, it is not possible to disentangle the causal relationship between general health, mental health and risky behaviours in this type of models but the explicit inclusion of these variables tends to reduce social employment inequalities in our results. In the female population, the impact of health status on employment does not seem to go through mental health as we measure it but more through a poor general health status and activity limitations ($-4pp$). Risky behaviours however appear to have no impact on job retention in women.

Past professional career information (in terms of security and stability of employment) is added in a third specification. It allows to control for the nature of the professional career, influencing both mental health and employment. While stable job trajectories (marked by long-term, more secure jobs) favours continued employment between 2006 and 2010, the deleterious effect of poor mental health condition on employment is resilient to this third specification in men. In women, employment stability does not participate to the transitions in employment between 2006 and 2010.

Just like in the empirical literature, it appears that we basically find the most conventional determinants influencing the labour market on our data. Age, the presence of children and part-time work among women, the level of education and professional category in men are found to have a significant impact on the ability for individuals to remain in employment. Mental health is found to be very significant in men but not in women, which again appears to be in line with the literature (Chatterji *et al.*, 2011; Ojeda *et al.*, 2010; Zhang *et al.*, 2009). The study of Frijters *et al.* (2014) however goes in the opposite direction, indicating a stronger effect in women which could possibly be explained by the lack of controls for general health status in this study, while the links between physical and mental health are strong in women (Devaux *et al.*, 2008; Leach *et al.*, 2008). As an illustration, our regressions also find a significant effect of mental health in women when we do not take into account general health status (Table 2, specification 1). Being a daily smoker is shown to have important consequences on men's employment in 2010, in agreement with the literature (Butterworth *et al.*, 2012; Jusot *et al.*, 2008). Alcohol and overweight do not play a significant role on employment in our regressions.

Table 1: Estimated probability of employment in 2010, male population

	Univar. Probit (M1)		Univar. Probit (M2)		Univar. Probit (M3)		Bivariate Probit (IV)	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**
Mental health in 2006								
At least one mental disorder	-.09***	*.02*	-.07***	*.02*	-.07***	*.02*		
Mental health (instr.) in 2006								
At least one mental disorder							-.13**	*.05*
Ind. characteristics in 2006								
Age (*ref.: 30-35 years-old*)								
- 35-39	.02	*.02*	.01	*.03*	.01	*.03*	-.01	*.03*
- 40-44	-.01	*.02*	-.03	*.02*	-.04	*.03*	-.03	*.03*
- 45-49	-.02	*.02*	-.01	*.03*	-.03	*.03*	-.03	*.03*
- 50-55	-.14***	*.02*	-.15***	*.02*	-.16***	*.02*	-.16***	*.03*
In a relationship (*ref.: Single*)	.03**	*.01*	.03**	*.01*	.03**	*.01*	.02	*.02*
Children (*ref.: None*)	-.02	*.02*	-.01	*.02*	-.01	*.02*	-.02	*.02*
Education (*ref.: French bac.*)								
- No diploma	-.06**	*.02*	-.05**	*.02*	-.05*	*.03*	-.06**	*.03*
- Primary	-.03	*.02*	-.01	*.02*	-.01	*.02*	-.01	*.02*
- Superior	-.00	*.02*	-.00	*.02*	-.00	*.02*	.01	*.02*
Employment in 2006								
Act. sector (*ref.: Industrial*)								
- Agricultural	-.03	*.02*	-.02	*.03*	-.02	*.03*	-.03	*.03*
- Services	-.00	*.01*	.00	*.01*	.00	*.01*	.01	*.02*
Activity status (*ref.: Private*)								
- Public sector	.03*	*.02*	.02	*.02*	.02	*.02*	.01	*.02*
- Self-employed	.04	*.03*	.04	*.03*	.03	*.03*	.03	*.04*
Prof. cat. (*ref.: Blue collar*)								
- Farmers	.15***	*.05*	.12**	*.05*	.12**	*.05*	.12**	*.06*
- Artisans	.07**	*.04*	.06*	*.04*	.06*	*.04*	.10**	*.04*
- Managers	.05**	*.02*	.04**	*.02*	.04**	*.02*	.04*	*.02*
- Intermediate	.03*	*.02*	.02	*.02*	.02	*.02*	.02	*.02*
- Employees	.01	*.02*	.00	*.02*	-.00	*.02*	-.01	*.02*
Part time (*ref.: Full-time*)	-.05	*.03*	-.04	*.02*	-.03	*.03*	-.01	*.04*
General health status in 2006								
Poor perceived health status			-.02	*.02*	-.02	*.02*	-.00	*.02*
Chronic diseases			.00	*.01*	.00	*.01*	.00	*.01*
Activity limitations			-.03*	*.02*	-.03*	*.02*	-.04**	*.02*
Risky behaviours in 2006								
Daily smoker			-.04***	*.01*	-.04***	*.01*	-.05***	*.01*
Risky alcohol consumption			-.00	*.01*	.00	*.01*	.01	*.01*
Overweight			.01	*.01*	.01	*.01*	.01	*.01*
Professional route								
Maj. of empl. in long jobs					.03*	*.02*	.02	*.01*
Stable career path					.01	*.01*	.00	*.01*
Rho							.22**	*.12*
Hausman test[4]							1,71	
N	2004		2004		2004		1860	

Reading: *Marginal effects, standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, men aged 30-55 in employment in 2006.*

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

Table 2: Estimated probability of employment in 2010, female population

	Univar. Probit (M1)		Univar. Probit (M2)		Univar. Probit (M3)		Bivariate Probit (IV)	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**
Mental health in 2006								
At least one mental disorder	-.05***	*.01*	-.02	*.02*	-.02	*.02*		
Mental health (instr.) in 2006								
At least one mental disorder							-.02	*.09*
Ind. characteristics in 2006								
Age (*ref.: 30-35 years-old*)								
- 35-39	.01	*.02*	.01	*.02*	.00	*.02*	.00	*.02*
- 40-44	.01	*.02*	.01	*.02*	.00	*.02*	.00	*.02*
- 45-49	-.04**	*.02*	-.03	*.02*	-.04	*.02*	-.04	*.02*
- 50-55	.10***	*.02*	-.10***	*.02*	-.10***	*.02*	-.10***	*.02*
In a relationship (*ref.: Single*)	.00	*.01*	.01	*.01*	.01	*.01*	.01	*.01*
Children (*ref.: None*)	-.08***	*.02*	-.07***	*.02*	-.07***	*.02*	-.07***	*.02*
Education (*ref.: French bac.*)								
- No diploma	-.03	*.03*	-.04	*.03*	-.04	*.03*	-.04	*.03*
- Primary	-.02	*.02*	-.01	*.02*	-.01	*.02*	-.01	*.02*
- Superior	.00	*.02*	-.00	*.02*	-.01	*.02*	-.01	*.02*
Employment in 2006								
Act. sector (*ref.: Industrial*)								
- Agricultural	.04	*.04*	.04	*.04*	-04	*.04*	-.04	*.04*
- Services	.05***	*.02*	.06***	*.02*	.06***	*.02*	.06***	*.02*
Activity status (*ref.: Private*)								
- Public sector	.01	*.01*	.02*	*.01*	.02	*.01*	.02	*.01*
- Self-employed	.07**	*.04*	.06*	*.04*	.06*	*.04*	.06*	*.04*
Prof. cat. (*ref.: Blue collar*)								
- Farmers	.02	*.07*	.01	*.07*	-.00	*.07*	-.00	*.07*
- Artisans	-.02	*.04*	-.03	*.05*	-.03	*.05*	-.03	*.05*
- Managers	.00	*.03*	-.01	*.03*	-.02	*.03*	-.02	*.03*
- Intermediate	-.00	*.02*	-.01	*.02*	-.01	*.02*	-.01	*.02*
- Employees	.01	*.02*	.00	*.02*	.00	*.02*	-.00	*.02*
Part time (*ref.: Full-time*)	-.03**	*.01*	-.03**	*.01*	-.02*	*.01*	-.02*	*.01*
General health status in 2006								
Poor perceived health status			-.04**	*.02*	-.03**	*.02*	-.03*	*.02*
Chronic diseases			.00	*.01*	-.00	*.01*	-.00	*.01*
Activity limitations			-.04**	*.02*	-.04**	*.02*	-.04*	*.02*
Risky behaviours in 2006								
Daily smoker			-.01	*.01*	-.00	*.01*	-.00	*.01*
Risky alcohol consumption			-.01	*.02*	-.01	*.02*	-.01	*.02*
Overweight			-.02	*.01*	-.01	*.01*	-.01	*.01*
Professional route								
Maj. of empl. in long jobs					.02	*.01*	.02	*.01*
Stable career path					.01	*.01*	.01	*.01*
Rho							.02	*.36*
Hausman test							.00	
N	2129		2129		2129		1982	

Reading: *Marginal effects, standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, women aged 30-55 in employment in 2006.*

3.2. Instrumented mental health

The last column of Table 1 and Table 2 presents the results of the bivariate probit models, respectively for men and women. The results for the bivariate mental health models are summarized in Table 3 (complete results of univariate and bivariate probit models for mental health are available in Table 34, Appendix 7). For these results, note that as explained in Section 2.3.2, only two identifying variables are used for men and women, respectively having suffered from violence during childhood (men and women), having experienced marital breakdowns (men only) and having been raised by a single parent (women only). After controlling for individual and employment-related characteristics, general health status, risky behaviours and professional route, the three identifying variables (being raised by a single parent, having experienced violence during childhood and having experienced many marital breakdowns) are good predictors of mental health as we measure it. Facing violence during childhood and several marital breakdowns in men respectively increase the probability to experience mental disorders in 2006 by $9pp$ and $3pp$. In women, being raised by a single parent or experiencing violence before age 18 increase the same probability of $7pp$ and $8pp$.

Table 3: Estimation of mental health in 2006

	Men		Women	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**
Identifying variables				
Raised by a single parent	-	-	.07***	*.02*
Suffered from violence during childhood	.09**	*.05*	.08***	*.02*
Experienced many marital breakdowns	.03**	*.01*	-	-

After controlling for individual characteristics, employment, general health status and professional career.
Reading: *Marginal effects, standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55 in employment in 2006.*

Despite the decrease in the accuracy of the estimates for employment status, the use of identifying variables should enable the establishment of a causal relationship. The use of this type of models seems justified by the significance (for men) of the correlation coefficient (ρ) between the residuals of the two simultaneous equations. In addition, evolutions in the results between univariate and bivariate employment and mental health models (Table 1, Table 2 and Table 34 in Appendix 7) reinforce this hypothesis. In men, the causal effect of mental health in 2006 on employment in 2010 seems corroborated by the bivariate analysis, indicating a drop of $13pp$ in the probability of remaining at work. It is also possible to reaffirm the direct role of smoking on the likelihood of job loss. Mental health remains non-discriminative on women's employment. Ultimately, our main results are confirmed by the bivariate analysis, and fall in line with the literature using the same methodologies. It is to be noted that the

results for Hausman tests are all rendered non-significant, indicating that the indentifying variable frameworks might not be very different from naive models, hence not mandatory.

3.3. Robustness checks

To assess the robustness of our results, we tested two other alternative specifications to better understand mental health (differentiating MDE and GAD and taking into account their cumulative effects), we considered other age groups[5] and a shorter temporal distance between mental health and employment (it indeed may be questionable to measure the role of poor mental health on employment four years later).

3.3.1. MDE versus GAD

We first wanted to better understand the respective roles of MDE and GAD on job retention. Table 4 shows the results when considering MDE alone (specification 1), GAD alone (specification 2) and a counter of mental disorders (indicating if an individual faced one or both mental disorders at once). This decomposition of mental health disorders did not change the results in the female population: even when women report suffering from both MDE and GAD, mental health problems do not significantly affect their employment trajectory. In men, GAD marginally plays the major role on the inability to remain in employment ($-10pp$ compared to $-8pp$ for MDE) and suffering from both mental disorders significantly deteriorates their labour market outcomes ($-14pp$).

Table 4: Impact of mental health in 2006 on employment in 2010 according to various measures, men and women

	Men		Women	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**
Instrumented mental health				
Suffers from MDE	-.08***	*.02*	-.01	*.01*
Suffers from GAD	-.10***	*.02*	-.02	*.02*
Disorders counter				
- One disorder	-.05*	*.02*	-.02	*.02*
- Two simultaneous disorders	-.14***	*.04*	-.02	*.03*

After controlling for individual characteristics, employment, general health status and professional career.
Reading: *Marginal effects, standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, men and women aged 30-55 in employment in 2006.*

3.3.2. An employment indicator over the period 2007-2010

The measurement of the impact of mental health on employment outcomes is potentially subject to biases given the duration of the observation period. Career paths and mental health

[5] *Sensitivity tests were performed by estimating the models on the 25-50, 30-50 and 25-55 years-old groups. These tests, not presented here, confirm our results in all cases.*

between 2006 and 2010 may have been significantly affected by the effects of economic conditions (notably the economic crisis of 2009) regardless of the mental health condition of 2006. To deal with this problem, we set-up a more restrictive approach by considering individuals having been at least 3 years in employment between 2007 and 2010 (and not only in employment in 2010 precisely). The results are presented in Table 5.

Table 5: Estimated probability of employment (binary variable 2007-2010)

	Men		Women	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**
Mental health in 2006				
At least one mental disorder	-.05***	.02	-.00	.02

After controlling for individual characteristics, employment, general health status and professional career.
Reading: *Marginal effects, standard errors in italics. ***: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55 in employment in 2006.*

4. Discussion and conclusion

This study demonstrates that a degraded mental health condition directly reduces the ability of men to remain in employment four years later after controlling for socioeconomic characteristics, employment, general health status, risky behaviours and the nature of past professional careers. A decrease of up to $13pp$ in the probability of remaining in employment 4 years later for men at work in 2006 can be observed. In the female population, general health status remains predominant in explaining their trajectory on the labour market. Our results, in line with those of the literature, provide original perspectives on French data about the capacity of mentally-impaired workers to keep their jobs. Considering separately MDE and GAD suggests that the disabling nature of mental health goes through both indicators. In addition, the accumulation of mental disorders (MDE and GAD) greatly increases the risk of leaving employment during the period ($-14pp$ for men facing both disorders compared to $-5pp$ for those only facing one of the two). These results are also supported by specific estimations on the 2007-2010 period, partly allowing to deal with the events occurring between 2006 and 2010.

Our study confirms the importance of mental health when considering work and employment. It appears appropriate to keep on with the implementation of public policies to support people with mental disorders starting from entry into the labour market but by extending them to common mental disorders such as depressive episodes and anxiety disorders, which prevalence is high in France. We bring new elements with respect to sex differences in the impact of mental health, after controlling for general health status. In men, activity limitations and GAD play a specific and independent role on professional paths. However in women,

only general health indicators (perceived health and activity limitations) are capable of predicting future job situations. This differentiation between men and women is also confirmed in terms of mental health determinants, which is taken into account here by using different identifying variables according to sex. Consequently, accompanying measures for men at work could be helpful in keeping them on the labour market. Notably, the French Psychiatry and Mental Health Plan 2011-2015 affirms the importance of job stress prevention and measures to enable easier job retention and return to work of people with mental disorders.

Following this first step, several extensions could be appropriate. First, an important weakness in our identification strategy remains possible. The identifying variables used may indeed be correlated with unobservable characteristics such as instability or the lack of self-confidence which are also related to outcomes on the labour market. This can possibly render the hypothesis of exogeneity of the relationship doubtful. If such characteristics are components or consequences of our mental health indicators, then it should not be problematic as their effect would transit completely through the latter. Yet, we cannot exclude that at least part of the variance induced by these unobservable characteristics is directly related to employment, regardless of our mental health indicators. Our results demonstrate a different impact of mental health on job retention. This difference may partly result from selection related to mental health and employment in 2006, differing by sex[6]. It can also be explained by differences in social norms related to the perception of mental disorders and employability, by differences in the disease severity and differentiated paths during the 2006-2010 period (as suggested by the health status trajectories for individuals in employment and ill in 2006 – see Table 31). As a consequence, the differences we find could very well be explained, at least partly, by the fact that a man and a women both declaring facing anxiety disorders or depressive episodes depicts two different realities. Notably, it is acknowledged that men have a tendency to declare such issues when their troubles are already at a more advanced state (in terms of intensity of the symptoms) than women. Even though our indicators are relatively robust to false positives, it is not as much the case for false negatives (as explained in Appendix 5). It would also be interesting to determine the transmission channels of these differences. The distinction between GAD and MDE demonstrates the sensitivity of our results to the definition of mental health. As such, robustness checks using a mental health

[6] *In the male population suffering from at least one mental disorder in 2006, 68.6% are employed against 90.9% in the non-affected population. Among women, the proportions were 64.5% and 77.0% respectively (Table 30).*

score to better assess the nature and intensity of mental health degradations would help to better assess its effect on employment. Yet, no such score is available in the survey.

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Chapter II: Work strains and chronic diseases

HARDER, BETTER, FASTER... YET STRONGER?

WORKING CONDITIONS AND SELF-DECLARATION OF CHRONIC DISEASES

Introduction

In a context of changing and increasing work pressures (Askenazy and Caroli, 2010), the question of working conditions has become even more acute. Notably, a law implemented in 2015 in France fits into this logic and either offers access to training programs in order to change jobs, or gives the most exposed workers an opportunity to retire earlier.

The relationship between employment, work and health status has received considerable attention in the scientific community, especially in fields such as epidemiology, sociology, management, psychology and ergonomics. From a theoretical standpoint in economics, the differences in wages between equally productive individuals can be explained by differences in the difficulty of work-related tasks, meaning workers with poorer working conditions are paid more than others in a perfectly competitive environment (Rosen, 1974). In this framework, it is possible to imagine that health capital and wealth stock are substitutable, hence workers may use their health in exchange for income (Muurinen and Le Grand, 1985). From an empirical point of view, the question of working conditions and their potential effects on health status becomes crucial in a general context of legal retirement age postponement being linked to increasing life expectancy and the need to maintain the financial equilibrium of the pension system. Prolonged exposures throughout one's whole career are indeed likely to prevent the most vulnerable from reaching further retirement ages, *a fortiori* in good health condition. However, this research area has received less attention because of important endogeneity problems such as reverse causality, endogenous selection and unobserved heterogeneity (Barnay, 2016) as well as the difficulty in fully embracing the diversity and magnitude of exposures. Nevertheless, a large majority of the studies agree that there is a deleterious effect on health status from detrimental working conditions.

In this paper, I examine the role of physical and psychosocial working conditions as well as their interactions when declaring chronic diseases. I expand on the aforementioned literature by two means. First, I rely on a sample of around 6,700 French male and female workers who participated in the French Health and Professional Path survey (*Santé et Itinéraire Professionnel* – Sip), for whom it is possible to use retrospective panel data for reconstructing their entire career from their entry into the labour market to the date of the survey. This allows me to resolve the inherent endogeneity in the relationship caused by selection biases and unobserved heterogeneity using a difference-in-differences methodology combined with matching methods. My second contribution arises from being able to establish and analyze the

role of progressive and differentiated types of exposures and account for potentially delayed effects on health status. I believe such a work does not exist in the literature and that it provides useful insights for policy-making, particularly in regard to the importance of considering potentially varying degrees of exposures as well as the physical and psychosocial risk factors in a career-long perspective.

The paper first presents an overview of the economic literature (Section 1), the general framework of this study (Section 2), the data (Section 3) and empirical methodology (Section 4). Then, the results are presented, along with robustness checks and a discussion (Section 5, Section 6 and Section 7).

1. Literature

1.1. Global effect of work strain on health status

Unlike in fields such as epidemiology, working conditions and their impact on health status did not receive a lot of attention in the economic literature (Barnay, 2016; Fletcher *et al.*, 2011). Yet, this literature agrees on a deleterious average effect of work strain on workers' health capital. The numerous existing indicators used to assess this role usually classify the strains into two main categories: those related to physical or environmental burdens (expected to influence mostly physical health status) and psychosocial risk factors (supposed to have a major part to play in the deterioration of mental health).

Having a physically demanding job is known to impact self-rated health (Debrand and Lengagne, 2008). Notably, Case and Deaton (2003) use multiple cross-sectional data to find that manual work significantly deteriorates self-assessed health status. This result is robust to the inclusion of classical socio-demographic characteristics such as education and it varies according to the levels of pay and skills involved. This was later confirmed by Choo and Denny (2006), who also used cross-sectional data, controlling for chronic diseases and risky health behaviours. Using panel data, Ose (2005) finds that, after taking into account possible compensations, a heavy workload causes ill health and greater absenteeism. Based also on panel data, Robone *et al.* (2011) focus on the role of the workplace, atypical work hours (including night work) and job satisfaction in general to find that working conditions influence both self-assessed health and well-being. Job satisfaction is confirmed to have a positive effect on objective and subjective health status measures, based on panel data used by Fischer and Sousa-Poza in 2009. Just like physical load, the work environment is found to have an influence on workers' health status. In a study on U.S. workers, the impact of facing

detrimental environmental working conditions (weather, extreme temperatures or moisture) is found to specifically impact young worker's self-rated health status (Fletcher *et al.*, 2011). This result, obtained on panel data using random effects ordered probits, accounts for initial health status. Datta Gupta and Kristensen (2008) use longitudinal data and cross-country comparisons to show that a favourable work environment and high job security lead to better health conditions, after controlling for unobserved heterogeneity.

Psychosocial risk factors have been studied more recently in the empirical literature (Askenazy and Caroli, 2010), even though their initial formulation in the psychological field is older (Karasek, 1979; Theorell and Karasek, 1996). Individuals in a situation of *Job strain* (*i.e.* exposed to high job demands and low decisional latitude) are found to suffer more frequently from coronary heart diseases (Kuper and Marmot, 2003). Johnson *et al.* (1989) demonstrated that social isolation combined with *Job strain* correlates with cardiovascular diseases (*Iso-strain* situation). Mental health is also potentially impaired by such exposures. Laaksonen *et al.* (2006) show that stress at work, job demands, weak decision latitude, lack of fairness and support are related to poorer health status. Bildt and Michélsen (2002) show that being exposed to various work stressors such as weak social support and lack of pride at work may be related to a worse mental health condition, while Cohidon *et al.* (2010) stress the role of being in contact with the public. Improving on this ground, part of the literature focuses on the role of rewards at work and how it might help in coping with demanding jobs (Siegrist, 1996). Notably, de Jonge *et al.* (2000) use a large-scale cross-sectional dataset to find effects of Job demands and Effort-Reward Imbalance on workers' well-being. Cottini and Lucifora (2013) use three waves of European data on 15 countries. They take into account the endogeneity of working conditions related to selection on the labour market based on initial health status and find that job quality (in particular job demands) affects mental health.

1.2. The role of simultaneous and chronic exposures

Even though the economic literature on the topic of exposure to detrimental working conditions is scarce in regard to both simultaneous exposures (multiple exposures at once) and cumulative exposures (length of exposure to given strains), other fields such as epidemiology have demonstrated their importance in terms of work strains and their impact on health status (Michie and Williams, 2003). By its very nature, the literature that focuses on Karasek's and Siegrist's models tend to study the results of combined exposures to several, simultaneous work stressors (*job strain* and *iso-strain*). de Jonge *et al.* (2000) show the independent and cumulative effects of both types of models. On the matter of cumulative exposures, Amick *et*

al. (1998) demonstrate, based on longitudinal data that chronic exposures to low job control is related to higher mortality in women. The study of Fletcher *et al.* (2011) uses panel data and analyses the role of cumulative physical and environmental exposures over five years (from 1993 to 1997) while controlling for initial health status and health-related selection. This study is very likely the closest paper in the literature to the present study. They aggregate several physical and environmental working conditions indicators and create composite scores, which they then sum over five years. They find clear impacts of these indicators, on both men and women, with variations depending on demographic subgroups. This work expands on this particular study notably by considering exposures to both physical and psychosocial risk factors as well as by taking into account exposures that occur throughout the whole career (it is easily imaginable that larger health effects may occur in cases of longer exposures). I also include the possibility of accounting for simultaneous exposures.

1.3. Biases

More often than not, the literature's assessment of the health-related consequences of exposures to working conditions is plagued with several methodological biases that can lead to potentially misleading results. First, the choice of a job is unlikely a random experience (Cottini and Lucifora, 2013), resulting in contradictory assumptions. In particular, healthier individuals may tend to prefer (self-selection) or to be preferred (discrimination) for more demanding jobs (Barnay *et al.*, 2015). In this case, the estimations are likely to be biased downwards because of individuals being both healthier and exposed to demanding jobs, thus being overrepresented in the sample (inducing a *Healthy Worker Effect* – Haan and Myck, 2009). Second, it is also reasonable to assume that workers with lesser health capital may have fewer opportunities in the labour market and thus be restricted to the toughest jobs, in which case an upward bias may result. Therefore, unobserved individual and temporal heterogeneities that are unaccounted for may also result in biased estimations (Lindeboom and Kerkhofs, 2009). Individual preferences and risk aversion behaviours as well as shocks, crises or other time-related events can cast doubt on the exogeneity hypothesis of working conditions (Bassanini and Caroli, 2015).

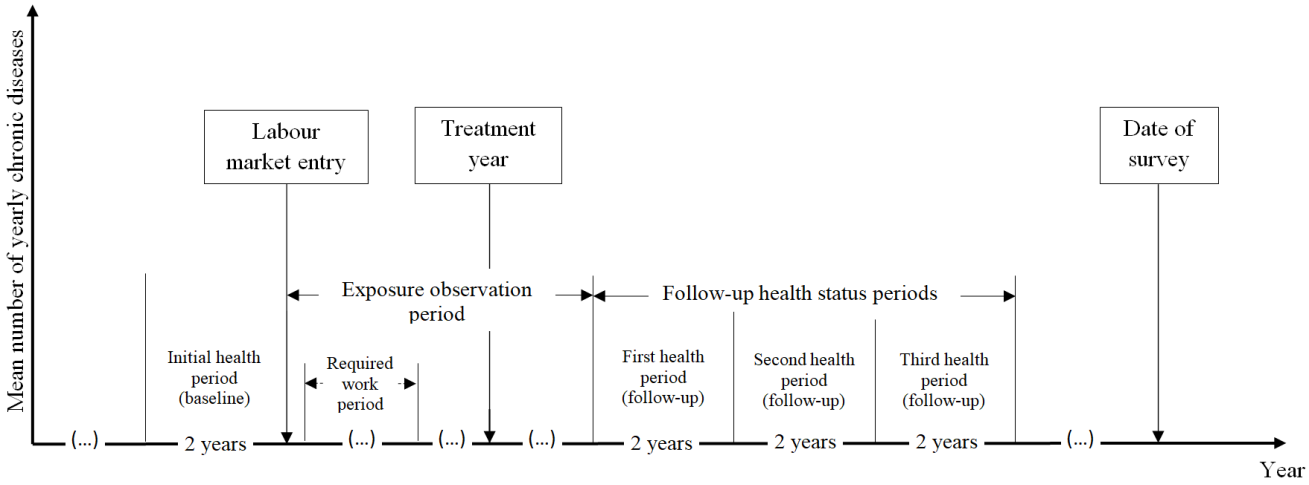
Due to a lack of panel data that includes detailed information on both work and health status over longer periods, few papers have actually succeeded in handling these biases. Notably, Cottini and Lucifora (2013) implemented an instrumental variable strategy on repeated cross-sectional data while relying on variations across countries in terms of workplace health and safety regulation, doing so in order to identify the causal effect of detrimental working

conditions on mental health. In most cases, the difficulty in finding accurate and reliable instruments for working conditions leads to the question of selection biases, and unobserved heterogeneity is either treated differently or avoided altogether when working on cross-sectional data.

2. General framework

The main objective of this study is to assess the role of varying levels of exposure to detrimental working conditions in declaring chronic diseases. To do so, I rely on a difference-in-differences framework which considers a *chronic diseases baseline period*, *i.e.*, the initial number of chronic diseases before all possible exposures to work strains, and a *follow-up period* after a certain degree of exposure has been sustained (the latter being called *the treatment*).

Figure V: Configuration of working conditions and chronic diseases periods



Source: *Author.*

Thus, a total of four chronic disease periods are defined (Figure V). The baseline period consists of the two years before labour market entry and represents an indicator for the initial exogenous health capital. Following labour market entry and potential subsequent exposures to work strains, three two-year chronic disease follow-up periods are reconstructed with short- to mid-term post-treatment health conditions indicated.

After labour market entry, employment and working conditions are observed and the treatment may take place. To allow for more homogeneity in terms of exposure and treatment dates, as well as to ensure that exposure periods cannot be very much separated from each

other, I observe working conditions within a dedicated period (starting from labour market entry year). In order to be treated, one must reach the treatment threshold within this observation period. Individuals not meeting this requirement are considered controls. Minimum durations of work are also introduced: because individuals who do not participate in the labour market are likely to be very specific in terms of labour market and health characteristics, they are at risk of not really being comparable to other workers (Llena-Nozal *et al.*, 2004).

Table 6: Thresholds description

Threshold Parameter	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9
Treatment thresholds									
Single exposure threshold	4	6	8	10	12	14	16	18	20
Poly-exposure threshold	2	3	4	5	6	7	8	9	10
Periods definition									
Working conditions observation period	6	9	12	15	18	21	24	27	30
Minimum duration at work	2	3	4	5	6	7	8	9	10

Indications: *in years.*
Reading: *For the seventh threshold (t_7), an individual must reach 16 years of single exposure or 8 years of poly-exposure within the 24 years following labour market entry to be considered treated. Also, he/she must have worked at least 8 years within this period to be retained in the sample. His/her health status will be assessed by the mean number of yearly chronic diseases at baseline (the 2 years before labour market entry), and three more times (follow-up periods) after the end of the working conditions observation period.*
Source: *Author.*

Nine progressive exposure levels (denoted t_N) have been designed in order to assess potentially varying effects of increasing strains on declaring chronic diseases. In order to take into account the cumulative effects between strains, two types of exposure are considered (see first half of Table 6): single exposure (when an individual faced only one strain at a time each year) and poly-exposure (if an individual faced two or more strains simultaneously each year). Then, the duration of exposure is accounted for by introducing varying minimum durations of exposure (thresholds). Empirically, this framework covers exposure thresholds ranging from 4 years of single exposure or 2 years of poly-exposure (t_1) to, respectively, 20 and 10 years of exposure (t_9), with a step of 2 years (*resp.* 1 year) from a threshold to another for single (*resp.* poly-) exposures. However, changing the treatment thresholds will, as a consequence, lead to other necessary changes in the framework, notably to the duration of the working conditions observation period and to the minimum duration at work within it (see second half of Table 6). More details about the choices made for these parameters can be found in Appendix 8. Note that only thresholds t_5 to t_9 are presented in the rest of the paper (for simplification

purposes), because previous thresholds reveal no significant effect on chronic diseases from exposure to detrimental working conditions.

Let us take the example of two fictive individuals, a and b, in the seventh threshold sample to illustrate the framework. To be a treated, individual a needs to be exposed to at least 16 years of single exposures or 8 years of poly exposures during the first 24 years after labour market entry. He also needs to have worked at least 8 years within this period to be retained in the sample. Individual b, in order to be in the control group, needs to have been exposed less than 16 years to single exposures and less than 8 years of poly exposures within the 24 years after labour market entry. b may or may not be exposed after the 24-year observation period but in any case will still be a member of the control group for the threshold level considered (t_7 in this example). Individual b needs, just like a, to have worked at least 8 years within his/her observation period to remain in the sample. All in all, the only element separating a from b is the fact that a reached the exposure threshold within the working conditions observation period, when b did not.

3. Data

3.1. The *Santé et Itinéraire Professionnel* (Sip) survey

I use data coming from the French Health and Professional Path survey (*Santé et Itinéraire Professionnel* – Sip). It has been designed jointly by the statistical departments of two French ministries in charge of Health[7] and Labour[8]. The panel is composed of two waves (2006 and 2010). Two questionnaires are proposed: the first one is administered directly by an interviewer and investigates individual characteristics, health and employment statuses. It also contains a life grid, which allows reconstructing biographies of individuals' lives: childhood, education, health, career and working conditions, as well as major life events. The second one is self-administered and focuses on more sensitive information such as health-related risky behaviours (weight, alcohol and tobacco consumption). Overall, more than 13,000 individuals were interviewed in 2006 and 11,000 in 2010, making this panel survey representative of the French population[9].

[7] *Directorate for Research, Studies, Assessment and Statistics (Drees) – Ministry of Health.*
[8] *Directorate for Research, Studies and Statistics (Dares) – Ministry of Labour.*
[9] *For a technical note on attrition management and data calibration in the Sip survey, see* De Riccardis (2012).

I make specific use of the biographic dimension of the 2006 survey by reconstructing workers' career and health events yearly[10]. I am therefore able to know each individual's employment status, working conditions and chronic diseases 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. The intensity of exposure to these work strains is also known. Individuals' health statuses are assessed by their declaration of chronic diseases, for which the onset and end dates are available.

In this study, I work with this reconstructed longitudinal retrospective dataset comprising more than 6,700 individuals, including their career and health-related data from childhood to the year of the survey. Thus, the final working sample is composed of around 3,500 men and 3,200 women, for whom complete information is available and who meet specific inclusion criteria described in Section 2 (see also Appendix 8 for more details).

3.2. Variables of interest

3.2.1. Working conditions: Definition of a treatment

Ten individual annual indicators are used to assess the exposure to detrimental work strains and I regroup them into three relevant categories. The first one represents the physical load of work and includes night work, repetitive work, physical load and exposure to toxic materials. The second one forms the psychosocial risk factors that include full skill usage, working under pressure, tensions with the public, reward, conciliation between work and family life and relationships with colleagues. The third one represents the global exposure to both physical and psychosocial strains (which includes all ten working conditions indicators). For each indicator, individuals must declare if they "Always", "Often", "Sometimes" or "Never" faced it during this period: I consider one individual to be exposed if he/she "Always" or "Often" declared facing these strains.

3.2.2. Chronic diseases

The indicator of health status is the annual number of chronic diseases[11]: a chronic disease is understood in the Sip survey to be an illness that lasts or will last for a long time, or an illness that returns regularly. Allergies such as hay fever or the flu are not considered chronic

[10] *It is not possible to know what happened between 2006 and 2010, making the latter wave unusable in this study.*
[11] *Only accidents, handicaps and chronic diseases can be reconstructed year by year in the Sip survey. To avoid mixing-up overly different types of indicators, I chose to keep only the latter.*

diseases. This definition is broader than the French administrative definition, and it is self-declarative. This indicator is available from childhood to the date of the survey (2006). Available chronic diseases include cardiovascular diseases, cancers, pulmonary problems, ENT disorders, digestive, mouth and teeth, bones and joints, endocrine, metabolic and ocular problems, nervous and mental illnesses, neurological problems, skin diseases and addictions.

3.3. General descriptive statistics

Table 7: Base sample description (t_7)

Variable	Mean	Std. error	Min	Max	Physical sample			Psychosocial sample			Global sample		
					Treated	Control	Diff.	Treated	Control	Diff.	Treated	Control	Diff.
Treatment													
Physical treatment	.47	*.50*	0	1	-	-	-	-	-	-	-	-	-
Psychosocial treatment	.44	*.50*	0	1	-	-	-	-	-	-	-	-	-
Global treatment	.68	*.47*	0	1	-	-	-	-	-	-	-	-	-
Health status													
Initial chronic diseases	.12	*.36*	0	4.67	.10	.13	-.04***	.12	.11	.01	.11	.14	-.03**
First health period	.63	*.93*	0	9.50	.65	.62	.03	.70	.58	.12***	.64	.61	.03
Second health period	.72	*.99*	0	9.00	.73	.70	.03	.80	.65	.15***	.73	.69	.04
Third health period	.82	*1.07*	0	9.00	.83	.82	.02	.91	.76	.15***	.83	.81	.03
Demography													
Entry year at work	1963	*8.65*	1941	1977	1962	1965	-2.7***	1963	1963	-0.37	1963	1965	-2.3***
Men	.51	*.50*	0	1	.63	.41	.21***	.54	.49	.05***	.57	.39	.19***
Women	.49	*.50*	0	1	.37	.59	-.21***	.46	.51	-.05***	.43	.61	-.19***
Age	59.67	*7.67*	42	74	60.20	59.20	.99***	59.94	59.47	.47*	60.09	58.78	1.31***
No diploma	.13	*.33*	0	1	.18	.08	.09***	.14	.11	.03**	.15	.08	.07***
Inf. education	.62	*.48*	0	1	.69	.57	.12***	.61	.64	-.03*	.64	.58	.06***
Bachelor	.12	*.32*	0	1	.07	.16	-.09***	.11	.12	-.01	.09	.17	-.07***
Sup. education	.12	*.32*	0	1	.05	.18	-.13***	.12	.12	-.00	.10	.16	-.07***
Childhood													
Problems with relatives	.44	*.50*	0	1	.47	.40	.07***	.48	.41	.07***	.46	.39	.07***
Violence	.09	*.29*	0	1	.10	.08	.02**	.12	.07	.05***	.10	.06	.04***
Severe health problems	.13	*.33*	0	1	.13	.12	.01	.14	.12	.02*	.13	.12	.02
Physical post-exposure													
None	.57	*.49*	0	1	.26	.85	-.59***	.48	.65	-.17***	.43	.88	-.46***
Low	.20	*.40*	0	1	.30	.11	.20***	.22	.18	.04***	.26	.07	.18***
High	.23	*.42*	0	1	.44	.04	.39***	.30	.17	.13***	.32	.04	.28***
Psycho. post-exposure													
None	.57	*.49*	0	1	.48	.66	-.18***	.27	.81	-.53***	.44	.85	-.41***
Low	.21	*.43*	0	1	.25	.18	.07***	.31	.14	.18***	.26	.09	.17***
High	.22	*.41*	0	1	.27	.17	.11***	.41	.06	.35***	.29	.05	.24***
Global post-exposure													
None	.43	*.50*	0	1	.22	.62	-.39***	.23	.59	-.35***	.26	.80	-.55***
Low	.18	*.38*	0	1	.19	.17	.03*	.19	.17	.01	.22	.10	.12***
High	.39	*.49*	0	1	.58	.21	.37***	.58	.24	.34***	.53	.10	.43***
Tobacco consumption													
During initial health period	.09	*.29*	0	1	.08	.10	-.03***	.10	.08	.02	.09	.10	-.01
During 1st health period	.23	*.42*	0	1	.24	.22	.03**	.23	.23	.01	.24	.21	.03**
During 2nd health period	.22	*.42*	0	1	.23	.21	.02	.22	.22	-.00	.23	.20	.03*
During 3rd health period	.21	*.41*	0	1	.22	.20	.02	.21	.21	-.00	.21	.19	.02

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. Standard errors in italics. The average number of chronic diseases in the whole sample before labour market entry is* 0.12*. In the future physically treated population, this number is* 0.10 *(which is significantly lower than for the future control group, i.e.,* 0.13 *at the 1% level). Such a difference at baseline in health statuses between future treated and control groups does not exist in the psychosocial sample.*
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7th threshold. Unmatched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Table 7 gives a description of the sample used in the 7th threshold described above. I chose this specific threshold because it should give an adequate representation of the average of the studied population (as it is the middle point between presented thresholds t_5 to t_9 and because it should not differ in non-treatment-related characteristics for the most part, due to the samples used for all thresholds being the same).

The main conclusions of these descriptive statistics are, first, that the populations who are to be physically and globally treated in the future seem to be in a better initial health condition than their respective control groups. Such a difference cannot be found in the psychosocial sample. Second, no significant effect of the physical and global treatments is observed on subsequent numbers of chronic diseases. This is once again the opposite for the psychosocial subsample, which displays growingly significant and negative differences in the number of chronic diseases between treated and control groups, thus revealing a potentially detrimental effect on health status from psychosocial exposures. However, because the structures of the treated and control groups are very heterogeneous in terms of observed characteristics, the differences in chronic diseases for each period between the two are likely to be unreliable. Yet, for at least the physically and globally demanding jobs, there seem to be signs of a sizeable selection effect indicating that healthier individuals prefer or are preferred for these types of occupations.

In a similar fashion, Table 8 below gives more detailed information about the different components of the reconstructed indicators for working conditions and chronic diseases for the 7th threshold. The first half of the table gives the average number of years of exposure to the ten work strains used in this study. The second half of the table gives an overview of the 15 chronic diseases families used and the average number of these faced by the sample. Note that these chronic disease statistics do not hold for a specific period of time, but rather account for the entire life of the sample up until the date of the survey.

Table 8: Working conditions and chronic diseases description (t_7)

Variable	Mean	Std. error	Min	Max	Physical sample			Psychosocial sample			Global sample		
					Treated	Control	Diff.	Treated	Control	Diff.	Treated	Control	Diff.
Working conditions													
Night work	1.34	*5.41*	0	32	2.58	.23	2.35***	1.88	.92	.95***	1.87	.19	1.68***
Repetitive work	4.35	*9.07*	0	40	7.88	1.20	6.68***	5.72	3.31	2.40***	5.86	1.17	4.68***
High physical load	8.31	*12.85*	0	46	15.80	1.59	14.20***	10.94	6.27	4.67***	11.60	1.31	10.28***
Hazardous materials	4.60	*9.99*	0	41	8.87	.76	8.11***	5.77	3.69	2.08***	6.43	.69	5.74***
Lack of skill usage	1.50	*4.80*	0	25	1.86	1.17	.69***	2.71	.56	2.15***	1.92	.61	1.31***
Work under pressure	3.76	*8.51*	0	38	5.45	2.24	3.20***	7.18	1.11	6.07***	5.15	0.80	4.35***
Tension with public	1.24	*5.01*	0	29	1.52	.98	.53***	2.46	.29	2.17***	1.71	.22	1.49***
Lack of recognition	3.72	*8.45*	0	40	5.41	2.21	3.20***	7.22	1.01	6.21***	5.11	.77	4.34***
Work/private life imbalance	1.43	*5.41*	0	31	1.90	1.01	.89***	2.82	.35	2.47***	1.98	.26	1.72***
Tensions with colleagues	1.34	*5.41*	0	32	.37	.31	.06	.59	.14	.45***	.42	.16	.26***
Chronic diseases													
Cardiovascular	.38	*.54*	0	3	.38	.38	.01	.39	.37	.02	.38	.38	.01
Cancer	.09	*.35*	0	3	.06	.11	-.04***	.08	.09	-.01	.07	.11	-.04**
Pulmonary	.16	*.43*	0	4	.19	.13	.07***	.16	.16	.01	.17	.13	.05**
ENT	.12	*.41*	0	3	.13	.11	.02	.13	.12	.01	.13	.12	.01
Digestive	.16	*.46*	0	4	.17	.15	.02	.17	.15	.02	.17	.15	.02
Mouth/teeth	.01	*.08*	0	2	.01	.01	.00	.01	.01	.00	.01	.00	.00
Bones/joints	.42	*.67*	0	3	.49	.36	.12***	.44	.40	.04	.44	.39	.05*
Genital	.08	*.32*	0	2	.08	.08	-.00	.08	.08	-.00	.08	.08	.00
Endocrine/metabolic	.26	*.52*	0	2	.26	.27	-.00	.23	.28	-.04*	.25	.29	-.04
Ocular	.09	*.33*	0	3	.08	.10	-.02	.09	.09	.01	.08	.10	-.02
Psychological	.19	*.51*	0	4	.18	.20	-.02	.24	.16	.08***	.20	.17	.03*
Neurological	.07	*.31*	0	2	.07	.07	.01	.08	.07	.00	.07	.08	-.00
Skin	.05	*.26*	0	1	.05	.05	-.00	.05	.05	.01	.05	.05	.00
Addiction	.02	*.17*	0	2	.02	.02	-.00	.02	.02	.00	.02	.02	-.00
Other	.14	*.44*	0	4	.14	.14	-.00	.12	.15	-.03*	.14	.13	.01

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. Standard errors in italics. The individuals present in the sample faced an average of* 8 *years of exposure to a high physical load at work. The physically treated population faced nearly* 16 *years of physical burden when their control group only faced one and a half. This difference of* 14 *years is significant at the 1% level. For chronic diseases, the sample faced an average of* .09 *cancer from the beginning of their lives to the date of the survey.*
Field: *Population aged 42-74 in 2006 and present from* i_1 *to* i_9. 7^{th} *iteration. Unmatched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

What can be learned from these descriptive statistics about working conditions is that the most common types of strains, in terms of mean number of years of exposures are, first, facing a high physical load (8 years), exposures to hazardous materials (4.5 years), repetitive work (4 years), work under pressure (3.8 years) and the lack of recognition (3.7 years). Important differences depending on the type of treatment can also be logically seen: when exposures to a high physical burden, to hazardous materials and to a repetitive work are predominant in the physically treated (*resp.* $+14.2$, $+8.1$ and $+6.7$ years in comparison to their control group), the lack of recognition and working under pressure are specific characteristics of the psychosocially exposed workers (*resp.* $+6.2$ and $+6.0$ years).

As can be seen from the second half of the table, the individuals of the seventh threshold faced differentiated types of chronic diseases during their lives. When the average number of

addictions is only $.02$, problems related to bones and joints are much more common ($.42$). Some expected differences between treated and control groups also appear (physically treated declaring more bone/joints or pulmonary problems; psychosocially treated more psychological issues). Yet some others are less intuitive (for instance, the physically treated group declares facing cancers less often than the control group). This is explained first by the fact that no specific period of time is targeted in these simple statistics and consequently these cancers may happen during childhood or during the work life but before an individual could reach the treatment threshold, in which cases facing such issues early (in comparison to the treatment onset) most likely reduces the probability to be a treated, especially in physical jobs.

4. Empirical analysis

4.1. Econometric strategy

The general framework of the difference-in-differences methodology is given by Equation 1 (Angrist and Pischke, 2009). The left-hand side member gives the observed performance difference between the treated and control groups. The first right-hand side member is the Average Treatment Effect on the Treated (ATT), and the far right-hand side member is the selection bias. The latter equals 0 when the potential performance without treatment (Y_{0i}) is the same whatever the group to which one belongs (independence assumption): $\{Y_{0i}, Y_{1i}\} \perp T_i$.

$$E(Y_i|T_i = 1) - E(Y_i|T_i = 0) = E(Y_{1i} - Y_{0i}|T_i = 1) + [E(Y_{0i}|T_i = 1) - E(Y_{0i}|T_i = 0)] \quad (1)$$

In practical terms, the estimation of the difference-in-differences for individual i and times $t-1$ (baseline) and $t+1$ (follow-up) relies on the fixed-effects, heteroskedasticity-robust Within panel data estimator[12] for the estimation of Equation 2, which explains the mean number of chronic diseases (y_{it}):

$$y_{it} = \beta_0 + \beta_1 \mathbf{1}_{(t+1)} + \beta_2 \mathbf{1}_{(T_i=1)} + \beta_3 \mathbf{1}_{(t+1)} \times \mathbf{1}_{(T_i=1)} + \beta_4 C'_{it} + \gamma_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$\mathbf{1}_{(t+1)}$ is a dummy variable taking value 1 if the period considered is $t+1$; $\mathbf{1}_{(T_i=1)}$ is a dummy variable for the treatment (taking value 1 when individual i is part of the treated

[12] *It is also possible to estimate such a specification using the Ordinary Least Squares estimator and group-fixed unobserved heterogeneity terms. The results should be relatively close (Givord, 2008), which has been tested and is the case in this study. Yet, panel data estimators appear to be the most stable because of the increased precision of the individual fixed effects in comparison to group-fixed effects, and thus have been preferred here.*

group); $\mathbf{1}_{(t+1)} \times \mathbf{1}_{(T_i=1)}$ (variable of interest) is a cross variable taking value 1 when individual i is treated in $t+1$; $C_{it}^{'}$ is a vector of covariates and β_1, β_2, β_3 and β_4 are their respective coefficients. γ_i and γ_t, respectively, represent the individual and temporal unobserved heterogeneities and ε_{it} the error term. The main objective of a difference-in-differences framework is to get rid of both γ_i and γ_t, as well as to account for the baseline situation ($y_{i,t-1}$), which may differ between the two groups.

In order to satisfy the independence assumption, *i.e.*, to reduce the *ex-ante* differences between treated and control groups as much as possible and thus handle the selection bias existing in the sample, I perform a matching method prior to the difference-in-differences setup using pre-treatment characteristics (X'_{it}) related to health status and employment elements, so that $\{Y_{0i}, Y_{1i}\} \perp T_i | X'_{it}$. A Coarsened Exact Matching method is implemented (CEM – Blackwell *et al.*, 2010). The main objective of this methodology is to allow the reduction of both univariate and global imbalances between treated and control groups according to several pre-treatment covariates (Iacus *et al.*, 2008). CEM divides continuous variables into different subgroups based on common empirical support and can also regroup categorical variables into fewer, empirically coherent items. It then creates strata based on individuals (treated or controls) achieving the same covariate values and match them accordingly by assigning them weights[13] (unmatched individuals are weighted 0). This offers two main advantages compared to other matching methods. It helps in coping effectively with the *curse of dimensionality* by preserving sample sizes: coarsening variables in their areas of common empirical support ensures a decent number of possible counterfactuals for each treated observation in a given stratum, and therefore decreases the number of discarded observations due to the lack of matches. In addition, CEM reduces the model dependence of the results (Iacus *et al.*, 2008). Yet, this matching method is still demanding in terms of sample size, and only pre-treatment variables (*i.e.* variables determined before the exposure to detrimental working conditions) must be chosen[14].

4.2. Matching variables and controls

[13] *The weight value for matched individuals equals* $\frac{n_S^T}{n_S^C} \times \frac{N^C}{N^T}$, *with* n_s *representing the sample size for respectively the treated (T) and control (C) groups in stratum* s *and* N *the total sample sizes for both groups.*

[14] *The data management has been done using SAS 9.4. The econometric strategy is implemented in Stata 11 using respectively the Coarsened Exact Matching (CEM) package and the "xtreg" procedure. Some robustness checks have also been conducted using the Diff package and the "regress procedure".*

Matching pre-treatment variables are chosen so that they are relevant in terms of health status and status determination in the labour market, in addition to helping cope with the (self-)selection bias (individuals sustaining high levels of exposure are bound to be particularly resilient or, in contrast, particularly deprived from better opportunities in the labour market). Individuals are matched according to their: year of entry into the labour market (in order to get rid of temporal heterogeneity related to generation/conjuncture effects); gender (Devaux *et al.*, 2008; Shmueli, 2003); education level (four levels: no education, primary or secondary, equivalent to bachelor degree and superior); health status before labour market entry (heavy health problems and handicaps) to have a better assessment of their initial health status and to cope with endogenous sorting in the labour market; and important events during childhood, aggregated into two dummy variables (on the one hand, heavy health problems of relatives, death of a relative, separation from one or more parent; on the other hand, violence suffered from relatives and violence at school or in the neighbourhood), as it is pretty clear that such childhood events may impact early outcomes in terms of health status (Case *et al.*, 2005; Lindeboom *et al.*, 2002). Matching the samples on such variables is bound to reduce the initial heterogeneity existing between the treated and control groups, as well as to limit the selection bias into employment and into different degrees of exposure, as part of the individuals' resilience to work strains is accounted for notably by proxy variables for their initial health capital.

After reaching the treatment threshold, workers can still be exposed to varying levels of working conditions. This possibility of post-treatment exposures is accounted for by a control variable in the difference-in-differences models (taking the value 0 at baseline and 1, 2 or 3 depending on if the individual has been exposed, respectively, hardly, a little or a lot to detrimental work strains during this post-treatment period). Health habits are also controlled for in the difference-in-differences models by adding a variable indicating if individuals, at any given time, are daily smokers or not. The idea behind this is that health-related behaviours (such as tobacco and alcohol consumption, being overweight and other health habits) are bound to be correlated with each other as well as with exposures to work strains and with the declaration of chronic diseases, all of which induce biased estimates when unaccounted for. This variable takes the value 0 when an individual is not a daily smoker and the value 1 if he/she is in either the baseline or follow-up periods.

4.3. Matched descriptive statistics

The naive results (descriptive statistics presented in Section 3.3 and the unmatched difference-in-differences results presented in Section 5.1) tend to confirm the possibility of a (self-)selection bias in the sample, suggesting that people are likely to choose their job while considering their own initial health status; in any case, the results justify an approach that takes into account this possibility. In order to minimize this selection process, a matching method is used prior to the difference-in-differences models.

Table 9 gives a description of the same sample used in t_7, which was presented earlier (for comparison purposes), after CEM matching. The matching method succeeds in reducing the observed structural heterogeneity between the treated and control groups for every single pre-treatment covariate. Residual heterogeneity still exists, namely for the year of entry into the labour market and age, but it is shown to be minor and, in any case, statistically non-significant (difference of less than a month in terms of labour market entry year and of approximately a quarter for age). It is also interesting to note that initial health status differences are also greatly reduced and that larger negative follow-up differences between treated and control groups can now be observed, making the hypothesis of a detrimental impact of working conditions on health status more credible.

Table 9: Matched sample description (t_7)

Variable	Physical sample			Psychosocial sample			Global sample		
	Treated	Control	Diff.	Treated	Control	Diff.	Treated	Control	Diff.
Health status									
Initial chronic diseases	.08	.10	-.02	.10	.10	.00	.09	.12	-.02
First health period	.63	.55	.07**	.68	.54	.13***	.63	.56	.07**
Second health period	.72	.63	.09***	.78	.62	.16***	.72	.63	.08**
Third health period	.82	.72	.10***	.89	.72	.17***	.83	.74	.09**
Demography									
Entry year at work	1962	1962	-.08	1963	1963	.01	1963	1963	-.04
Men	.63	.63	0	.54	.54	0	.56	.56	0
Women	.37	.37	0	.46	.46	0	.44	.44	0
Age	60.02	60.31	-.28	59.82	59.61	.21	59.59	59.64	-.05
No diploma	.15	.15	0	.13	.13	0	.11	.11	0
Inf. education	.72	.72	0	.65	.65	0	.70	.70	0
Bachelor	.06	.06	0	.10	.10	0	.09	.09	0
Sup. education	.05	.05	0	.11	.11	0	.10	.10	0
Childhood									
Problems with relatives	.45	.45	0	.46	.46	0	.41	.41	0
Violence	.07	.07	0	.07	.07	0	.04	.04	0
Severe health problems	.10	.10	0	.10	.10	0	.09	.09	0

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. After matching, there is no significant difference between the future treated and control groups in terms of initial mean number of chronic diseases for physical, psychosocial and global samples.*
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7th threshold. Matched (weighted) sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

5. Results

5.1. Naive results

The results for unmatched difference-in-differences naive models for the five thresholds (t_5 to t_9) are presented in rows in Table 35, Table 36 and Table 37 (Appendix 9), and can be interpreted as differences between groups and periods in the mean numbers of chronic diseases. Despite not taking into account for the possibility of endogenous selection in the sample nor differences in observable characteristics between the two groups' structures, these models do take care of unobserved, individual-fixed heterogeneity. As expected after considering the sample description given in Table 7, unmatched baseline differences (*i.e.* differences in chronic diseases between treated and control populations before labour market entry) display statistically significant negative differences between future physically treated and controls in men (Table 35). These differences cannot be witnessed in women or for the psychosocial treatment (Table 36). The possibility of endogenous sorting hence cannot be excluded. The positive follow-up differences (*i.e.* differences in the numbers of chronic conditions between treated and control populations after the treatment period and not accounting for initial health status) indicate that the treated population reported higher numbers of chronic diseases than the control group in average. Logically, these differences are growing in magnitude as the exposure degree itself becomes higher.

Difference-in-differences results (*i.e.* the gap between treated and control populations, taking into account for differences in initial health status) suggest a consistent effect of detrimental work strains on the declaration of chronic conditions, which increases progressively as exposures intensify. While physical strains appear to play a role on the declaration of chronic diseases straight from t_5 in women and t_6 in men, effects after psychosocial strains seem to require higher levels of exposure to become statistically significant: in men, first significant differences appear from t_6 (t_7 in women). For the global treatment (Table 37), first significant differences happen for t_6 in women and t_7 in men. These effects do not turn out to be short term only, as the differences tend to grow bigger when considering later periods of time.

5.2. Main results

The results for matched difference-in-differences models for the five thresholds are provided in Table 10, Table 11 and Table 12 below. These results, relying on matched samples, take care of the selection biases generated by endogenous sorting in the labour market and observed heterogeneity, as well as unobserved individual-fixed and time-varying heterogeneities as a result of using difference-in-differences frameworks.

Table 10: Matched difference-in-differences results (t_5 to t_9), physical treatment

Treatment Sex	Baseline Diff. Coeff.	 Std. Err.	Follow-up Diff. Coeff.	 Std. Err.	Diff.-in-Diff. Coeff.	 Std. Err.	Mean chronic diseases in treat.	N (treat./tot.)	% matched (treat./contr.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures									
Men									
First health period			.012	*.069*	.036	*.065*	.488		
Second health period	-.024	*.020*	.012	*.050*	.036	*.068*	.500	1908/3212	
Third health period			.024	*.066*	.048	*.047*	.562		90% / 88%
Women									
First health period			.086	*.056*	.100*	*.052*	.439		
Second health period	-.014	*.019*	.087	*.058*	.101**	*.043*	.496	1226/3044	
Third health period			.097*	*.051*	.111**	*.048*	.522		
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures									
Men									
First health period			.016	*.072*	.038	*.070*	.497		
Second health period	-.022	*.019*	.017	*.074*	.039	*.073*	.561	1890/3196	
Third health period			.024	*.076*	.046	*.072*	.620		90% / 88%
Women									
First health period			.134***	*.055*	.148**	*.058*	.597		
Second health period	-.014	*.020*	.142**	*.060*	.156***	*.053*	.653	1162/3036	
Third health period			.155**	*.067*	.169**	*.066*	.762		
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures									
Men									
First health period			.024	*.075*	.047	*.074*	.607		
Second health period	-.023	*.017*	.032	*.076*	.055	*.075*	.681	1890/3226	
Third health period			.066	*.078*	.089	*.077*	.815		91% / 88%
Women									
First health period			.178***	*.068*	.185***	*.064*	.769		
Second health period	-.007	*.018*	.192***	*.073*	.199***	*.069*	.862	1128/3042	
Third health period			.196**	*.081*	.203***	*.076*	.959		
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures									
Men									
First health period			.063	*.069*	.076*	*.052*	.736		
Second health period	-.013	*.017*	.84	*.070*	.097**	*.054*	.833	1820/3224	
Third health period			.87	*.076*	.100**	*.055*	.946		92% / 87%
Women									
First health period			.193***	*.072*	.193**	*.079*	.904		
Second health period	-.000	*.019*	.210***	*.078*	.210***	*.074*	.970	1064/3022	
Third health period			.221**	*.083*	.221***	*.068*	1.044		
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures									
Men									
First health period			.80	*.064*	.087**	*.051*	.764		
Second health period	-.007	*.016*	.110*	*.066*	.117**	*.060*	.871	1694/3232	
Third health period			.113*	*.070*	.120***	*.060*	.986		92% / 86%
Women									
First health period			.225***	*.075*	.228***	*.082*	.909		
Second health period	-.003	*.019*	.229***	*.086*	.232***	*.077*	.961	970/2976	
Third health period			.246***	*.081*	.249***	*.070*	1.045		

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The baseline and follow-up columns show the results for the first differences between the treated and control groups, respectively, before and after the treatment. The diff.-in-diff. column shows the results for the second differences (i.e., the difference between follow-up and baseline differences). The mean chronic diseases column indicates the mean number of chronic diseases of the treated population in the health period considered. The N column gives the sample sizes for, respectively, the treated and total populations. The last column denotes the percentage of the initial sample that found a match for, respectively, the treated and control groups.*

Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Matched (weighted) sample.*

Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Table 11: Matched difference-in-differences results (t_5 to t_9), psychosocial treatment

Treatment Sex	Baseline Diff. Coeff.	 Std. Err.	Follow-up Diff. Coeff.	 Std. Err.	Diff.-in-Diff. Coeff.	 Std. Err.	Mean chronic diseases in treat.	N (treat./tot.)	% matched (treat./contr.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures									
Men									
First health period			.018	*.039*	.016	*.035*	.357		
Second health period	.014	*.016*	.046	*.041*	.032	*.037*	.408	1560/3318	
Third health period			.045	*.045*	.031	*.042*	.432		89% / 93%
Women									
First health period			.037	*.053*	.040	*.048*	.380		
Second health period	-.003	*.024*	.053	*.054*	.056	*.046*	.419	1354/3068	
Third health period			.064	*.056*	.067	*.044*	.445		
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures									
Men									
First health period			.089*	*.043*	.080**	*.040*	.464		
Second health period	.009	*.016*	.090*	*.046*	.081**	*.040*	.521	1534/3288	
Third health period			.139***	*.047*	.130***	*.045*	.632		90% / 91%
Women									
First health period			.035	*.053*	.047	*.051*	.516		
Second health period	-.012	*.024*	.053	*.058*	.065	*.045*	.569	1310/3072	
Third health period			.055	*.062*	.067	*.056*	.660		
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures									
Men									
First health period			.117**	*.049*	.112**	*.046*	.613		
Second health period	.005	*.016*	.118**	*.056*	.113**	*.056*	.664	1496/3320	
Third health period			.139**	*.066*	.134**	*.067*	.734		90% / 93%
Women									
First health period			.151***	*.059*	.156***	*.055*	.743		
Second health period	-.005	*.023*	.155***	*.065*	.160***	*.063*	.867	1272/3142	
Third health period			.157**	*.072*	.172***	*.061*	.969		
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures									
Men									
First health period			.123**	*.050*	.111**	*.047*	.671		
Second health period	.012	*.017*	.131**	*.067*	.119**	*.048*	.696	1410/3290	
Third health period			.161**	*.069*	.149**	*.069*	.830		91% / 92%
Women									
First health period			.179***	*.065*	.181**	*.079*	.881		
Second health period	-.002	*.023*	.204***	*.072*	.206***	*.068*	.963	1192/3106	
Third health period			.218***	*.081*	.220***	*.061*	1.058		
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures									
Men									
First health period			.127***	*.053*	.116**	*.052*	.714		
Second health period	.011	*.017*	.133**	*.073*	.122**	*.050*	.730	1274/3272	
Third health period			.154***	*.074*	.143***	*.053*	.861		91% / 91%
Women									
First health period			.206***	*.066*	.209***	*.078*	.917		
Second health period	-.003	*.023*	.222***	*.072*	.225***	*.067*	1.015	1110/3098	
Third health period			.230***	*.081*	.233***	*.061*	1.125		

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The baseline and follow-up columns show the results for the first differences between the treated and control groups, respectively, before and after the treatment. The diff.-in-diff. column shows the results for the second differences (i.e., the difference between follow-up and baseline differences). The mean chronic diseases column indicates the mean number of chronic diseases of the treated population in the health period considered. The N column gives the sample sizes for, respectively, the treated and total populations. The last column denotes the percentage of the initial sample that found a match for, respectively, the treated and control groups.*

Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Matched (weighted) sample.*

Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Table 12: Matched difference-in-differences results (t_5 to t_9), global treatment

Treatment Sex	Baseline Diff. Coeff.	 Std. Err.	Follow-up Diff. Coeff.	 Std. Err.	Diff.-in-Diff. Coeff.	 Std. Err.	Mean chronic diseases in treat.	N (treat./tot.)	% matched (treat./contr.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures									
Men									
First health period			-.003	*.067*	.023	*.066*	.391		
Second health period	-.026	*.022*	-.003	*.070*	.023	*.069*	.401	2256/3002	
Third health period			.017	*.053*	.043	*.049*	.434		82% / 94%
Women									
First health period			.024	*.056*	.025	*.051*	.386		
Second health period	-.001	*.023*	.032	*.054*	.033	*.047*	.438	1850/3018	
Third health period			.034	*.056*	.035	*.049*	.473		
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures									
Men									
First health period			-.019	*.073*	.013	*.073*	.431		
Second health period	-.032	*.021*	-.010	*.074*	.022	*.075*	.491	2192/2962	
Third health period			.025	*.076*	.057	*.076*	.589		80% / 94%
Women									
First health period			.067	*.057*	.076	*.054*	.527		
Second health period	-.009	*.021*	.078	*.054*	.087	*.050*	.586	1734/2978	
Third health period			.089	*.063*	.098*	*.056*	.688		
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures									
Men									
First health period			.018	*.038*	.049	*.067*	.588		
Second health period	-.031	*.020*	.038	*.070*	.069	*.069*	.671	2160/2978	
Third health period			.049	*.074*	.80	*.073*	.804		81% / 94%
Women									
First health period			.143***	*.071*	.148***	*.067*	.740		
Second health period	-.005	*.020*	.157***	*.058*	.162***	*.054*	.859	1710/3010	
Third health period			.167***	*.063*	.173***	*.059*	.972		
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures									
Men									
First health period			.058	*.066*	.080	*.064*	.703		
Second health period	-.022	*.019*	.065	*.071*	.087	*.069*	.772	2126/3024	
Third health period			.114	*.074*	.136*	*.073*	.934		82% / 94%
Women									
First health period			.138*	*.083*	.139*	*.081*	.840		
Second health period	-.001	*.019*	.170**	*.071*	.171**	*.068*	.936	1652/3034	
Third health period			.180***	*.064*	.181***	*.061*	1.044		
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures									
Men									
First health period			.097	*.063*	.100*	*.055*	.724		
Second health period	-.003	*.017*	.099	*.067*	.102*	*.056*	.777	2146/3172	
Third health period			.113*	*.071*	.116*	*.068*	.925		86% / 93%
Women									
First health period			.191**	*.077*	.190**	*.075*	.885		
Second health period	.001	*.019*	.206***	*.061*	.205***	*.058*	.992	1586/3072	
Third health period			.210***	*.067*	.209***	*.064*	1.095		

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The baseline and follow-up columns show the results for the first differences between the treated and control groups, respectively, before and after the treatment. The diff.-in-diff. column shows the results for the second differences (i.e. the difference between follow-up and baseline differences). The mean chronic diseases column indicates the mean number of chronic diseases of the treated population in the health period considered. The N column gives the sample sizes for, respectively, the treated and total populations. The last column denotes the percentage of the initial sample that found a match for, respectively, the treated and control groups.*

Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Matched (weighted) sample.*

Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

It should be noted that around 90% of the initial sample is preserved after matching in physical and psychosocial samples, and that at least 80% of the sample is preserved for the global treatment (because of the higher number of treated). Matching the samples on pre-treatment variables consistently succeeds in reducing initial health status gaps between treated and control groups, to the point where none of them are still present in the matched results.

It appears that men are clearly much more exposed to detrimental working conditions than women, especially for physically demanding jobs (with an average of 20 percentage points (pp) more in men than in women), but also to a lesser extent for psychosocial risk factors ($+3pp$ in men). In comparison to women, the gender gap regarding all working conditions (global treatment) is approximately $+16pp$ in men. A clear impact of exposures to work strains on the declaration of chronic diseases can be observed in the difference-in-differences (columns 5 and 6). Treated workers indeed seem to suffer from a quicker degradation trend in their health status than their respective control groups. This trend exists between levels of exposure (thresholds), but it is also suggested by the evolution of the number of chronic diseases by health status observation period, even though these differences in means are unlikely to be statistically significant. This main result holds for all treatment types and for both genders, and it tends to demonstrate possible long-term effects of exposures rather than only short-term consequences.

In the physical sample, the first significant consequences in terms of health status degradation can be seen in women, starting from t_5 (*i.e.,* after 12 years of single exposure or 6 years of simultaneous exposures), while this is the case much later in men, at t_8 (*resp.* after at least 18 or 9 years of exposure). Between t_5 and t_9, the differences between treated and control groups in the mean number of chronic diseases in women increase from $.100$ to $.249$; while in men the differences between t_8 and t_9 range from $.076$ to $.120$. In order to have an idea of the meaning of these differences, it is possible to compare them to the mean number of chronic diseases in the treated population after the treatment occurred, given in column 7. In physically exposed women (*resp.* men), exposures to work strains may account for 20% to 25% of their chronic diseases (*resp.* a little more than 10%). Psychosocial strains have a more homogenous initial impact on the declaration of chronic diseases, with sizeable health status consequences happening at t_6 in men (*resp.* 14 or 7 years of exposure) and t_7 in women (*resp.* 16 or 8 years of exposure). The difference in women (*resp.* in men) goes from $.156$ in t_7 ($.080$ in t_6) to $.233$ in t_9 ($.143$ in t_9). Thus, in psychosocially exposed women (*resp.* men), approximately 21% of chronic diseases in the treated population can be explained by

psychosocial strains (*resp.* 17%). For the global treatment, effects of exposures start at t_7 in women (*resp.* t_8 in men) and go from $.148$ to $.209$ (*resp.* $.100$ to $.136$ in men). According to the results for this global type of exposure, 20% (*resp.* 10% to 15%) of exposed women's (*resp.* men's) chronic diseases come from combined physical and psychosocial job strains. The effects of the global treatment appear weaker in terms of onset and intensity, which is most likely due to the fact that the exposure thresholds are easier to reach because of the greater number of working condition indicators considered. Nevertheless, even though women are less exposed than men to work strains, it seems that their health status is more impacted by them.

6. Robustness checks

6.1. Common trend assumption

In order to ensure that the results obtained using a difference-in-differences framework are robust, one needs to assess whether the treated and control groups share a common trend in terms of the number of chronic diseases before all possible exposures to detrimental working conditions, *i.e.,* before labour market entry.

Figure VIII, Figure IX and Figure X (Appendix 10), respectively, present the chronic disease trends for the treated and control groups in the matched physical, psychosocial and global samples for t_7. The first panel represents the baseline period and stops at the mean year of labour market entry for this sample. From all three graphs, one can see that both treated and control groups share the same trend in terms of a rise in chronic diseases. This is no longer the case after labour market entry. The common trend hypothesis seems to therefore be corroborated. It should be noted that the test results on unmatched samples (available upon request) are rather close, but they are not as convincing.

6.2. Model dependency

I also test whether the results obtained using matched difference-in-differences could be obtained more easily by relying only on a matching method. Yet because CEM is not in itself an estimation method, I set up a simple, heteroskedasticity-robust specification that was estimated using Ordinary Least Squares on matched data with the same control variables (specification 3), followed by a comparison of the results with those obtained through difference-in-differences using specification 2 (Table 38, Appendix 11).

$$y_i = \beta_0 + \beta_1 \mathbf{1}_{(T_i=1)} + \beta_2 C_i' + \varepsilon_i \quad (3)$$

The results for all three samples on t_7 indicate that, in terms of statistical significance, the detrimental impact of exposure to work strains on the number of chronic diseases is confirmed. This is not very surprising, as CEM has the particularity to reduce the model dependence of the results (Iacus *et al.*, 2008). Yet, the amplitude of the effect is mostly a bit higher in OLS. This could be explained by the fact that these simple OLS regressions neither account for initial differences in terms of health status, nor do they take into account individual and temporal unobserved heterogeneities when both these phenomena are going in opposite directions. As a consequence, difference-in-differences results are preferred here because of their increased stability and reliability.

6.3. Single *vs.* simultaneous exposures

I tested the relevance of the differentiation made between single and multiple exposures in the three working condition treatments, *i.e.,* the relevance of considering that a certain number of single exposures are equivalent to half that number of poly-exposures (inspired from the French legislation – Sirugue *et al.*, 2015).

Table 39 (Appendix 12) presents several results. The first two columns indicate, for t_7, the results obtained with a treatment considering 16 years of single exposures or 8 years of poly-exposures (which are the main results presented in this paper). The next two columns indicate the results when considering treatment while accounting only for 16 years of single exposures. The last two columns present the results for a treatment when considering only 8 years of poly-exposures.

It should be noted that, logically, single exposures induce a weaker effect on the number of chronic diseases than poly-exposures. All the results still converge towards a positive and statistically significant effect of exposures on the declaration of chronic diseases. In addition, the differences in intensity that can be observed between individuals exposed to 16 years of single exposures and those exposed to 8 years of simultaneous exposures do not appear to be statistically significant.

6.4. Health habits

Even though a part of the role that health habits play in the relationship between working conditions and health (possibly generating endogeneity issues) is accounted for by controlling

for the evolutions in tobacco consumption in the difference-in-differences, other behaviours are not taken into account directly (because they cannot be reconstructed in a longitudinal fashion using Sip data), even if they are likely correlated with smoking habits.

Table 40 (Appendix 13) presents an exploratory analysis on the wages and risky health-related behaviour differences in 2006, on t_7, between treated and control groups for all three treatments. In unmatched samples, important differences can be observed in terms of monthly wage, regular physical activities, alcohol, tobacco consumption and being overweight. The treated group on average earns less and does less sport but has more health-related risky behaviours than the control group. In matched samples, no statistically significant difference remains between the two groups in 2006 except for wages. This indicates that the treatment effects presented here should not pick up specific effects of health-related behaviours, except possibly those related to health investments (as the control groups are generally richer than the treated groups).

6.5. Gender gap

Important gender differences appear to exist in terms of effects from a certain degree of exposure to detrimental working conditions. In order to try and explain these differences, an exploratory analysis specifically on year 2006 has been conducted in Appendix 14.

First, men and women may be employed in different activity sectors, the latter being characterized by different types of exposures to working conditions (Table 41). As expected, very large differences exist in the gender repartition as well as work strain types encountered within activity sectors. Thus, it is likely that men and women are not exposed to the same types of strains. Table 42 confirms this intuition and indicates that, for at least five out of ten working conditions indicators, a statistically significant difference exists between men and women in terms of repartition into strains.

As a consequence, the explanation for this gender-gap in working conditions and health is most likely twofold. First, there might be declarative social heterogeneity between men and women. Both may not experience an objectively comparable job situation in the same way, just as they may not experience an objectively comparable health condition in the same way (Devaux *et al.*, 2008; Shmueli, 2003). However, what could also be true is that men and women may not be exposed to the exact same typology of working conditions within a certain treatment. Even though belonging to a specific treatment group ensures a quantitatively similar exposure (in terms of number of strains at a given time and in terms of lengths of

exposures), it does not completely ensure that the types of strains are qualitatively equivalent, which in turn could explain part of the observed differences. Yet, this hypothesis should be partially relaxed by the use of two different treatment types (one handling physical demands and another for psychosocial risk factors).

7. Discussion and conclusion

In this study, I use French retrospective panel data to highlight links that physical and psychosocial working conditions – separately and combined – have with chronic diseases in exposed males and females. Workers facing gradually increasing strains in terms of duration or simultaneity of exposure are more frequently coping with rising numbers of chronic diseases. Using combined difference-in-differences and matching methods, the empirical strategy helps to handle both (self-)selection in the labour market based on health status and other observable characteristics as well as unobserved individual and temporal heterogeneity. Based on a career-long temporal horizon for exposures and health status observation periods, I find major differences in health conditions between treated and control groups, which are very likely the result of past exposures to work strains. To my knowledge, this is the first paper to work on both the simultaneous and cumulative effects of two distinct types of work strains and their combination with such a large temporal horizon, while acknowledging the inherent biases related to working conditions.

However, the paper suffers from several limitations. First, working with retrospective panel data and long periods of time leads to estimates being at risk of suffering from declaration biases. The individuals are rather old at the date of the survey, and their own declarations in terms of working and health conditions are therefore likely to be less precise (recall biases) or even biased (*a posteriori* justification or different conceptions according to different generations). Even if it is impossible to deal completely with such a bias, matching on entry year into the labour market (*i.e.*, their generation) and on education (one of the deciding factors when it comes to memory biases) should help in reducing recall heterogeneity. Also, simple occupational information notably tends to be recalled rather accurately, even over longer periods (Berney and Blane, 1997). Yet, justification biases most likely remain (for instance, ill individuals may declare they faced detrimental working conditions more easily because of their health condition), especially considering the declarative nature of the data. Second, potential biases remain in the estimations. I work on exposures happening during the first half of the professional career (*i.e.*, to relatively young workers), at a time when

individuals are more resilient to these strains. This means that the impact found in this study would most likely be higher for an equivalent exposure level if an older population were targeted. I am also unable to completely account for possible positive healthcare investments in the treated population, because if the most exposed are also better paid (hedonic price theory, Rosen, 1974) this wealth surplus could be used for relatively more health capital investments. Alternatively, the treated and control groups may have different health habits. Hence it is possible that the mean results I find are once again biased. Yet, even though wealth-type variables are endogenous, this hypothesis has been tested empirically with an alternative specification in the study by Fletcher *et al.* (2011) and they were found to be irrelevant. Also, health-related risky behaviours are at least partly accounted for by implementing a variable for tobacco consumption in the difference-in-differences model. Another important point about potentially remaining biases in the estimations is that time-varying individual unobserved heterogeneity still is unaccounted for. For instance, a specific unobserved shock impacting both exposures to work strains and chronic diseases with heterogeneous effects depending on individuals cannot be accounted for (one can think for example to an economic crisis which usually degrades, in average, work quality and may also deteriorate individuals' health status – in this particular case, the estimations are at risk to be biased upwards). One must thus be careful concerning the causal interpretation of the results. Third, because of the method I use and the sample sizes I am working with, it is not possible to clearly analyse the potential heterogeneity in the effect of working conditions on health status across demographic and socio-economic categories, even though this mean effect is shown to vary (Fletcher *et al.*, 2011; Muurinen and Le Grand, 1985). Fourth, part of the selection process into a certain level of exposure possibly remains. Considering that the sample is matched with elements of human and health capitals and because I consider only homogenous individuals present in the survey for at least 38 years (who worked at least 10 years and for whom the post-treatment exposures are controlled for), I should have rather similar individuals in terms of resilience to detrimental working conditions, *i.e.*, with similar initial abilities to sustain a certain level of severity of exposure. So, to some extent at least, the selection into a certain level of treatment is acknowledged. Yet, it is impossible to directly match the samples depending on the fact that whether or not they reached a certain level of treatment (because it is endogenous). Because of that, it is likely that some degree of selection remains (notably, only the "survivors" are caught in the data, which possibly induces downward-biased estimations). It should also be noted that part of the heterogeneity of the results between men and women can still be explained by declarative social heterogeneity

regarding their working and health conditions as well as qualitative differences in their exposures, both elements which cannot really be accounted for using such declarative data. Finally, I use a wide definition of chronic conditions as an indicator for health status. This indicator does not allow for direct comparisons with the literature (commonly used indicators, such as self-assessed health status or activity limitations, are not available on a yearly basis). Yet, I believe that it may represent a good proxy of general health status while at the same time being less subject to volatility in declarations compared to self-assessed health (i.e., more consistent).

These results justify more preventive measures being enacted early in individuals' careers, as it appears that major health degradations (represented by the onset of chronic conditions) tend to follow exposures that occur as early as the first half of the career. These preventive measures may first focus on workers in physically demanding jobs while also targeting workers facing psychosocial risk factors, the latter still being uncommon in public policies. These targeted schemes may benefit both society in general (through higher levels of general well-being at work and reduced healthcare expenditures later in life) and firms (more productive workers and less sick leaves). It notably appears that postponing the legal age of retirement must be backed up by such preventive measures in order to avoid detrimental adverse health effects linked to workers being exposed longer while also taking into account both types of working conditions (which is not the case in the 2015 French pension law). Today, the human and financial costs of exposures to detrimental working conditions seem undervalued in comparison to the expected implementation cost of these preventive measures.

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Chapter III: Health status after retirement

RETIRED, AT LAST?

THE ROLE OF RETIREMENT ON HEALTH STATUS IN FRANCE

This chapter is co-written with Thomas BARNAY (Paris-Est University)

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 13. 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 13: General descriptive statistics

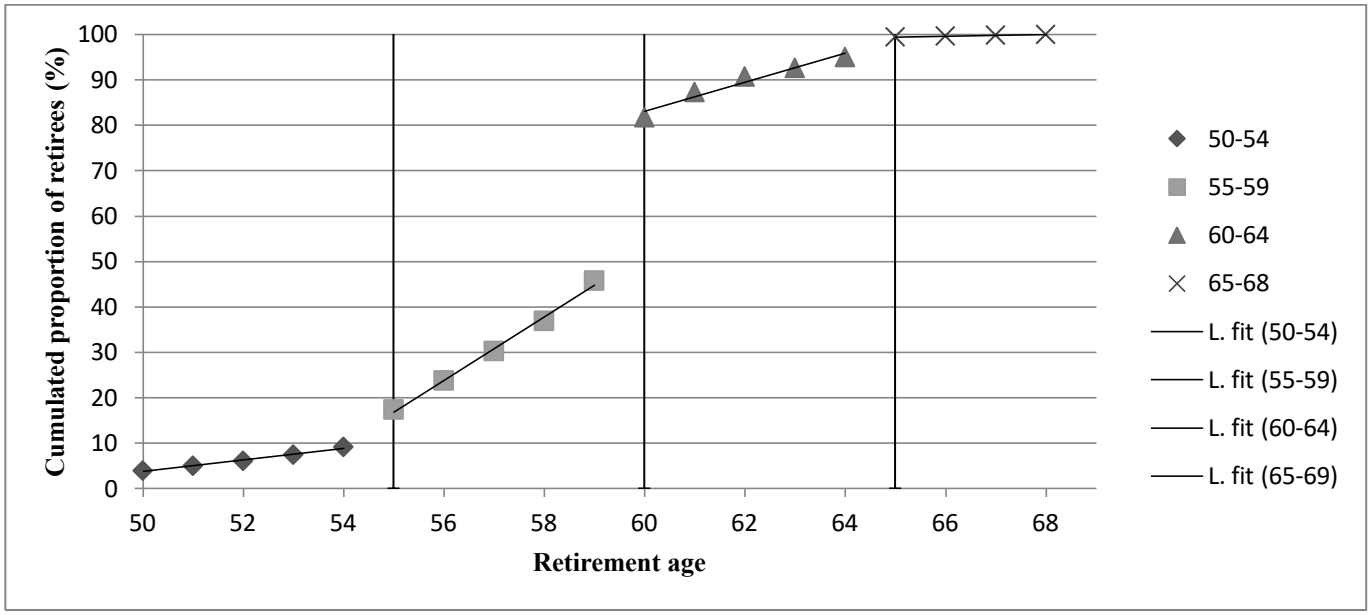
Variable	Mean	Std. error	Min.	Max.	N	Mean Retirees	Mean non-retirees	Diff.
Retirement								
Retired	.42	*.49*	0	1	2071	-	-	-
Aged 55 or more	.74	*.44*	0	1	3629	.98	.55	-.44***
Aged 60 or more	.45	*.50*	0	1	2235	.90	.13	-.77***
Aged 65 or more	.18	*.38*	0	1	876	.40	.01	-.39***
Health status								
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 VI 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 15 (Figure XI and Figure XII).

Figure VI: 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.

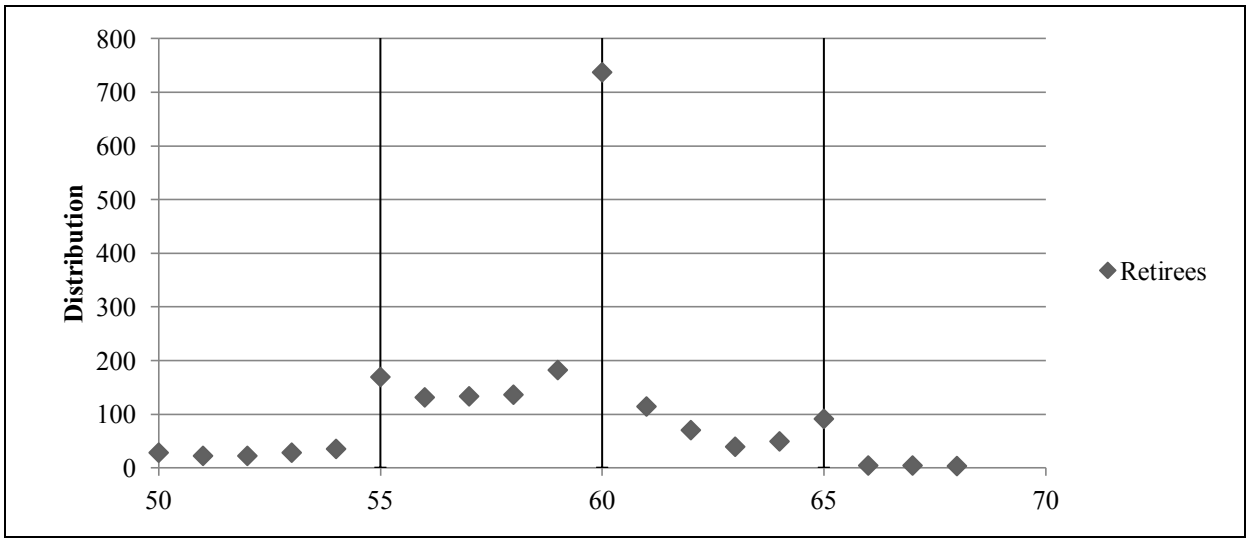
4.2.2. Hypotheses

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 VII 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 VII: 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):

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

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

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):

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

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

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.

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

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

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[15]:

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

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 16): 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 17 and Appendix 18).

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

[15] *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.*

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 14 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 43 (Appendix 19).

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 14: 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[16]	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.*

[16] *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 19 (Table 43 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 15 and Table 16), by education levels (Table 17 and Table 18) and possible past exposures to physically (Table 19 and Table 20) or psychosocially (Table 21 and Table 22) demanding jobs. The models have also been conducted on a subsample excluding civil servants (Appendix 20, Table 44 and Table 45). 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 15 and for women in Table 16 below).

Table 15: 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 16: 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 17) and on the other hand, the ones that reached a level at least equivalent to the French *baccalaureat* (Table 18). 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 17: 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 18: 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 19 and Table 20) and high and low psychosocial exposures (Table 21 and Table 22) during the whole career.

Table 19: 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 20: 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 21: 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 (*ref.: women*)	.01	.01	.02	.02	.02	.02	-.06***	-.06**	-.03	-.03
	.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 (*ref.: none*)	-.01	-.01	.03	.03	-.02	-.02	.05	.04	.02	-.02
	.06	*.06*	*.07*	*.06*	*.06*	*.06*	*.05*	*.05*	*.05*	*.05*
Education										
< BAC (*ref.: no dipl.*)	-.09	-.08	-.02	.01	-.00	.01	.02	.07	.01	.02
	.06	*.06*	*.06*	*.06*	*.05*	*.06*	*.04*	*.05*	*.04*	*.04*
= BAC (*ref.: no dipl.*)	-.19***	-.18**	.01	.03	-.00	.01	.05	.08*	-.01	.01
	.09	*.07*	*.07*	*.07*	*.07*	*.07*	*.04*	*.05*	*.05*	*.05*
> BAC (*ref.: no dipl.*)	-.32***	-.31***	-.09	-.08	-.06	-.05	-.00	.00	-.06	-.05
	.07	*.07*	*.07*	*.07*	*.07*	*.07*	*.04*	*.05*	*.05*	*.05*
Employment										
Public sector (*ref.: private*)	-.05	-.06	-.11*	-.14**	-.20***	-.21***	.00	-.04	-.03	-.07
	.06	*.06*	*.06*	*.06*	*.06*	*.06*	*.04*	*.04*	*.04*	*.04*
Self-employed (*ref.: private*)	-.09	-.07	-.14	-.14	-.01	-.01	.02	.03	.01	-.00
	.10	*.10*	*.10*	*.10*	*.09*	*.09*	*.06*	*.06*	*.03*	*.03*
Long-term jobs (*ref.: short term*)	-.11**	-.10*	-.09	-.06	-.10**	-.09*	-.03	-.01	-.06*	-.04
	.05	*.05*	*.05*	*.05*	*.05*	*.05*	*.03*	*.03*	*.03*	*.03*
Stable career (*ref.: unstable*)	.01	.02	-.04	-.03	.03	-.03	-.05	-.07***	.01	.02
	.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 22: 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 20, Table 44 and Table 45).

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 23: 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 24: 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 23). 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 24). 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 VI as well as Figure XI and Figure XII in Appendix 15). 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 21, Table 46 and Table 47).

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 21, Table 48) are resilient to LPM modelling. It is the same for the results of auxiliary retirement models, which are also stable (Appendix 21, Table 49). 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 21, Table 50 and Table 51).

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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General conclusion

1. Main results

Because of its temporal approach, the main findings of this Ph.D. Dissertation can be summed-up in terms of occupational and health cycles.

Starting from the beginning of the work life, this Ph.D. Dissertation was able to find that exposures to detrimental working conditions early on are related to higher amounts of chronic diseases in exposed men and women (Chapter 2). Based on a career-long temporal horizon both for physical and psychosocial exposures and health status, major differences in terms of health condition between the most and least exposed workers related to job strains are indeed found. Workers facing gradually increasing strains in terms of duration or simultaneity of exposure are more frequently coping with raising numbers of chronic diseases, being either physical or mental conditions. Even though these workers are supposedly more resilient to such strains being exposed during the first part of their career, sensible health status degradations are visible. Accounting for baseline characteristics including childhood important events, this result is robust to selection processes into a job and unobserved heterogeneity. In physically exposed men, around 10% of chronic diseases can be explained by gradually increasing levels of exposures. Exposures to psychosocial strains account for 17% of them. In women, increasing physical (*resp.* psychosocial) exposures explain between 20% and 25% (*resp.* 21%) of their number of chronic diseases, after exposure. As a consequence, women (when not being the most exposed), are found to experience the most degrading effect of such exposures.

In part, workers may experience health shocks during their career, which are susceptible to deteriorate their capacity to remain in their job. Notably, mental health conditions such as depressive episodes or anxiety disorders appear as strong explanatory factors of this capacity (Chapter 1). After accounting for socioeconomic characteristics, employment, general health status, risky behaviours and most importantly the professional career, suffering from common mental disorders induces a decrease of up to $13pp$ in the probability of remaining in employment four years later for men at work in 2006. In the female population, no such effect can be found, as general health status remains predominant in explaining their trajectory on the labour market. This result is in line with the literature about employability of individuals facing mental health conditions in the general population, but provides insights about the capacity for ill workers to remain in employment. Considering separately depressive episodes and anxiety disorders suggests that the disabling nature of mental health goes through both indicators. In addition, the accumulation of mental disorders increases the risk of leaving

employment during the period ($-14pp$ for men facing both disorders compared to $-5pp$ for those only facing one of the two). These findings induce that individuals facing such impairments are more likely to know more fragmented careers.

As a consequence retirement's role on health status differs according to the nature of past circumstances, notably related to initial human capital and job characteristics. It is indeed found to be beneficial for individuals' physical and mental health status overall, with disparities depending notably on the nature of the career. Accounting for reverse causality and unobserved heterogeneity, retirement decreases the probability to declare activity limitations ($-11pp$), anxiety disorders ($-11pp$) and depressive episodes ($-13pp$) when no significant effect can be found on self-assessed health and chronic diseases in men. In women, retirement benefits appear only on mental health outcomes (*resp.* $-6pp$ in anxiety and $-9pp$ in depression). Heterogeneity in this global effect is found, indicating a particularly strong relationship 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. As far as explanatory mechanisms go, a greater ability for retirees to have more social and physical daily activities ($+10pp$) and smaller tobacco consumption ($-8pp$) are likely to generate these positive health outcomes. Yet, retirees are also found to be significantly more at risk for alcohol consumption ($+8pp$) and overweight ($+12pp$).

2. Limitations and research perspectives

Every chapter of this dissertation relies on survey data. All chapters make use of the French panel data of the *Santé et Itinéraire Professionnel* survey (Sip). Moreover they all rely, at least partly, on retrospective information (*i.e.* information from the past gathered at the time of the survey, possibly much later). Thus, because of the nature of the data, biases in declarative behaviours and memory flaws cannot be excluded. It is indeed possible that, depending on some characteristics, individuals might answer a given question differently even if the objective answer would be the same (Devaux *et al.*, 2008; Shmueli, 2003). Apart from that, *a posteriori* justifications or rationalisations are also likely to generate misreporting and measurement errors (Gannon, 2009; Lindeboom and Kerkhofs, 2009). Also, the indicators used in this dissertation are more or less subjective measures for the most part. Health status indicators like self-reported self-assessed health, chronic diseases, activity limitations, generalized anxiety disorders and major depressive episodes are all, to a certain extent,

subjective measurements for health conditions. Yet, it is to be noted that these indicators also appear to be reliable and valid to assess individuals' health status and are standard and widely used. Self-assessed health is notoriously correlated with life expectancy (Idler and Benyamini, 1997), anxiety disorder and depressive episodes are consolidated measures coming from the *Diagnostic and Statistical Manual of Mental disorders* (DSM-IV) and chronic diseases and activity limitations are, by definition, less subject to volatility in declarations compared to other indicators (because of their long-lasting and particularly disabling nature), even if self-declared. Working conditions are also subjective and self-declared in this dissertation, and hence cannot really allow for detailed comparison to legislative frameworks, which are based on objective measures. However, these objective measures only hold on physical strains and nothing else (simply because psychosocial risk factors are, by definition, subjective feelings) when more subjective indicators better succeed in embracing the whole picture of work strains. Also, when it is understandable that the legislator seeks for objectivity in a context of potential compensations, the subjective feelings beyond objective strains appear as much more relevant when trying to assess the role of these strains on health status.

Some research perspectives for Chapter 1 are possible. Results suggest very different types of impact of mental health on job retention. It would be interesting to be able to disentangle the mechanisms behind these differences. They may partly be explained by differences in social norms related to the perception of mental disorders and employability, as well as by differences in the severity of diseases. As is, it is not possible to assess such social norms or the severity of the disease. A mental health score would most likely allow for it, as well as providing a more stable indicator for mental health (as it is apparent that the amplitude of the results depends a lot on the retained definition of mental health). The results are also conditioned by the fact that the 2006-2010 period is particular in terms of economic conjuncture, asking the question of the external validity of the results. Obviously, clarifying the exact role of the economic crisis in the relationship we observe in this Chapter would allow for more detailed interpretations.

Chapter 2 may also benefit from some extensions. It would first be interesting to test potential heterogeneous effects of working conditions on health, depending on the time of exposure. If there is already a sensible effect of exposure early on, when individuals are more resilient to these strains, it is definitely a possibility that exposure on older workers would imply even greater health disparities. Yet, this hypothesis needs to be tested empirically. Another interesting topic would be to establish the part between what is induced by exposures

themselves and what is implied by health-related behaviours (Fletcher *et al.*, 2011). Exposed workers may have specific behaviours in terms of tobacco or alcohol consumption for instance, or some specific features in terms of healthcare usage that would be correlated with their exposures and health status. Finally, detailed work on heterogeneity sources in the effect seems important, in terms of demographic and socioeconomic characteristics.

Research perspectives for Chapter 3 include specific work to determine if the average effect of retirement on health status differs according to the distance with retirement shock. Is the effect majorly led by short-, mid- or long-run consequences? Is the impact on health status happening right after retirement or in a lagged fashion? Another question that will need to be answered is whether or not the effect of retirement on health status differs depending on the retirement profile, *i.e.* if the individual retires early or late. It is indeed possible that the effect might be stronger in workers retiring early (because of more detrimental exposures during their career to work strains), or stronger in workers retiring late (because of longer exposures) notably. This specific dilemma would be interesting to test.

3. Policy implications

Some recommendations can be suggested, based on this work.

First, because their incapacitating nature is lower than heavier mental health disorders, depressive episodes and anxiety disorders generally received less attention from policy makers. Yet, these disorders are more widespread (6% of men and 12% of women suffer from at least one of these condition in France, according to our data), and their detrimental role on the capacity of workers to remain in employment seems verified, at least in the male population. Because of the onset of depression or anxiety, the probability of male workers to remain in employment within a timespan of four years is significantly decreased. Hence, policies should account for such conditions and increase support for workers facing them in the workplace. Policies focusing on adapting the workplace to the needs of these ill workers and making it easier for them to find a job are most likely the two most relevant kinds of frameworks that could help in reducing the role of their disease on their career outcomes (which is partly suggested by the *Plan Psychiatrie et santé mentale 2011-2015*, in France). On the long run, positive results can be expected from these frameworks, with both increased productivity in the workplace, a greater career stability and an increased health condition for workers, likely to result in decreased healthcare expenditures at the state level (mental health-related expenditures currently represents around 3 to 4% of the GDP because of decreased

productivity, increased sick-leaves and unemployment according to the International Labour Organisation). Current work intensification and increased pressures on employees are both likely to make this problem even more topical in the coming years. At the European level, a *European Pact for Mental Health and Well-being* was established in 2008 and promotes mental health and well-being at work as well as the need to help people suffering from mental health disorders to return to the labour market.

Chapter 2 suggests that long exposures to detrimental physical and psychosocial working conditions can have a long-term impact on health status, through increased numbers of chronic diseases. The first significant increase being found after less than 10 years of exposure implies that work strains are relevant in terms of health degradation starting from the beginning of workers' career. The results also suggest that psychosocial risk factors are very important in the determination of workers health. When the *Compte Pénibilité* in France makes a step in the right direction by allowing exposed workers to objectively measured physical strains to follow trainings, to work part-time or to retire early, this study advocates that workers' feelings about their working conditions are close to equivalent in terms of magnitude in the effects on health, and thus that psychosocial strains should not be excluded from public policies even if there are intrinsically harder to quantify. At the European level, the *European Pact for Mental Health and Well-being* also focuses on improving work organisation and hierarchical practices in order to promote mental health. Then, because of the timing of exposure (usually starting early on during the career) and considering the long-lasting detrimental effects on health status (onset of chronic diseases), a greater emphasis may need to be put on preventive measures such as health and safety promotion at work and the design of a more health-preserving workplace, instead of curative frameworks. Overall, by being able to better quantify the long-term health costs of strenuous jobs, a need for a change from the currently dominating position of curative scheme to preventive measures starting from the very design of the workplace seems mandatory. The European Commission (1989) states that "work shall be adapted to individuals and not individuals to work", and insists since then on the concept of work sustainability (EU strategy 2007-2012 – European Commission 2007).

In a context of overall kick back of legal ages of retirement due to deficits in pension systems induced, notably, by constant increases in life expectancy, the question of the role of retirement on the determination of health status is crucial. Chapter 3 demonstrates a clear positive impact of retirement on general and mental health, both for men and women, but with

variations across sex, education and exposure levels to detrimental working conditions. It appears that retirement bears even more beneficial effects for the less educated and more exposed workers during their career, especially to psychosocial strains. Postponing retirement decisions seem then all the more risky that as it is, retirement in general appears as the one tool to relieve workers from their potentially poor working conditions. In that sense, postponing legal retirement ages may not be successful in balancing pension systems, simply because there are consequences in terms of health status at old ages of these reforms, and also because exposed workers may not be able to reach these higher thresholds at work (hypothesis quite possibly at least partly verified by existing low levels of employability for senior workers). Extensions of the contribution period or the reversibility of the retiree's status (increasingly desired in Europe in recent years – Barnay, 2016) should be accompanied by preventive measures for work strains (which is in line with the conclusions of Chapters 2 and 3) during the career, or at least by differentiated retirement schemes depending on the nature and intensity of the entire work life of pensioners. Because retirement generally seems to promote more healthy behaviours due to the increase of available free time but yet also suggests an increase in alcohol consumption and overweight, information campaigns and specific incentives towards retirees in that sense could be introduced.

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Appendices

Appendix 1: 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 answer, 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 2: 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 answers 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 3: Initial selection of the sample in 2006

This study does not claim to measure the impact of mental health on employment but tries to establish the causal effect of mental health on job retention. The unemployed population in 2006 is therefore discarded, even though their reported prevalence of anxiety disorders and depressive episodes is far superior to those in employment (22% *vs.* 6% in men and 21% *vs.* 12% in women; see Table 25 and Table 26, Appendix 6).

Hence, this study does not suffer from selection biases linked to the status in employment in 2006. However, if the goal was to measure the impact of mental health on the participation to the labour market, restricting the sample to individuals in employment in 2006 would lead to an underestimation of the effect of mental health on employment. Socioeconomic and health characteristics of people suffering from mental disorders in 2006 are very different according to contemporary employment status. For instance, 24% of workers reporting at least one mental disorder in 2006 report having activity limitations against 52% among the unemployed population in 2006.

In addition, such a study working on the whole sample (including the unemployed) would suffer from significant methodological biases (reverse causality and direct simultaneity). A method in two consecutive steps to estimate the probability of being employed in 2006 and the probability of keeping a job conditional to the participation equation could then be conducted. However, identification problems would arise because of the difficulty to rigorously distinguish the explanatory mechanisms between the probability of employment in 2006 and continued employment between 2006 and 2010.

Appendix 4: Attrition between the two waves

Attrition between the 2006 and 2010 waves can induce the selection of a population with specific characteristics. There are no significant differences in demographic, socioeconomic and health characteristics of our sample between respondents and non-respondents to the 2010 survey on the basis of their first wave characteristics (see Table 27 and Table 28, Appendix 6). However, differences in the response rate to the 2010 survey exist according to perceived health status, activity limitations, the declaration of major depressive episodes and the declaration of motion or sleep disorders (De Riccardis, 2012). A weighting system to reflect this non-response was thus established. It is calculated using employment situations, urban units, age groups, education, sex and health status. Logit models are used to estimate the response behaviour of interviewees depending on whether they actually have answered the survey in 2010 or not. This procedure allows identifying homogeneous response groups (HRG) in which the individual probability to answer the survey is equivalent and independent between each HRG. They are then used as sample stratifications, wherein a second sample is then selected with a sample rate equalling the individual probability to respond for each HRG. One can then determine weights assigned to each individual depending on his/her HRG.

Sample calibration allows the use of a sample matching the characteristics of the general French population. Calibration is performed on the average of the four Quarterly Employment surveys of year 2006. The variables used are urban units, age groups, education, ethnicity and the number of dwelling inhabitants (De Riccardis, 2012).

Weighting in the Sip survey allows taking into account for attrition between the two waves, notably related to poor general, physical or mental health status and to match the sample with the general population on a number of socio-demographic characteristics.

Appendix 5: Measurement and validity of mental health indicators in Sip

The mental health protocol for the Sip survey is based on the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV), created in 1952 by *the American Psychiatric Association* (APA). It focuses exclusively on mental illnesses unlike the *International Classification of Diseases* (Cim-10), which covers all types of disease. In Sip, modules regarding major depressive episodes (MDE) and generalized anxiety disorder (GAD) from the *Mini International Neuropsychiatric Interview* (Mini) are comprehensive. The precise construction of MDE and GAD is detailed in Appendix 1 and Appendix 2. Through successive filters, it reduces the number of "false positives", *i.e.* people wrongly detected as suffering from these disorders, given the diagnostic criteria.

According to the DSM-IV assessed by the Mini, 6.8% of the surveyed population currently suffers from MDE. Within this population, 45% experience recurrent depressive disorders. According to these criteria, 5.7% of the population undergoes GAD. The comparison with the results of the survey "Life Events and Health Status" (EVS), conducted over the same period in the general population and with an identical protocol, revealed extremely close results to those of the Sip survey (Beck *et al.*, 2010). As expected, this result differs from those from the French Mental Health in General Population survey (11% of MDE in the past two weeks and 13% of GAD). Mental Health in General Population (SMPG) is based on the Cim-10 (*International Diseases Classification*, version 10) version of the algorithm (not the one based on DSM-IV) and detects more easily MDE or GAD. Measuring mental health in Sip is consistent with a more restrictive definition (DSM-IV) and seems valid in comparison to similar fields in France.

While the questionnaire on mental disorders makes full use of the nomenclature proposed by the Mini, it has no diagnostic value. It can rather be seen as diagnostic interviews conducted by an interviewer, based on all the symptoms described by the DSM-IV and Cim-10. It must not lead to a medical diagnosis (Bahu and Mermilliod, 2014). However, it appears that according to the results of a qualitative post-survey interview about some indicators used in the Sip survey including health indicators (Guiho-Bailly *et al.*, 2009), the over-reporting phenomenon (false positives) of mental disorders in the survey is not widespread, while in contrast under-reporting (false negative) may occur more often. In the study of the impact of mental health on job retention, this would lead to an underestimation of the effect of mental health.

Appendix 6: Descriptive statistics

Table 25: Selection analysis – Population in employment *vs.* unemployed in 2006

	Men (%)		Women (%)	
	Employed population in 2006	Unemployed population in 2006	Employed population in 2006	Unemployed population in 2006
Mental Health, 2006				
At least one mental disorder	5,9	22,2	11,6	21,0
No mental disorder	94,1	77,8	88,4	79,0
MDE	3,4	16,7	8,3	16,4
No MDE	96,6	83,3	91,7	83,6
GAD	3,5	13,2	6,6	13,1
No GAD	96,5	86,8	93,4	86,9
Individual characteristics, 2006				
30-34	17,3	11,6	16,0	15,9
35-39	21,7	10,9	20,2	15,1
40-44	20,2	16,4	19,9	16,4
45-49	20,1	19,6	21,4	18,5
50-55	20,8	41,5	22,5	34,1
In a relationship	82,1	55,0	77,6	71,5
Single	17,9	45,0	22,4	28,5
At least one child	12,2	5,1	8,3	6,1
No child	87,8	94,9	91,7	93,9
No diploma	8,0	15,1	6,7	15,3
Primary	45,8	53,6	39,1	45,8
Equivalent to French baccalaureat	18,2	14,2	19,1	17,2
Superior	26,3	16,1	33,3	18,5
Job characteristics, 2006				
Agricultural sector	9,0		3,1	
Industrial sector	21,0		9,1	
Services sector	70,0		87,7	
Private sector	66,7		58,9	
Public sector	19,1		29,1	
Self-employed	10,9		6,6	
Farmer	4,7		1,2	
Artisans	7,0		4,3	
Manager	16,4		11,1	
Intermediate	24,1		22,2	
Employee	12,7		45,1	
Blue collar	29,8		9,2	
Part-time job	3,0		30,7	
Full time job	97,0		69,3	
General Health, 2006				
Good perceived health	82,1	48,9	77,8	61,2
Poor perceived health	17,9	51,1	22,2	38,8
No chronic disease	75,3	56,6	71,9	60,3
Chronic disease	24,7	43,4	28,1	39,7
No activity limitation	90,7	59,8	88,5	75,1
Activity limitations	9,3	40,2	11,5	24,9
Risky behaviours, 2006				
Daily smoker	27,5	47,8	23,6	24,5
Not a daily smoker	72,5	52,2	76,4	75,5
Drinker at risk	46,2	42,2	13,6	13,1
Not a drinker at risk	53,8	57,8	86,4	86,9
Overweight	51,3	46,7	28,5	41,6
Normal weight or underweight	48,7	53,3	71,5	58,4
Professional route				

	Men (%)		Women (%)	
	Employed population in 2006	Unemployed population in 2006	Employed population in 2006	Unemployed population in 2006
Majority of employment in long jobs	83,5	45,3	71,7	58,0
Most of the professional route out of job	16,5	54,7	28,3	42,0
Stable career path	74,3	51,5	68,9	27,0
Unstable career path	25,7	48,6	31,1	73,0

Field: *Santé et Itinéraire Professionnel survey, employed and unemployed individuals aged 30-55 in 2006. Weighted and calibrated statistics.*

Table 26: Selection analysis – Main characteristics of individuals reporting at least one mental disorder in 2006, according to their employment status in 2006

	In employment in 2006 (%)	Unemployed in 2006 (%)
Individual characteristics, 2006		
30-34	12,2	19,8
35-39	19,7	16,5
40-44	20,6	15,2
45-49	22,3	15,6
50-55	25,2	32,9
In a relationship	72,3	59,1
Single	27,7	40,9
At least one child	12,2	8,1
No child	87,8	91,9
No diploma	5,2	18,2
Primary	49,3	47,9
Equivalent to French baccalaureat	18,1	13,7
Superior	26,3	14,6
General Health, 2006		
Good perceived health	47,2	27,1
Poor perceived health	52,8	72,9
No chronic disease	56,6	39,1
Chronic disease	43,4	60,9
No activity limitation	75,8	48,5
Activity limitations	24,2	51,5
Risky behaviours, 2006		
Daily smoker	31,7	42,9
Not a daily smoker	68,3	57,1
Drinker at risk	29,2	29,6
Not a drinker at risk	70,8	70,4
Overweight	34,8	48,3
Normal weight or underweight	65,2	51,7
Professional route		
Majority of employment in long jobs	73,9	29,0
Most of the professional route out of job	26,1	71,0
Stable career path	66,7	44,0
Unstable career path	33,3	56,0

Reading: *24.2% of workers declaring at least one mental disorder in 2006 report suffering from activity limitations against 51.5% in the unemployed population in 2006.*

Field: *Santé et Itinéraire Professionnel survey, individuals reporting at least one mental disorder and aged 30-55 in 2006. Weighted and calibrated statistics.*

Table 27: Attrition analysis – panel population (interviewed in 2006 and 2010) *vs.* attrition population (interviewed in 2006 and not in 2010)

	Men (%)		Women (%)	
	Panel pop.	Attrition pop.	Panel pop.	Attrition pop.
Mental Health, 2006				
At least one mental disorder	5,9	5,9	11,6	13,5
No mental disorder	94,1	94,1	88,4	86,5
MDE	3,4	4,4	8,3	9,0
No MDE	96,6	95,2	91,7	91,0
GAD	3,5	3,7	6,6	6,9
No GAD	96,5	96,3	93,4	93,1
Individual characteristics, 2006				
30-34	17,3	18,9	16,0	15,3
35-39	21,7	21,5	20,2	23,5
40-44	20,2	21,3	19,9	21,6
45-49	20,1	17,8	21,4	18,6
50-55	20,8	20,5	22,5	21,0
In a relationship	82,1	71,7	77,6	61,8
Single	17,9	28,3	22,4	38,2
At least one child	12,2	23,8	8,3	18,4
No child	87,8	86,2	91,7	81,6
No diploma	8,0	8,0	6,7	7,8
Primary	45,8	46,7	39,1	40,4
Equivalent to French bac.	18,2	14,8	19,1	21,0
Superior	26,3	29,1	33,3	29,4
Job characteristics, 2006				
Agricultural sector	9,0	4,8	3,1	3,5
Industrial sector	21,0	16,6	9,1	8,2
Services sector	70,0	78,6	87,7	88,3
Private sector	66,7	65,2	58,9	60,2
Public sector	19,1	20,7	29,1	28,4
Self-employed	10,9	10,0	6,6	5,9
Farmer	4,7	1,4	1,2	1,2
Artisans	7,0	9,6	4,3	4,3
Manager	16,4	16,8	11,1	12,0
Intermediate	24,1	20,7	22,2	22,9
Employee	12,7	12,9	45,1	44,7
Blue collar	29,8	32,4	9,2	8,0
Part-time job	3,0	4,1	30,7	25,1
Full time job	97,0	95,9	69,3	75,0
General Health, 2006				
Good perceived health	82,1	79,7	77,8	74,7
Poor perceived health	17,9	20,3	22,2	25,3
No chronic disease	75,3	79,0	71,9	73,5
Chronic disease	24,7	21,1	28,1	26,5
No activity limitation	9,3	88,5	88,5	88,2
Activity limitations	90,7	11,5	11,5	11,8
Risky behaviours, 2006				
Daily smoker	27,5	34,9	23,6	30,1
Not a daily smoker	72,5	65,1	76,4	69,9
Drinker at risk	46,2	44,0	13,6	14,1
Not a drinker at risk	53,8	36,0	86,4	85,9
Overweight	51,3	48,6	28,5	21,3
Normal weight or underweight	48,7	51,4	71,5	78,7
Professional route				
Maj. of empl. in long jobs	83,5	69,9	71,7	69,4
Most of the prof. route out of job	16,5	30,1	28,3	30,6
Stable career path	74,3	76,0	68,9	67,6
Unstable career path	25,7	24,0	31,1	32,5

Field: *Santé et Itinéraire Professionnel survey, employed individuals aged 30-55 in 2006. Weighted and calibrated statistics.*

Table 28: Attrition Analysis – panel population *vs.* attrition population according to mental health and employment status in 2006

	Attrition (%)	Panel (%)
Mental Health, 2006		
At least one mental disorder	18,6	81,4
No mental disorder	16,9	83,1
MDE	19,5	80,5
No MDE	16,9	83,1
GAD	17,7	82,3
No GAD	17,0	83,0
Employment status in 2006		
In employment	16,0	84,0
Unemployed	22,1	77,9
Health status and employment in 2006		
In employment in 2006		
At least one mental disorder	16,6	83,4
No mental disorder	15,9	84,1
MDE	17,1	82,9
No MDE	15,9	84,1
GAD	15,7	84,3
No GAD	16,0	84,0
Unemployed in 2006		
At least one mental disorder	22,6	77,4
No mental disorder	22,0	78,0
MDE	23,5	78,1
No MDE	21,9	76,5
GAD	21,6	78,4
No GAD	22,2	77,8

Interpretation: *Among individuals declaring in 2006 having at least one mental disorder, 18.6% were not re-interviewed in 2010, and 81.4% were. In individuals not reporting any mental disorders in 2006, 16.9% were not re-interviewed.*
Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55 in 2006. Weighted and calibrated statistics.*

Table 29: General descriptive statistics

	Men (%)		Women (%)	
	Prevalence	Employment probability (2010)	Prevalence	Employment probability (2010)
Mental Health, 2006				
At least one mental disorder	5,9	82,0	11,6	86,3
No mental disorder	94,1	93,1	88,4	92,0
MDE	3,4	81,3	8,3	85,1
No MDE	96,6	92,8	91,7	91,9
GAD	3,5	78,5	6,6	87,8
No GAD	96,5	93,0	93,4	91,6
Individual characteristics, 2006				
30-34	17,3	96,3	16,0	92,9
35-39	21,7	96,6	20,2	93,7
40-44	20,2	95,2	19,9	96,2
45-49	20,1	94,8	21,4	91,1
50-55	20,8	79,8	22,5	83,9
In a relationship	82,1	93,1	77,6	91,5
Single	17,9	89,3	22,4	90,6
At least one child	12,2	96,3	8,3	85,6
No child	87,8	91,9	91,7	91,9
No diploma	8,0	86,8	6,7	88,0
Primary	45,8	90,6	39,1	90,5

	Men (%)		Women (%)	
	Prevalence	Employment probability (2010)	Prevalence	Employment probability (2010)
Equivalent to French baccalaureat	18,2	95,5	19,1	92,5
Superior	26,3	95,1	33,3	92,4
Job characteristics, 2006				
Agricultural sector	9,0	94,6	3,1	92,5
Industrial sector	21,0	92,3	9,1	84,3
Services sector	70,0	92,5	87,7	92,6
Private sector	66,7	91,8	58,9	90,8
Public sector	19,1	93,5	29,1	92,8
Self-employed	10,9	97,0	6,6	95,8
Farmer	4,7	98,9	1,2	94,0
Artisans	7,0	96,4	4,3	94,9
Manager	16,4	94,9	11,1	92,3
Intermediate	24,1	92,8	22,2	91,7
Employee	12,7	93,8	45,1	92,5
Blue collar	29,8	89,5	9,2	85,8
Part-time job	3,0	87,5	30,7	90,3
Full time job	97,0	92,9	69,3	92,4
General Health, 2006				
Good perceived health	82,1	93,8	77,8	92,9
Poor perceived health	17,9	86,2	22,2	85,6
No chronic disease	75,3	93,6	71,9	91,8
Chronic disease	24,7	88,8	28,1	90,0
No activity limitation	90,7	93,4	88,5	92,1
Activity limitations	9,3	83,2	11,5	85,4
Risky behaviours, 2006				
Daily smoker	27,5	90,4	23,6	90,8
Not a daily smoker	72,5	93,2	76,4	91,8
Drinker at risk	46,2	92,5	13,6	89,9
Not a drinker at risk	53,8	92,4	86,4	91,6
Overweight	51,3	92,7	28,5	88,8
Normal weight or underweight	48,7	92,5	71,5	92,4
Professional route				
Majority of employment in long jobs	83,5	92,6	71,7	92,4
Most of the professional route out of job	16,5	92,0	28,3	88,5
Stable career path	74,3	92,9	68,9	92,2
Unstable career path	25,7	91,2	31,1	89,4

Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55 in 2006. Weighted and calibrated statistics.*

Table 30: Employment status in 2006, according to mental health condition

	Men (%)		Women (%)	
	Employed	Unemployed	Employed	Unemployed
Mental Health, 2006				
At least one mental disorder	68,6	31,4	64,5	35,5
No mental disorder	90,9	9,1	77,0	23,0

Reading: *68.6% of men with at least one mental disorder in 2006 are employed at the same date, against 64.5% of women in the same situation.*

Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55 in 2006. Weighted and calibrated statistics.*

Table 31: Mental health status in 2010 of individuals in employment and reporting mental health disorders in 2006

	Men (%)		Women (%)	
	At least one mental disorder in 2010	No mental disorder in 2010	At least one mental disorder in 2010	No mental disorder in 2010
Mental health in 2006				
At least one mental disorder	67,9	32,1	69,6	30,4
- MDE	15,7	84,3	29,8	70,2
- GAD	59,4	40,6	56,6	43,4

Reading: *67.9% of employed men with at least one mental disorder in 2006 are still suffering from mental disorders in 2010, against 69.6% of women in the same situation.*
Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55, in employment and suffering from at least one mental disorder in 2006. Weighted and calibrated statistics.*

Appendix 7: Instruments validation

Table 32: Correlations of identifying variables (men)

	Correlation coefficient		Sample size
	Employment (2010)	Mental health (2006)	
Violence suffered during childhood	-0,04	0,07**	2004
Many marital breakdowns	-0,03	0,08***	2004

Reading: ****: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, men aged 30-55 in employment in 2006.*

Table 33: Correlations of identifying variables (women)

	Correlation coefficient		Sample size
	Employment (2010)	Mental health (2006)	
Violence suffered during childhood	-0,01	0,09***	2129
Raised by a single parent	-0,01	0,07***	2129

Reading: ****: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, women aged 30-55 in employment in 2006.*

Table 34: Mental Health estimations in 2006

	Uniprobit (Men)		Biprobit(Men)		Uniprobit (Women)		Biprobit (Women)	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**
Ident. variables (men)								
Violence during childhood	.08**	*.04*	.09**	*.05*				
Many marital breakdowns	.02**	*.01*	.03**	*.01*				
Ident. variables (women)								
Violence during childhood					.08***	*.03*	.07***	*.02*
Raised by a single parent					.07***	*.02*	.08***	*.02*
Ind. characteristics, 2006								
Age (*ref.: 30-35 years-old*)								
- 35-39	.05**	*.02*	.05**	*.02*	-.03	*.03*	-.03	*.03*
- 40-44	.01	*.02*	.01	*.02*	.02	*.02*	.02	*.02*
- 45-49	.02	*.02*	.02	*.02*	.00	*.03*	.00	*.03*
- 50-55	.02	*.02*	.02	*.02*	.01	*.03*	.01	*.03*
In a relationship (*ref.: Single*)	-.05***	*.01*	-.05***	*.01*	-.03**	*.01*	-.03**	*.01*
Children (*ref: None*)	.02	*.02*	.03	*.02*	.01	*.03*	.02	*.03*
Education (*ref.: French bac.*)								
- No diploma	-.02	*.03*	-.02	*.03*	-.03	*.04*	-.03	*.04*
- Primary	.00	*.02*	-.00	*.01*	.01	*.02*	.01	*.02*
- Superior	-.00	*.02*	-.01	*.02*	.00	*.02*	.00	*.02*
Employment in 2006								
Act. sector (*ref.: Industrial*)								
- Agricultural	.01	*.03*	.01	*.02*	-.03	*.05*	-.02	*.05*
- Services	.02	*.01*	.02	*.01*	-.03	*.02*	-.03	*.02*
Activity status (*ref.: Private*)								
- Public sector	-.00	*.01*	-.01	*.01*	-.04**	*.02*	-.03**	*.02*
- Self-employed	.05**	*.02*	.04*	*.02*	-.04	*.04*	-.04	*.04*
Prof. cat. (*ref.: Blue collar*)								
- Farmers	-.08*	*.05*	-.08*	*.05*	.05	*.07*	.05	*.07*
- Artisans	-.02	*.03*	-.02	*.03*	.07	*.05*	.07	*.05*
- Managers	.02	*.02*	.02	*.02*	.01	*.03*	.00	*.03*
- Intermediate	-.00	*.01*	-.00	*.01*	-.01	*.03*	-.01	*.03*
- Employees	-.03	*.02*	-.03	*.02*	.01	*.02*	.01	*.02*
Part time (*ref.: Full-time*)	-.03	*.03*	-.03	*.03*	.02*	*.01*	.02	*.01*
General health status in 2006								
Poor perceived health status	.09***	*.01*	.09***	*.01*	.14***	*.02*	.14***	*.02*
Chronic diseases	.00	*.01*	.00	*.01*	.02	*.02*	.02	*.02*
Activity limitations	.01	*.02*	.01	*.02*	.03*	*.02*	.03	*.02*
Risky behaviours in 2006								
Daily smoker	.00	*.01*	.01	*.01*	.02	*.02*	.03	*.02*
Risky alcohol consumption	.01	*.01*	.01	*.01*	.03	*.02*	.03	*.02*
Overweight	-.01	*.02*	-.01	*.01*	-.02	*.02*	.02	*.02*
Professional route								
Maj. of empl. in long jobs	-.00	*.02*	.00	*.02*	-.01	*.02*	-.00	*.02*
Stable career path	-.01	*.01*	-.01	*.01*	.01	*.02*	.01	*.02*
N	1876		1860		2143		1982	

Reading: ****: significant at 1%, **: significant at 5%, *: significant at 10%.*
Field: *Santé et Itinéraire Professionnel survey, individuals aged 30-55 in employment in 2006.*

Appendix 8: Detailed description of the parameters

The nine thresholds are designed according to increasing levels of exposures to detrimental working conditions: a 2-year step for single exposures from one threshold to another. Poly-exposure durations are half that of single ones, based on the requirements of the 2015 French law requiring that past professional exposures to detrimental working conditions be taken into account in pension calculations (in which simultaneous strains count twice as much as single exposures – Sirugue *et al.*, 2015). The durations of the observation periods for working conditions are set arbitrarily to allow some time for reaching the treatment thresholds: It represents three halves of the maximum duration of exposure needed to be treated, *i.e.,* three halves of the single exposure threshold). This way, individuals are able to reach the treatment even though their exposure years are not necessarily a continuum. The minimum duration at work during the observation period is set as the minimum exposure threshold to be treated, *i.e.,* it equals the poly-exposure threshold. As individuals not meeting this minimum requirement are not in capacity to reach the treatment (because the bare minimum to do so is to work and be exposed enough to reach the poly exposure threshold), they are dropped from the analysis for comparability purposes. The length of observation periods for chronic diseases is set to two years in order to avoid choosing overly specific singletons (some specific isolated years may not perfectly reflect individuals' health condition) while preserving sample sizes (because the longer the intervals, the greater the sample size losses).

The estimations are performed on these nine thresholds using the same sample of individuals: I keep only individuals existing in all nine of them for comparison purposes. The sample is thus based on the most demanding threshold, t_9. This means that, in this setup, individuals must be observed for a minimal duration of 38 years (2 years before labour market entry for baseline health status, plus 30 years of observation and 6 years of follow-up health status periods, as well as a minimum of 10 years in the labour market – see Figure V). In other words, with the date of the survey being 2006, this means that the retained individuals (6,700) are those who entered the labour market before 1970 (and existing in the dataset before 1968), inducing heavily reduced sample sizes in comparison to the 13,000 starting individuals.

Appendix 9: Naive unmatched difference-in-differences models

Table 35: Unmatched difference-in-differences results (t_5 to t_9), physical treatment

Treatment Sex	Baseline Diff. Coeff.	 Std. Err.	Follow-up Diff. Coeff.	 Std. Err.	Diff.-in-Diff. Coeff.	 Std. Err.	Mean chronic diseases in treat.	N (treat./tot.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures								
Men								
First health period			.021	*.047*	.053	*.037*	.506	
Second health period	-.032**	*.016*	.023	*.044*	.055	*.044*	.554	2124/3586
Third health period			.027	*.041*	.059	*.041*	.600	
Women								
First health period			.068	*.047*	.091**	*.040*	.480	
Second health period	-.023	*.019*	.074	*.052*	.097**	*.043*	.531	1356/3426
Third health period			.073	*.049*	.096**	*.045*	.581	
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures								
Men								
First health period			.038	*.046*	.078*	*.042*	.565	
Second health period	-.040**	*.016*	.054	*.051*	.094**	*.045*	.639	2108/3586
Third health period			.054	*.048*	.094**	*.048*	.695	
Women								
First health period			.081	*.050*	.102**	*.048*	.614	
Second health period	-.021	*.019*	.089	*.054*	.110**	*.044*	.660	1228/3426
Third health period			.101*	*.059*	.122**	*.054*	.773	
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures								
Men								
First health period			.053	*.052*	.098*	*.052*	.689	
Second health period	-.045***	*.016*	.056	*.054*	.101**	*.049*	.755	2066/3586
Third health period			.075	*.057*	.120**	*.055*	.890	
Women								
First health period			.103*	*.066*	.119*	*.068*	.772	
Second health period	-.016	*.019*	.119*	*.073*	.135**	*.055*	.867	1246/3426
Third health period			.128**	*.060*	.144**	*.060*	.927	
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures								
Men								
First health period			.083	*.055*	.119**	*.052*	.782	
Second health period	-.036**	*.015*	.093*	*.057*	.129**	*.054*	.878	1976/3586
Third health period			.096*	*.062*	.132**	*.060*	1.010	
Women								
First health period			.109*	*.065*	.120*	*.069*	.910	
Second health period	-.011	*.020*	.149**	*.071*	.160**	*.066*	.983	1168/3426
Third health period			.163***	*.076*	.174***	*.060*	1.045	
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures								
Men								
First health period			.070	*.056*	.101*	*.053*	.778	
Second health period	-.031**	*.015*	.085	*.058*	.116**	*.055*	.882	1832/3586
Third health period			.086	*.061*	.117**	*.059*	1.012	
Women								
First health period			.121*	*.067*	.140*	*.074*	.923	
Second health period	-.019	*.020*	.162**	*.073*	.181***	*.068*	.994	1058/3426
Third health period			.176***	*.079*	.195***	*.062*	1.060	

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The baseline and follow-up columns show the results for the first differences between the treated and control groups respectively before and after the treatment. The diff.-in-diff. column shows the results for the second differences (i.e. the difference between follow-up and baseline differences).*
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Unmatched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Table 36: Unmatched difference-in-differences results (t_5 to t_9), psychosocial treatment

Treatment Sex	Baseline Diff. Coeff.	 Std. Err.	Follow-up Diff. Coeff.	 Std. Err.	Diff.-in-Diff. Coeff.	 Std. Err.	Mean chronic diseases in treat.	N (treat./tot.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures								
Men								
First health period			.018	*.035*	. 004	*.031*	.316	
Second health period	.014	*.015*	.034	*.037*	.020	*.033*	.371	1734/3586
Third health period			.035	*.040*	.021	*.037*	.396	
Women								
First health period			.90*	*.048*	.058	*.043*	.445	
Second health period	.032	*.020*	.098**	*.049*	.066	*.040*	.497	1554/3426
Third health period			.102**	*.052*	.070	*.044*	.522	
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures								
Men								
First health period			.086*	*.039*	.080**	*.037*	.442	
Second health period	.006	*.015*	.094**	*.041*	.088**	*.039*	.513	1690/3586
Third health period			.141***	*.045*	.135***	*.043*	.641	
Women								
First health period			.091*	*.050*	.066	*.044*	.567	
Second health period	.025	*.020*	.102*	*.053*	.077	*.031*	.600	1480/3426
Third health period			.105**	*.057*	.080	*.048*	.674	
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures								
Men								
First health period			.101**	*.045*	.097**	*.043*	.613	
Second health period	.004	*.015*	.132***	*.047*	.128***	*.045*	.713	1644/3586
Third health period			.154***	*.050*	.150***	*.048*	.806	
Women								
First health period			.134**	*.063*	.107*	*.061*	.769	
Second health period	.027	*.020*	.147**	*.069*	.120**	*.050*	.876	1410/3426
Third health period			.160***	*.057*	.133**	*.055*	.974	
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures								
Men								
First health period			.126***	*.049*	.116**	*.046*	.700	
Second health period	.010	*.016*	.154***	*.050*	.144***	*.048*	.785	1574/3586
Third health period			.186***	*.054*	.176***	*.052*	.918	
Women								
First health period			.165***	*.060*	.145**	*.066*	.928	
Second health period	.020	*.020*	.194***	*.065*	.174***	*.059*	1.021	1318/3426
Third health period			.209***	*.071*	.189***	*.054*	1.115	
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures								
Men								
First health period			.122***	*.050*	.111**	*.047*	.704	
Second health period	.011	*.016*	.154***	*.052*	.143***	*.049*	.796	1412/3586
Third health period			.181***	*.056*	.170***	*.053*	.923	
Women								
First health period			.196***	*.062*	.182***	*.068*	.944	
Second health period	.014	*.020*	.219***	*.066*	.205***	*.061*	1.049	1208/3426
Third health period			.224***	*.073*	.210***	*.056*	1.148	

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The baseline and follow-up columns show the results for the first differences between the treated and control groups respectively before and after the treatment. The diff.-in-diff. column shows the results for the second differences (i.e. the difference between follow-up and baseline differences).*
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Unmatched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

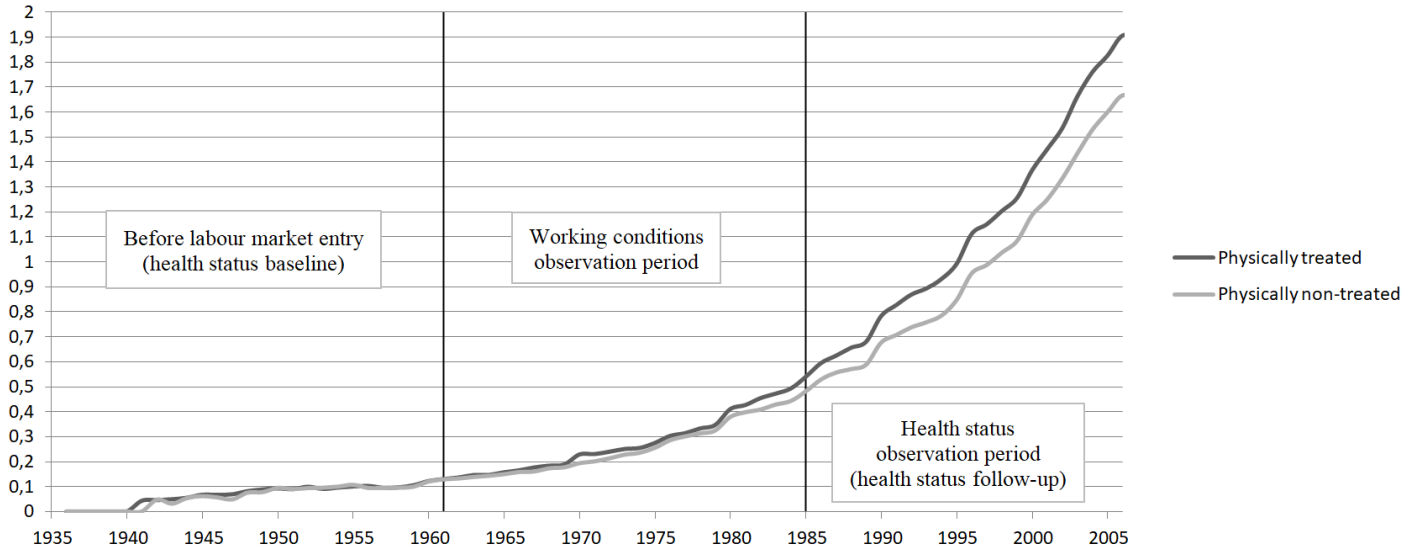
Table 37: Unmatched difference-in-differences results (t_5 to t_9), global treatment

Treatment Sex	Baseline Diff. Coeff.	 Std. Err.	Follow-up Diff. Coeff.	 Std. Err.	Diff.-in-Diff. Coeff.	 Std. Err.	Mean chronic diseases in treat.	N (treat./tot.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures								
Men								
First health period			-.012	*.050*	.027	*.047*	.390	
Second health period	-.039**	*.02*	-.007	*.035*	.032	*.041*	.434	2796/3586
Third health period			-.006	*.047*	.033	*.044*	.464	
Women								
First health period			.045	*.051*	.036	*.044*	.427	
Second health period	.007	*.02*	.051	*.046*	.044	*.038*	.481	2190/3426
Third health period			.052	*.048*	.045	*.041*	.517	
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures								
Men								
First health period			.000	*.048*	.041	*.045*	.470	
Second health period	-.041**	*.019*	.017	*.050*	.058	*.048*	.538	2770/3586
Third health period			.031	*.053*	.072	*.051*	.643	
Women								
First health period			.075	*.051*	.073*	*.043*	.569	
Second health period	.002	*.020*	.082*	*.047*	.080**	*.039*	.614	2100/3426
Third health period			.091*	*.055*	.089**	*.041*	.705	
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures								
Men								
First health period			.035	*.053*	.078	*.050*	.644	
Second health period	-.043**	*.019*	.058	*.055*	.101*	*.053*	.729	2720/3586
Third health period			.088	*.057*	.131**	*.056*	.849	
Women								
First health period			.101*	*.064*	.100*	*.058*	.764	
Second health period	.001	*.020*	.120**	*.053*	.121**	*.047*	.862	2046/3426
Third health period			.125**	*.058*	.124**	*.052*	.971	
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures								
Men								
First health period			.085	*.056*	.122**	*.053*	.749	
Second health period	-.037**	*.018*	.094*	*.057*	.131**	*.055*	.823	2638/3586
Third health period			.132**	*.061*	.169***	*.059*	.977	
Women								
First health period			.106*	*.067*	.109*	*.062*	.869	
Second health period	-.003	*.020*	.125**	*.061*	.128**	*.055*	.972	1960/3426
Third health period			.133***	*.055*	.136***	*.050*	1.063	
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures								
Men								
First health period			.071	*.054*	.096*	*.052*	.746	
Second health period	-.025	*.017*	.076	*.056*	.101*	*.054*	.817	2502/3586
Third health period			.103*	*.060*	.128**	*.058*	.965	
Women								
First health period			.140**	*.067*	.146**	*.063*	.897	
Second health period	-.006	*.020*	.157***	*.060*	.163***	*.056*	1.007	1826/3426
Third health period			.157***	*.055*	.163***	*.050*	1.101	

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The baseline and follow-up columns show the results for the first differences between the treated and control groups respectively before and after the treatment. The diff.-in-diff. column shows the results for the second differences (i.e. the difference between follow-up and baseline differences).*
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Unmatched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

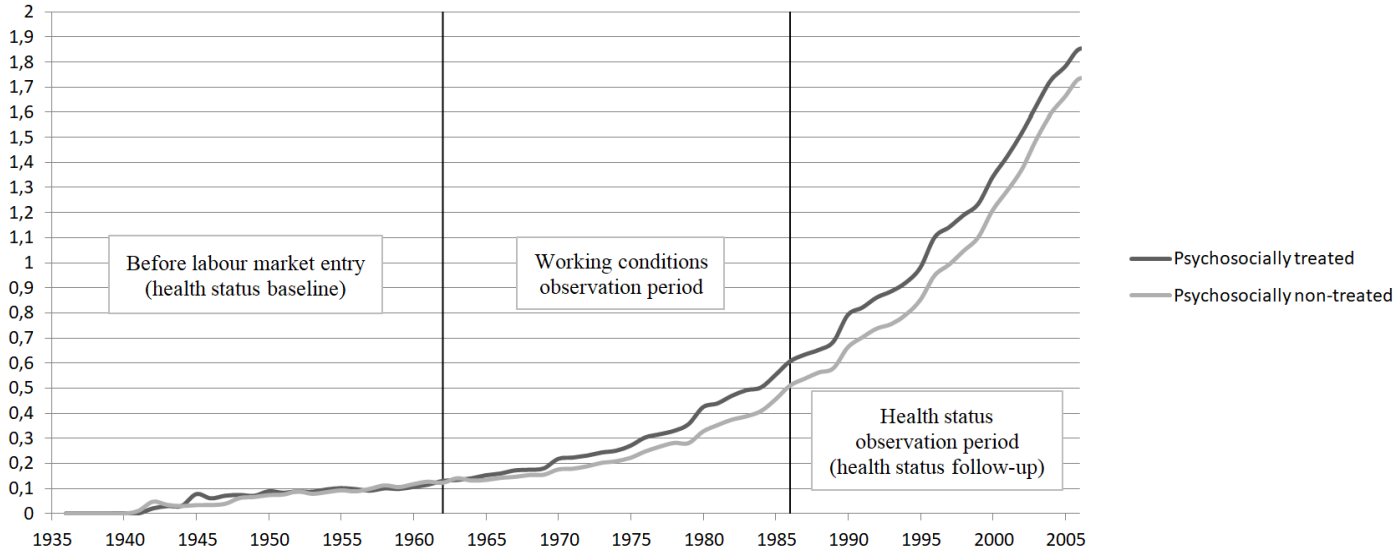
Appendix 10: Common trend assumption test

Figure VIII: Common trend assumption test – Physical sample (t_7)



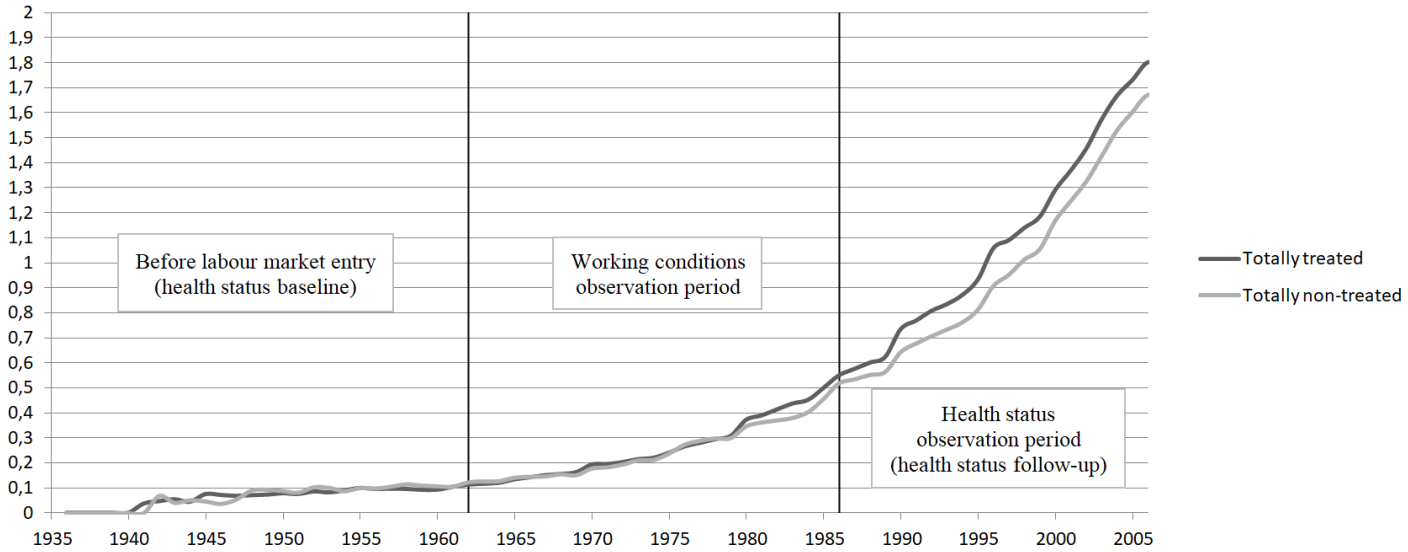
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7th threshold. Matched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Figure IX: Common trend assumption test – Psychosocial sample (t_7)



Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7th threshold. Matched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Figure X: Common trend assumption test – Global sample (t_7)



Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7^{th} threshold. Matched sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Appendix 11: Specification test

Table 38: Specification test – Matched Diff.-in-Diff. *vs.* Matched Ordinary Least Squares – Physical, psychosocial and global treatments (t_7) – Matched

Treatment	Matched Diff.-in-Diff.		Matched OLS	
Sex	Coeff.	Std. Err.	Coeff.	Std. Err.
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures				
Physical treatment				
Men				
First health period	.047	*.074*	.037	*.075*
Second health period	.055	*.075*	.046	*.076*
Third health period	.089	*.077*	.079	*.078*
Women				
First health period	.185***	*.064*	.193***	*.068*
Second health period	.199***	*.069*	.207***	*.073*
Third health period	.203***	*.076*	.209***	*.080*
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures				
Psychosocial treatment				
Men				
First health period	.112**	*.046*	.126***	*.049*
Second health period	.113**	*.056*	.129***	*.057*
Third health period	.134**	*.067*	.149***	*.066*
Women				
First health period	.156***	*.055*	.162***	*.059*
Second health period	.160***	*.063*	.166***	*.072*
Third health period	.172***	*.061*	.179***	*.064*
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures				
Global treatment				
Men				
First health period	.049	*.067*	.031	*.068*
Second health period	.069	*.069*	.054	*.070*
Third health period	.080	*.073*	.098	*.073*
Women				
First health period	.148***	*.067*	.146***	*.040*
Second health period	.162***	*.054*	.168***	*.058*
Third health period	.173***	*.059*	.176***	*.063*

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. Standard errors in italics.*
Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7^{th} threshold. Matched (weighted) sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Appendix 12: Threshold test

Table 39: Thresholds tests – Normal treatment *vs.* Single exposures only *vs.* Poly-exposures only – Physical, psychosocial and global treatments (t_7) – Matched

Treatment Sex	Normal Diff.-in-Diff. (16 single or 8 poly)		Single Diff.-in-Diff. (16 single)		Poly Diff.-in-Diff. (8 poly)	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures Physical treatment						
Men						
First health period	.047	*.074*	.010	*.060*	.104	*.074*
Second health period	.055	*.075*	.015	*.067*	.107	*.078*
Third health period	.089	*.077*	.017	*.068*	.110	*.075*
Women						
First health period	.185***	*.064*	.109*	*.064*	.234***	*.097*
Second health period	.199***	*.069*	.129**	*.072*	.239***	*.085*
Third health period	.203***	*.076*	.130**	*.076*	.242***	*.074*
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures Psychosocial treatment						
Men						
First health period	.112**	*.046*	.094*	*.054*	.152**	*.061*
Second health period	.113**	*.056*	.097*	*.057*	.158***	*.046*
Third health period	.134**	*.067*	.127**	*.059*	.159***	*.073*
Women						
First health period	.156***	*.055*	.111**	*.060*	.210***	*.074*
Second health period	.160***	*.063*	.115**	*.068*	.213***	*.060*
Third health period	.172***	*.061*	.120**	*.076*	.223***	*.065*
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures Global treatment						
Men						
First health period	.049	*.067*	.031	*.049*	.110	*.076*
Second health period	.069	*.069*	.064	*.051*	.117	*.075*
Third health period	.080	*.073*	.070	*.054*	.127	*.083*
Women						
First health period	.148***	*.067*	.108*	*.060*	.223***	*.067*
Second health period	.162***	*.054*	.130**	*.062*	.225***	*.054*
Third health period	.173***	*.059*	.133**	*.063*	.243***	*.059*

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. Standard errors in italics. In physically treated women, the fact of being exposed to at least* 16 *years of single exposures only increases the mean number of chronic diseases by* .109, .129 *and* .130 *for, respectively, the first, second and third health periods. Being exposed to at least* 8 *years of simultaneous exposures only (at least two) increases this number by, respectively,* .234, .239 *and* .242*. Even though the years of simultaneous exposures increase the number of chronic diseases more in the treated group than do the years in single exposure, no significant difference between the two can be observed (the standard errors cross each other).*
Field: *Population aged 42-74 in 2006 and present from* t_1 *to* t_9*. 7th threshold. Matched (weighted) sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Appendix 13: Exploratory analysis on health habits

Table 40: Wage and risky behaviours in 2006 – Unmatched and matched samples

Variable	Mean	Std. error	Min	Max	Physical sample			Psychosocial sample			Global sample		
					Treated	Control	Diff.	Treated	Control	Diff.	Treated	Control	Diff.
Unmatched													
Wage (monthly)	1639	*1546*	0	20000	1482	1740	258***	1580	1675	94	1549	1773	224**
Physical activities	.30	*.46*	0	1	.27	.32	.06***	.29	.30	.01	.28	.33	.05***
Alcohol	.22	*.41*	0	1	.23	.21	-.03*	.22	.23	-.01	.23	.19	-.04**
Overweight	.58	*.49*	0	1	.63	.53	-.10***	.57	.58	.01	.60	.54	-.06***
Tobacco	.16	*.37*	0	1	.16	.16	.00	.16	.16	-.01	.16	.16	-.01
Matched													
Wage (monthly)	1622	*1324*	0	20000	1492	1725	233***	1579	1649	71	1564	1752	188**
Physical activities	.27	*.42*	0	1	.27	.28	.01	.29	.30	.01	.29	.31	.02
Alcohol	.25	*.40*	0	1	.24	.25	.02	.22	.24	.02	.24	.25	.02
Overweight	.61	*.46*	0	1	.63	.60	-.02	.58	.59	.01	.59	.58	-.00
Tobacco	.16	*.35*	0	1	.16	.17	.01	.17	.16	-.01	.16	.16	-.01

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. Standard errors in italics. 30% of the general sample (unmatched) had daily physical activities in 2006 when only 27% of the physically treated sample did (vs. 32% of the physical control group). This difference of 6 percentage points is significant at the 1% level. After matching, no significant difference between physically treated and control groups remain concerning daily physical activities.*

Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. 7th threshold. Unmatched and matched (weighted) samples.*

Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

Appendix 14: Exploratory analysis on gender-gaps

Table 41: Gender and working conditions typologies, per activity sector in 2006

Variable	Activity sector					
	Farmer (%)	Artisan (%)	Manager (%)	Intermediate (%)	Employee (%)	Blue collar (%)
Gender						
Men	69.60	64.27	55.54	45.25	19.06	80.03
Women	30.40	35.73	44.46	54.75	80.94	19.97
Working conditions						
Night work	3.96	7.19	2.79	6.44	6.16	15.60
Repetitive work	17.62	11.46	5.49	9.40	20.09	34.51
Heavy load	63.88	50.56	17.75	26.09	36.24	54.59
Hazardous materials	31.72	22.25	6.42	15.94	13.72	38.03
Cannot use skills	7.49	4.72	7.44	9.75	16.80	17.95
Work under pressure	19.38	28.31	44.80	33.69	22.64	24.22
Tensions with public	4.41	11.01	13.36	15.33	12.37	4.92
Lack of recognition	43.61	17.98	22.91	31.67	36.94	37.19
Cannot conciliate private and work lives	14.98	16.18	15.81	10.66	8.01	7.10
Bad relationships with colleagues	4.41	3.15	4.48	5.23	7.52	9.23

Interpretation: *30% of farmers are women, when 70% are men. In farmers, 4% declared working at night.*
Field: *General Santé et Itinéraire Professionnel survey sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

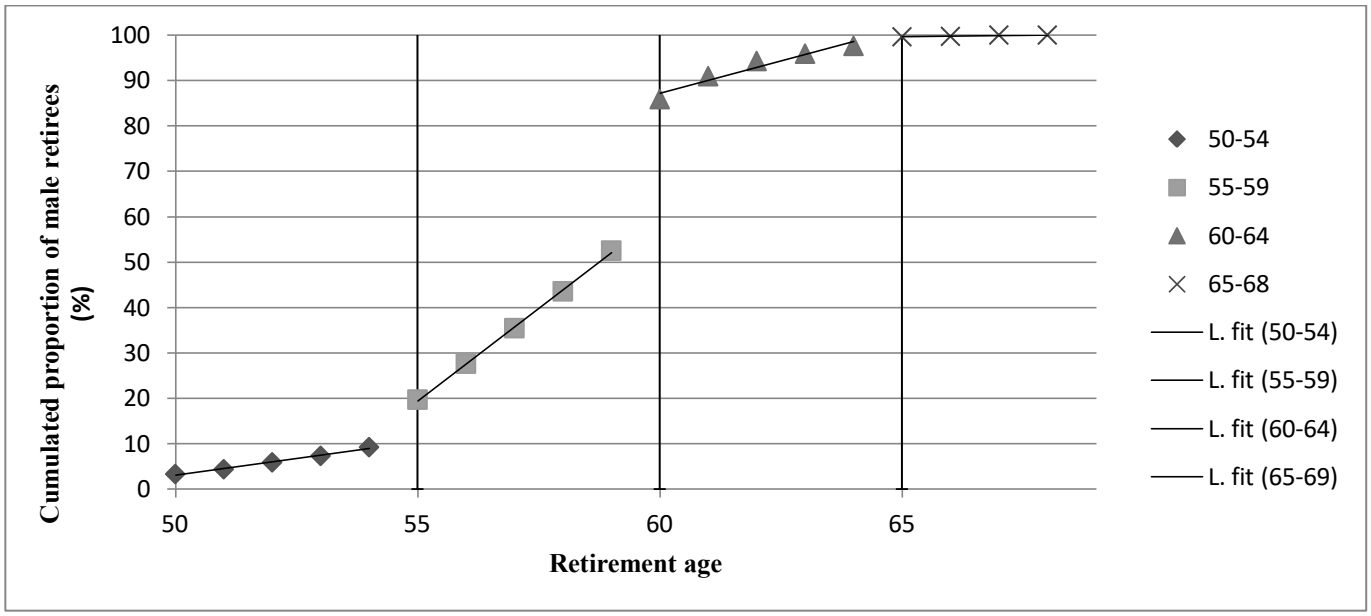
Table 42: Working conditions typology, by gender in 2006

Variable	Gender		Difference
	Men (%)	Women (%)	Men/Women (Chi² test)
Working conditions			
Night work	70.36	29.64	***
Repetitive work	49.90	50.10	
Heavy load	51.10	48.90	***
Hazardous materials	61.85	38.15	***
Cannot use skills	46.29	53.71	
Work under pressure	52.25	47.75	***
Tensions with public	44.02	55.98	***
Lack of recognition	47.16	52.84	
Cannot conciliate private and work lives	49.21	50.79	
Bad relationships with colleagues	47.83	52.17	

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. 70% of night workers are men and 30% are women. The difference in proportions is significant at the 1% level.*
Field: *General Santé et Itinéraire Professionnel survey sample.*
Source: *Santé et Itinéraire Professionnel survey (Sip), wave 2006.*

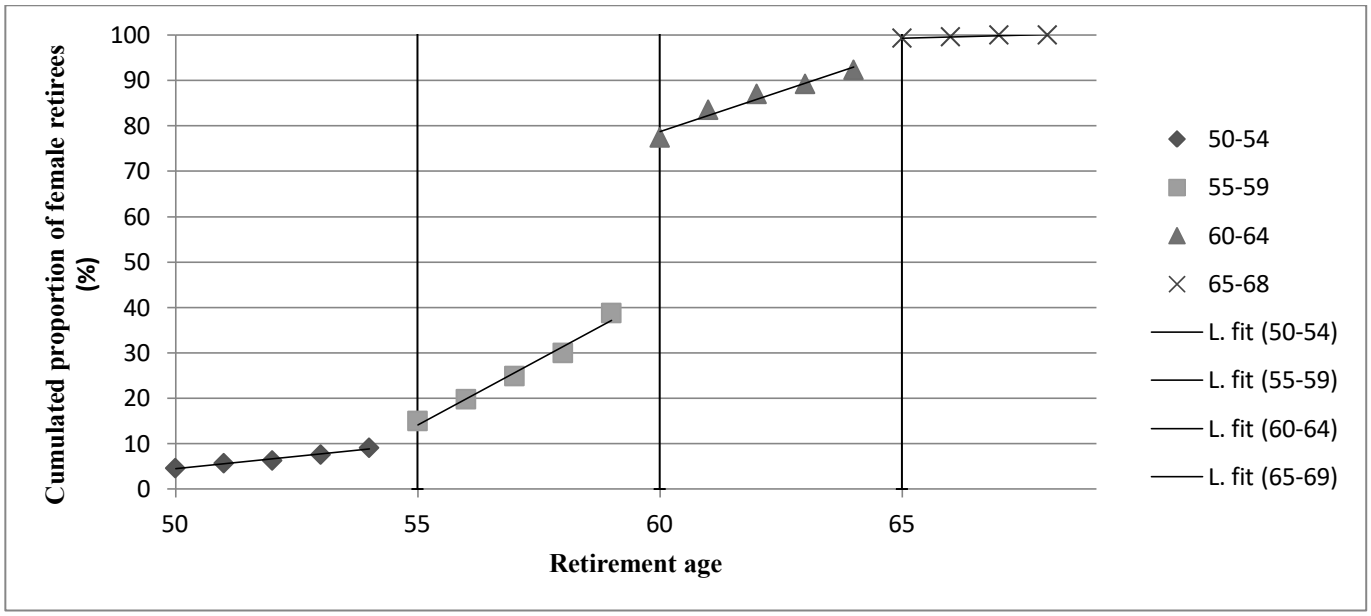
Appendix 15: Proportion of retirees, male and female samples

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



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

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



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

Appendix 16: 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 17: 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 18: 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 19: Main auxiliary models

Table 43: 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 20: Civil servants

Table 44: 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 45: 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 21: Robustness checks

Table 46: 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 47: 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 48: 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 49: 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 50: 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 51: 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.*