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The socioeconomic and gender impacts of health events on employment transitions in France: a panel data study

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The socioeconomic and gender impacts of health events on employment transitions in France: a panel data study[1]

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Abstract

This article explores the effect of accidents and chronic illnesses on participation in the French labor market, while accounting for socioeconomic and gender effects. We use a dynamic definition of the control group and the difference-in-differences exact matching estimator, which controls for unobserved heterogeneity. We find that the accidents have a slightly smaller effect than chronic illnesses on employment, but generate more inequalities across workers. Women and the less educated workers are the most disadvantaged and almost all the transitions go from employment to inactivity. We interpret these results in relation to the incentives provided by the French social welfare system and to the different positions workers had in the labor market before the shock.

JEL: C14, C23, I14, J16, J20, J60.

Keywords: Health, Labor, Gender, Accident, Chronic illness, Matching, Difference in differences, France.

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1. Introduction

Health shocks have detrimental effects on labor market participation and subsequent career outcomes, which may differ according to their cause, and relate to sex or gender. For instance, women are more prone to autoimmune diseases than men (Ngo et al. (2014)), while men have a higher risk of road accidents when they are young (Al-Balbissi (2003), Regev et al. (2018)). Such health shocks may be more or less disabling. Moreover, the consequences of health shocks also depend on the occupation, level of education and past attachment to the labor market (Barnay et al. (2015), Lundborg et al. (2015), Jones et al. (2019), Lehnart (2019)). In many countries, the social welfare system covers a part of the loss of revenues in case of an exit from the labor market, so it is likely to moderate its consequences. In France, more wealthy workers are more able to pay for additional private health insurances. In the French system, labor market participation is strongly affected by the public social welfare scheme (health and disability insurance), by the occupational health legislation and by the private complementary insurances. Since the public insurance is provided to all the workers, the correlation between the socio-economic status and the health insurance is restricted to the privately funded part and to the duration of the exit from the labor market. This topic has only been partially studied in the literature. There are some works in the fields of disabilities (Charles (2003), Barnay et al. (2015) for a survey) and of chronic illnesses (Garcia Gomez (2011), Jones et al. (2019), Lehnart (2019)) and a few on accidents (Moller-Dano (2005), Crichton et al. (2011)). Our goal is to evaluate the impact of two kinds of health events, accidents and chronic diseases, on labor market participation in France. We will account for the individual characteristics of the workers, and interpret our results according to the specificities of the French health insurance system. In the French context, there are a few works that target a working age population. For instance, the study conducted by Tessier and Wolff (2005) is focused on limited, cross-sectional data. Most papers focus on workers close to retirement (Barnay (2005), Blanchet and Debrand (2007), Debrand and Sirven (2009), Behaghel, Blanchet, Debrand and Roger (2011)).

In order to study this issue, we start by considering the context of the French system, financing healthcare and sick leave. The healthcare and sick leave funding system is particularly protective in the French case and is, on average, more generous than the systems available in many English-speaking countries. It is essentially a Bismarckian model, close to the German one, based on a compulsory health insurance system financed by social contributions. More recent features introduced universality into its functioning and brought it somewhat closer to a Beveridgian model, as in the UK, with a share of funding linked to tax collection and the distribution of universal benefits.

The French system offers different levels of compensation for long-term sick leave, due to chronic long-term illnesses or accidents. It differentiates between funding for care and compensation for sick leave according to the cause of the sick leave and its duration. In the case of a common illness or an accident, the same compulsory insurance system works for the reimbursement of care and the compensation for sick leave. However, a list of 30 long and expensive illnesses, known as “ALD30”, is managed with a more controlled and generous system. Having in mind such an institutional context is useful when interpreting the results from the evaluation of the impact of health shocks affecting French workers on labor market outcomes. The focus of our study is on the consequences of accidents and of a set of specific chronic diseases, which are specifically taken into account by the French social security system. This has not been studied before in the French case.

For that purpose, we use a panel data set which identifies all the stages of a professional history and records the health events occurring over the same period. Using such data, we are able to control for unobservable heterogeneity. Moreover, a full timing of events is needed in order to avoid a biased measurement related to the reverse causality problem. When the accurate timing of the events is recorded, we are able to know whether a person was ill before going inactive, or working before experiencing an accident, while with a cross-section, we do not have enough information to disentangle the health-labor and labor-health causations. Our data set provides annual information about labor market participation and the occurrence of health events. As a result, we can clearly distinguish between the period before and after the health events, and perform a difference-in-differences analysis with matching. We use the “Health and Professional Histories” (Santé et Itinéraires Professionnels, SIP) survey. It is a representative sample of individuals, which describes both health events and employment history, on a yearly basis. This is the first time that such information has been made available in France, and we can use it to perform a dynamic analysis about health and employment. In order to estimate the impact of accidents and chronic diseases on activity, we implement a difference-in-differences method with exact matching. This method allows us to identify the causality running from health events to employment. We find that health events have important effects on participation in the labor market. In particular, accidents have a slightly smaller effect than chronic illnesses on employment, but generate more inequalities between workers. Some explanations can be highlighted. First, there are some incentives from the social security work that depend to a greater or lesser degree on the type of health shock (accident or chronic disease). Given that, in the case we study, the diagnosis of chronic diseases and the identification of the incapacity involved is verified by the social security, the exit from the labor market is relatively unaffected by the will of the worker or by incentives from the social security during a three-year period. It is less the case for accidents. Second, whereas the most advantaged workers face incentives to quickly return to work, the most disadvantaged ones, i.e. women and less-educated workers, face lower incentives to return to work. Almost all their transitions go from employment to inactivity. Women are proved to be more affected by accidents than men and to be less paid. Before the health shock, the less educated workers were more often submitted to hard working conditions which could prevent them from returning to work.

The paper is organized as follows: in the second section, we summarize the evidence from the economic literature and discuss the way our paper contributes to the literature. The third section presents the institutional setting. The data used in this application and the econometric method are presented in the fifth section. The results are discussed in the sixth section.

2. Review of the literature

Effects of health events on labor market outcomes. Poor health has negative and significant economic and social impacts in the labor market, especially owing to the departures from the labor market it induces. For example, Chaupain-Guillot and Guillot (2010) evaluated from Eurostat data, the direct and indirect costs resulting from periods of inactivity due to illness at €90 billion in Europe, i.e. about 1% of the GDP of European countries. Since the 1990s, there has been a growing amount of literature dealing with the impact of health on labor market participation, earnings and wages, following the seminal theoretical model of health capital by Grossman (1972) and its Mincerian extensions. In these models, a higher stock of health capital is expected to increase earnings and wages because it allows workers to increase the number of hours worked and because a higher health capital increases productivity. Most of the empirical studies based on these theoretical grounds use cross-sectional data, which do not take into account unobservable heterogeneity. An overview of the empirical literature by Currie and Madrian (1999) shows that poor health reduces the ability to work and has significant effects on wages, labor force participation and job choice, but the results are sensitive to the measurement of health, and within the surveyed literature relatively few studies are based on longitudinal surveys.

The analysis of the dynamics of the impact of health in the labor market is now expanding. This requires addressing the endogenous nature of health with respect to labor supply (Cai and Kalb (2006), Haan and Myck (2009), Cai (2010)). However these works still mainly focus on older workers and on the decision to retire early (see, for example, Bound et al. (1999), Disney et al. (2006), Angelini et al. (2009) and in the French case Barnay (2005), Blanchet, Debrand (2007), Behaghel et al. (2011)). More recently, Trevisan and Zantomio (2016) try to evaluate the impact of acute health shocks -- cancer, stroke or heart attack -- on the labor supply of older European workers. They combine data from the English Longitudinal Study of Ageing (ELSA) and the Survey of Health, Ageing and Retirement in Europe (SHARE) for 16 European countries from 2002 to 2013. They use stratification and propensity score matching methods. The results show that experiencing an acute health shock strongly increases the risk that an older worker will leave the labor market, and is associated with a deterioration in physical function and mental health, as well as a reduction in perceived life expectancy.

For working age workers, Contoyannis and Rice (2001), produced one of the first studies shedding light on the overall effect on psychological health on wages, by taking into account unobservable heterogeneity. They used a single fixed effects wage equation with self-reported health indicators among the regressors. They found that reduced psychological health has an effect on hourly wages for men, while an excellent self-reported health for women has a significant impact on their hourly wage. Another study by Cai and Kalb (2006) includes some dynamic characteristics concerning the labor market, using Australian data from the Hilda database. They use a self-reported health measure, based on the limitations of everyday activities, and a measure based on the SF 36, producing scores on eight aspects of health. The endogenous nature of the health status in the labor force participation equation is addressed by estimating the health equation and the labor participation equation simultaneously. The results show that improved health increases the probability of labor force participation for all age groups and both genders, but the biggest effect is obtained for the older workers and for women.

It also appears that both the structure of the labor market and the design of social benefits and pension schemes may influence the impact of a health shock on labor market outcomes (see, for example, Garcia Gomez 2011, Datta Gupta et al. 2015). In a recent study, Jones et al. (2019) examine the way the labor market reacted to acute health shocks after the Great Recession. They adopt the same definition of acute health shocks as Trevisan and Zantomio (2016) and use UK databases of five waves of Understanding Society, the UK Household Longitudinal Study that builds on the British Household Panel Study (BHPS), from 2009 to 2015. Implementing coarsened exact matching and propensity score matching, they find a significant reduction of labor participation of younger workers strongly attached to the labor market. For the older workers and for women, the role of preferences, financial constraints and the division of labor inside the household are key determinants of labor supply decisions.

Another point was highlighted recently by Lundborg et al. (2015), in the case of Sweden. They demonstrate that there is a substantial heterogeneity in the effect of health shocks on labor market outcomes, which depends on the socioeconomic status. A similar result was found by Garcia–Gomez et al. (2013) in the Netherlands and Jones et al. (2019) in the United Kingdom from the 2008 economic crisis. Also based on UK data, the study led by Lehnart (2019) covering a period of time preceding the economic crisis demonstrates that the effects are strongest for individuals experiencing severe health shocks, for men and for individuals with higher education and for those holding managerial jobs. The author explains this result by an increase in health care expenditure and use, and by a loss of productivity of such managers.

In the French case, the study by Tessier and Wolf (2005) is one of the first dealing with the impact of health on participation in the labor market but they use cross-sectional data, which prevent them from dealing with reverse causality over time. Neither do they account for the incentives provided by the French social welfare system to explain their results. Due to the restriction of the data they process, they choose to use two measures of health: self-reported health status and a self-reported measure indicating the existence of a chronic disease that the authors consider to be more objective. They account for the simultaneity between the two variables. The estimations bring to light the following results. First, good health has a positive impact on labor market participation and labor market participation has no significant effect on health. Second, health significantly affects participation in the labor market from the first years of potential activity, even for relatively young workers. However, the study by Tessier and Wolff does not focus on the impact of health events on employment trajectories, due to the lack of adequate data. The SIP survey that we use in this study fills this gap.[2] Moreover, with the SIP survey, we are also able to account for individual variables that proved to have an important influence on health, such as childhood living conditions.[3] The SIP data have been used by Barnay et al. (2015) for evaluating the impact of a disability on activity.

The impact of injuries on work and employment. While the impact of accidents on employment is rather well studied, especially in relation to working conditions[4], the impact of domestic, sport or road accidents on employment has been studied much less. These also deserve to be studied, since the economic and human costs of such accidents are high and the effects on employment trajectories are potentially significant. For example, in 2000, road accidents injured 1.3 million individuals in Europe (Moller-Dano, 2005). In France, the total direct and indirect costs estimated by the French Office for Road Security (ONISR) are estimated to be 1.3 % of the GDP for 2008.

One of the rare studies dedicated to the microeconomic effects of road accidents on employment shows that, for Denmark, the effects of road accidents are serious for both employment and earnings: the rates of employment are respectively 10 and 8 points lower for injured men only. Besides, earnings are significantly reduced for men whatever their age, and for the oldest women (Moller-Dano (2005)) although the Danish public transfer income is high. In order to identify the causal impact of car accidents on earnings and rates of employment, the author had to correct the effects of selection associated with the risk of accidents. It is indeed necessary to correct the selection bias insofar as the motoring behavior of young men is said to be more risky. Moreover, their earnings are lower than those of older men. Another rare study was conducted by Crichton, Stillman, Hyslop (2011) for New Zealand. With a similar methodology, the authors show that there are strong and negative impacts of accidents (including workplace accidents) on employment and earnings. The authors mention that New Zealand has a comprehensive accident insurance system that generously covers both work and non-work injuries whatever the cause of injuries. Overall, the employment rates are 12% lower for those who have a period of injury of 7 to 24 months and who benefit from long-term sick pay during this period. They

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[2] Concerning the links between health and unemployment, see Haan and Myck (2009), Böckerman and Ilmakunnas (2009).

[3] Precarious conditions during childhood have important consequences for future health (see e.g. Wadsworth and Butterworth (2006), Trannoy et al. (2010), Duguet and Le Clainche (2014)). Lindeboom et al. (2006) also find a link with the performance in the labor market.

[4] See Karasek and Theorell (1990), Reville and Schoeni (2001), Wichert (2002). For France see Hamon-Cholet and Sandret (2007).

also found that accidents giving the right to long-term earnings compensations owing to the inability to work have a more negative impact on women, older workers and people with low incomes. Lastly, restricting the analysis to accidents occurring on the way to and from work, in order to identify the causal effect of health in the labor market, Halla and Zweilmüller (2013) implemented a fixed effect difference-in-differences estimate and found a negative and persistent effect on employment and earnings.

Difference in differences. A series of works implemented the difference-in-differences approach to similar topics. They focused on the impact of health events in the labor market by implementing various methods of matching and by taking into account the variables related either to career or to past health. These include Lechner and Vazquez-Alvarez (2004, 2011) on German data, Garcia-Gomez and Lopez-Nicolas (2006) and Garcia-Gomez (2011) on Spanish data, Halla and Zweilmüller (2013) on Austrian data and Barnay et al. (2015) on French data. However, except for Garcia-Gomez (2011), these studies focused on the impact of disability on various labor market outcomes. The results emphasise that a health shock leads to an exit from employment, which is more directed toward inactivity rather than toward unemployment. We also notice that this methodology has been used to study the reverse causation, from employment to health (Gebel and Vossemer, 2014).

In comparison to the published works discussed above, the originality of our work lies in the two following points. First, we discuss our results in more depth regarding the specificity of healthcare financing and the sick leave scheme. Second, we distinguish two types of health events in the light of the different benefit schemes the workers benefit from.

The first issue is tackled by Jones et al (2019) and Garcia-Gomez (2011), with regard to the incentives provided by the social welfare system. However, these two papers do not develop the more structural and specific role of the healthcare financing system and the sick leave system beyond the disability benefit scheme.

Jones et al (2019) mention the transition of social welfare systems in many European countries toward the adoption of incentives to keep disabled workers in employment. They show that this has been especially the case in the United Kingdom since 2008, where the focus has been on identifying those able to work despite their handicap. Garcia-Gomez (2011) offers a more detailed analysis of the role of institutions when analyzing the effects of health shocks on labor market outcomes in Europe. The analysis uses data from the European Community Household Panel and different matching techniques in order to control for the non-experimental nature of the data. The results she obtained suggest that there is a significant causal effect of health on the probability of employment: individuals who are affected by a health shock are more likely to transit into disability. The estimates differ across countries, with the smallest effect in France and Italy when compared with other European countries. Differences in social security legislations are considered to be a credible explanation for these results. There are two differences between our paper and Garcia-Gomez (2011). First, her study deals with the impact of a self-reported health shock, the cause of which does not appear precise. Second, the disabilities studied appear to be a later consequence of the shocks we are studying in this paper. Our study mainly targets the previous phase, which is the one where the affected employees expect benefits from the standard healthcare and sick leaves system. In France, after three years as a worker on sick leave, one is likely to be eligible for disability benefits. Our results may, for this reason, differ from Garcia-Gomez (2011). In this article, we show that if the French system of long-term care financing is likely to moderate the effects of the health shocks on participation in the labor market, it cannot prevent the exit from the labor market of the most vulnerable workers, i.e. the less educated and, to a lesser extent, women. Second, we distinguish the case of accidents, financed by the standard health system and long-term illnesses. We are then able to compare the effects of two different health events according to the benefits associated with them.

3. Institutional Setting

The standard health insurance system, known as the *Sécurité Sociale*, reimburses part of the health costs paid by sick people. The workers can buy a complementary health insurance in order to increase the reimbursement rate. Unemployed workers and people who are not eligible for the standard health insurance system owing to their exit from the labor market, benefit from a universal health coverage (*CMU*) and benefit from the same reimbursement rate than those people who are part of the labor market. They also benefit from a free revenue-based complementary universal health coverage (*CMU-C*) that reimburses a part of the out-of-pocket money remaining after the reimbursement by the *Sécurité Sociale*. Overall, the French health system formed by the social security and universal health insurance coverages cover the current health payments relatively well, although some costs are not fully covered and can lead to a significant financial burden.

In addition to the funding of health care, workers benefit from sick pay, which amounts to a percentage of their previous wage. Workers benefit from social security benefits from the third day of sick leave. The conditions to benefit from it are strict and depend on the duration of the sick leave. For sick leave of less than or equal to 6 months, the recipient must have worked at least 150 hours during the quarter preceding the departure, or have received a salary of at least 1015 times the amount of the hourly minimum wage during the 6 months preceding the sick leave.

For sick leaves longer than 6 months, the recipient must have worked at least 600 hours, or have received a salary of at least 2030 times the hourly minimum wage during the year preceding the leave, and have been affiliated to the social security system for at least one year. The sick pay system in France is therefore based, in the private sector, on a compensation architecture at three levels: a basic social security coverage, a complementary coverage and an optional corporate coverage. Only the first level falls within the scope of compulsory health insurance, with the last two depending on negotiations within each sector. The sick pay is equal to 50% of the average wage calculated over the 3 months preceding the sick leave. From three dependent children, the daily benefits are increased from the 31st day of the sick leave: they are equal to two thirds of the average salary. The payment of daily benefits is capped at 360 days per period of three consecutive years. This cap applies regardless of the number of sick leaves obtained during the period considered. This applies regardless of the cause, illness or accident.

The situation is different for chronic illnesses, defined by a list of 30 diseases (ALD30), which lead to costly or long-term care. In this case, the employees benefit from more compensatory benefits than with the usual sick leave. Employees supported under a long-term illness (ALD30) also benefit from a longer payment period for the daily benefits, by periods of 3 to 6 months, which are renewable for a maximum of three years. Daily benefits paid for an ALD30 are not subject to income tax. In addition to the daily benefits paid by the compulsory health insurance system, there is sometimes an additional compensation from the company that can reach between 90% to 100% of the gross reference salary, after inclusion of the daily benefits. This compensation is carried out under the company pension plan or the collective agreement. This is particularly the case in large companies. An employee of such a company can also benefit from a provident scheme in the event of an accident.

After 3 years, the employee, whatever the size of the company they work for, receives disability benefits from the social security system, until retirement if their working capacity is reduced by two-thirds. The amount of this compensation is 30% of the average annual salary calculated over the best ten years in the event of partial incapacity and 50% in the event of total incapacity. Therefore, if we wish to compare the effects of chronic illnesses and accidents on labor market participation, we should account for the fact that the cost of chronic illnesses is borne in full by the public insurance system, while it may not be the case for accidents. In the latter case, part of the accident treatment costs may be borne by the workers or by the provident scheme if a policy was taken out beforehand. Otherwise, we should also take into account the fact that the daily benefits are paid over a longer period for chronic diseases than for accidents.

Overall, the financial consequences of accidents are related to locomotor functions and depend on the professional status of the worker in the labor market. The consequences are smaller for executives than for blue collar workers (Santé Publique France, 2016). The sequelae of chronic illnesses can lead to more gradual departures from the labor market (Duguet and Le Clainche 2014, 2016).

Overall, the revenue compensation is better for public servants and the workers of large corporations. While the workers belonging to the private sector benefit from complementary benefits, the generosity of which depends on the collective agreements, in addition to social security benefits. Public servants benefit from a national status that is more generous than that received by most private sector workers. Due to a heath shock, public servants can be out of the labor market for one year and still get a wage that is roughly similar to their wage before the accident or illness. On the second and third years after the health shock, the public servants still receive half of their wage if they have stopped working.

Among the different workers, independent workers are the most exposed on average to a significant loss of revenue. If they are compensated by the social security system like other workers, they must have taken out an expensive supplementary private insurance policy for the heath shock to be adequately covered.

The return to work is regulated in the public as well as the private sector. An occupational health doctor ("médecin du travail") must give the authorization for a return to work, either in the same job or another job. In the case of chronic illnesses, the return-to-work authorization of a *Sécurité Sociale* (public health insurance) doctor is also needed for some workers and the worker is monitored in order to facilitate the integration. In case of accidents, the return-to-work can be more complicated since there are fewer mechanisms to accompany the worker.

In France, the prevalence of chronic illnesses is high and tends to increase as in most developed countries, but the evaluation of this phenomenon varies with the definitions of the term "chronic illness". Using the French "ALD 30" definition, we get the following facts. According to the National Health Insurance Fund, the number of people with chronic illnesses is 20 million in 2017, nearly 35% of the population covered by the public health insurance system. In this population, there are 10.7 million people who are supported for a chronic illness under the ALD system. Between 2011 and 2017, admissions in "ALD 30" increased at an average annual rate of +5.1% compared with +4.1% for the 2006-2011 period. The annual level of new admissions in "ALD 30" has increased from 869,000 in 2001 to 1,680,300 in 2017. Excluding severe arterial hypertension, the prevalence of "ALD 30" increased by 4.0% in 2017 from 3.1% including severe hypertension. Chronic liver illnesses, disabling stroke, heart disease, arrhythmia and valvulopathy, neurological and muscular disorders are the fastest growing chronic illnesses with rates above 5% (CNAM 2017).

The effects of such illnesses in the French labor market are detrimental (Barnay, 2016; Barnay et al., 2015; Duguet and Le Clainche, 2014) and lead to risks of premature departures from the labor market, especially for the least educated. In addition to these illnesses, car or home-related accidents can have very significant effects on labor market participation depending on the extent to which they restrict activity. In France, it is estimated that about 200,000 car accidents or everyday life accidents have serious consequences for people aged 18 and over. A minority causes disability (Santé Publique France, 2016; ONISR, 2018). The risk of road and life-related accidents for participation in the labor market is much lower than for chronic illnesses, but the magnitude of the risk can be stronger if it exposes the individual to a long-term or permanent disability. Given limitations resulting from a chronic illness or car or life accident, the consequences may be different for employees because of the type of more or less reversible sequelae, career interruptions for treatment or the financing of these temporary breaks. This results in a complex situation regarding the replacement incomes, which are significantly heterogeneous in the private sector.

4 Data

The SIP survey. The "Health and Professional Histories" (Santé et Itinéraire Professionnel, SIP) survey was carried out from November 2006 until January 2007, on a sample of people aged between 19 and 74 years. The data were collected by teams composed of a researcher and a doctor. This survey was used to identify all the stages of a professional history and record the health events occurring over the same period. The survey included questions about childhood and activity periods. Here, one should be cautious about the retirement periods, because they imply inactivity on the one hand, and, at the same time, the date of onset of some chronic illnesses, like cancer, is correlated with the age of the people. In this paper, we want to measure the effect of health events on relatively young, supposedly strongly active individuals. Therefore, we focus on the people above 19 years old, and we keep the individuals who had not already retired at the time of the health event. This definition includes the retirements that would be caused by health events.

Sample Statistics. We extracted a data set containing the full history of 9165 individuals (Table 1), which included 6031 individuals with no health event, 1063 with an accident and 2071 with a chronic illness. These individuals were followed retrospectively from their arrival on the labor market and the original panel includes 316,894 observations. In order to compute a before-after estimator we needed at least 3 years of data for each individual, since we compare the year before the health event (t-1, say) to the year after (t+1) and, also, to check that another health event did not occur in t+1. Notice also that the individuals with a health event could be used in the control group before they had their health event.

There are strong differences in individual characteristics (gender, education, childhood and age) between these three populations that justify the use of matching. The matching variables are important because they can influence both the performance in the labor market and the effect of the health events; they are called the confounding variables in the literature.

Compared to the individuals with no health event, chronic illnesses predominantly affected women (59.6% vs 55.9%), the less educated (29.3% above the A level vs 45.3%), people who had had health problems more frequently during their childhood (37.7% vs 24.7%). They were more likely to have been separated from their relatives (15.1% vs 11.2%) and their parents were more likely to have had health problems (17.3% vs 12.2%).

The individuals had a chronic illness at 40.7 years old on average. If we consider their situation one year before the beginning of the chronic illness, they were more often living with someone else (85.3% vs 76.8%) and were less likely to be out of work than the population with no health event (18.6% vs 20.6%).

Table 1. Sample Statistics

Variables	Accident	Chronic illness	No health event
Age in 2006	51.7	55.8	46.1
Gender:			
Women	29.4%	59.6%	55.9%
Men	70.6%	40.4%	44.1%
Education:			
Primary	29.5%	32.3%	18.4%
Secondary	44.1%	38.4%	36.3%
Above A level	26.3%	29.3%	45.3%
Childhood:			
Health problems	35.0%	37.7%	24.7%
Separation from close relatives	14.1%	15.1%	11.2%
Parents had health problems	14.1%	17.3%	12.2%
Age at health event	31.8	40.7	-
*One year before the health event**			
Living in couple	62.4%	85.3%	76.8%
Last known occupation:			
Independent	8.5%	9.8%	8.3%
Executive	3.9%	7.3%	9.2%
Intermediate	14.4%	15.0%	16.5%
Employees	15.9%	26.4%	25.0%
Blue collars	34.1%	22.8%	20.3%
None	23.3%	18.7%	20.6%
Employment:			
Public sector	14.4%	19.7%	19.6%
Private sector	62.3%	61.7%	59.9%
Jobless	23.3%	18.6%	20.6%
Number of observations	1063	2071	6031

*The figures for the “no health event” column were obtained by taking the average of the corresponding years among the people with no health event

This is different from accidents. Compared with the individuals who reported no health event, they affect mainly men (70.6% vs 44.1%). The education and childhood variables are similar to chronic illnesses, with a shorter education (26.3% above the A level vs 45.3%) and harder childhood conditions. They were more likely to have had health problems (35.0% vs 24.7%), were more frequently separated from their relatives (14.1% vs

11.2%) and their parents also were in worse health (14.1% vs 12.2%). They had their accident at a younger age than the chronic illnesses (31.8 years compared with 40.7). One year before their accident, they were less likely to living with someone else (62.4% vs 76.8%) and were more often out of work than the population without health events (23.3% vs 20.6%).

Overall, a direct comparison of the accidents and chronic illnesses populations shows that accidents concern younger people, more often men, with similar education and health problems during their childhood.

Figures 1 and 2 show the change of the employment rate around the health event dates. It is a simple before-after analysis, also called the naive estimator in the literature because it doesn't account for the confounding variables or the fixed individual and time effects.

Figure 1: Employment rate before and after an accident, by gender

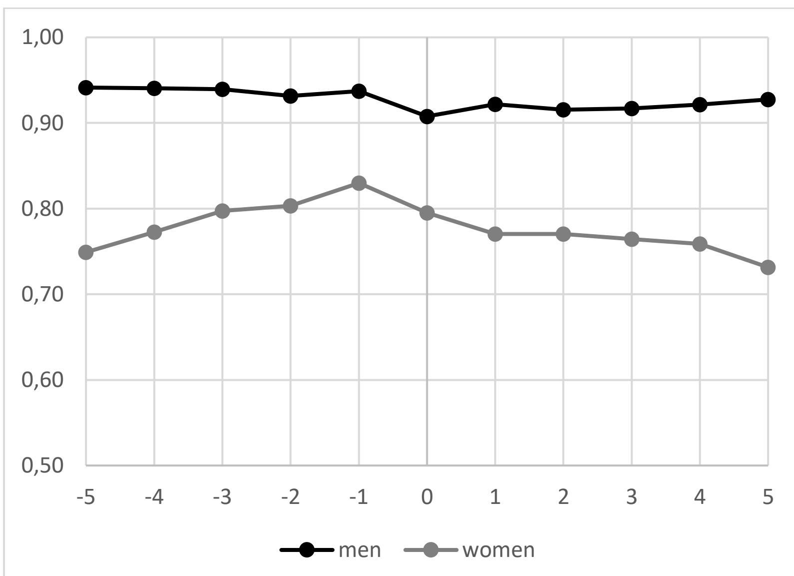


Figure 1 shows that the effect of the accident date is small for men and strong for women. In the latter case, there is a 10-points drop in the employment rate. There is only a slight decrease for men, of about 3 points. Figure 2 shows that chronic illnesses have stronger effects than accidents. For men, the employment rate is close to 95% five years before the chronic illness and decreases slowly to 92% one year before it. One year after, it is close to 85% and slowly decreases to 82% five years after the chronic illness. There is clearly a fall in the employment rate around the chronic illness onset date. We find a similar result for women. Their employment rate is about 75% before the chronic illness and decreases to 70% one year after and 65% five years after.

Figure 2: Employment rate before and after a chronic illness, by gender

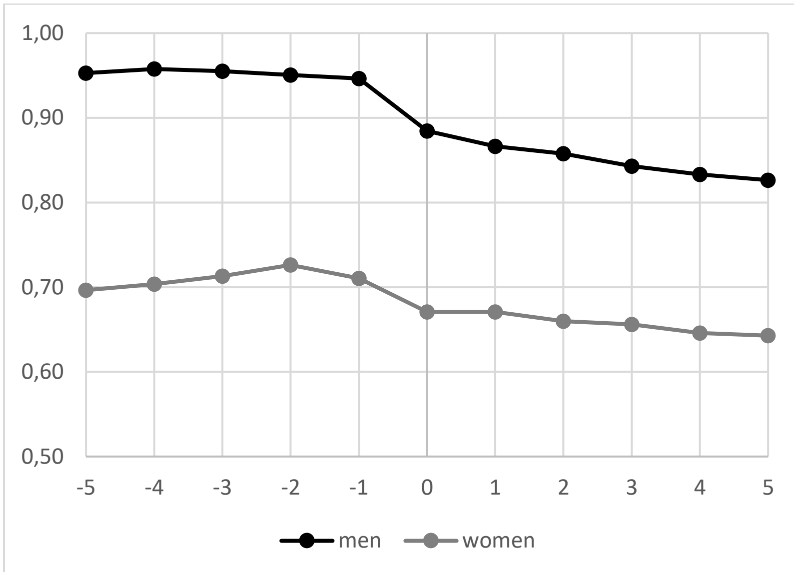
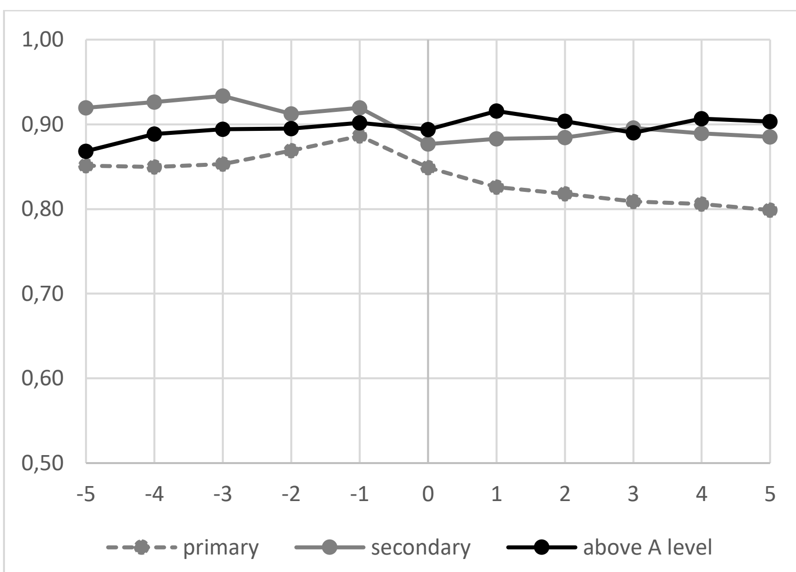
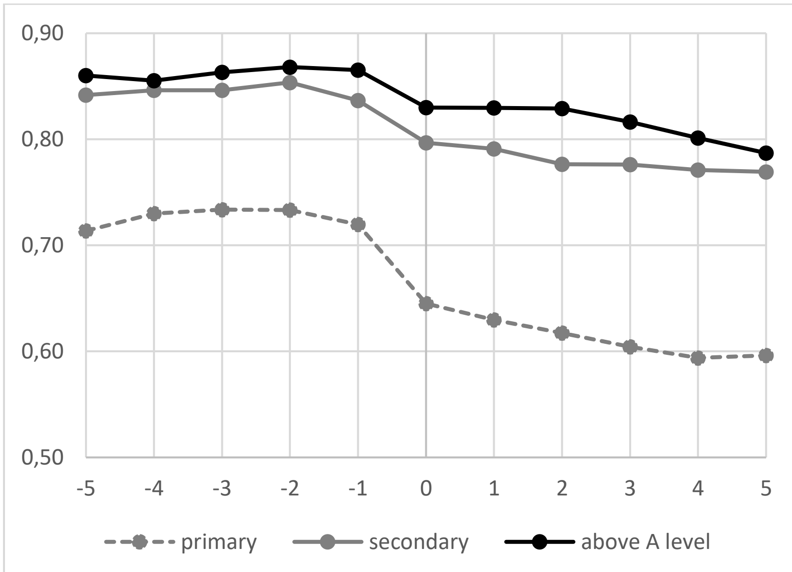


Figure 3: Employment rate before and after an accident, by education level



Figures 3 and 4 show the changes in the employment rates by level of education. For both illnesses and accidents, two main groups of workers show up. The workers with the lowest education level always have both a lower employment rate before the health event, and experience a stronger decrease of their employment probability than the other workers do. The two highest education levels share similar progression for accidents, and we can see a small advantage for the most educated workers in the case of illnesses.

Figure 4: Employment rate before and after a chronic illnes, by education level



These graphs are interesting but they could be affected by the confounding variables and the individual and time fixed effects. The methodology aims to control for the confounding variables through matching and for the fixed effects through differencing.

4. Methodology

General principles. Our estimation method is similar to Heckman et al. (1998). We compare the individuals i in a treatment group ($T_i = 1$), experiencing an accident or a chronic illness at time t_i, and a control group ($T_i = 0$) that had not experienced health problems yet. Each person in the sample has two potential outcomes $(y_{0i}(t), y_{1i}(t))$ depending on whether they experience a health event ($y_{1i}(t)$) or not ($y_{0i}(t)$). By definition, we only observe one of the two potential outcomes:

$$y_i(t) = T_i y_{1i}(t) + (1 - T_i) y_{0i}(t) = \begin{cases} y_{1i}(t) & \text{if } T_i = 1 \\ y_{0i}(t) & \text{if } T_i = 0 \end{cases}$$

For each treated individual, we observe an empirical counterpart of what happens when there is a health event but we do not observe what would have happened without the health event.[5] For an effect k years after the health event, we observe what has happened to the treated individuals:

$$\mathrm{E}(y_{1i}(t_i + k) - y_{0i}(t_i - 1)|T_i = 1)$$

and we need to estimate the following quantity, the counterfactual, what would have happened to the treated individuals if they had not been treated: [6]

$$\mathrm{E}(y_{0i}(t_i + k) - y_{0i}(t_i - 1)|T_i = 1).$$

The first problem to solve is to define the control group; the second problem is to estimate the counterfactual from the control group.

Control group. The definition of the control group would be straightforward with cross-sectional data, because there are clear sets of treated and non-treated individuals. On panel data, the definition of the treated set varies over time. We consider individuals i which are in the data set from year t_i^- to year t_i^+. The individuals who are treated at date $t_i \in [t_i^-, t_i^+]$ were not treated before this date. Therefore, the treated individuals can be used as controls before their health event happens. We advocate the use of these future treated individuals in the control group for the following reason: if we didn't, we would only keep those individuals in the control group who, over a long time period, never have an accident or an illness. And these individuals would serve as a match to estimate what would have happened to the individuals with an accident or an illness. We doubt that this would produce a good reference because the people, to whom nothing ever happens, have little chance to be representative of the general population. One may think that they are more efficient than the general population. Therefore, their performance in the absence of health events may be superior to the performance of the general population, and we would underestimate the effect of health events on the outcome variables. In this paper, we use the following control group for the treated individuals i evaluated on the period $[t_i - 1, t_i + k]$: the people that did not have any health event before or during year $t_i + k$. This control group includes both the people that never have a health event, and the people that will have a health event after $t_i + k$. The condition on year $t_i + k$ is needed to make sure that the outcome of a control is not influenced by a health event.[7] An additional argument for using this control group is the following: it is the definition that is implicitly

[5] Following a common practice, we do not use the outcome data from the year of the health event t_i because the health problem may happen anytime between the 1st of January and the 31st of December. Hence the measurement of the effect in t_i may be partial. We compare the outcome of the year with no health event at all ($t_i - 1$) with the outcomes of the years that follow the health event ($t_i + k, k \geq 1$).

[6] Notice that these within-individual differences allow us to eliminate the fixed effects unobserved heterogeneity.

[7] Let t_j be the treatment date of a twin in the control group, we impose the condition $t_j > t_i + k$. When j is not treated, we set $t_j = \{+\infty\}$ and the condition is always valid.

used in all cross-sectional studies. Indeed, when working with a cross section we cannot know the future values of the health variables, therefore the non-treated group necessarily includes people who will get sick or have an accident at a later date.

Counterfactual estimation. The estimation is achieved by looking for individuals with similar characteristics as the treated among the non-treated individuals (the «twins»). It remains to choose a matching method. Ideally we would like the treated and the non-treated individuals to be identical, so that the non-treated individuals could be used to produce a credible estimate of what would have happened to the treated individuals if they had not been treated. Following the literature regrouped in Rubin (2006), one can use perfect matching for qualitative variables, distance-based matching for continuous variables, propensity score matching ("PSM") for both continuous and qualitative variables, or a mix of these methods.[8] In practice, the choice is often guided by the matching rate, defined as the percentage of the treated individuals that can be matched. For some data sets, perfect matching may be too demanding and produce too small a matching rate. In this case, PSM is to be preferred. But when perfect matching produces high matching rates, it should be preferred, at least because a perfect match on the matching variables implies a perfect match on the propensity score.[9] In our application, the matching rate was between 99.9% and 100% with perfect matching on the qualitative variables and a 3-year calliper on age[10], so that we kept perfect matching. Using PSM would not allow us for improving on the matching rate with our data set. Another advantage of perfect matching over PSM is that we do not need to check for covariate balancing: all the categorical variables are identical in the two groups by definition of the method. The allowance of an age difference creates a small average age difference between the treated individuals and their matches, around 1 year in this study, which is too small to influence our results. Last, notice that the matching rate is also related to the definition of the control group: there are more twins available with the dynamic definition of the control group that we use in this application. Overall, the estimator is defined as:[11]

$$\widehat{\mathrm{ATT}}(k) = \frac{1}{I}\sum_{i\in I}\left(y_i(t_i+k) - y_i(t_i-1) - \frac{1}{J(i)}\sum_{j\in J(i)} y_j(t_i+k) - y_j(t_i-1)\right)$$

$$k \in \{1, \dots, 5\}$$

where I is the treated set and their number, and $J(i)$ the set of i's twins and their number:

$$J(i) = \left\{ j : t_j > t_i + k, X_j = X_i \text{ and } \left| x_j - x_i \right| \leq 3 \right\}$$

[8] The propensity score is the probability to be treated. It can be estimated by Logit or Probit models.
[9] In practice, the explanatory variables of the propensity score are used as matching variables.
[10] We allow for a maximum age difference of 3 years between the treated individuals and their non-treated twins.
[11] For a discussion of these methods on panel data, see Lechner (2013).

where X_i is the vector of the qualitative variables and x_i the age of the worker. Matching is done with replacement: we use all the twins available for each treated in order to reduce the bias of the estimator (Dehejia and Wahba, 1999; Stuart, 2010). The variance of the estimator is derived in appendix 1.

Application. In the standard difference-in-differences approach ("DiD"), there is a common trend hypothesis. Our approach relaxes this assumption, like in Gebel and Vossemer (2014). By matching on individual characteristics, we allow for the time trends to be different between individuals. The slopes of the trends are allowed to depend on the individual characteristics used in the matching process. It is possible to test the standard parallel trend hypothesis by comparing the simple DiD estimates with the matching-DiD estimates. If there is a significant difference between the estimates, the standard parallel trend hypothesis can be rejected. We report the estimations of the DiD in appendix 2 standard (without matching). We find that the simple DiD method underestimates the long-term effect of accidents and overestimates the long term effect of chronic illnesses.

5. Results

The matching DiD estimations are presented in Table 2 for the accidents and in Table 3 for chronic illnesses. Before commenting on the results, it is important to notice two points. First, the sum of the three activity dummies (employment, unemployment, inactivity) always equal 1. The averages of these dummies give the corresponding activity proportions, which also sum to 1. Our estimators can be expressed as differences between the activity proportions of the treated and non-treated groups, so that the sum of these differences equals 0. This implies that the sum of the three impact coefficients (employment, unemployment, inactivity) reported in the tables equals 0. Any increase of one effect implies a decrease of at least another effect. We interpret this property in the following way: each health event creates a deformation of the activity probabilities. For instance, a decrease in the employment probability is compensated by an increase in the inactivity probability. Secondly, it is possible to calculate the effects of the health events for sub-samples of the original data set, provided there are enough observations. We find that this is the case for gender and education. Therefore, we will examine whether men and women face comparable consequences in the labor market after a health event, and whether a higher education level allows individuals to compensate for the anticipated negative effect of health events on activity.

Table 2. Effect of accidents

Difference-in-differences with matching. Matching variables: year of birth (3 years calliper), gender (2 classes), education level (3 classes), health problems during childhood (2 classes), separated from close relatives during childhood (2 classes), parents had health problems during childhood (2 classes), marital status (2 classes), occupation (6 classes), sector (3 classes), lagged employment (2 classes). ATT: Average effect of the treatment on the treated. ASE: Asymptotic standard error.

	Treated	Matched	Number of	Employment		Unemployment		Inactivity	
			matches	ATT	ASE	ATT	ASE	ATT	ASE
Full Sample									
t+1	1063	99.7%	17	-0.032*	0.011	0.004	0.006	0.029*	0.010
t+2	994	99.9%	17	-0.032*	0.013	0.004	0.007	0.028*	0.011
t+3	954	99.9%	16	-0.029*	0.013	0.004	0.007	0.025*	0.012
t+4	901	99.9%	16	-0.028*	0.014	0.004	0.007	0.024*	0.012
t+5	838	99.9%	16	-0.021	0.015	0.006	0.007	0.015	0.013
Women									
t+1	312	99.7%	15	-0.053*	0.021	0.020†	0.012	0.033†	0.018
t+2	289	100%	15	-0.048†	0.026	0.017	0.014	0.031	0.022
t+3	277	100%	15	-0.050†	0.029	0.011	0.015	0.039	0.025
t+4	251	100%	15	-0.063*	0.031	0.015	0.015	0.048†	0.028
t+5	233	100%	14	-0.055	0.035	0.033†	0.017	0.022	0.032
Men									
t+1	751	99.7%	18	-0.024†	0.013	-0.003	0.007	0.027*	0.011
t+2	705	99.9%	17	-0.025†	0.015	-0.001	0.008	0.026*	0.012
t+3	677	99.9%	17	-0.020	0.015	0.001	0.008	0.019	0.013
t+4	650	99.8%	17	-0.014	0.015	-0.001	0.007	0.015	0.013
t+5	605	99.8%	16	-0.007	0.015	-0.005	0.008	0.012	0.014
Primary education									
t+1	314	100%	14	-0.052*	0.021	0.002	0.009	0.051*	0.020
t+2	301	100%	14	-0.054*	0.023	0.001	0.010	0.053*	0.021
t+3	294	100%	14	-0.061*	0.025	0.006	0.011	0.054*	0.023
t+4	280	100%	14	-0.054*	0.027	0.011	0.012	0.042†	0.025
t+5	261	100%	14	-0.052†	0.028	0.017	0.013	0.036	0.027
Secondary education									
t+1	469	100%	21	-0.032†	0.018	0.010	0.011	0.023	0.015
t+2	439	100%	21	-0.021	0.020	0.011	0.012	0.011	0.016
t+3	424	100%	20	-0.013	0.020	0.015	0.011	-0.002	0.017
t+4	402	100%	20	-0.013	0.021	0.007	0.011	0.006	0.017
t+5	374	100%	20	-0.002	0.022	0.000	0.012	0.002	0.019
Education above A-level									
t+1	280	98.9%	13	-0.010	0.018	-0.003	0.011	0.014	0.015
t+2	254	99.6%	13	-0.023	0.023	-0.003	0.015	0.026	0.018
t+3	236	99.6%	13	-0.019	0.025	-0.017	0.014	0.037	0.021†
t+4	219	99.5%	12	-0.022	0.025	-0.013	0.012	0.035	0.022
t+5	203	99.5%	11	-0.014	0.027	0.003	0.012	0.011	0.024

* significant at the 5% level. † significant at the 10% level.

Table 3. Effect of chronic illnesses

Difference-in-differences with matching. Matching variables: year of birth (3 years calliper), gender (2 classes), education level (3 classes), health problems during childhood (2 classes), separated from close relatives during childhood (2 classes), parents had health problems during childhood (2 classes), marital status (2 classes), occupation (6 classes), sector (3 classes), lagged employment (2 classes). ATT: Average effect of the treatment on the treated. ASE: Asymptotic standard error.

	Treated	Matched	Number of matches	Employment		Unemployment		Inactivity	
				ATT	ASE	ATT	ASE	ATT	ASE
Full Sample									
t+1	2072	99.8%	15	-0.029*	0.009	-0.007	0.005	0.036*	0.008
t+2	1985	99.7%	15	-0.038*	0.010	-0.006	0.005	0.044*	0.009
t+3	1874	99.7%	14	-0.047*	0.011	0.000	0.006	0.047*	0.010
t+4	1758	99.7%	14	-0.051*	0.012	0.005	0.006	0.047*	0.011
t+5	1662	99.7%	14	-0.049*	0.013	0.003	0.007	0.047*	0.012
Women									
t+1	1236	100%	15	-0.023†	0.012	-0.008	0.007	0.031*	0.010
t+2	1183	100%	15	-0.041*	0.014	-0.003	0.008	0.044*	0.012
t+3	1122	100%	15	-0.046*	0.015	0.003	0.009	0.043*	0.014
t+4	1050	100%	14	-0.050*	0.017	0.007	0.009	0.043*	0.015
t+5	994	100%	14	-0.055*	0.018	0.004	0.009	0.050*	0.017
Men									
t+1	836	99.4%	14	-0.039*	0.014	-0.005	0.007	0.044*	0.012
t+2	802	99.4%	14	-0.034*	0.015	-0.011	0.007	0.045*	0.014
t+3	752	99.3%	14	-0.049*	0.016	-0.004	0.008	0.053*	0.015
t+4	708	99.3%	14	-0.053*	0.017	0.001	0.008	0.052*	0.016
t+5	668	99.3%	14	-0.041*	0.018	0.000	0.008	0.041*	0.017
Primary education									
t+1	669	100%	12	-0.056*	0.017	-0.004	0.008	0.061*	0.015
t+2	653	100%	11	-0.063*	0.019	-0.012	0.009	0.075*	0.018
t+3	628	100%	11	-0.083*	0.021	0.000	0.011	0.082*	0.020
t+4	594	100%	11	-0.096*	0.023	0.002	0.011	0.094*	0.022
t+5	572	100%	11	-0.094*	0.024	-0.001	0.011	0.095*	0.023
Secondary education									
t+1	796	100%	17	-0.021	0.015	-0.009	0.008	0.033*	0.014
t+2	767	100%	17	-0.033†	0.017	0.000	0.009	0.033*	0.014
t+3	730	100%	16	-0.034†	0.018	0.000	0.010	0.034*	0.016
t+4	692	100%	16	-0.028	0.020	0.003	0.011	0.025	0.018
t+5	658	100%	16	-0.019	0.021	-0.001	0.011	0.020	0.019
Education above A level									
t+1	607	99.2%	16	-0.010	0.015	-0.007	0.009	0.017	0.012
t+2	565	99.1%	15	-0.017	0.017	-0.007	0.010	0.024	0.015
t+3	516	99.0%	15	-0.023	0.019	0.000	0.010	0.023	0.017
t+4	472	98.9%	14	-0.028	0.021	0.011	0.012	0.017	0.019
t+5	432	98.8%	14	-0.037	0.023	0.013	0.013	0.024	0.021

* significant at the 5% level. † significant at the 10% level.

An important issue of the matching estimators is the matching rate. If the matching rate is small, there may strong selection biases. We are clearly not in this case, since we reach rates between 98.9% and 100%. The reason why the matching rates are high is that we use a dynamic matching method with replacement. We match the treated individuals with the people who are not treated yet and we use the same controls several times, while correcting the variance of our estimator accordingly, as indicated in appendix 1.

Effect of an accident on employment. Overall, accidents decrease the probability of employment by -3.2 percentage points (pp) in the year that follows, and this effect is stable over time. It remains significant during the first four years, and becomes insignificant five years after the accident. Almost no transition is made toward unemployment. Rather, accidents increase inactivity during the four years that follow the accident. The inactivity rate increases by +2.9 percentage points (pp) after one year, and by +2.4 pp after four years, and becomes insignificant after five years. However, this global effect hides two composition effects. On the one hand, women experience a stronger effect than men on employment, from -5.3 pp after one year to -6.3 pp after four years. After five years, the effect of -5.5 pp is not significant owing to the small number of observations (233 treated individuals), but the increase in unemployment is (+3.3 pp). Men's employment probability decreases during the two first years only, i.e. about -2.4 pp, and remains almost stable. After five years, the effect of the accident (-0.7 pp) is not significant. Overall, women suffer much more from accidents than men. Accidents clearly drive women out of the labor market or into unemployment more often than men. Several underlying mechanisms may explain these effects. On the one hand, they may suffer more strongly from the consequences of accidents. On the other hand, due to their lower earnings in the labor market compared to men they may exit earlier. Regarding the severity of accidents, we do not have the opportunity to study them in our data. But French statistics on accidents in everyday life and on road accidents show that accidents are more disabling for women than for men, except for those under the age of 25 years (Santé Publique France 2016). In addition, women who are in a relationship have a lower wage than their spouse, all other things being equal. It is therefore possible that a joint decision is made within the couple so that women leave the labor market in the event of a severe disability due to an accident. Let's bear in mind that, after three years, the regular French social security benefits end and are replaced by a disability benefit. The pre-accident wage and post-accident disability benefit gap is lower for women than for men. The incentives offered by disability benefits scheme compared to pre-shock wages are therefore in favor of a more frequent exit from the labor market for women than for men.

The effect of accidents on employment also decreases with the education level. Workers with a primary education level see their employment probability decrease from -5.2 pp one year after an accident, and the decrease is stable up to five years after the accident. People with a secondary education level experience a much smaller drop in employment, from -3.2 pp after one year, and no significant change afterwards. The effect is almost twice as small. Finally, the most educated workers (above A-level) do no experience any significant effect of accidents on their probability of employment. The impact of an accident decreases significantly with the level of education.

These effects can be compared to those of the other articles about the effects of accidents. The results of the main comparable studies are reported in appendix 3. Moller-Dano (2005) finds a drop of 8 to 10 percentage points in the probability of employment after an accident for men only. Crichton et al. (2011) find that employment rates are 12% lower 18 months after the accident and 10% lower after 2 years.

These authors consider that more studies are needed to understand why women and less qualified workers are more affected by accidents and their consequences. We believe that the links between the level of education and the health consequences of accidents pass through various channels, including risky behavior on the one hand and access to healthcare on the other hand. In France, as in many developed countries, access to healthcare is widespread regardless of education level, and healthcare coverage is generous. Therefore, the effect of the level of education on health after an accident mainly passes through risky behavior. It therefore appears that prevention policies should be implemented to lower accident rates, especially among the youngest. Regarding women, it is possible that an age effect is combined with a severity effect: while road accidents are more frequently fatal for young men, all-cause accidents can be more disabling for women than for men with age.

We can consider that there is a combination of two factors at play here: a first effect similar to that described for women and an effect linked to the greater severity of the consequences of accidents for the less educated than for the most educated, in particular. French data on everyday accidents and car accidents indeed highlight a social gradient in the severity of accidents linked to risky behavior (Santé Publique France 2016; ONISR 2018).

Another factor is also at play: education level is a good indicator of the type of job held by the workers. We see that the less qualified workers are more often blue-collar workers or employees. These jobs are more likely to involve physical work, so that the effect of the health events should decrease with the education level. This is clearly the case. The physical jobs are concentrated in the lowest education levels (Cambois, Garrouste, Pailhé, 2016). When an accident happens, the workers may not be able to continue their occupation. The negative effect would mean that a proportion of the workers is not able to find a job compatible with their new health status. This could mean that a fraction of the accidents may cause serious disabilities. It is possible that this effect hides gender differences but we do not have enough observations among unqualified workers to test that assumption in a satisfactory way. Overall, accidents have a strong negative effect on women and the less educated workers.

Effect of a chronic illness on employment. A simple look at Table 3 clearly shows that the effect of illnesses is stronger than the effect of accidents. The effect of illnesses increases over time, from -2.9 pp after one year, to -4.9 pp after five years. A similar result is found for the education levels. The less educated workers see their employment probability decrease from -5.6 pp after one year to -9.4 pp after five years, while there is no significant effect for the more educated workers. We find a similar result as with accidents, but the negative impact of illnesses is stronger than that of accidents.

These results can be compared to the ones of previous studies reported in appendix 3. As for some previous work, which study the effect of chronic diseases like cancer, e.g. in Denmark (Heinesen and Kolodziejczyck (2013)) and Sweden (Lundborg et al. (2015)), we also find a social gradient for the impact of health events in the labor market. However, another part of the literature finds contradictory results. They are explained by the generosity of the income replacement schemes. For example, Trevisan and Zantomio (2015) found higher exit rates for the most educated older women in Europe; Jones et al. (2019), on UK data during the economic crisis, found a larger reduction in labor market participation for the most educated workers. The same result is obtained by Lehnart (2019), based on the same data but in a period before the economic crisis. It is explained by the healthcare expenditure and healthcare use and by a loss in productivity for the higher educated. Garcia-Gomez (2011) who focused on the effects of self-reported health shock leading to disability found that French disabled people suffer less than workers from other European countries owing to disability allowances. Howere, some results in the literature report a social gradient affecting the intensive margin rather than the extensive margin (Jones et al. 2019, for example).

This result can be explained by several mechanisms: less educated workers, who are also less well-paid, attend health services less often and illnesses can be diagnosed at a more severe stage, preventing the return to work (e.g. Mackenbach et aL. 2008). Furthermore, as explained above, illnesses within the ALD30 list are scrupulously diagnosed and recorded and social security doctors monitor the consequences in terms of funding for care and sick leave. Employees generally do not have the opportunity to challenge their gap in the labor market. Whatever the incentives linked to the social security system, the return to work does not depend on the behavior of the employee but rather on the decision of the social security doctor and the occupational doctor authorizing the return to work. Regarding the consequences of these illnesses and for one to three years of incapacity, the French social security system has proven to be very protective. Beyond that, the effect is generally more detrimental for the less educated than for the most educated individuals because they benefit less from provident schemes.

Common trend assumption. The estimates reported in Table A.1 can be used to address the parallel trend issue. Strictly speaking, the common trend assumption cannot be tested directly because it is an identifying assumption. All the tests are, for this reason, indirect. We perform the following test by comparing two estimators: one that relaxes the common trend assumption (DiD with matching, which does not depend on the standard common trend assumption), and another estimator that does fully depend on the standard common trend assumption (DiD without matching, reported in Table A.1). We find a strong difference for accidents since simple DiD does not show any significant effects and clearly underestimates the effect of accidents on employment. When we compare the estimates for illnesses, we find the reverse results: simple DiD strongly overestimates the effect of illnesses (-8.0 pp. after 5 years instead of -4.9 pp for DiD with matching). Therefore, the evidence goes against the parallel trend hypothesis.

Balanced sample estimates. The selections were originally avoided, in order to increase the quality of the estimations. Using balanced estimates does not only modify the control group, but also the treated group. Since the issue is empirical, we have performed another regression on the balanced sample (using the same treated and non-treated individuals for all the dates), reported in Table A2. We find no difference for chronic illnesses and slightly lower estimates for the accidents. The latter are not always significant due to the decrease in the number of observations. Overall, our unbalanced estimates do not show a strong departure from the balanced one.

Conclusion

Until recently, the effects of health shocks on working age populations have not yet been researched to any great extent in France, due to the lack of adequate data which accounts for the specificities of these types of shocks. Here we study the effect of health shocks on the extensive margin. Given the impact that such shocks may have on the remaining expected professional career, it is necessary to account for these effects more thorougly, with the appropriate data and methods. In addition, we also take into account the specificity of the French social welfare system, in order to explain the differentiated consequences of accidents and chronic diseases. We find that health events have a significant and negative effect on activity even for relatively young workers. These negative effects are greater for chronic diseases than for accidents. We also find that the negative effects of health events tend to be stronger for the less educated workers and, in the case of accidents, for women. These results can be explained by peculiarities of the French social security system. First, workers benefit from sick leave benefits due to illness or accidents and second, if return to work is impossible, inactivity and disability benefits. Additionally, a distinction is made between benign illnesses or accidents, which are not as well covered by social security, and chronic illnesses, the consequences of which are well covered over three years.

However, despite significant differences in the social security systems, our results are globally in line with previous works. Women and the less qualified workers face harder condition in case of health events. The effects by which education or gender affect health therefore require preventive public health policy measures, which is the poor relation of health policies in many countries. The effects of health shocks on employment also show that social welfare and insurance systems play an important role through the incentives they provide. A large gap between labor income and replacement income may drive some worker out of the labor market while they are still able to return to work.

Overall, we find that all the health events worsen the situation of the workers that are already the least favoured in the labor market, and contribute to increase economic inequality. The main lesson learnt from the French context is that the incentives from the social and insurance systems work well to allow the most educated men to return to work after three years. But we also find that those incentives are not fully efficient for the return to work of women and the less well educated, who are most severely affected by health events and less well attached to the labor market. One consequence in the French context is that health events would drive a high number of workers toward the minimum assistance revenues. Note that our data do not allow us to study the intensive margin effect. Indeed, hours worked or incomes are not included in the data. Note also that in France, the long-term contracts are not interrupted after a health shock and that the return to work can be gradual, associated with fewer work hours. Most of the time, it is possible to reduce the hours worked for a limited time depending on the employment status. However, the reduction in hours worked cannot generally be extended for long for the employees working in managerial jobs.

Our results call for a review of policies oriented towards adapting the workplace to the most common health events. Indeed, as the French Health Authority highlights in a recent report (HAS, 2019), the workplace accomodations in connection with care pathways are not applied everywhere in France, despite the existing laws. Depending on the type of health shock and on the way the care is provided, the return-to-work is more or less easy for the workers. Rather than grading partial absence, which can be effective to reduce long-term absences (Hassink, 2018), training sessions could be planned and organized for the workers, whose health problems prevent them from returning to the same job. Indeed, due to the generosity of the French social security in case of sickness, firms are not being given incentives to adopt partial absence programs.

Beyond the French context, we may highlight that these effects can be broken down in order to understand which public policy measures would be most appropriate to reduce the consequences of health events. First, we have to focus on the link between age, education, gender and the health status. Second, we have to understand how the incentives provided by the social welfare system and insurance play their own role to improve labor market participation. Insofar as the most disadvantaged workers are also the less well protected from risky behavior when compared to other workers, we recommend improving focused safety measures regarding healthy behavior. It would also be appropriate to increase the risk pooling between women and men, since in many countries women are the most affected by health events in the labor market and, at the same time, have less good opportunities in the labor market owing to the education of children.

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Appendix 1 – Computation of the variance

We first regroup the treated in G classes defined by the levels of their categorical variables. We will treat the continuous variables later. These classes define a partition of the treated individuals. Let I be the treated set and I_g the group defined by the g-th combination of the categorical variables, $g \in G$, we have $I = \bigcup_{g \in G} I_g$ and $\bigcap_{g \in G} I_g = \emptyset$. From the treated categorical variables, we define twins as the individuals with the same levels of the categorical variables. For the value g, the set is denoted $J_g = J(I_g)$ where $J(.)$ is the matching function. Similarly, we define $J = J(I)$ and we have $J = \bigcup_{g \in G} J_g$ and $\bigcap_{g \in G} J_g = \emptyset$. Without continuous variables, we just take the difference of the means of the outcome variables inside each g group and weight them by the number of treated individuals inside each group, in order to get an unbiased estimate of the average effect of the treatment on the treated individuals. We introduce the following notations in order to simplify the exposition:

$$z_i = y_i(t_i + k) - y_i(t_i - 1), i \in I$$
$$z_j = y_j(t_i + k) - y_j(t_i - 1), j \in J(I)$$

Under perfect matching, we get the following estimator:

$$\hat{c}_1 = \sum_{g \in G} \frac{I_g}{I} \left(\frac{1}{I_g} \sum_{i \in I_g} z_i - \frac{1}{J_g} \sum_{j \in J_g} z_j \right) = \sum_{g \in G} \frac{I_g}{I} \left(\bar{z}(I_g) - \bar{z}(J_g) \right)$$

where $\bar{z}(I)$ denotes the arithmetic mean of the z's for $i \in I$. The derivation of the variance is straightforward because the z's are iid. We have

$$\mathrm{V}(\hat{c}_1) = \sum_{g \in G} \left(\frac{I_g}{I} \right)^2 \left(\mathrm{V}\left(\bar{z}(I_g) \right) + \mathrm{V}\left(\bar{z}(J_g) \right) \right)$$

When we include a continuous variable among the matching variables, we need to set a calliper. Let x be the continuous variable and m_x the calliper. A twin $j \in J(i)$ of the treated i must satisfy the condition:

$$|x_i - x_j| \leq m_x.$$

The inclusion of this calliper creates the following complication. We cannot use the average of all the twins $\bar{z}\left(J(I_g) \right)$ anymore, but we must compute it from a subsample of $J(I_g)$. We define the twins' set of the treated set i as:

$$J(I_g, x_i) = \{ j \in J(I_g) : |x_i - x_j| \leq m_x \}$$

Here, the difficulty comes from the fact that the twins' sets are not disjoint anymore. This has to be accounted for both in the mean and in the variance formulas. We define the following matching dummies for $j \in J_g$, equal to 1 when j can be matched with i, equal to 0 otherwise:

$$d_{ij} = \begin{cases} 1 & \text{if } j \in J(I_g, x_i) \\ 0 & \text{otherwise} \end{cases}$$

The corresponding counterfactual is defined as the mean over the twins (with replication):

$$\bar{z}\left(J(J_g, x_i)\right) = \frac{\sum_{j \in J_g} d_{ij} z_j}{\sum_{j \in J_g} d_{ij}} = \sum_{j \in J_g} \frac{d_{ij}}{d_{i+}} z_j$$

with $d_{i+} = \sum_{j \in J_g} d_{ij}$, the number of twins in J_g who can be matched with the treated set $i \in I_g$. The effect of the treatment on the treated set can be estimated by:

$$\hat{c}_1 = \sum_{g \in G} \frac{I_g}{I} \left(\frac{1}{I_g} \sum_{i \in I_g} \left(z_i - \bar{z}\left(J(J_g, x_i)\right)\right)\right)$$

The counterfactual can be simplified further by inverting the sums in the expression that follows:

$$\frac{1}{I_g} \sum_{i \in I_g} \bar{z}\left(J(J_g, x_i)\right) = \frac{1}{I_g} \sum_{i \in I_g} \sum_{j \in J_g} \frac{d_{ij}}{d_{i+}} z_j = \frac{1}{I_g} \sum_{j \in J_g} z_j \left(\sum_{i \in I_g} \frac{d_{ij}}{d_{i+}} \right)$$

Rewriting, we get:

$$\frac{1}{I_g} \sum_{i \in I_g} \bar{z}\left(J(J_g, x_i)\right) = \frac{1}{J_g} \sum_{j \in J} \tilde{z}_j = \overline{\tilde{z}\left(J_g\right)} \text{ with } \tilde{z}_j = z_j \frac{J_g}{I_g} \left(\sum_{i \in I_g} \frac{d_{ij}}{d_{i+}} \right) \tag{1}$$

so that

$$\hat{c}_1 = \sum_{g \in G} \frac{I_g}{I} \left(\bar{z}(I_g) - \overline{\tilde{z}\left(J_g\right)} \right)$$

and its variance is given by:

$$\mathrm{V}(\hat{c}_1) = \sum_{g \in G} \left(\frac{I_g}{I}\right)^2 \left(\mathrm{V}\left(\bar{z}(I_g)\right) + \mathrm{V}\left(\overline{\tilde{z}\left(J_g\right)}\right)\right)$$

Notice the following special case. When there is no continuous variable, every treated individual can be matched with every twin of the same class so that $d_{ij} = 1$ and $d_{i+} = J_g$, and equation (1) reduces to the basic case $\tilde{z}_j = z_j$. The estimations have been performed with R 3.0.2. by the authors.

Appendix 2 – Additional estimations

Table A.1: simple DiD estimates

Difference in differences. No matching performed.
ATT: Average effect of the treatment on the treated. ASE: Asymptotic standard error.

Health event	Employment		Unemployment		Inactivity	
	ATT	ASE	ATT	ASE	ATT	ASE
Accident						
t+1	-0.018†	0.010	0.004	0.005	0.014	0.009
t+2	-0.015	0.012	0.006	0.006	0.009	0.010
t+3	-0.011	0.013	0.008	0.007	0.003	0.011
t+4	-0.007	0.013	0.004	0.006	0.003	0.012
t+5	-0.005	0.014	0.004	0.007	0.001	0.013
Chronic illness						
t+1	-0.046*	0.008	-0.004	0.005	0.050*	0.007
t+2	-0.059*	0.010	-0.007	0.005	0.066*	0.009
t+3	-0.070*	0.010	-0.002	0.006	0.072*	0.010
t+4	-0.078*	0.011	-0.001	0.006	0.079*	0.010
t+5	-0.080*	0.012	-0.003	0.006	0.083*	0.011

* significant at 5%. † significant at 10%.

Table A.2. Balanced sample estimates

Health event	Treated	Matched	Number of matches	Employment		Unemployment		Inactivity	
				ATT	ASE	ATT	ASE	ATT	ASE
Accident									
t+1	838	99.9%	17	-0.022†	0.012	0.001	0.006	0.021†	0.011
t+2	838	99.9%	16	-0.021	0.013	-0.001	0.007	0.022†	0.012
t+3	838	99.9%	16	-0.023	0.014	-0.002	0.007	0.025*	0.012
t+4	838	99.9%	16	-0.023	0.014	-0.002	0.007	0.025†	0.013
t+5	838	99.9%	16	-0.021	0.015	0.006	0.007	0.015	0.013
Illness									
t+1	1661	99.7%	15	-0.027*	0.010	-0.006	0.005	0.033*	0.009
t+2	1661	99.7%	14	-0.038*	0.011	-0.003	0.006	0.041*	0.010
t+3	1661	99.7%	14	-0.044*	0.012	0.000	0.006	0.044*	0.011
t+4	1661	99.7%	14	-0.047*	0.013	0.005	0.007	0.042*	0.012
t+5	1661	99.7%	14	-0.049*	0.013	0.003	0.007	0.047*	0.012

* significant at 5%. † significant at 10%.

Appendix 3 - Main related studies on longitudinal data

Reference	Data	Health event	Outcome	Method	Results on the employment probability (rounded)
Moller Dano, *Health Economics* 2005	Denmark, 1981-2000, 20-54 years old	road injuries	annual disposable income, annual earnings, annual individual employment rate, annual individual public transfer income	Difference in differences with propensity score matching	From 1 to 6 years after the accident Women: - 5pp not significant after the accident Men: -10 pp.
Garcia-Gomez, Lopez-Nicolas *Health Economics* 2006	Spain, 1994-2001, 16-60 years old	one year of good health declaration followed by two years of bad health declaration	probability of employment, labor income	Difference in differences with propensity score matching	All: -5pp on the probability to be employed
Haan, Myck *Journal of Health Economics* 2009	Germany, 1996-2007, 30-59 years old	self-assessed poor or very poor health status	non employment	two-equation LDV, maximum likelihood	All: poor health increases the future probability of non-employment. Strong effects found on specific simulations, between 7pp and 35pp on non-employment
Chrichton, Stillman, Hyslop *Industrial and Labor Relations* 2011	New Zealand, 1999-2004, 15-69 years old	receives an income form the ACC (Accident Compensation Corporation)	probability of employment, on-benefit, receiving ACC later	Difference in differences with matching and regressions	Effect 12 months after the first ACC income All: -3.7pp for a 6 months injury, -10 for a 2-year injury Women: -3.6pp for a 6 months injury, -13.5pp for a 2-year injury Men: -3.8pp for a 6 months injury, -8.6pp for a 2-year injury income<Q1: -15.4pp income>=Q1: between -9pp and -10pp
Garcia-Gomez *Journal of Health Economics* 2011	9 European countries, 1994-2001, 16-64 years old	Two measures: (1) one year of good health declaration followed by two years of bad health declaration	probability of employment	Propensity score matching	First year effect All: between 0 and -11pp depending on the country

		(2) self-declared chronic illness and disability			
Garcia-Gomez, van Kippersluis, O'Donnell, van Doorslaer *Journal of Human Ressources* 2013	Netherlands, 1998-2005, 18-64 years old, working population	unscheduled hospitalization that cannot be postponed, with a stay of at least three nights	employment and income	Difference in differences with propensity score matching	Results after two years of hospitalization All : -7pp Women: -8.4pp Men: -6.5pp age 18-49 : -6.7pp age 50-64 : -8.1pp income<Q1 : -9.3pp income>=Q3: -5.5pp
Halla, Zweimüller *Labour Economics* 2013	Austria, 2000-2002 (accident), up to 2007 (outcome) 25-50 years old, working population, private sector without self-employed or farmers	commuting accidents	employment and income	Difference in differences with matching	Effect up to five years after treatment All: -3pp Women: -3.6pp Men: -2.8pp age<38: -2.4pp age>=38: -4.1pp
Lundborg, Nilsson, Vikström *Oxford Economic Papers* 2015	Sweden, 1992-2000, 30-59 years old, working population five to two years before the health shock	first unplanned patient admission over the period, 10 most common ICD codes	employment and income	Difference in differences	All: the effect of health events for the workers without university education is 7pp lower than the effect for the workers with a university education
Trevisan, Zantomio *Labour Economics* 2016	16 European countries, 2002-2013, 50 or older, working population	first onset of myocardial infarction, stroke or cancer	employment and hours worked	Propensity score matching	Effect after one year Women: -13pp Men: -10pp Income<median women : -9pp men : -10pp Income>=median women: -18pp men: -10pp Education < median women: -11.5pp men : -11.7pp Education>=median women: -15.4pp men: -7.6pp
Lenhart *European Journal of Health Economics* 2019	United Kingdom, 2000-2008, 18-64	decline in self-reported health status, onset of a new health condition (among 15)	employment, hours, earnings	Difference in differences with propensity score matching	All: no effect after 1 year, between -2pp and -7pp after 2 years, between -3pp and -12pp after 3 years

Jones, Rice, Zantomio *Economics and Human Biology* 2020	United Kingdom, 2009-2016, 16-65, working population	acute health shock (cancer, stroke, heart attack)	employment, hours, earnings	Matching	All:-3pp after 1 year, -6pp after 2 years, -9pp after 3 years, -8pp after 4 years Women: -3.7pp after 1 year Men: -1.8pp not significant after 1 year age 16-51: -0.4pp not significant after 1 year age 52-65: -5pp after 1 year