COLLATERAL EFFECTS OF A PENSION REFORM IN FRANCE

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We measure the effects of a pension reform on health outcomes. We use the 1993 French pension reform, which has created heterogeneity in work incentives among seniors born between 1933 and 1943. Given that the reform concerned only private sector workers, we use a difference-in-differences analysis to compare health outcomes between sectors between cohorts. We use data from the 2005 wave of the Health Barometer survey conducted by the French National Public Health Agency. This survey contains information on the sector of activity of the respondents, information on their individual characteristics, health status indicators (Duke health profiles) measuring their perceived health, physical, mental health, as well as an indicator of their social life. The results show a negative effect of the 1993 reform on perceived and physical health, concentrated on less-educated individuals exclusively.

1. INTRODUCTION

The relationship between work and health is a political concern, especially if this link is heterogeneous among the population. It could generate or increase inter and intra-generational health inequalities. Moreover, the social security budget may be impacted by workers' health in two possible ways. On the one hand, bad health decreases life expectancy (all things being equal) and thus the number of people who receive a pension, which, in turn, increases the benefits of Social Security. On the other hand, since one constituent of Social Security is the coverage of health spending, the social security budget could be deteriorated by workers' health decline.

Facing strong budgetary constraints, governments implemented retirement reforms aiming at reducing costs, by increasing working time. In France, recent studies analyzed the potential role of social security programs incentives on retirement in France (Bozio, 2008, 2011; Behaghel, Blanchet, and Roger, 2016). Numerous studies are interested in the effect of major pension reforms on retirement, among them the 1993 reform, using econometrics tools and micro-simulation techniques (Mahieu and Blanchet, 2004; Walraet and Mahieu, 2012; Salem, Blanchet, Bozio, and Roger, 2012). New stakes have emerged since incentives to work longer may affect older individuals health.

However, the relation between work and health is far from obvious. In fact, delaying retirement can entail stress and strain which are detrimental to health, as confirmed by Ekerdt, Bosse, and Locastro (1983). Symmetrically, Bound and Waidmann (2008) find evidence that retirement has a positive, albeit temporary, effect on men (but not women) health in the United Kingdom. Coe and Lindeboom (2008) show that retirement has a positive effect on subjective measurements of health in the United States. Coe and Zamarro (2011) find a similar effect in Europe using SHARE (Survey of Health, Ageing and Retirement in Europe). Eibich (2015) shows a long-run improvement in health upon retirement in Germany. Lucifora and Vigani (2018) show that health care utilization increases when individuals retire. Brockmann, Muller, and Helmert (2009) show that earlier retirement reduces mortality depending on the health status in Germany. Bloemen, Hochguertel, and Zweerink (2017), using a temporary decrease in the age of eligibility benefits in the Netherlands, find that early retirement decreases the mortality for men.

Conversely, a number of studies show that retirement has a negative effect on cognitive functioning in the United States and in Europe (Bonsang, Adam, and Perelman, 2012; Rohwedder and Willis, 2010; Mazzonna and Peracchi, 2012; Bingley and Martinello, 2013)[1] and increases the probability of being obese (Godard, 2016). Bamia, Trichopoulous, and Trichopoulous (2007) show that early retirement is associated with higher mortality in Greece. Kuhn, Staubli, Wuellrich, and Zweimüller (2018) find a positive effect of early retirement on the probability of dying before age 67 in Austria. Mazzonna and Peracchi (2017) find evidence of heterogeneous effects of retirement across occupational groups. They find that retirement increases the age-related decline of health and cognitive abilities for most workers, however, they also find evidence of an immediate positive effect of retirement for those employed in highly physically demanding jobs. Nevertheless, some studies find no effect of retirement age on mortality: Hernaes, Markussen, Piggott, and Vestad (2013) use a series of policy changes in Norway that reduced the retirement age for a part of the population. Hagen (2018) finds no evidence of an increase in retirement age on mortality and health care utilization for Swedish women. Thus, to our knowledge, there is no consensus in the literature as to a predominant effect of an increase of working time on health, or on the causal impact of retirement on health.[2]

The main issue to measure the effects of work on health is that reverse causality may conceal the effect of work on health (less healthy people may be inclined to leave employment more easily, whereas healthier people tend to stay on the labor market i.e. "healthy worker effect", which would create a positive correlation between work and health).[3] This

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[1]Earlier studies argue that retirement may be stressful and associated with the mental impacts of feeling older and loneliness (Bradford, 1979; Carp, 1967; Eisdorfer and Wilkie, 1977; Macbride, 1976; Sheppard, 1976).

[2]One of the reason for this lack of consensus is the variety of definitions for health which do not coincide perfectly. An indicator of health at the country level is life expectancy and being in good health is defined as having a weak propensity to die. It is the most objective indicator but not totally sufficient since it allows no precise variation and does not presume good health (as an illustration, firemen who have a high propensity to die compared to the rest of the population still cannot be considered as in bad health). The notion of "healthy life years" developed by the European Union shows that good health cannot be resumed as a long life. It is defined by the number of disability-free years, which gives a negative and functional definition of health. Another dimension of health is given by the World Health Organization (WHO) which argues for a definition of health as "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity".

[3]See Blanchet and Debrand (2008), Kalwij and Vermeulen (2008), and Pagan (2011) on part-time work

creates a selection bias. Lindeboom and Kerkhofs (2004) find that health has a strong effect on work choices and that health slowly deteriorates when work becomes more strenuous using rich panel data on Dutch seniors' employment and health (with subjective and objective variables).

To address this endogeneity issue, we use a French pension reform, which created heterogeneity in work incentives among seniors, to investigate whether an increase in working life affects the several dimensions of health. The French pension system is a pay-as-you-go system and its equilibrium depends on the employee-retiree ratio. This balance is in jeopardy as baby boomers leave the labor market and life expectancy lengthens. French governments have been implementing a set of reforms for more than 20 years. In 1993, the French government gradually increased incentives for seniors to work in the private sector.[4] Our identification strategy is based on the 1993 reform which was exogeneously introduced. For each generation, the government increased incentives via two main tools: the contribution period required to entitle a full pension and the number of reference earning years taken to calculate pensions. This reform is a good example of natural experiment since it was implemented independently from individuals characteristics, the increase in working incentives depended only of their birth year.[5] We study the impact of the 1993 reform on workers' health using a difference-in-differences analysis. Our method consists in comparing individuals with different incentives to work. We take public sector employees as a control group since the reform did not concern them. We find a negative effect of the 1993 reform on perceived and physical health, which is driven by less educated seniors.

We contribute to the literature in several ways. First, we develop an identification strategy which is different from those previously employed in the literature. We focus our study on one specific reform in France, whereas previous studies use eligibility ages for pension benefits as instrumental variables for retirement across states or countries (Coe and Lindeboom, 2008; Coe and Zamarro, 2011; Rohwedder and Willis, 2010; Mazzonna and Peracchi, 2012, 2017). This ensures that our results cannot be biased by country-specific or state-specific effect. Second, we measure the effect of a pension reform (which aims at delaying retirement), whereas most studies measure the impact of early retirement on health. These two effects are not necessary symmetric: for instance, an increase in working time could have no effect on health, whereas retirement could have a positive or a negative impact. In the same way, some studies measured the effect of reduction of working time on health-related behaviors (Berniell and Bietenbeck, 2017), however reduction of working time could have an asymmetrical effect on health compared to an increase in working time (elasticities may be different depending on the sign of the variation). As this reform made the index-linking of pensions to inflation official, all in all, pensions fell a total of 8% between 1994 and 2003 (Bridenne and Brossard, 2008). Con-

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in the case of disability.

[4]Unexpectedly, the OECD statistics do not show an increase in average age of retirement in France after 1993. On the contrary, they show a slight decrease up to 2005: http://www.oecd.org/els/emp/average-effective-age-of-retirement.htm. However, a study based on the EU labor Force Survey microdata and a difference-in-differences approach, Aliaj, Flawinne, Jousten, Perelman, and Shi (2016) estimate for France a significant increase of the 50-64 year-old employment rates, specifically after 2001.

[5]The main purpose of the government was to reduce the deficit of the Health System and did not expect the potential collateral effects of this reform on health. In France, the consequences of hardness of work was taken into account much later.

sequently it may be difficult to determine the potential mechanisms which explain the negative effect of the 1993 reform on health.

The paper is structured as follows: Section 2 presents the institutional framework and the 1993 French pension reform. Section 3 presents the data and some descriptive statistics. Section 4 presents the empirical strategy and Section 5 the difference-in-differences results.

2. INSTITUTIONAL FRAMEWORK

2.1. *Pension schemes in the private sector before the reform*

There are various pension schemes in France. Private sector workers pay into a general mandatory pay-as-you-go pension scheme. Pension amounts depend on the time workers contribute to this system hence the length of working life in the private sector and their best-earning years. Before 1993, workers had to contribute 37.5 years to be entitled to a full pension and the amount paid was proportional to the average wages of the best-earning years. This amount was calculated as follows:

$$(1) \qquad P = \tau \times \omega_r \times \min\left(1, \frac{d}{150}\right)$$

where P denotes the pension level, d the number of contribution quarters, w_r the reference wage and τ is computed as follows:

$$(2) \qquad \tau = 0.5 - \delta \times \max[0, \min(4 \times (65 - a), 150 - d)]$$

where δ is the minimization coefficient, equal to 1.25% per quarter of missing contributions (5% per year), and a is the age on drawing the pension (i.e. retirement age). Pension amounts are dictated by contributions not made before age 65 or before reaching 150 contribution quarters.[6] If a worker retires at 65 or contributes to the general system for more than 37.5 years, there is no pension reduction. In this case, the replacement rate (that is $\frac{P}{w_r}$) is 50%.[7]

2.2. *Pension schemes in the public sector*

Individuals who worked in the public sector are subject to the same legal retirement age as private sector workers, i.e. 60 years up to the 1951 generation (before the 2010 reform). Retirement in the civil service generally takes place at the normal age (legal age) and thereafter (up to 65). However, the average wages of the last 6 months is taken into account to calculate the pension amount (compared to 10 years in the private sector), the replacement rate is 75% of the last 6 months' wages before retirement, which is more than

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[6]For instance, if the pension drawing age is 61 and the number contribution quarters is 140, then $4 \times (65 - 61) = 16$ and $150 - 140 = 10$. The individual would have to contribute 10 more quarters to reach 150 contribution quarters and 16 more quarters before reaching 65 years old. The pension is computed taking the smallest difference (10) (see (Bozio, 2011)).

[7]The individual in the previous example has an underestimated pension which corresponds to 1.25% per quarter, i.e. 12.5%, τ is then $0.5 - 0.0125 \times 10 = 0.375 = 37, 5\%$ for an individual aged 61 who contributes 140 quarters. This individual's replacement rate is then: $P/\omega_r = \tau \times \min(1, \frac{d}{150}) = 0.375 \times 140/150 = 0.35$.

in the private sector (50% rate).

This public pension scheme was partly reform in 2003, affecting the 1944 generation and the following ones. For this reason, we reduced our sample to generations born between 1928 and 1943. The government gradually increased the number of quarters required to get a full pension with the aim of converging the public and private sectors. Individuals born prior to or in 1943 have to contribute 150 quarters to obtain a full pension in the public sector.[8]

2.3. *The 1993 pension reform*

In 1993, the government led by Prime Minister E. Balladur chose to reform the general private pension system. This reform did not concern public sector employees[9]. We describe the implementation of the 1993 reform in Table I. First, the number of years of contributions required for a full pension was gradually raised from 37.5 to 40 years, cohort by cohort, starting with the 1934 generation. As shown by Table I, the number of contribution quarters required for a full pension increased by one quarter per year: 150 for the 1933 generation (in 1993) and 151 for the 1934 generation (in 1994) and so on, through to 160 for the 1943 generation (in 2003). Second, the reform reduced the reference wage by gradually raising the number of years required for its calculation with each generation from 10 to 20 years for individuals born in 1943. Third, the reference wage was indexed on prices (but this last measure does not vary by cohort). Equation (2) then becomes:

$$(3) \qquad \tau' = 0.5 - \delta \times \max[0, \min(4 \times (65 - a), D - d)]$$

where D, the needed quarters required for a full pension, goes from 150 to 160 according to the generation.

Figure 1 shows the effect of the reform as regards incentives to work comparing two seniors who had contributed 140 quarters at age 60: the first one is concerned by the 1982 system (he was born before 1934) and the second by the 1993 reform. The first one has to contribute ten supplementary quarters (2.5 years) to be entitled to a full pension and if he retires at age 62 his replacement rate is reduced by 2.5 percentage points ($\alpha \times \delta = 2 \times 1.25 = 2.5$). The second senior, affected by the reform has to contribute 20 supplementary quarters for a full pension and if he retires at age 62, his replacement rate is reduced by 15 percentage points ($\alpha \times \delta = 12 \times 1.25 = 15$).

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[8]More precisely, the 2003 reform extended the 1993 reform to include civil servants, implementing a convergence between the 150 contributed quarters for the 1943 generation to 160 for the 1948 generation (the number of contributed quarters has increased by two quarters per birth year). The 2003 reform has increased the number of contributed quarters to reach 163 quarters for the 1951 generation (for the two sectors). The 2003 reform introduced, on the one hand, an increase of the contribution period required to get a full pension and has led to an increase in the proportion of retirement after 60 years. On the other hand, the long career mechanism, from the same reform, has led to an increase in the proportion of early retirements before age 60 (Soulat, Cambier, and Poujardieu, 2014). Thus, there are two contradicting effects on retirement age following the 2003 reform.

[9]See the act of 22 July 1993.

1) Senior who has to contribute **150 quarters** for FP (1982 system) and has contributed 140 at 60:

$$\alpha$$

2) Senior who has to contribute **160 quarters** for FP (1993 system) and has contributed 140 at 60:

$$\alpha$$

Notes: $\alpha = \min(4 \times (65 - a), D - d)$ in equation 3 with a=62, d=140, D=150 in the first case and D=160 in the second one. Thus, α is the number of additional quarters needed for FP (Full Pension).
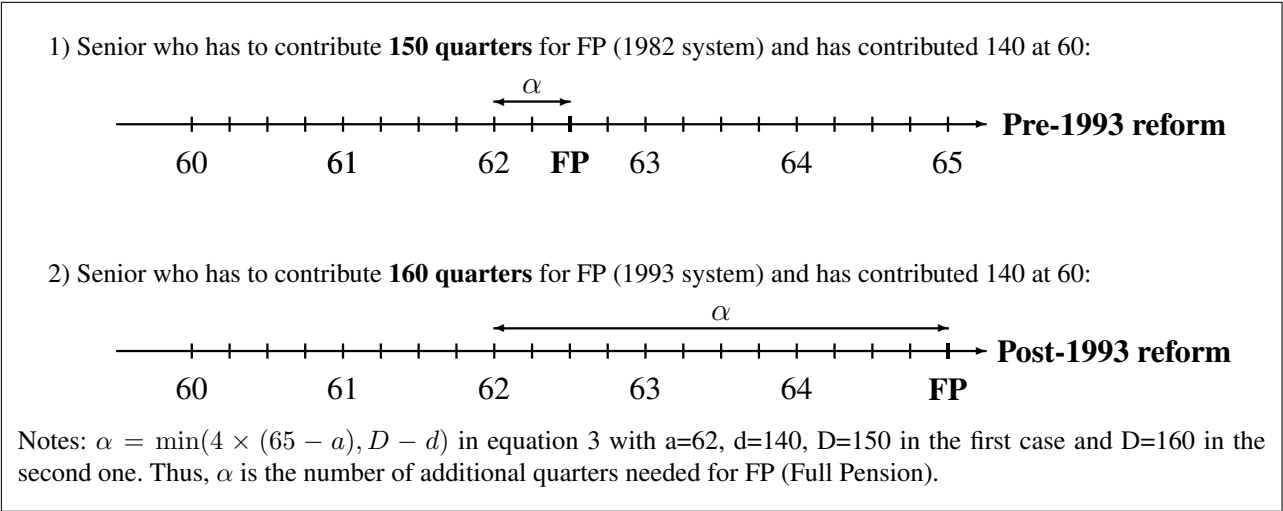
Figure 1: The effect of the 1993 reform for a senior who retires at 62 years old.

Table I: Heterogeneity in the treatment by generation

Generation	Age in 1993	Age in 2005	Nb of contributed quarters	Nb of reference years
1928	65	77	150	10
1929	64	76	150	10
1930	63	75	150	10
1931	62	74	150	10
1932	61	73	150	10
1933	60	72	150	10
1934	59	71	151	11
1935	58	70	152	12
1936	57	69	153	13
1937	56	68	154	14
1938	55	67	155	15
1939	54	66	156	16
1940	53	65	157	17
1941	52	64	158	18
1942	51	63	159	19
1943	50	62	160	20

This reform thus raised the incentive to work longer before the age of 65 and reduced the pension level, which, in turn, reduced the replacement rate.[10] It was implemented gradually, as shown in Table I, which allows for a detailed evaluation of this reform.

Bozio (2011) estimates the effects of the increase in the number of contribution quarters on working lives by measuring the elasticity of the pension drawing age to the contribution period. This survey was conducted on the Cross-Sample of Pension Scheme Beneficiaries (*Echantillon Inter-régimes des retraités* , i.e. EIR) and National Pension Fund

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[10]The replacement rate for the above-studied individual would then be:$P/\omega_r = \tau' \times \min(1, \frac{d}{150}) = (0.5 - 0.0125 \times 12) \times 140/150 = 0.32$ (if we only take into account the required years of contribution).

for Salaried Workers (*Caisse Nationale d'Assurance Vieillesse*, i.e. CNAV) administrative data. As mentioned above, there is heterogeneity in treatment, which enables an estimate of the impact of an increase in the number of contribution quarters on the pension drawing age. Bozio (2011) shows that one extra quarter in contributions (required for full pension entitlement) increases the retirement age. A survey conducted by Bridenne and Brossard (2008) of National Pension Fund for Salaried Workers (CNAV) administrative data finds that the pension drawn by individuals who retired between 1994 and 2003 was lower than it would have been without the reform. This shortfall widened with each cohort over the reform period. These parameter effects combined with a pension adjustment effect, which increased with each year of pension payment. The 1993 reform made the index-linking of pensions to inflation official. All in all, therefore, pensions fell a total of 8% between 1994 and 2003. The combined parameter and index-linking changes had a significant impact on general scheme pension levels.

3. DATA

We use a French database which is the Health Barometer (*Baromètre Santé*) conducted every five years by the French National Public Health Agency (*Santé publique France*). It contains information on respondents' knowledge and opinions about their health and health-related behaviors. We use the 2005 survey (n=30,514).[11] Individuals were affected by the 1993 reform between 2 and 11 years before the 2005 survey depending on the generation, i.e. the 1934 generation was affected in 1994, the 1935 generation in 1995 and so on, through to 2003 for the 1943 generation.[12]

Health measures Beyond the medical dimension, Sen (2002) considers health as essential to thrive. Three dimensions are generally highlighted (Blanchet, Debrand, Dourgnon, and Laferrere, 2007): the medical dimension which considers health as a physiological or psychical norm; the functional dimension which defines health as a capacity to blossom in a social environment and a subjective measure which focuses on the perception of the individual on their health state. We define health using the functional dimension and the subjective measure. The *Baromètre Santé* data contains highly specific questions on perceived and mental health, social life and capacity for daily tasks (physical health), used to build the Duke Health indicators, based on self-reported, yet accurate information on the state of respondents' health. The Duke Health Profiles used as health measures, are built on a 17-item generic questionnaire-based on self-reported items.[13] Our definition of health is thus multidimensional: it includes perceived health, self-perception of mental,

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[11]Information differs from one survey wave of the Health Barometer (*Baromètre Santé*) to the next. Some information in the 2005 wave is not included in the previous and following waves. Information on the sector of work is not included in other survey waves. In the 2000 wave, we do not know the sector in which the 2000 wave pensioners used to work.

[12]In 1997, Prime minister Alain Juppé attempted to implement a reform in the public sector, but had to beat a retreat due to a rash of strongly supported strikes all over the country. François Fillon, as Minister of Social Affairs, managed to push through a similar reform in the public sector in 2003 with gradual implementation starting to the generation 1944. In 2003, there was a creation of the possibility to retire for people who had started to work early (between 14 and 17 years old). They can retire between 56 and 59 years old. Our baseline sample is not affected by this reform, in addition 92% of our sample is retired.

[13]The Duke Health Profiles are built by Duke University researchers and are validated by the French Health Ministry in its research program *Programme Hospitalier de Recherche Clinique du Ministère de la Santé*. The Duke health profiles measures health following the three major WHO (World Health Organization) dimensions: physical, mental and social well-being. In addition, it provides an overall general health

physical health and social life. We focus on four positive measures of health (physical, mental, perceived health and social life). Table II shows how each score is built (we focus on 16 self-reported items). People have three possible choices which are coded as 0,1 or 2. Answers are reported with respect to their increased quality in terms of health. Duke Health Profiles equals 100 if the individual is in very good health, and 0 if the individual is in bad health (for health measures). For instance, the score of physical health is calculated by multiplying by 10 the sum of the points obtained at each question relative to physical health (questions 8,9,10,11 and 12), the score equals 100 if individual is in very good health $(2 + 2 + 2 + 2 + 2) \times 10$. The score of perceived health equals 100 if the individuals replies "yes exactly" to the affirmation "I am basically a healthy person".

Table II: Duke Health Profiles

		Perceived health	Physical health	Mental health	Social life
	Self-description **(0=not at all,1=somewhat, 2=yes exactly)**				
1	I like who I am			10	
2	I am an easy person to get along with				10
3	I am basically a healthy person	50			
4	I give up too easily			10	
5	I have difficulty concentrating			10	
6	I am happy with my family relationships				10
7	I am comfortable being around people				10
	Today would you have any physical **trouble or difficulty:** **(0=a lot, 1=some, 2=none)**				
8	Walking up a flight of stairs		10		
9	Running the lenght of a football field		10		
	During the past week how much **trouble have you had with:** **(0=a lot, 1=some, 2=none)**				
10	Sleeping		10		
11	Hurting or aching in any part of your body		10		
12	Getting tired easily		10		
13	Feeling depressed or sad			10	
14	Nervousness			10	
	During the past week how often did you **(0=none, 1=some, 2=a lot)**				
15	Socialize with other people (talk or visit with friends or relatives)				10
16	Take part in social, religious or recreation activities (meetings, church, movies, sports, parties)				10

Note: Answers are reported as 0,1 or 2 with respect to their increased quality in terms of health (some questions are formulated negatively, the coding takes into account this inversion. Duke Health Profiles equals 100 if the individual is in very good health, and 0 if the individual is in bad health. For instance, the score of physical health is calculated by multiplying by 10 the sum of the point obtained at each question relative to physical health (questions 8,9,10,11 and 12), the score equals 100 if the individual is in very good health $((2 + 2 + 2 + 2 + 2) \times 10)$. In the same way, the score of perceived health is calculated by multiplying by 50 the point obtained at question 3, the score equals 100 if the individual answers yes exactly to the affirmation "I am in good health" (2×50).

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measure to englobe these three dimensions, a separate perceived health measure to indicate the individual assessment of health status, and a sub-scale for self-esteem. Dysfunction is indicated by separate measures for anxiety, depression, pain and disability (Parkerson, Broadhead, and Tse, 1990).

4. EMPIRICAL STRATEGY

Difference-in-Differences (DiD) approach In order to estimate the impact of the reform, we compare the inter-generational shift in health scores (i.e. Duke Health Profiles) in the public and the private sectors, since only the latter was affected by the reform. This approach is a difference-in-differences method based on birth cohorts instead of time spans since the reform impact depends on the year of birth.

We identify a causal effect of the pension reform under the following assumption: without the reform, differences between treated and untreated generations would have been the same in the public and private sectors. Thus, we assume that seniors, in a given sector, have not experienced other shocks that could affect their health.

Private and public sectors in France are structurally different but there are very few reasons why the inter-generational difference in health would be different. One difference between these sectors is about pre-retirement which only concerns the private sector[14], however, the pre-retirement rules changed a lot before the 1990's, but not for generations retiring after 1998 and for generations who are concerned by the 1993 reform.

We assume that people did not migrate from private to public sectors after the reform announcement, which means that there is no selection bias. Seeing as there is no valid reason for seniors at near-retirement age to change their pension system, we can rule out this possibility. According to the 2005 French Labor Force Survey (*Enquête Emploi*), only very few people moved from the private to the public sector before retirement.

The treatment is heterogeneous between cohorts in the private sector. Individuals born between 1934 and 1943, i.e. treated individuals, have to contribute 5.5 supplementary quarters on average to have a full pension, compared to individuals born before 1934, i.e. non-treated individuals. The pension amount of treated individuals are computed on 5.5 supplementary earnings years (on average), compared to untreated individuals. The DiD estimator measures the difference in health between people affected by the reform (treated) and those unaffected (non-treated) between the private sector and the public sector.

We estimate:

$$(4) \qquad Y_i = \beta_0 + \beta_1 T_i + \beta_2 P_i + \beta_3 T_i \times P_i + \beta_4 X_i + u_i$$

where Y_i is the health status of an individual i (Duke health scores described in Table II), T_i is a dummy variable taking value 1 if individual is treated (i.e., born in 1934 and afterwards) and value 0 if non-treated (i.e., born before 1934). P_i is a dummy variable taking value 1 if individual is/was in the private sector and value 0 if individual is/was in the public sector. X_i is a set of controls (including age, age^2, gender, years of education, household size, children or not, marital status, income, education and regional area).

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[14]Pre-retirement was created in 1972 with an agreement introducing a guarantee of resources for workers aged 60 to 64 in order to protect them against unemployment. Workers over 60 who lost their job can receive a replacement income (up to 70% of their previous wage) until they reach the age of retirement.

Finally, u_i denotes the error term.

The estimator β_3 identifies a causal effect of the pension reform under the following assumption: without the reform, differences between the generations studied would have been the same in the public and private sectors. One might expect that public-sector employees are quite different from private-sector employees. They might be different in terms of health or age profiles violating the main identification assumption. For instance, this could occur if the health of people in the private sector starts to decline earlier than those of the public-sector. In order to check this hypothesis, we consider the health differential between sectors between cohorts who have homogeneous retirement constraints. We conduct placebo tests i) on younger individuals ii) on older individuals who have homogeneous retirement constraints.[15]

We did some robustness checks to make sure that there was no bias due to the fact that a part of the treated individuals were born during the Second World War and may have suffered from bad conditions (malnutrition) during childhood. People impacted by the reform may be in worst health because generation 1939 to 1943 are born during the Second World War, using the public sector as a control group enables to control for cohort effects (treated people in the control group are also born during the WW II). We rerun our regressions for people born before the Second World War (between 1929 and 1938), our results are virtually unchanged (Table A4 in Appendix).[16]

Descriptive statistics We include all individuals born between 1928 and 1943 in our baseline analysis (n=4,619 see Table A1 in Appendix). As the health outcomes, i.e. Duke health profiles, are sometimes missing, we include all possible observations for each outcome to maximize sample size. Approximately 70% of our sample is or was in the private sector (30% in the public sector), 92% are retired. This proportion of retired people is the same in the public and the private sector.[17]

As descriptive statistics, we compare the average health scores in each sector, for treated individuals (born in 1934 and after, who are affected by the reform in the private sector) and untreated individuals (born before 1934, who are not affected) in the main sample (people born between 1928 and 1943). If we compare these two groups directly, treated individuals are in better health since they are younger, the health status is negatively associated with age (Figure 2). We have to find a strategy to approximate the health difference (between treated and untreated) which we would have been observed without the reform.

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[15]For many cohorts in the study the observation period (2005) is far away from the potential treatment (reform) and selective mortality might be an issue especially for the older cohorts. For instance, people born in 1930 were 75 years old in 2005. So even if assuming the identification assumption holds, the effect of retirement might be biased by selective mortality. Public sector workers may live less or longer than private sector workers. We are unable to correct for this bias. As a robustness check, we consider health differentials between sectors between cohorts who have homogeneous retirement constraints for older cohorts unaffected by the 1993 reform (people born between 1928 and 1933, cf. Table VII). We find no significant effect.

[16]There is no distinction between age and cohort effects, due to the cross-sectional nature of the data, we assume that the cohort/age effect on health would have been the same between the private and the public sectors in absence of reform.

[17]Figure A1 shows the proportion of high-educated people in each sector per birth year, the composition is the same across cohorts. The public sector is higher educated, but the difference is stable across cohorts. To check the presence of composition effects, Table A2 presents the jobs composition in the public sector by group; i.e. untreated (1928-1933 generations) and treated individuals (1934-1943 generations). The proportion in each category is stable between treated and untreated individuals. The difference in means is not significantly different by group.
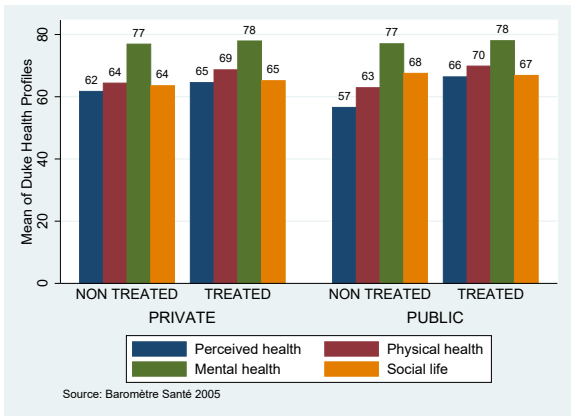
Figure 2: Difference in health for the baseline sample

As the 1993 reform concerns the private sector only, we use a difference-in-differences method to measure the effect of the reform on health using the public sector as a control group.

Table III: Summary statistics of demographic and health variables for the baseline sample

	All sample		High educated		Low educated	
	mean	N	mean	N	mean	N
Perceived health	63.73	2986	67.85	972	61.70	2014
Physical health	67.56	2965	69.92	967	66.39	1998
Mental health	77.66	2960	79.47	963	76.77	1997
Social life	65.30	2931	68.72	955	63.61	1976

Source: Baromètre Santé 2005, Santé publique France.

The average perceived health score is 63.73 for individuals born between 1928 and 1943 (Table III). As we expected that the effect of the 1993 pension reform may be heterogeneous according to the kind of work, we divide our analysis per educational levels (as a proxy of the social condition). First of all, we notice that less-educated individuals are a majority in France for the generations studied, accounting for approximately 70% of the sample (i.e. generation 1928 to 1943).[18] Less educated individuals (i.e. not having obtained the French school-leaving certificate, i.e. *baccalauréat*) are less healthy whatever the health indicator. The average perceived health score is 61.70 for less-educated people, compared to 67.85 for better-educated people (having qualifications equal to or post French school-leaving certificate, i.e. *baccalauréat*), low-educated individuals are in poorer physical and mental health compared to highly-educated individuals (Table III).

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[18]This is consistent with the *Enquête Emploi* survey conducted by the French National Institute of Statistics and Economic Studies (INSEE) in 2009 (Clerc, Monso, and Pouliquen, 2011).

5. RESULTS

5.1. *Main results*

We implement a difference-in-differences strategy in which the public sector is used as a control group. Estimates of Equation 4 are presented in Table IV.[19] Each line presents the coefficient (resp. robust standard error and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for a different health outcome (where T_i is the treatment dummy). Our results show a negative effect of the 1993 reform, the health score of perceived health decreases by approximately 7 points for people in the private sector affected by the reform in the whole sample (Panel A). It corresponds to a decrease by approximately 10 % of the score of perceived health (see Table III). However other health indicators are not significant at standard levels. Thus, we find that the 1993 pension reform was detrimental to perceived health.

This impact probably differs with the type of work. In particular, work may be more strenuous for unskilled workers. We approximate the skill levels of their work through their education. We divide the population into two groups: high school graduates and non-graduates (i.e. have not obtained the French school-leaving certificate, *baccalauréat*). The results of our estimations are shown in Table IV, Panel B groups the less-educated people, Panel C groups the highly-educated people. [20]

We notice that high school graduates are a minority in France for the generations studied, accounting for just 30% of the baseline sample (i.e. 1928 to 1943 generation). This is consistent with the *Enquête Emploi* survey conducted by the French National Institute of Statistics and Economic Studies (INSEE) in 2009 (Clerc, Monso, and Pouliquen, 2011). The main trend found by our first estimation is thus probably due to less-educated individuals (approximately 70% of the main sample).

Table IV shows a negative effect of the 1993 reform, the score of perceived health decreases by approximately 13 points (i.e. 20 %, see Table III) for less-educated people affected by the reform in the private sector, relatively to the public sector (Panel B). The score of physical health decreases by approximately 5 points (i.e. 7%, see Table III), this coefficient is significant at 10% (without control), at 15% (with controls), however the intensity of the coefficient is identical meaning that we may have a power problem in the second estimation (with controls).

The parameters reported in Table IV for social life scores are all non-significant, however, they are positive for Panel A (all sample) and Panel C (highly educated people). The same is observed in Tables in Appendix. These results seem to be driven by high-educated individuals. Thus, it cannot be excluded that staying at work for longer periods (delaying retirement) affects individuals' social life in a favorable way. This result is interesting and could be put in relation with the results obtained in several studies, which found a positive effect of delaying retirement on cognitive functioning (Bonsang, Adam, and Perelman, 2012; Rohwedder and Willis, 2010; Mazzonna and Peracchi, 2012; Bingley and Martinello, 2013).[21]

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[19]The detail for the all regression is presented in Table A3 in Appendix.

[20]We rerun a sensitivity analysis without including income as control (because of a potential endogeneity issue). Our results are virtually unchanged.

[21]However, this effect is not significant whatever the specification.

Table IV: Difference-in-Differences analysis - Baseline analysis (1934 as pivot cohort)

People born between 1928 and 1943						
	Without control	s.e.	N	With controls	s.e.	N
Panel A – All sample						
Perceived health	-6.987**	(3.539)	2986	-7.243*	(4.201)	2280
Physical health	-2.666	(2.128)	2965	-3.543	(2.408)	2267
Mental health	0.016	(2.045)	2960	-0.755	(2.334)	2266
Social life	2.290	(1.879)	2931	2.322	(2.138)	2248
Panel B – Low-educated						
Perceived health	-13.197***	(5.047)	2014	-12.876**	(5.759)	1574
Physical health	-5.470*	(3.212)	1998	-5.756	(3.533)	1564
Mental health	-3.530	(3.367)	1997	-4.944	(3.563)	1565
Social life	-0.047	(2.653)	1976	-0.481	(3.070)	1552
Panel C – High educated						
Perceived health	-2.582	(5.517)	972	-2.352	(7.146)	706
Physical health	-1.138	(3.263)	967	-0.333	(3.869)	703
Mental health	1.089	(2.816)	963	-0.012	(3.266)	701
Social life	4.262	(2.998)	955	3.806	(3.400)	696

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include (T_i) and (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in 1934 and afterwards) and 0 if non-treated (i.e. born before 1934). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the public sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France.*

5.2. *Potential mechanisms*

Behaghel, Blanchet, and Roger (2016) illustrate the observed evolution of pathway probabilities of retirement. It appears that after the 1993 reform, unemployment and early retirement pathway increased dramatically, as well as disability among women and low-skilled workers. This could constitute mechanisms to explain the impact of the 1993 reform on health. Unfortunately, we do not have enough information on careers to know the pathway probabilities in our database.

The 1993 reform could have an impact on health through two different ways. Firstly, there may be an income effect. De Grip et al. (2009) show that an unexpected decrease in replacement rates in Dutch pension system implies an increase in depression among seniors. The reform may reduce income and diminish purchasing power, as a consequence health consumption may, in turn, decrease. This decrease could have a negative impact on health.[22] Bridenne and Brossard (2008) show an 8% decrease of pensions between 1994 and 2003 (i.e. for generations 1934 to 1943). Unfortunately, we have information on income brackets only, this is not enough precise to test this hypothesis. Secondly, there may be an activity effect, i.e. an increase in working life has repercussions on health. Bozio (2011) showed that the reform increased retirement age. We are not able to distinguish between these two effects, the effect on health could be a combination of these two effects.

The reform does not affect the treated cohorts uniformly. In other words, the retirement disincentive increases over time, simultaneously as the distance to treatment decreases.

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[22]Snyder and Evans (2006) exploit an exogenous change in the US Social Security system which offered to adjacent cohorts very different levels of pension benefits. They show that the higher-income group has a statistically significantly higher mortality rate, contradicting the literature results.

Consequently, the impact on health may depend on the generation. Individuals were affected by the 1993 reform between 2 and 11 years before the 2005 survey depending on the generation, i.e. the 1934 generation was affected in 1994, the 1935 generation in 1995 and so on, through to 2003 for the 1943 generation. However, if we compare the 1933 cohort with that of 1934, the difference in the retirement incentive is rather small (in terms of contribution quarters and reference earning years) while the retirement incentive between 1933 and 1943 cohorts is larger.

5.3. *The reform design*

We restricted our sample in order to estimate the different effects for the different generations. We rerun our regressions for generations born between 1929 and 1938, considering a lower bandwidth around the 1934 generation (the first generation to be impacted by the 1993 reform). Part A of Tables V and VI shows the results (see Table A4 in Appendix, which is derived from the baseline analysis). We restrict the cohorts in the sample excluding those more affected by the reform (1939 and younger). They are the first cohorts affected by the reform, i.e. the distance to the treatment ranges between 7 and 11 years. Each line presents the coefficient (resp. robust standard error and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for a different health outcome (where T_i is the treatment dummy), see Equation 4. Our results confirm a negative effect of the 1993 reform, the health score of perceived health decreases by approximately 8 points for people affected by the reform in the private sector (see Table V, specification with controls). Thus, our results are virtually the same for generations born 5 years before and after the 1934 threshold, a negative impact on perceived and physical health, entirely driven by less-educated individuals (-15 and -7 respectively, specification with controls). The coefficients are not significantly different compared to those of the baseline analysis.[23]

We rerun our regressions by considering a lower bandwidth around the 1934 generation (4 and 3 years). Our samples are smaller. We have larger standard errors, so our results are less precise. Nevertheless, the results tend to be the same. Table V shows a negative effect on physical health 4 and 3 years before and after the 1934 generation (see part B and C of Table V). Table VI shows that effects are more significant and larger for the low-educated individuals, meaning that the effect on the whole sample is driven by low-educated individuals (see part B and C of Table VI). The coefficients are not significantly different between the different specifications.[24]

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[23]There may be a cohort effect on health. For instance people born between the Second World War may be in bad health conditions because of malnutrition during childhood. Using the public sector as a control group enables to control for cohort effects. Moreover, we show that our results are virtually unchanged when we exclude people who are born during the WW2.

[24]The coefficients are not significantly different for perceived and physical health if we restrict the bandwidth to 2 and 1 year(s) around the 1934 generation, however standard errors are higher as we restrict the sample.

Table V: Difference-in-Difference analysis by cohort bracket – 1934 as pivot cohort

	Without control	s.e.	N	With controls	s.e.	N
A. People born between 1929 and 1938						
Perceived health	-10.201**	(3.987)	1888	-8.225*	(4.610)	1411
Physical health	-3.705	(2.410)	1872	-3.870	(2.733)	1400
Mental health	-0.169	(2.308)	1868	-0.637	(2.632)	1401
Social life	2.228	(2.105)	1847	2.912	(2.421)	1387
B. People born between 1930 and 1937						
Perceived health	-8.855**	(4.496)	1528	-8.397*	(5.082)	1145
Physical health	-4.429*	(2.637)	1512	-6.285**	(2.956)	1133
Mental health	-1.967	(2.474)	1511	-3.534	(2.795)	1136
Social life	3.039	(2.364)	1499	3.593	(2.675)	1127
C. People born between 1931 and 1936						
Perceived health	-7.886	(5.274)	1127	-8.021	(5.818)	853
Physical health	-6.015*	(3.084)	1114	-6.363*	(3.443)	844
Mental health	0.966	(2.914)	1111	-0.338	(3.239)	843
Social life	5.178*	(2.756)	1104	3.752	(3.179)	837

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include (T_i) and (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in 1934 and afterwards) and 0 if non-treated (i.e. born before 1934). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the public sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France.*

Table VI: DiD analysis for the less-educated individuals – 1934 as pivot cohort

	Without control	s.e.	N	With control	s.e.	N
A. People born between 1929 and 1938						
Perceived health	-16.867***	(5.582)	1330	-15.489**	(6.319)	1033
Physical health	-7.238**	(3.555)	1316	-7.391*	(3.890)	1023
Mental health	-2.749	(3.779)	1316	-4.510	(4.019)	1026
Social life	-0.966	(2.921)	1299	-0.746	(3.318)	1015
B. People born between 1930 and 1937						
Perceived health	-16.473***	(6.246)	1086	-15.690**	(6.886)	851
Physical health	-7.611**	(3.869)	1072	-8.441**	(4.156)	840
Mental health	-5.085	(4.077)	1074	-7.342*	(4.179)	845
Social life	0.764	(3.301)	1064	1.011	(3.620)	837
C. People born between 1931 and 1936						
Perceived health	-18.719**	(7.324)	807	-16.749**	(7.839)	634
Physical health	-11.267**	(4.463)	795	-10.634**	(4.676)	626
Mental health	-3.281	(4.794)	794	-4.666	(4.776)	627
Social life	2.230	(3.861)	790	2.073	(4.259)	621

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include (T_i) and (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in 1934 and afterwards) and 0 if non-treated (i.e. born before 1934). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the public sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France.*

Thus, we find no difference in the intensity of the effects, nevertheless the effects are less precise when we tighten the bandwidth around the first generation impacted (1934). This could be due to a lack of precision owning to the number of observations, which is not large enough per cohort. This could be because the income effect prevails (see Section 5.2). The distance to the treatment decreases over time, simultaneously as the retirement disincentive increases. The magnitude of the effect could decrease per cohort, si nce the

first affected generation did not expect the reform. Moreover, the first generation was impacted 11 years before the 2005 survey, whereas the 1943 generation was impacted 2 years before the 2005 survey. The effects on health could appear later, and more time is needed to observe these effects. Thus, there could be an effect "distance to the treatment" (which may compensate the effect "intensity of the treatment").

5.4. *Robustness checks*

5.4.1. *Placebo tests*

As robustness checks, we consider health differentials between sectors between cohorts who have homogeneous retirement constraints: i) we rerun our regressions for people who are not affected by the 1993 reform (people born between 1928 and 1933, see Table I); ii) we rerun our regressions for people who are affected in the same way by the reform (people born between 1960 and 1975). We conduct placebo tests on older individuals ii) on younger individuals. There should be no β_3 effect.

For many cohorts in the study the observation period (2005) is far from the potential treatment (the 1993 reform) and selective mortality might be an issue especially for the older cohorts. So even assuming the identification assumption holds, the effect of retirement might be bias by selective mortality. Public sector workers may live slightly longer than private sector workers. The placebo tests enable to consider health differential between sectors between older cohorts who have homogeneous retirement constraints.[25] We estimate Equation 4 for people born between 1928 and 1933, who are not affected by the reform, considering the generation 1931 as the first generation affected by an hypothetical reform, i.e. T_i is a dummy variable taking value 1 if an individual is treated (born in 1931, 1932 or 1933) and value 0 if non-treated (born before 1931). P_i is a dummy variable taking value 1 if the individual comes from the private sector and 0 if the individual comes from the public sector. Table VII shows that, at a given age, the difference between younger generations and older generations is the same in the private and public sectors (if the threshold is the 1931 generation).

We estimate Equation 4 for people born between 1960 and 1975, who are affected in the same way by the reform, considering the generation 1970 as the first generation affected by an hypothetical reform, i.e. T_i is a dummy variable taking value 1 if an individual is treated (born in 1970 and afterwards) and value 0 if non-treated (born before 1970). P_i is a dummy variable taking value 1 if the individual comes from the private sector and 0 if the individual comes from the public sector.[26] Results are presented in Table VIII. Each line presents the coefficient (resp. robust standard errors and number of observations in the model) associated with the interaction $T_i \times P_i$ for different health indicators. Our results show that, at a given age, the difference between younger generations and older generations is the same in the private and public sector (given as threshold the 1970 generation).

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[25]See Table VII, where we find no significant effect.

[26]The 2003 reform extended the 1993 reform to include civil servants, implementing a convergence between the 152 contributed quarters for the 1944 generation to 160 for the 1948 generation (the number of contributed quarters has increased by two quarters per birth year). The 2003 reform has increased the number of contributed quarters to reach 163 quarters for the 1951 generation (for the two sectors). We are sure that people born between 1960 and 1975 are affected in the same way by the 2003 reform in the same way.

Table VII: Placebo – Difference-in-Differences analysis for older cohorts (people born between 1928 and 1933, 1928 to 30 versus 1931 to 33)

People born between 1928 and 1933						
	Without control	se	N	With controls	se	N
Panel A – All sample						
Perceived health	0.749	(6.171)	848	8.271	(7.885)	613
Physical health	4.455	(3.745)	836	6.518	(4.420)	606
Mental health	-7.617**	(3.484)	842	-4.248	(4.153)	611
Social life	-5.449*	(3.245)	830	0.892	(3.898)	604
Panel B – Low-educated						
Perceived health	10.624	(8.668)	607	16.721	(10.230)	464
Physical health	4.420	(5.608)	598	8.333	(5.954)	459
Mental health	-6.938	(5.660)	602	-1.090	(6.032)	463
Social life	-4.563	(4.547)	595	-0.870	(5.531)	457
Panel C – High-educated						
Perceived health	-3.594	(9.837)	241	10.608	(16.281)	149
Physical health	7.115	(5.709)	238	9.161	(8.249)	147
Mental health	-6.201	(4.821)	240	-7.352	(6.599)	148
Social life	-2.869	(5.218)	235	-2.397	(6.793)	147

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include (T_i) and (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in 1931 and afterwards) and 0 if non-treated (i.e. born before 1931). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the public sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France.*

Table VIII: Placebo – Difference-in-Differences analysis for younger cohorts (people born between 1960 and 1975, 1960 to 69 versus 1970 to 75)

People born between 1960 and 1975						
	Without control	se	N	With controls	se	N
Panel A – All sample						
Perceived health	-2.865	(2.042)	5290	-3.412	(2.101)	4812
Physical health	0.527	(1.231)	5281	0.336	(1.243)	4805
Mental health	0.159	(1.236)	5280	-0.270	(1.233)	4804
Social life	0.008	(1.128)	5251	-0.316	(1.144)	4780
Panel B – Low-educated						
Perceived health	-5.314	(4.340)	2046	-5.831	(4.676)	1858
Physical health	0.447	(2.490)	2039	-0.726	(2.546)	1853
Mental health	0.410	(2.515)	2040	-1.300	(2.588)	1854
Social life	0.143	(2.338)	2030	-0.890	(2.371)	1846
Panel C – High-educated						
Perceived health	-1.555	(2.412)	3244	-1.747	(2.445)	2954
Physical health	0.539	(1.425)	3242	0.951	(1.438)	2952
Mental health	0.826	(1.454)	3240	0.508	(1.460)	2950
Social life	-0.658	(1.307)	3221	-0.109	(1.368)	2934

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include (T_i) and (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in 1970 and afterwards) and 0 if non-treated (i.e. born before 1970). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the public sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France.*

We rerun placebo tests changing the first cohort fictitiously impacted by the reform (controlling or not the regressions by individual characteristics). Tables A5 and A6 in Appendix show no impact of the "fictive" reform regardless of the generation taken as pivot for older (see Table A5) and younger cohorts (see Table A6).[27] This confirms that the health differential between the cohorts between the two sectors is due to policy differentials.

Overall, these placebo tests provide evidence that the negative impact on less-educated health for the generations born in 1934 and afterwards is explained by the 1993 reform.

5.4.2. *The common trend assumption*

The main assumption of our estimation is that, given the control variables, the only thing that could explain health differentials between cohorts between sectors is due to retirement policies.[28] The identifying assumption is that the age/cohort profiles would have been the same, up to a constant shift, in the absence of the reform. We check this assumption on pre-reform cohorts, not affected by the 1993 reform. The 1933 generation is the last generation not impacted by the reform, it is more easily comparable to the ones following. First, we check the common trend between the generations 1933 and the previous ones[29]. Second, we show the effect β_3 for each generation, taking generation 1933 as control group, as it is the youngest generation not impacted by the reform, controlling by individual characteristics. Figure 3 shows the evolution of the average of Duke-Health Profiles for pre-reform cohorts for less-educated individuals (see Figure 3a) and highly-educated individuals (see Figure 3b). More precisely, the outcome (on the $Y-$axis) corresponds to the average of physical, mental, perceived health and social life, it gathers information contained in Table II. The evolution of this synthetic indicator is the same between these two pre-reform cohorts. Figures A2a and A2b show the difference-in-differences estimation for cohorts impacted by the reform taking generation 1933 as control group.

Tables A7, A8 and A9 in Appendix show the difference-in-differences estimation for cohorts not impacted by the reform taking generation 1933 as control group. We presents the interaction term between cohorts and sectors for individuals born between 1930 and 1933.[30]. The coefficients of the interaction are not significant per education level (see Tables A8 and A9). Moreover, the coefficients are not significantly different between the three interaction terms for each indicator.

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[27]We present these placebo tests for the low-educated because the effect on health is concentrated on this sub-population.

[28]Most papers test this assumption by studying other periods.

[29]We delete generations 1928 and 1929 because of small number of observations by cohorts (see Table A1 in Appendix).

[30]As previously, we delete generations 1928 and 1929 because of small number of observations by cohorts (see Table A1 in Appendix).
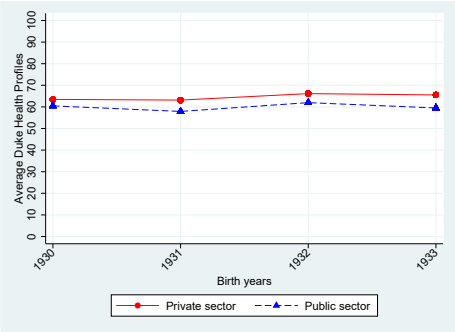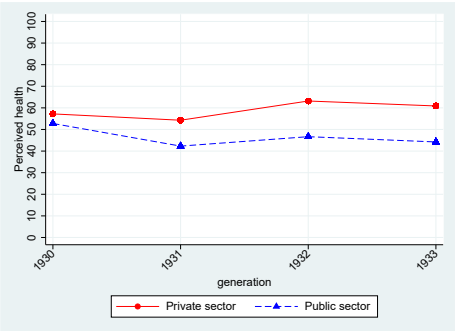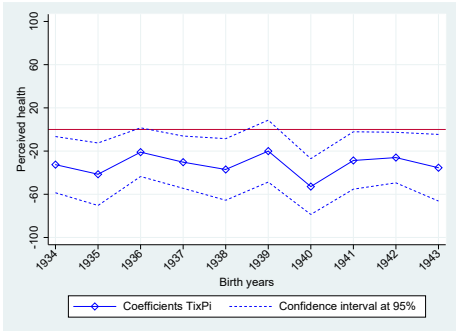
(a) Less-educated individuals   (b) Highly-educated individuals
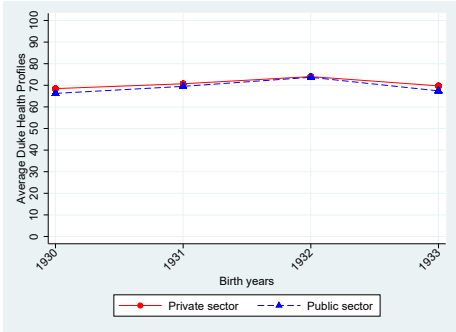
Note: The outcome (on the $Y-$axis) corresponds to the average of four positive measures: physical, mental, perceived health and social life. It gathers information contained in Table II. Source: *Baromètre Santé 2005, Santé publique France*.

Figure 3: Common trend – pre-reform cohorts (Duke Health Profiles)

(a) Common trend on perceived health   (b) DiD on perceived health
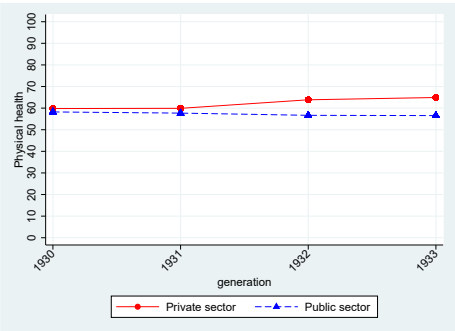
(c) Common trend on physical health   (d) DiD on physical health
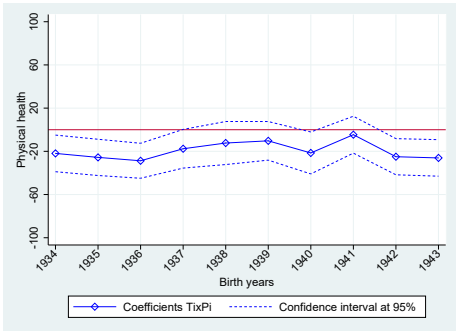
Note: Figure 4a and 4c present the common trend between generations 1930 and 1933, not affected by the reform (without control). In Figure 4b and 4d, Equation 4 is repeated for each cohort taken generation 1933 as control group. All regressions include treated (T_i) and private sector (P_i). For the first coefficient $T_i = 1$ if the individual is born in 1934, 0 if the individual is born in 1933. Controls are income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Figure 4: Reform impact on health scores between cohorts (less-educated individuals)

Figures 4b and 4d correspond to the health difference public-private sectors between each cohort (1934-1943) and the 1933 cohort, not affected by the reform (specifications with controls); whereas Figures 4a and 4c correspond to the common trend between 1930,

1931, 1932 and 1933 (taken as a reference).[31] Equation 4 is repeated for each cohort taken generation 1933 as control group. The results are virtually the same, i.e. a negative effect on perceived and physical health for low-educated individuals. We add a health indicator: good health or not as a proxy of SRH (self-rated health), which is an indicator often used in the literature. Respondents answer to the question: "I am basically an healthy person" (not, somewhat, yes exactly). We attribute the value 1 to the variable if the individual answers is "yes exactly" to this question, 0 otherwise. This indicator confirms the results based on Duke Health Profiles for all our specifications, we present the DiD Figure A3b in Appendix (common trend is presented in Figure A3a). The low-educated are the only ones where we see a clear (graphically) common trend before the reform for average, perceived, good and physical health, this is not the case for high-educated individuals, for each indicator separately. That is why we need to be cautious about the absence of effect on high-educated individuals. However, Table A9 shows that the interaction terms are not significant for highly educated pre-reform cohorts.

6. CONCLUSION

As a conclusion, a difference-in-differences approach can provide a good estimate for retirement reform impact on health. We contribute to the literature in several ways. We develop an identification strategy which is different in spirit from those previously employed in the literature. We consider the effect of a pension reform on health in a specific country (France), whereas previous studies use eligibility ages for pension benefits as instrumental variables for retirement across states or countries. This ensures that our results cannot be biased by country-specific or state-specific effects.

Health measures in this paper are subjective, meaning that they may suffer from a self-reported bias. Nevertheless, clinical validity of the Duke Health Profiles was checked by Parkerson, Broadhead, and Tse (1990), testing the correlation and coherence between the Profiles and clinical problems.[32] Basically, we used Duke Health Profiles for two reasons. First, they give a global view of an individual's health taking into account mental, physical, perceived health and social well-being. Second, they are medically validated (Parkerson, Broadhead, and Tse, 1990).

We find that individuals were impacted by the 1993 reform consider themselves less healthy. This effect is driven by the less educated individuals, who are affected in terms of perceived and physical health. These effects are robust to several specifications. We change the bandwidth around the first generation impacted by the reform (1934). We find no difference in the intensity of the effect, nevertheless the effects are imprecise. We do placebo tests on older generations not impacted by the 1993 reform and on the younger ones impacted by the reform in the same way. We find no effect. These results are robust to the variation in the first cohort fictitiously impacted by the reform. We show negative effect on less-educated perceived and physical health for each generation impacted by the reform (taking the 1933 generation as control group, i.e. the last generation not impacted

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[31]We focus on outcomes which are always significant in Table VI.

[32]However, their demonstration of clinical validity is hampered by the relatively small size of the data set, the presence of a large variety of health problems and extensive co-morbidity and the benign nature of most of the health problems. In addition, health status should be monitored over time to test the effectiveness of the Duke Health Profiles to detect changes of clinical relevance and to determine precision in terms of how small a change can be measured.

by the 1993 reform).

These negative effects on health may be due to the fact that with greater incentives to work, people stay on the labor market despite being in bad health, which worsens the average health of workers. In the latter case, the difference between the effective and the desired amount of work is detrimental to health (Bassanini and Caroli, 2015). The 1993 reform could have an impact on health through two different channels : i) there may be an income effect (i.e. an income decrease has repercussions on health); ii) there may be an activity effect (i.e. an increase in working life has repercussions on health). Our data does not enable us to go beyond mere speculations on this matter.

The external validity of our findings depends on the similarity between the 1928-1943 cohorts and the current cohorts of pensioners. However, this finding raises the question of the long-term efficiency of retirement reforms. First, they may have a detrimental effect on people's health. Second, they may increase health inequality since less educated people are more affected by the negative effects of the reforms.

APPENDIX
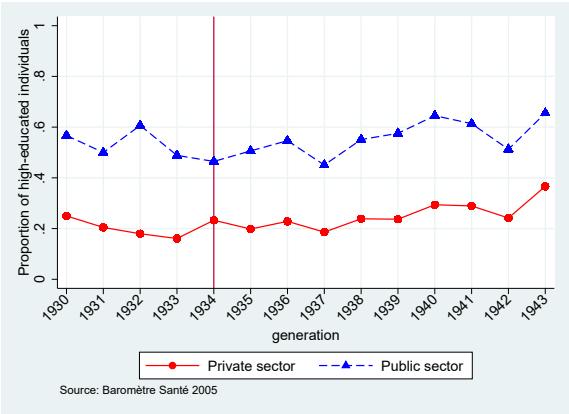
Figure A1: Proportion of highly-educated people by sector
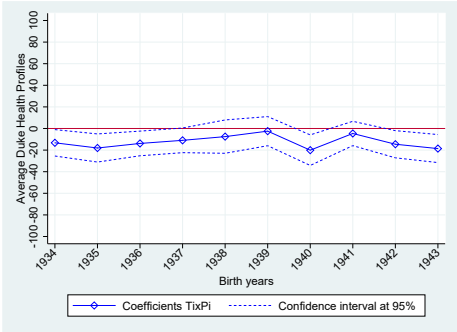
(a) Less-educated individuals
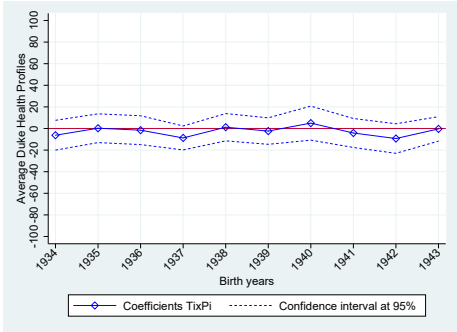
(b) Highly-educated individuals

Note: The outcome (on the $Y-$axis) corresponds to the average of four positive measures: physical, mental, perceived health and social life. It gathers information contained in Table II. In Figures A2a and A2b, Equation 4 is repeated for each cohort taken generation 1933 as control group. All regressions include treated (T_i) and private sector (P_i). For the first coefficient $T_i = 1$ if the individual is born in 1934, 0 if the individual is born in 1933. Controls are income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Figure A2: Difference-in-Differences (Duke Health Profiles)
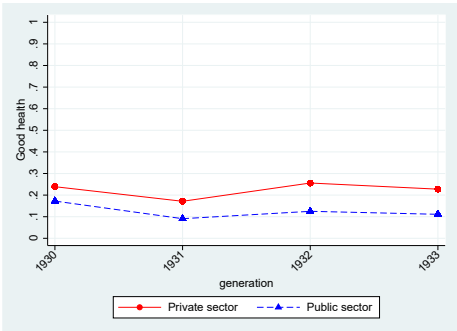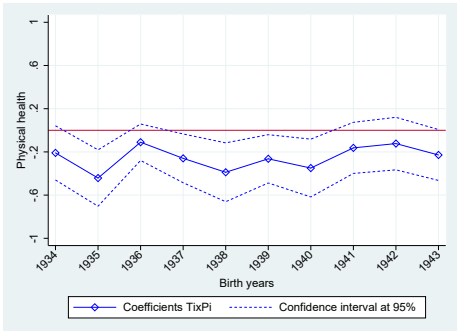
(a) Common trend

(b) Difference-in-Differences

Note: Figure A3a presents the common trend between generations 1930 and 1933, not affected by the reform (without control). In Figure A3b, Equation 4 is repeated for each cohort taken generation 1933 as control group. All regressions include treated (T_i) and private sector (P_i). For the first coefficient $T_i = 1$ if the individual is born in 1934, 0 if the individual is born in 1933. Controls are income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Figure A3: Reform impact on the probability to report being in good health (less-educated individuals)

Table A1: Number of observations by
birth cohort for the baseline sample

Generation	Freq.	Percent
1928	23	0.5
1929	164	3.6
1930	283	6.1
1931	264	5.7
1932	267	5.8
1933	287	6.2
1934	290	6.3
1935	313	6.8
1936	318	6.9
1937	322	7.0
1938	362	7.8
1939	355	7.7
1940	321	7.0
1941	323	7.0
1942	330	7.1
1943	397	8.6
Total	4,619	100

Table A2: PCS repartition in the public sector

Composition - public sector	Untreated 1928-1933	Treated 1934-1943	t-test t	Observations N
Executives	26.42%	26.72%	-0.6296	1,258
Intermediary professions	35.56%	38.79%	-0.5337	1,258
Employees	38.02%	34.50%	1.1223	1,258

Table A3: Difference-in-Differences - Baseline analysis (1934 as pivot cohort)

	Perceived health		Physical health		Mental health		Social life	
T×P	-6.987**	-7.243*	-2.666	-3.543	0.0158	-0.755	2.290	2.322
	(3.539)	(4.201)	(2.128)	(2.408)	(2.045)	(2.334)	(1.879)	(2.138)
T	9.810***	7.550	6.943***	1.797	0.993	2.391	-0.674	-1.554
	(3.080)	(4.977)	(1.779)	(2.960)	(1.801)	(2.819)	(1.650)	(2.492)
P	5.144*	8.665**	1.471	3.339	-0.113	0.129	-3.987**	-2.039
	(3.075)	(3.797)	(1.822)	(2.136)	(1.764)	(2.096)	(1.628)	(1.914)
age		0.836		5.529		0.847		2.704
		(8.060)		(5.276)		(4.563)		(4.127)
age^2		-0.008		-0.046		-0.0049		-0.011
		(0.061)		(0.040)		(0.035)		(0.031)
Men		1.039		9.378***		5.536***		-2.612***
		(1.624)		(1.061)		(0.930)		(0.862)
Household size		-0.514		-0.442		-1.395		-1.475*
		(1.530)		(1.033)		(0.992)		(0.825)
Children (yes/no)		2.651		0.865		-0.738		1.449
		(2.655)		(1.505)		(1.362)		(1.337)
Married		-2.292		1.535		4.673***		3.691***
		(2.176)		(1.371)		(1.308)		(1.161)
Observations	2,986	2,280	2,965	2,267	2,960	2,266	2,931	2,248

Note: robust standard errors in parentheses. *** P-value<0.01, ** p-value<0.05, * p-value<0.1. Additional controls are income, education and regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Table A4: Difference-in-Differences analysis (1934 as pivot cohort)

People born between 1929 and 1938						
	Without control	se	N	With controls	se	N
Panel A – All sample						
Perceived health	-10.201**	(3.987)	1888	-8.225*	(4.610)	1411
Physical health	-3.705	(2.410)	1872	-3.870	(2.733)	1400
Mental health	-0.169	(2.308)	1868	-0.637	(2.632)	1401
Social life	2.228	(2.105)	1847	2.912	(2.421)	1387
Panel B – Low-educated						
Perceived health	-16.867***	(5.582)	1330	-15.489**	(6.319)	1033
Physical health	-7.238**	(3.555)	1316	-7.391*	(3.890)	1023
Mental health	-2.749	(3.779)	1316	-4.510	(4.019)	1026
Social life	-0.966	(2.921)	1299	-0.746	(3.318)	1015
Panel C – High-educated						
Perceived health	-6.847	(6.369)	558	-3.986	(8.112)	378
Physical health	-1.801	(3.847)	556	2.740	(4.625)	377
Mental health	-1.228	(3.231)	552	-1.349	(3.986)	375
Social life	5.032	(3.423)	548	4.546	(4.265)	372

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include (T_i) and (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in 1934 and afterwards) and 0 if non-treated (i.e. born before 1934). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the public sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Table A5: Placebo tests for the low-educated - DiD analysis for older cohorts (1928 to 1933)

	Without control	s.e.	N	With control	s.e.	N
1930 as pivot cohort						
Perceived health	13.915	(9.901)	607	14.174	(12.223)	464
Physical health	5.323	(6.546)	598	7.409	(7.224)	459
Mental health	-2.434	(6.319)	602	4.111	(6.984)	463
Social life	-4.719	(5.300)	595	-7.695	(6.891)	457
1931 as pivot cohort						
Perceived health	10.624	(8.668)	607	16.721	(10.230)	464
Physical health	4.420	(5.608)	598	8.333	(5.954)	459
Mental health	-6.938	(5.660)	602	-1.090	(6.032)	463
Social life	-4.563	(4.547)	595	-0.870	(5.531)	457
1932 as pivot cohort						
Perceived health	13.299	(8.557)	607	14.982	(9.802)	464
Physical health	7.974	(5.539)	598	9.129	(5.848)	459
Mental health	-7.067	(5.836)	602	-2.821	(5.788)	463
Social life	-1.680	(4.619)	595	2.476	(5.646)	457

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include treated (T_i) and private sector (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in the cohort pivot and afterwards) and 0 if non-treated (i.e. born before the cohort pivot). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the private sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. We do not consider the 1929 cohort as a pivot cohort because of the small number of observations for individuals born in 1928 (see Table A1 in the paper). Source: *Baromètre Santé 2005, Santé publique France.*

Table A6: Placebo tests for low-educated - DiD analysis for younger cohorts (1960 to 1975)

	Without control	s.e.	N	With control	s.e.	N
1961 as pivot cohort						
Perceived health	-4.301	(7.647)	2046	-8.231	(8.168)	1858
Physical health	7.418	(5.898)	2039	5.702	(6.241)	1853
Mental health	6.062	(4.881)	2040	0.799	(4.555)	1854
Social life	-3.337	(5.435)	2030	-3.786	(5.490)	1846
1962 as pivot cohort						
Perceived health	2.536	(5.416)	2046	2.136	(5.900)	1858
Physical health	3.635	(3.913)	2039	2.056	(3.999)	1853
Mental health	4.951	(3.624)	2040	1.088	(3.426)	1854
Social life	1.605	(4.295)	2030	-0.319	(4.296)	1846
1963 as pivot cohort						
Perceived health	-1.357	(4.797)	2046	-2.791	(5.094)	1858
Physical health	0.882	(3.305)	2039	-0.471	(3.370)	1853
Mental health	1.965	(3.056)	2040	-1.257	(2.929)	1854
Social life	-0.504	(3.223)	2030	-2.015	(3.193)	1846
1964 as pivot cohort					se	N
Perceived health	-2.684	(4.265)	2046	-3.459	(4.495)	1858
Physical health	1.396	(2.839)	2039	0.509	(2.880)	1853
Mental health	1.005	(2.687)	2040	-1.113	(2.643)	1854
Social life	-0.333	(2.648)	2030	-0.467	(2.654)	1846
1965 as pivot cohort					se	N
Perceived health	-0.204	(3.978)	2046	-0.521	(4.236)	1858
Physical health	0.318	(2.550)	2039	0.037	(2.614)	1853
Mental health	1.494	(2.461)	2040	-0.969	(2.447)	1854
Social life	-0.217	(2.339)	2030	-0.534	(2.318)	1846
1966 as pivot cohort						
Perceived health	-3.763	(3.899)	2046	-3.376	(4.192)	1858
Physical health	1.462	(2.437)	2039	0.794	(2.504)	1853
Mental health	2.020	(2.383)	2040	-0.807	(2.386)	1854
Social life	0.335	(2.216)	2030	0.217	(2.227)	1846
1967 as pivot cohort					se	N
Perceived health	-4.559	(3.855)	2046	-5.820	(4.149)	1858
Physical health	1.521	(2.389)	2039	1.056	(2.459)	1853
Mental health	2.034	(2.349)	2040	-0.384	(2.360)	1854
Social life	1.224	(2.181)	2030	0.381	(2.202)	1846
1968 as pivot cohort						
Perceived health	-3.325	(3.884)	2046	-4.286	(4.194)	1858
Physical health	0.165	(2.362)	2039	-0.209	(2.416)	1853
Mental health	0.001	(2.329)	2040	-1.353	(2.348)	1854
Social life	0.092	(2.174)	2030	-0.811	(2.200)	1846
1969 as pivot cohort						
Perceived health	-2.939	(4.014)	2046	-4.653	(4.326)	1858
Physical health	-0.769	(2.386)	2039	-2.009	(2.433)	1853
Mental health	-1.214	(2.385)	2040	-2.586	(2.414)	1854
Social life	-0.189	(2.213)	2030	-1.176	(2.249)	1846
1970 as pivot cohort						
Perceived health	-5.314	(4.340)	2046	-5.831	(4.676)	1858
Physical health	0.447	(2.490)	2039	-0.726	(2.546)	1853
Mental health	0.410	(2.515)	2040	-1.300	(2.588)	1854
Social life	0.143	(2.338)	2030	-0.890	(2.371)	1846
1971 as pivot cohort						
Perceived health	-7.491	(4.596)	2046	-7.520	(4.896)	1858
Physical health	-1.773	(2.582)	2039	-1.521	(2.679)	1853

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	Without control	s.e.	N	With control	s.e.	N
Mental health	-0.064	(2.660)	2040	-0.469	(2.760)	1854
Social life	1.427	(2.505)	2030	1.441	(2.572)	1846
1972 as pivot cohort						
Perceived health	-4.136	(5.366)	2046	-3.945	(5.670)	1858
Physical health	-2.218	(2.882)	2039	-2.047	(3.049)	1853
Mental health	1.276	(2.895)	2040	0.667	(2.981)	1854
Social life	2.346	(2.620)	2030	2.270	(2.683)	1846
1973 as pivot cohort						
Perceived health	-0.331	(6.602)	2046	-1.136	(6.809)	1858
Physical health	-1.525	(3.460)	2039	-1.582	(3.707)	1853
Mental health	1.516	(3.596)	2040	0.670	(3.648)	1854
Social life	1.901	(3.026)	2030	2.411	(3.143)	1846
1974 as pivot cohort						
Perceived health	2.097	(7.558)	2046	-1.532	(7.440)	1858
Physical health	1.323	(4.498)	2039	4.765	(4.443)	1853
Mental health	5.198	(4.734)	2040	4.808	(4.815)	1854
Social life	0.249	(4.095)	2030	-1.090	(3.908)	1846

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1. Each line presents the coefficient (resp. robust standard error in parentheses and number of observations used in the model) associated with the interaction term $T_i \times P_i$ for each health outcome. All regressions include treated (T_i) and private sector (P_i). T_i is a dummy variable taking value 1 if individual is treated (i.e. born in the cohort pivot and afterwards) and 0 if non-treated (i.e. born before the cohort pivot). P_i is a dummy variable taking value 1 if individual is/was in the private sector and 0 if individual is/was in the private sector. Controls are age, age^2, income, gender, children or not, education, size of the household and marital status and regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Table A7: Common Trend Assumption

	(1) Duke health profiles	(2) Good health	(3) Perceived health	(4) Physical health	(5) Mental health	(6) Social life
1930 cohort×private sector	-5.129	-0.009	-14.221	-7.168	5.352	-3.796
	(5.236)	(0.103)	(11.275)	(6.659)	(6.007)	(5.247)
1931 cohort×private sector	-5.485	-0.036	-12.371	-9.119	2.487	-3.690
	(5.081)	(0.101)	(10.541)	(6.842)	(5.549)	(6.216)
1932 cohort×private sector	-5.069	0.044	-5.290	-9.210	-11.342**	6.445
	(5.218)	(0.109)	(11.226)	(5.984)	(5.679)	(5.479)
1930 cohort	-4.774	-0.041	-15.117	-0.184	-10.952	1.215
	(6.600)	(0.149)	(14.103)	(8.434)	(7.326)	(7.606)
1931 cohort	-1.746	-0.061	-9.253	3.281	-4.519	0.316
	(5.595)	(0.114)	(11.695)	(7.360)	(6.004)	(6.741)
1932 cohort	3.318	-0.021	-1.412	7.129	8.216	-4.716
	(4.972)	(0.100)	(10.381)	(5.360)	(5.221)	(5.328)
private sector	8.112**	0.055	18.202**	11.587***	3.095	-2.634
	(3.505)	(0.070)	(7.268)	(4.397)	(4.105)	(3.386)
N	507	809	527	520	526	520

Note: Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Generation 1933 is taken as control group. Controls are age^2, income, gender, children or not, education, size of the household, marital status, regions of residence. Source: Baromètre Santé 2005, Santé publique France.

Table A8: Common trend assumption – less-educated individuals

	(1) Duke health profiles	(2) Good health	(3) Perceived health	(4) Physical health	(5) Mental health	(6) Social health
1930 cohort×private sector	-9.704	-0.035	-24.068	-11.366	3.495	-7.365
	(6.617)	(0.127)	(16.372)	(8.867)	(9.085)	(7.093)
1931 cohort×private sector	-5.421	-0.076	-12.424	-9.605	2.371	-7.360
	(7.025)	(0.118)	(13.560)	(9.153)	(7.484)	(9.895)
1932 cohort×private sector	-7.141	-0.060	-14.408	-7.765	-7.835	-0.252
	(8.107)	(0.133)	(15.769)	(7.922)	(10.098)	(8.096)
1930 cohort	-4.820	-0.126	-8.332	-0.044	-14.027	3.974
	(7.628)	(0.181)	(18.501)	(10.597)	(9.966)	(9.145)
1931 cohort	-5.340	-0.091	-10.951	-0.902	-7.546	1.910
	(7.376)	(0.139)	(14.180)	(9.750)	(8.130)	(10.246)
1932 cohort	4.594	0.068	10.048	4.518	3.505	0.435
	(7.725)	(0.126)	(14.650)	(7.326)	(9.600)	(7.710)
private sector	10.179**	0.154**	26.754***	11.292**	4.877	-0.070
	(4.554)	(0.074)	(9.339)	(5.728)	(5.440)	(4.425)
N	385	612	400	395	400	395

Note: Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Generation 1933 is taken as control group. Controls are age^2, income, gender, children or not, education, size of the household, marital status, regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

Table A9: Common trend assumption – highly-educated individuals

	(1) Duke health profiles	(2) Good health	(3) Perceived health	(4) Physical health	(5) Mental health	(6) Social life
1930 cohort × private sector	0.103	-0.087	-4.986	-3.692	6.486	0.048
	(10.082)	(0.220)	(21.449)	(11.992)	(8.830)	(10.360)
1931 cohort × private sector	-4.694	-0.116	-18.320	2.356	0.622	-5.178
	(10.574)	(0.255)	(24.627)	(14.668)	(10.953)	(11.996)
1932 cohort × private sector	-6.627	-0.010	-8.309	-15.446	-12.072	12.958
	(10.664)	(0.241)	(21.265)	(12.257)	(9.845)	(10.336)
1930 cohort	2.130	0.710**	-7.151	15.199	4.166	-4.513
	(17.035)	(0.358)	(43.203)	(16.376)	(14.893)	(17.198)
1931 cohort	6.492	0.447*	8.898	6.344	6.815	6.316
	(11.706)	(0.258)	(31.675)	(12.155)	(10.329)	(12.554)
1932 cohort	2.651	0.090	-6.262	11.656	13.778	-8.981
	(8.635)	(0.185)	(21.098)	(8.703)	(8.609)	(8.133)
private sector	8.396	0.081	19.197	13.731	2.799	-2.962
	(8.123)	(0.181)	(16.881)	(9.520)	(6.884)	(7.403)
N	122	197	127	125	126	125

Note: Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Generation 1933 is taken as control group. Controls are age^2, income, gender, children or not, education, size of the household, marital status, regions of residence. Source: *Baromètre Santé 2005, Santé publique France*.

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