Does Postponing Minimum Retirement Age Improve Healthy Behaviours Before Retirement? Evidence from Middle-Aged Italian Workers.

Does postponing minimum retirement age improve healthy behaviors before retirement? Evidence from middle-aged Italian workers

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Abstract

By increasing the residual working horizon of employed individuals, pension reforms that rise minimum retirement age can affect individual investment in health-promoting behaviors before retirement. Using the expected increase in minimum retirement age induced by a 2004 Italian pension reform and a difference-in-differences research design, we show that middle-aged Italian males affected by the reform reacted to the longer working horizon by increasing regular exercise, with positive consequences for obesity and self-reported satisfaction with health.

Keywords: retirement, working horizon, healthy behaviors, pension reforms

JEL codes: H55, I12, J26.

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Introduction

There is substantial research exploring the causal effects of retirement on individual health and health behaviors *after* retirement. This literature typically reports that the transition into retirement has positive effects both on self-reported health and on indices of physical health. Recent evidence includes Insler, 2014, for the U.S., Coe and Zamarro, 2011, and Eibich, 2015, for Europe and Zhao et al., 2017, for Japan.[1] A mechanism explaining these effects is the positive change in health-promoting behaviors – such as additional physical exercise and reductions in drinking and smoking – induced by retirement (see also Kaempfen and Maurer, 2016, and Celidoni and Rebba, 2016).[2]

The existing literature, however, has somewhat overlooked that exogenous changes in minimum retirement age can also affect behavior *before* retirement, by altering the residual working horizon of workers who – in the absence of constraints – would have chosen an optimal retirement age that falls below the minimum required by retirement rules. Changes in behavior due to a longer working horizon can occur, for instance, if earnings and employment in the additional period before retirement depend on health. In this case, affected individuals have an incentive to keep fit so as to reap these benefits, and may therefore invest more in health-promoting behaviors.

To the best of our knowledge, only few contributions have examined the effects of a longer working horizon on individual behaviors before retirement, and none has considered the impact on health-promoting behaviors. Hairault et al., 2010, show that French workers exposed to an exogenous increase in their expected retirement age increase job search effort. They explain this finding by showing that the economic returns to jobs depend on their expected duration, which increases with retirement age. In a similar vein, Carta and De Philippis, 2017, study how a longer working horizon affects the labor supply of Italian females, and Montizaan et al., 2010, and Brunello and Comi, 2015, use respectively Dutch

[1] Godard, 2016, finds instead that the retirement transition has a positive effect on the incidence of obesity among European workers. This effect is particularly pronounced among those who were employed in blue-collar and physically demanding jobs. The studies on the effects of retirement on cognition generally find negative effects (see Rohwedder and Willis, 2010, Adam et al., 2012, Mazzonna and Peracchi, 2012, and Celidoni et al., 2017). The evidence is less clear-cut for mental health (see Charles, 2004, Börsch-Supan and Jürges, 2009, Johnston and Lee, 2009, Clark and Fawaz, 2009, Bonsang and Klein, 2012, Heller-Sahlgren, 2017, Bertoni and Brunello, 2017, and Fonseca et al., 2015).

[2] These positive effects, however, may be short-lived and disappear with time (the so-called 'honeymoon effect' of retirement). For instance, Mazzonna and Peracchi, 2017, and Bertoni et al., 2017, estimate that - given age - a longer time spent in retirement has a negative effect on an index of overall physical health and on muscle strength, a robust predictor of disability, cardiovascular diseases and mortality.

and Italian data to show that policies that increase the residual working horizon have positive consequences on training participation by active older workers.[3] In a study close to ours, De Grip et al., 2012, find that a Dutch reform reducing pension rights and postponing the minimum retirement age of public sector workers has reduced their mental health.

Using data on several cohorts of Italian working men aged 42 to 51 during the period 2001 to 2005, we contribute to this literature by investigating whether changes in minimum retirement age – induced by a pension reform affecting eligibility conditions – have affected health-promoting behaviors before retirement.[4]

Eligibility to retirement in Italy depends on three parameters: age, sector of employment and accrued years of social security contributions. Until 2004, Italian male public and private sector employees could retire at age 57 (58 for the self-employed) with a seniority pension, conditional on having paid social security contributions for at least 35 years, or at any age conditional on having paid 38 years of contributions (40 for the self-employed).[5] In August 2004, the newly appointed Welfare Minister Roberto Maroni modified these eligibility requirements by introducing a sharp 3-years increase in minimum eligibility age (the so-called "scalone" or "big jump"), from 57 to 60 years for public and private employees, and from 58 to 61 for the self-employed, starting from year 2008. Requirements on minimum years of contributions remained, however, unaltered. As a result, because of differences in accrued years of contributions, and conditional on age and sector of employment, some workers experienced a change in their expected working horizon, whereas others did not.

We exploit these changes in eligibility conditions in a difference-in-differences framework.[6] We compare changes in the adoption of healthy behaviors before and after the reform for workers who experienced an increase in their working horizon (the "treated" group) and

[3] Montizaan and Vendrik, 2014, find that the same policies negatively affected job satisfaction of treated Dutch workers. A longer working horizon may also have inter-generational consequences on the children of potential retirees. Manacorda and Moretti, 2006, find negative effects of a longer parental working horizon (and thus higher parental income) on the nest-leaving decisions of Italian youngsters. Battistin et al., 2014, find that policies raising the retirement age have negatively affected the supply of informal childcare provided by Italian grandparents, thereby reducing the number of grandchildren. Coda Moscarola et al., 2016, find that older Italian employed women reacted to the postponement of retirement induced by a recent reform by increasing their sick leave, and that this effect was stronger among low-income grandmothers living in areas with limited supply of childcare services.

[4] By considering male workers aged 42 to 51, we focus on individuals who are in a 10-year age window just below the earliest retirement eligibility age in the pre-reform regime (52 years).

[5] The last requirement increased to 40 years for those retiring from 2008 onwards.

[6] Carta and De Philippis, 2017, use a similar strategy for another Italian reform.

workers with an unaltered horizon (the "control" group), conditional on cell (defined by age, school leaving age and sector) and year fixed effects.

Since the adoption of healthy behaviors can affect health, with positive consequences on working careers, the allocation to treatment based on actual years of contribution is likely to be endogenous because of reverse causality. To circumvent this problem, we define workers differentially affected by the reform on the basis of age, sector and *potential* rather than *actual* years of contribution, where the former is computed using potential labor market experience, or age minus school leaving age, a pre-determined variable in our setup. Potential years differ from actual years if individuals do not have continuous careers spanning the interval between current age and the age of school completion.

This strategy implies that our estimates should be interpreted as the Intention To Treat (ITT) effects of changes in the *potential* working horizon on the adoption of healthy behaviors.[7] Our research design relies on the assumption of parallel trends in the evolution of healthy behaviors over time and across treatment groups had both groups not been exposed to the reform. We show that this assumption holds during the period before the reform. Since treated individuals are exposed to different reform-induced changes in the work horizon, ranging from 1 to 4 years, we maximize efficiency by considering a difference-in-differences estimator with variable treatment intensity.

We study the effects of changes in minimum retirement age on regular exercise, smoking and drinking habits before retirement. We also consider the impact on obesity, self-reported satisfaction with health, and a few supplementary indicators of nutritional habits.[8] Our results show that a one-year increase in the potential working horizon – triggered by a pension reform - increases the likelihood of exercising regularly by 3.2 percentage points (equivalent to about 14 percent of the mean value of the outcome for treated workers in the pre-reform period), the probability of having a body mass index below the level indicating obesity (30) by 1.6 percentage points (or 1.8 percent) and the probability of reporting a high satisfaction with own health by 2.7 percentage points (or 13.5 percent).

[7] The possibility of using actual years of contributions is precluded to us, as we do not observe accrued years of contribution in our data. Still, using supporting data from the Bank of Italy SHIW survey - where there is no information on healthy behaviors, but we can observe accrued years of contributions - we show that there is a positive and significant effect of changes in potential years to retirement on changes in actual years.

[8] Our measures of investments in healthy behaviors are self – reported and drawn from a survey that does not include either time diaries or objective health measures. Additionally, the range of health behaviors that we observe in the available data does not exhaust all the important behaviors that may affect health. For instance, we do not have any information on the use of illicit drugs or unsafe sex.

Potential mechanisms explaining why healthy behaviors change in the presence of pension reforms that increase minimum retirement age include the lifetime income effects associated to a longer working life and the need to keep fit longer. While the former mechanism applies to all workers, the latter is less likely to apply to public sector employees, who in Italy have stronger job guarantees than private sector workers, and therefore may be less concerned with preserving their health in order to work longer. Our empirical results do not produce conclusive evidence in favor of either mechanism. On the one hand, we find that the impact of a longer residual work horizon on exercising regularly does not vary across sectors, in line with the higher lifetime income hypothesis. On the other hand, the impact on the likelihood of weighting below obesity and of being satisfied with own health is larger for private sector workers, as suggested by the need to keep fit hypothesis. The estimated differences across sectors, however, are not always statistically significant.

Assessing the effects of a longer working horizon on behaviors before retirement has relevant policy implications. Several OECD countries have recently introduced pension reforms that rise minimum retirement age in order to deal with the increased burden of population ageing on public finances. By delaying retirement and by increasing the residual working horizon of employed individuals, these reforms may generate unexpected costs and benefits. In this paper, we highlight that one benefit could be better health before retirement, as constrained individuals react to the longer horizon by investing in some healthy behaviors and reducing some unhealthy ones. Ceteris paribus, in countries with universalistic public health care, better health before retirement may generate important savings, and these savings should be accounted for when evaluating the impact of pension reforms.

The remainder of the paper is organized as follows. In Section 1 we introduce the institutional background and the Maroni 2004 Reform. We discuss the data in Section 2 and our empirical setup in Section 3. Results are shown in Section 4. Conclusions follow.

1. The 2004 Maroni Reform

Before 1992, the minimum age for old age pension for Italian men was 60 for employees in the private sector and for self-employed workers and 65 for public sector employees – conditional on having paid social security contributions for at least 15 years. Early retirement with a seniority pension was instead possible at any age for workers who had paid social security contributions for at least 35 years.[9]

Several reforms affecting eligibility took place starting in 1992. First, a minimum retirement age for seniority pensions was initially set at 52 for employees in the private and public sector; second, the requirements for eligibility to old age pensions were progressively increased to reach at least 20 years of paid contributions and age 65 by 2001 (the so called Amato reform); third, the eligibility requirements for seniority pensions were tightened so as to reach gradually from 1997 to 2008 either 40 years of paid contributions independently of age, or 57 years of age and 35 years of paid contributions for public and private employees and 58 years and 35 years of contributions for the self-employed (the Dini and Prodi reforms).

In August 2004, Welfare Minister Roberto Maroni introduced a sharp discontinuity in the eligibility requirements for seniority pensions by increasing minimum eligibility age for those retiring from year 2008 by three years (the so-called "scalone" or "big jump"), from 57 to 60 years for public and private employees, and from 58 to 61 for the self-employed. However, requirements in terms of years of contributions remained unaltered, as shown in Table A1 in the Appendix.

Three years later, in 2007, the incoming left-wing government led by Romano Prodi (or "Prodi bis", elected in 2006) postponed the proposed three-year increase to 2011, and replaced the "scalone" with a gradual adjustment in the requirements. Although no worker actually retired under the requirements prescribed by the Maroni reform, this reform is relevant for our purposes because it sharply altered the expected length of the residual working horizon from its introduction in 2004 to at least the general elections held in early 2006. Since the "scalene" was postponed in 2007 after a change in the ruling coalition in the wake of these elections, it is unlikely that changes in the Maroni reform could have been anticipated in 2004 or 2005.[10]

2. The Data

[9] See Angelini et al., 2009, and Bottazzi et al., 2011, among others for further details on Italian pension reforms. Since our empirical analysis is restricted to men, we do not discuss here the changes in pension eligibility rules for females.

[10] Evidence that expectations about retirement age change following pension reforms altering minimum retirement age is reported – among others – by Bottazzi et al., 2006, and Baldini et al., 2015 for Italy, De Grip et al., 2012, for the Netherlands, Okumura and Usui, 2014, for Japan and Ciani et al., 2017, using data for several European countries.

Our data consist of a main and an auxiliary sample. The main sample is from the survey "*Aspetti della Vita Quotidiana"* (*Aspects of Daily Life*, hereafter AVQ), carried out on a yearly basis by the Italian Bureau of Statistics (ISTAT), and the auxiliary sample is from the *Survey on Household Income and Wealth* (SHIW from now on), conducted on a bi-annual basis by the Bank of Italy.

AVQ is a cross-sectional annual survey of a representative sample of about 50,000 individuals. It covers several aspects of daily life, including behaviors such as exercising, smoking, drinking and several dietary habits. Information on most healthy behaviors is collected since 1997, but for some - including height and weight, that we use to compute BMI (body mass index) and obesity - data collection started only in 2001. For this reason, we select 2001 as the first pre-reform year.

Our data do not include 2004, because the survey did not take place in that year. We also exclude the year 2006, when a general election took place and a change of government could have generated anticipations of a further change in the minimum retirement age, which eventually took place in 2007. Therefore, our data cover the years 2001, 2002, 2003 and 2005.

We focus on males aged between 42 and 51 years, too young to be retired but not too far from retirement. We exclude females because their labor market careers – a crucial aspect in our empirical exercise – are often more discontinuous than those of men, due to their childbearing responsibilities. To enhance internal validity, we also exclude workers who – in the pre-reform period – were still experiencing positive changes in the residual work horizon, as a consequence of previous reforms (see Section 1 and Figure 1 below for details).[11] After eliminating from the sample the very few who were retired, disabled or had never worked in their life, as well as those with missing values in the variables used in the analysis, we end up with a final sample of 9,093 individuals.[12]

We construct the following indicators of healthy lifestyles or behaviors: a dummy equal to 1 if the individual exercises on a regular basis, and 0 otherwise; a dummy equal to 1 if he does not smoke, and 0 otherwise; a dummy equal to 1 if he does not drink alcohol regularly and 0

[11] In a robustness test we show that results are stable even when we include this group of workers in our sample.

[12] This sample includes the currently employed and the unemployed with at least a previous job (1.5% of the sample). For each individual in the sample, we have information on the sector of current or last employment.

otherwise;[13] a dummy equal to 1 if his BMI is below 30 (not obese), and 0 otherwise. As indicator of health satisfaction, we also define a dummy equal to 1 if the individual is very satisfied with his own health and 0 otherwise. As supplementary outcomes, we also include the following indicators of nutritional habits: a dummy equal to 1 if the individual refrains from eating red meat at least once a day and 0 otherwise; a dummy equal to 1 if he eats vegetables or fruit at least once a day, and 0 otherwise; a dummy equal to 1 if he refrains from having soft drinks at least once a day, and 0 otherwise.[14]

The AVQ survey includes variables that we use as covariates in our regressions: age, educational attainment, sector of employment in the current or previous job (private, public or self-employment), macro-area of residence (northern, central or southern Italy), marital status, presence of children, type of job - whether physically demanding or not - and type of accommodation in six categories (including villa, luxury or standard apartment, social housing, rural house, sheltered house), that we take as a proxy of wealth.

We measure the residual work horizon with potential years to retirement (*PYR)* at time *t*, defined as the minimum number of years to retirement prescribed by the law in place at the time, under the assumption that the years of paid social security contributions are equal to the years of potential labor market experience.[15] Potential years to retirement differ from actual years to retirement (*YR*) because the latter are based on actual rather than potential labor market experience. By using PYR rather than YR, we isolate the variation in the working horizon induced by pension reforms from potentially endogenous changes in the length of working careers.

We illustrate the changes in the residual working horizon from 2001 to 2005 in Figure 1, where we plot PYR separately by sector (private, public, self-employment), age (42 to 51) and school leaving age (15, 17, 19, 22 or 24). We identify three groups of individuals. Following the Maroni reform, the first group experienced in 2004 a one to four years increase in minimum retirement age. The second group includes those for whom PYR did not change

[13] We define regular drinking if the individual drinks at least 1 or 2 glasses of either wine or beer per day, or if he drinks alcohol outside meals on a daily basis. Our data do not have information on binge drinking.

[14] While the measurement of behaviors such as smoking and obesity in our data is in line with standard definitions, this is not the case for exercise, drinking, nutrition and health satisfaction. For these behaviors we are constrained by data availability to use the measures described above.

[15] We compute school leaving age as the canonical number of years required to complete the highest attained school leaving age plus six – the school starting age. This variable takes the following values: 14 for individuals with a lower secondary degree; 17 for those with a short-term high school diploma; 19 for those with a regular high school degree; 22 for those with a bachelor degree and 24 for those with higher degrees. We use minimum working age (15) in place of school leaving age for those who have attained at most lower secondary education.

after the introduction of the reform. This group comprises workers who, having already accumulated many years of social security contributions had their time to retirement determined by rules based exclusively on years of contributions that were unaltered by the reform. The third group includes workers who experienced positive changes in PYR even before the Maroni reform. Since these changes were due to previous reforms, we exclude the last group from our sample.

The AVQ survey does not include information on the total years of paid social security contributions, because of the lack of data on labor market histories. Therefore, we can compute in the main dataset potential years to retirement PYR but not actual years YR. For the latter, we turn to the auxiliary sample (the SHIW survey), which includes data on (self – reported) years of paid social security contributions at the time of the interview, but has no information on health-promoting behaviors. This sample consists of 3,670 males aged 42 to 51 in 2000, 2002, 2006, for whom we can compute both PYR and YR. Although available, we do not consider data for 2004 because the date of the interview is not known and we cannot distinguish between people interviewed before or after the introduction of the reform in August 2004.

Table 1 presents the summary statistics of the main variables introduced in this section. In our main sample, average potential distance from retirement is about 10 years, and average actual distance is 14.5 years.[16] In addition, close to 20 percent of the individuals exercise regularly, 67 percent do not smoke, 43 percent do not drink alcohol regularly, 90 percent is not obese, and 19 percent are very satisfied with their health. Moreover, 83 percent do not eat red meat at least once a day, 85 percent eat fruits or vegetables at least once a day, 87 percent do not drink soft drinks at least once a day. Average school leaving age is just below 18, and the share of self-employed and public sector employees is 29 and 21 percent respectively. Finally, the percent married and with no children is 85 and 18 percent respectively.

3. The Empirical Approach

Galama et al., 2013, have recently developed a structural model of consumption, leisure, health, health behaviors, wealth accumulation and retirement decisions, using the human capital framework of health developed by Grossman, 2000. We present in the Appendix a simplified version of this model with the purpose of illustrating how changes in minimum retirement age R_{min} affect investment in healthy behaviors.

[16] This difference is due to the presence of gaps in working careers.

In the model, the health stock is in the utility function both during working life and during retirement, and also affects earnings during working life. Individuals cannot modify their health stock directly, but can invest in costly healthy behaviors, which affect current and future health. The optimal health investment before retirement equalizes marginal benefits and costs. Optimal retirement age *R* is also subject to choice, and it is jointly determined with consumption and investment in healthy behaviors.

Exogenous changes in minimum retirement age R_{min} affect only the individuals with an optimal retirement age equal to or lower than R_{min}. In the Appendix we show that a sufficient condition for an increase in R_{min} to promote investment in healthy behaviors before retirement is that the marginal benefits of better health during the additional period of active working life – in terms of higher utility and earnings – are higher than the marginal costs – in terms of the foregone benefits due to the shorter retirement period. We use this model to guide our interpretation of the empirical results.

3.1. Identification

Our research design is based on difference-in-differences. As discussed in Section 1 and shown in Figure 1, the 2004 Maroni reform modified the eligibility requirements based on minimum retirement age but left unaltered the requirements based exclusively upon the accrued years of social security contributions. As a result, some workers experienced a change in their expected working horizon, but others did not.

To illustrate with an example, consider two private sector workers (A and B) aged 50, who both have continuous working histories, but entered the labor market at different ages: worker A started working at 17 – after completing vocational secondary education – and worker B started at 24 – after completing a master degree. At age 50, their accrued years of contributions are 33 and 26 respectively. Under the pre-Maroni regime, workers A and B have a residual work horizon of 7 and 9 years. With the Maroni reform, the working horizon remains constant for worker A but increases by two years for worker B. Under both regimes, worker A can retire at age 57 after having completed 40 years of contributions. Worker B, on the other hand, can retire at 59 having paid 35 years of contribution under the former regime, but has to wait until age 61 in the new regime (see Table A1 in the Appendix).

In our setup, assignment to treatment is determined by a pension reform that we treat as an exogenous event. The example above clarifies that this assignment depends also on accrued years of social security contributions. A problem with this is that, conditional on age, sector and school leaving age (and therefore potential experience), individuals could differ in these years because of gaps in careers, for instance because of negative health events – either currently or in the past – which in turn may have occurred because of unhealthy behaviors. This generates reverse causality, as people who have experienced bad health – perhaps because of their unhealthy behaviors – tend to accumulate fewer years of contributions, and therefore have a longer work horizon.

To avoid reverse causality, we do not assign individuals to treatment on the basis of age, sector and *actual* years of contributions, but we substitute the latter with *potential* years of contribution, or potential experience, a pre-determined variable in our setup. Potential years to retirement differ from actual years to retirement because, while the latter uses actual labor market experience, the former assumes that individuals have worked continuously since completing their education.

Our difference-in-differences exercise compares changes in the adoption of healthy behaviors before and after the introduction of the Maroni reform for workers experiencing increases in PYR (the "treated" group) and workers who do not expect any increase (the "control" group), conditional on year and cell fixed effects.[17] While the former control for shocks common to all individuals observed in a given time period, the latter control for the effects of any cell specific and time invariant characteristics.

If the treated and the control group were fully comparable on every aspect, as in a randomized experiment, we could simply compare the outcomes of the two groups after the treatment took place, without the need to rely on difference-in-differences. However, in Table A2 in the Appendix we show that there are relevant compositional differences between treated and control subjects – the former are older, better educated, more likely to be public employees and less likely to be self-employed than the latter. Since we cannot give a causal interpretation to simple comparisons of the levels of the outcomes after the treatment, because they identify both the treatment effect and a selection bias term due to compositional differences, we use difference-in-differences.

[17] We include one dummy for each group of workers of the same age, who left school at the same age and work in the same sector. In total, there are 107 age-by-school leaving age-by-sector cells with more than 5 workers in our data. Of these, 62 belong to the treated group and 45 to the control group. Average cell size is 85 workers. We have dropped 18 cells with at most 5 workers. Since the change in PYR induced by the reform varies across cells defined by age, school leaving age and sector, the cell fixed effects fully determine assignment to treatment and nest the treatment indicator, a dummy equal to one if $\Delta PYR_c > 0$ and to zero otherwise. We show later in the paper that our results are unchanged when we use this indicator in place of the cell dummies.

In this research design, compositional differences are not problematic for identification, which relies *solely* on the assumption that trends in behavior would have been parallel across treatment groups had the Maroni reform not been implemented. If this is the case, any change in the outcome experienced by the treated group across the periods before and after the implementation of the reform that is not mirrored by an equivalent change experienced by the control group can be genuinely attributed to the reform. We provide evidence in support of this assumption in Section 4.

Our empirical strategy identifies the ITT effect of a reform-induced change in PYR on healthy lifestyles. An alternative approach that combines difference-in-differences with instrumental variables to estimate the causal effect of changes in the actual working horizon, YR, using PYR as instrument for YR, is precluded to us because our main dataset does not have data on actual years of social security contributions that are required to compute YR.

Actual years are available in an alternative dataset - the Bank of Italy SHIW survey – but these data do not have information on healthy behaviors. We use this alternative source to provide supportive evidence that a positive and statistically significant “first stage” effect exists between the reform-induced changes in potential years to retirement and actual years to retirement. However, since main and alternative datasets provide data for slightly different years (2001, 02, 03, 05 for the main ISTAT AVQ data; 2000, 02, 06 for the supplementary SHIW data), we refrain from estimating two-sample two-stage least square models.

3.2. Estimation

Let indexes *i*, *c* and *t* stand for individuals, cells defined by the combinations of age, school leaving age and sector of employment (private, public or self-employed), and time, respectively. Since individuals are exposed to different reform-induced changes in the residual work horizon, to maximize efficiency we consider a difference-in-differences estimator with variable treatment intensity (as done for instance by Waldinger, 2010). Treatment intensity in each cell, ΔPYR_c, is the change in potential years to retirement experienced by individuals in cell c as a consequence of the introduction of the Maroni reform.[18] Our main estimating equation is

$$B_{ict} = \alpha_c + \gamma_t + \delta X_{ict} + \beta\, 1(t \geq 2004) \times (\Delta PYR_c) + \varepsilon_{ict} \qquad (1)$$

[18] In a robustness test, we show that our estimates are qualitatively unchanged but slightly less precise when we use a simple indicator for belonging to the treated group - that is, having $\Delta PYR_c > 0$ - and discard the information on treatment intensity.

where B_{ict} is a vector of healthy behaviors, described in Section 2, α_c are age by school leaving age by sector cell fixed effects, γ_t are year fixed effects, and X_{ict} are individual predetermined covariates, also described in Section 2, that we include in our specification to increase precision. The parameter of interest is $\beta,$ the coefficient associated with the interaction of a dummy for the post-reform period, $1(t \geq 2004),$ and treatment intensity, (ΔPYR_c), that identifies the ITT effect of a reform-induced one-year change in PYR on the probability of selecting the outcome. Finally, ε_{ict} is an error term that we allow to be clustered by cell c.

We estimate equation (1) for each behavior separately. We also perform two robustness exercises: first, we consider all behaviors jointly using seemingly unrelated regressions and test whether the coefficients associated to PYR are jointly equal to zero. We strongly reject this hypothesis (p-value of the test < 0.01). Second, we use the stepdown methods for multiple testing based on re-sampling devised by Romano and Wolf, 2005, and show that the statistical significance of our estimates is mostly confirmed even when we take into account the problem of multiple testing and the consequent over-rejection of the true null hypothesis.

4. Empirical Results

4.1. First stage effect of PYR on YR

In support of the validity of our research design – based on *potential* rather than actual years to retirement – we use data from the auxiliary SHIW sample to estimate the "first stage" relationship between the reform-induced changes in potential years to retirement PYR and YR, the actual years to retirement. Table 2 reports the linear probability model estimates of Equation (1) with YR as the outcome. While estimates in Panel A control only for cell and year fixed effects, estimates in Panel B include also additional individual controls.[19] Results indicate that a one-year increase in PYR leads to about a one-third of a year increase of YR.

4.2. Intention-To-Treat (ITT) effects of PYR on healthy behaviors and health satisfaction: graphical analysis and baseline estimates

Figure 2 shows how the averages of the selected outcomes – regular exercise, no smoking, no daily drinking, no obesity and very good self-rated health – vary by treatment group (all cells are pooled) and year, with their 95% confidence intervals. We notice that the assumption of parallel trends for the treated and the control group during the pre-reform period is rather

[19] Information on type of accommodation and whether the job is physically demanding is not available in the SHIW dataset. Therefore, we omit these variables from the set of controls in these estimates.

plausible for all outcomes except smoking. For this outcome, trends diverge already in 2003, before the implementation of the reform, a fact confirmed by the estimates in Table 3. Panels A and B of the table show the results of placebo regressions based on Equation (1) and data for the pre-reform 2001-03 period, where we fictitiously anticipate the timing of implementation of the reform to 2002 and 2003, respectively. Under the hypothesis that trends are parallel, we should find that these placebo reforms have zero effects. Consistently with the graphical evidence presented in Figure 2, our estimates show that the parallel trends assumption is satisfied for both fictitious changes and for all outcomes, with the exception of smoking. For this outcome, we detect significant differences between the treated and the control group already for the period 2001-02 vs. 2003. Therefore, we refrain hereafter from commenting our estimates for smoking, as the parallel trends assumption does not hold for this outcome.

Figure 2 provides graphical evidence of positive treatment effects for regular exercise, not being obese, and being very satisfied with health. Conversely, there is no detectable effect for daily alcohol consumption. We report in Table 4 the estimated ITT effects of a one-year change in the potential minimum time to retirement PYR on the probability of exercising regularly, refraining from smoking and regular alcohol consumption, having a BMI lower than 30 and being very satisfied with own health.

These effects are estimated using Equation (1) and a linear probability model. In our preferred specification, which includes all available individual controls and is reported in Panel B, we find that a one-year increase in PYR raises the probability of exercising regularly by 3.2 percentage points, or by 14 percent of the mean outcome for the treated group before the reform. Consistently with the increase in regular exercising, we find that the probability of not being obese increases by 1.6 percentage points (or 1.8 percent). Our estimates also indicate that a higher PYR increases the probability of being very satisfied with own health by 2.7 percentage points (or 13.5 percent). These are not small effects.

Since changes in body weight are driven by the difference between calories intake and calories expenditure, we also look at the effects of changes in PYR on nutritional choices. Table 5 show that the estimated effects on the probability of refraining from eating red meat or drinking soft drinks and the probability of eating fruit and vegetables at least once a day are small and imprecisely estimated. We infer from this evidence that eating habits have not changed because of the longer working horizon.[20]

4.3. ITT effects: robustness tests

The estimated *ITT* effects presented in Table 4 are robust to several sensitivities. To begin with, as a specification test we replace the probability of not being obese with BMI. Consistently with the positive effect on the probability of not being obese, we find that a one-year increase in PYR reduces BMI by 0.65%, an effect that is statistically significant at the 5 percent level of confidence.

Additional experiments are reported in Table 6.[21] First, Panel A of the Table provides additional evidence on the robustness of our results to potential violations of the parallel trends assumption by showing that estimates are similar to the baseline even after including age-specific linear time trends.[22]

Second, Panel B shows that our results are confirmed when, instead of using age by school leaving age by sector cell-specific dummies, we adopt a more parsimonious specification that only includes a dummy for belonging to the treated group - $1(\Delta PYR_c > 0)$.

Third, we show in Panel C that our results do not change qualitatively when we substitute the treatment intensity index ΔPYR_c with a dummy for any positive change in PYR induced by the reform, that is, we estimate the effect of $1(t \geq 2004) \times 1(\Delta PYR_c > 0)$. Since the average change in PYR among the treated is close to two years, the estimated magnitudes are also comparable. However, estimates are less precise, as we discard useful information on treatment intensity.

A potential concern with our sample selection rules is that, to increase the internal validity of our research design, we have dropped from the sample the individuals belonging to cells experiencing a positive trend in PYR before the introduction of the Maroni reform, due to the implementation of previous reforms. The excluded group accounts for less than fifteen percent of the total sample (1,579 out of 10,672 total observations). The descriptive statistics

[20] We report graphs analogous to Figure 2 for the selected nutritional outcomes in Figure A1 in the Appendix. There is evidence of parallel trends before the introduction of the reform, and of absence of visible treatment effects of the reform.

[21] For brevity, the robustness tests on the outcomes presented in Table 5 are not presented here, but are available from the authors. Similarly, we only report results for the specification with all controls (see Panel B of Table 4). Results without controls are similar and available from the authors.

[22] When we try to introduce 107 cell-specific linear time trends, point estimates remain comparable but standard errors increase dramatically.

reported in Table A3 in the Appendix show that individuals in this group are older, less educated and less likely to be public employees or self-employed than workers in our selected sample.

These differences could induce one to wonder whether excluding this group from our baseline estimates improves internal validity at the cost of reducing external validity. Yet Panel D of Table 6 shows that adding the excluded group to our sample produces ITT estimates that are comparable to those in Table 4.

Another concern is that, since we are simultaneously testing effects on multiple outcomes, we may over-reject some of the true null hypotheses because of pure chance.[23] Reassuringly, as reported in Panel E of the Table 6, adjusting the p-values of our estimates for multiple testing using the stepdown method devised by Romano and Wolf, 2005, does not alter the statistical significance of our estimates for exercising and satisfaction with health. However, the statistical significance of the effect on the likelihood of not being obese declines ($p = 0.107$).

Finally, Panel F of Table 6 shows that results hold qualitatively when we restrict our sample to individuals aged 47 to 51, who are closer to retirement age. Due to the smaller sample size, however, the effect of ΔPYR_c on the probability of not being obese loses statistical significance.

4.4. Heterogeneous ITT effects

In our baseline specification, we have assumed that an increase in the working horizon has a linear effect on health behaviors. Yet the response of individuals experiencing a one-year increase in the working horizon could be smaller than that of individuals with larger changes in PYR (two years or more). Similarly, we might expect that older individuals show a stronger response to the reform, since for younger individuals there is more uncertainty around whether the regulations of the reform will still apply to them by the time they reach the relevant ages. Furthermore, since individuals working in physically demanding jobs are typically less educated and forward looking than individuals in sedentary occupations, they might respond less to the changes induced by the reform. Last but not least, responses to

[23] If a single test is performed at the 5% level of confidence and the null hypothesis being tested is true, we expect a 5% chance of incorrectly rejecting it. If N independent tests are simultaneously carried out and all corresponding null hypotheses are true, the probability of at least one incorrect rejection is $1\text{-}0.95^N$. In our case, since N=5, this probability is equal to 22.6%. Romano and Wolf, 2005, have devised a stepdown method for multiple testing based on resampling, which allows control over the Family Wise Error Rate – that is, the probability of incorrectly rejecting *one or more* true null hypothesis – and accounts for dependence across tests to improve power.

changes in PYR may change with the sector of activity (public employees, private employees and self-employed workers).

We explore nonlinearities and heterogeneous effects by allowing the parameter β in Eq. (1) to vary across different groups.[24] Starting with nonlinearities, Panel A of Table 7 shows the estimates and Figure A2 in the Appendix presents a graphical analysis of the trends in health behaviors for three different groups: those with PYR equal to 1, those with PYR higher than 1 and the control group. There is evidence that the response of exercising regularly is larger for those experiencing an increase in PYR of two or more years than for those experiencing a single year. The marginal effect on the likelihood of not being obese is also larger for the former group than for the latter, although the difference in the estimated coefficients is not statistically significant.

As reported in Panel B of Table 7, we also find that the marginal effect of changes in PYR on regular exercising and on the likelihood of not being obese is smaller for individuals in physically demanding jobs than for those in other jobs. Conversely, the marginal effect on being very satisfied with one's health is larger for the former group. However, the difference in the estimated coefficients is only significant for exercising. The smaller effect on exercising could be due to the fact that individuals in physically demanding jobs do not need to go to the gym to keep fit. An additional mechanism could be that these individuals are on average less educated than those in sedentary jobs. It is often recognized that education helps people understand intertemporal choice and delay immediate gratification for future rewards (see for instance Warner and Pleeter, 2001).

In Panel C of Table 7 we investigate whether marginal effects vary between those aged 42 to 46 and those aged 47 to 51. We find that the marginal responses of the likelihood of not being obese and of satisfaction with own health are larger in absolute value for the older age group, although the differences with the younger group are only statistically significant for health satisfaction.[25]

Finally, Panel D of Table 7 shows that the marginal responses to treatment of the likelihood of not being obese and of satisfaction with own health are larger for individuals working in

[24] Results (available from the authors) are similar when we use fully interacted models or implement split-sample estimation.

[25] When we compare marginal effects between the group aged 32 to 41 and those aged 42 to 51, we find that they are larger for the latter group for exercising, the likelihood of not being obese and satisfaction with own health. The estimated differences, however, are generally not statistically significant.

the private sector than for those in the public sector. Again, the differences in the estimated coefficients are statistically significant only for satisfaction with health.

Mechanisms explaining why healthy behaviors change in the presence of pension reforms that increase minimum retirement age include income effects – when pension benefits are lower than earnings before retirement,[26] additional years of working life raise expected lifetime earnings and the willingness to spend for the gym or for healthier food – and the need to keep healthy longer, either by exercising more or by controlling the body mass index. This need is less pressing for public sector workers, who in Italy have stronger job guarantees than private sector workers, and therefore may be less concerned with preserving their health in order to work longer. While the former mechanism applies to all workers, the latter applies mainly to private sector employees and the self-employed.

Our empirical results do not produce conclusive evidence in favor of either mechanism. On the one hand, we find that the impact of a longer residual work horizon on exercising regularly does not vary across sectors, in line with the higher lifetime income hypothesis. On the other hand, the impact on the likelihood of weighting below obesity and of being satisfied with own health is larger for private sector workers, as suggested by the need to keep fit hypothesis. The estimated differences across sectors, however, are not always statistically significant.

Conclusions

While much research has been devoted to establishing whether and how retirement affects the health of retired individuals, less has been done to understand whether policy measures that alter the length of the residual working horizon affect health and healthy behaviors before retirement.

Using a difference – in – differences approach, we have estimated the effects of postponing minimum retirement age on the healthy behaviors and self-reported health before retirement of several cohorts of middle aged Italian working men during the period 2001 to 2005, before and after a pension reform that increased both minimum retirement age and the expected residual working horizon.

We have found that a one-year increase in the potential time to retirement, which differs from actual time because it is computed using potential rather than actual labor market experience,

[26] According to the OECD, 2007, the net replacement rate in Italy in the early 2000 was 77.9 percent for males with mean incomes.

has raised the likelihood of exercising regularly by 14 percent and the probability of having a BMI below obesity by 1.8 percent with respect to the pre-reform average outcomes. Considering that potential time to retirement has increased in our sample by about 2 years between 2001 and 2005, these effects are not small. Since the post-reform period includes only one year, they capture the short-term responses to policy changes. Whether these responses survive in the medium run is an important question that we cannot answer with the current research design.

We have also found that changes in potential time to retirement have had no statistically significant effects on drinking habits and on the available measures of nutritional choices. We infer from this that the decline in the probability of being obese is associated to higher exercising rather than to healthier nutritional choices. Consistently with these findings, we have also estimated a positive effect on self-reported high satisfaction with health.

Our finding that regular exercise responds to economic and financial incentives is not new in the empirical literature. Mitchell et al, 2013, conduct a meta-analysis of empirical studies that have investigated the impact of financial incentives on exercise related behaviors in the US. They report that incentives have significant and positive effects on exercise in eight of the eleven studies they consider. Qualitatively similar conclusions are reached by Dishman et al, 2009, in their evaluation of the *Move to Improve* intervention in the US, and by Eibich, 2015, who uses German data to show that an important mechanism by which retirement affects health is an increase in physical activity.

Previous literature has used cross-country differences in retirement ages and found potential positive effects of retirement on health. An implication of this literature is that delaying retirement could have negative effects on health after retirement. The key contribution of this paper is to show that there are also positive effects, which occur before retirement, and are induced by the anticipation of a longer residual working horizon. Because of these positive effects, retiring individuals are likely to start their retirement with a higher stock of health, which could compensate at least in part for the expected decline after retirement.

Over the last decades, nearly all European countries have increased their early and statutory retirement ages. While our study refers to Italy, we believe that the widespread introduction of similar reforms elsewhere in Europe increases its potential relevance beyond the specific national institutions. Given the pressure of ageing societies, most countries are likely to further raise retirement ages in the future well above the threshold of 60 years introduced by the Maroni reform. When this happens, the pool of individuals with an average potential distance from retirement close to 10 years is going to be somewhat older than the one considered in our research. However, since we have found little evidence that marginal responses to changes in the residual working horizon vary significantly with age, it seems unlikely that we are grossly under-estimating future responses.

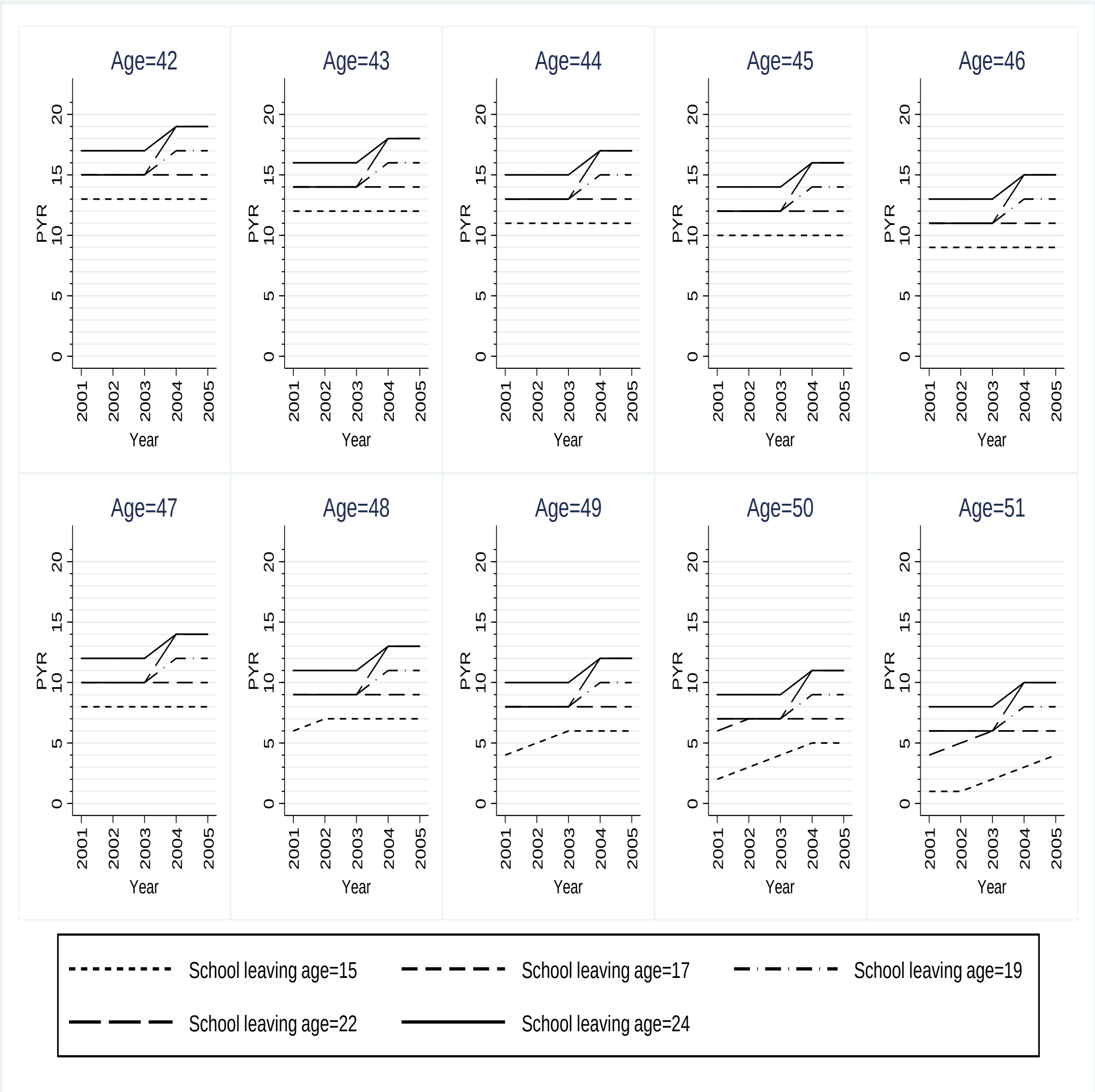
By delaying retirement and by increasing the residual working horizon of employed individuals, pension reforms may reap unexpected dividends. We have shown that one such dividend could be better health before retirement, as constrained individuals react to the longer expected horizon by investing in healthy behaviors such as regular exercise. Better health before retirement may generate important savings to private and public expenditure, and these savings should be accounted for when evaluating the overall impact of pension reforms.[27]

[27] One might argue that the adoption of healthy behaviors could increase longevity. However, given the abundant empirical evidence supporting the "compression on morbidity" hypothesis – see e.g. Felder et al., 2010 – we do not expect that a longer life will lead to increased health expenditure, as the relevant determinant of health expenditure is time-to-death, not age per se.

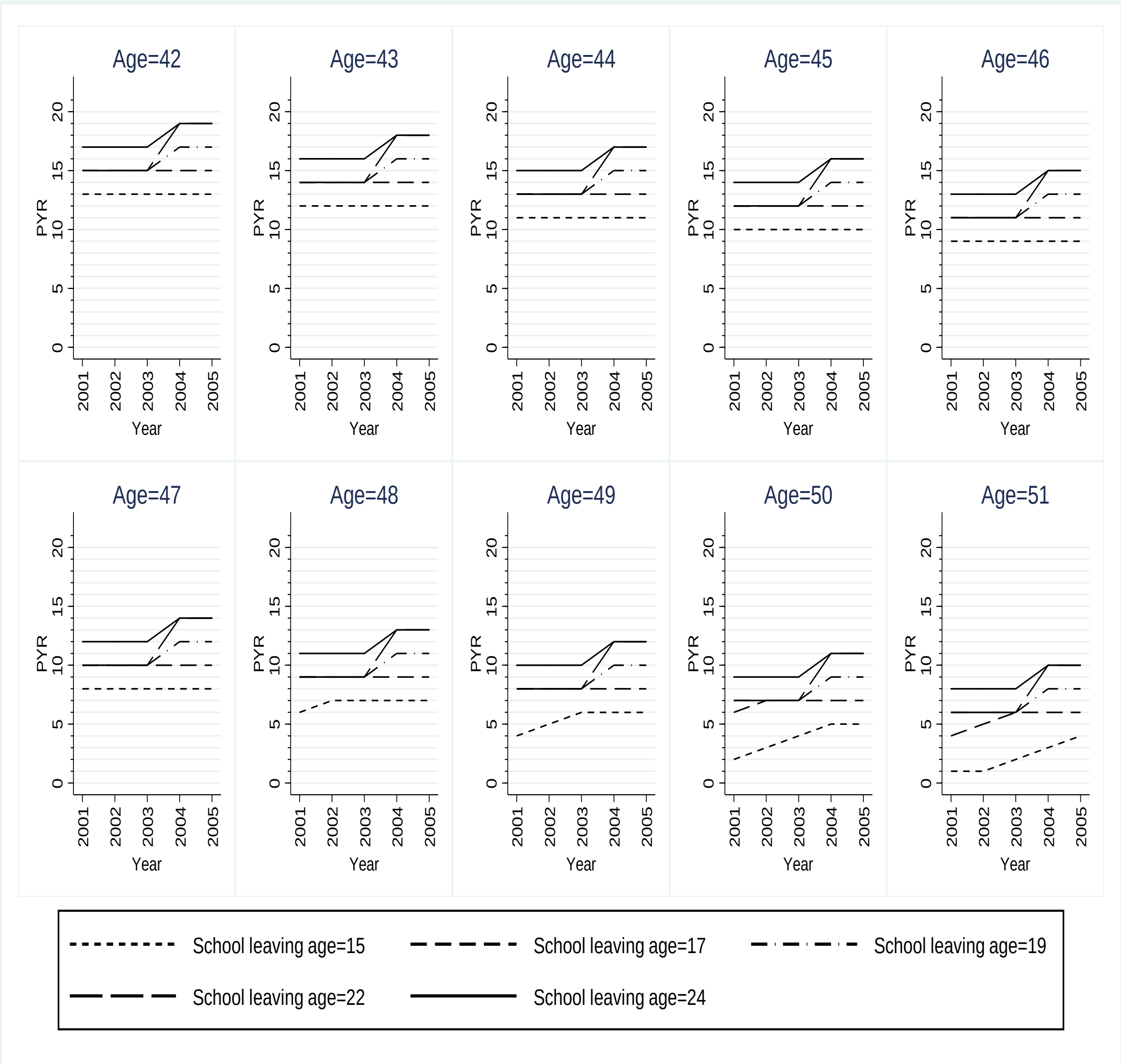
Figures and Tables

Figure 1. Changes in PYR over time, sector of activity, age and school leaving age.

a. Private sector employees



b. Public sector employees



c. Self-employed

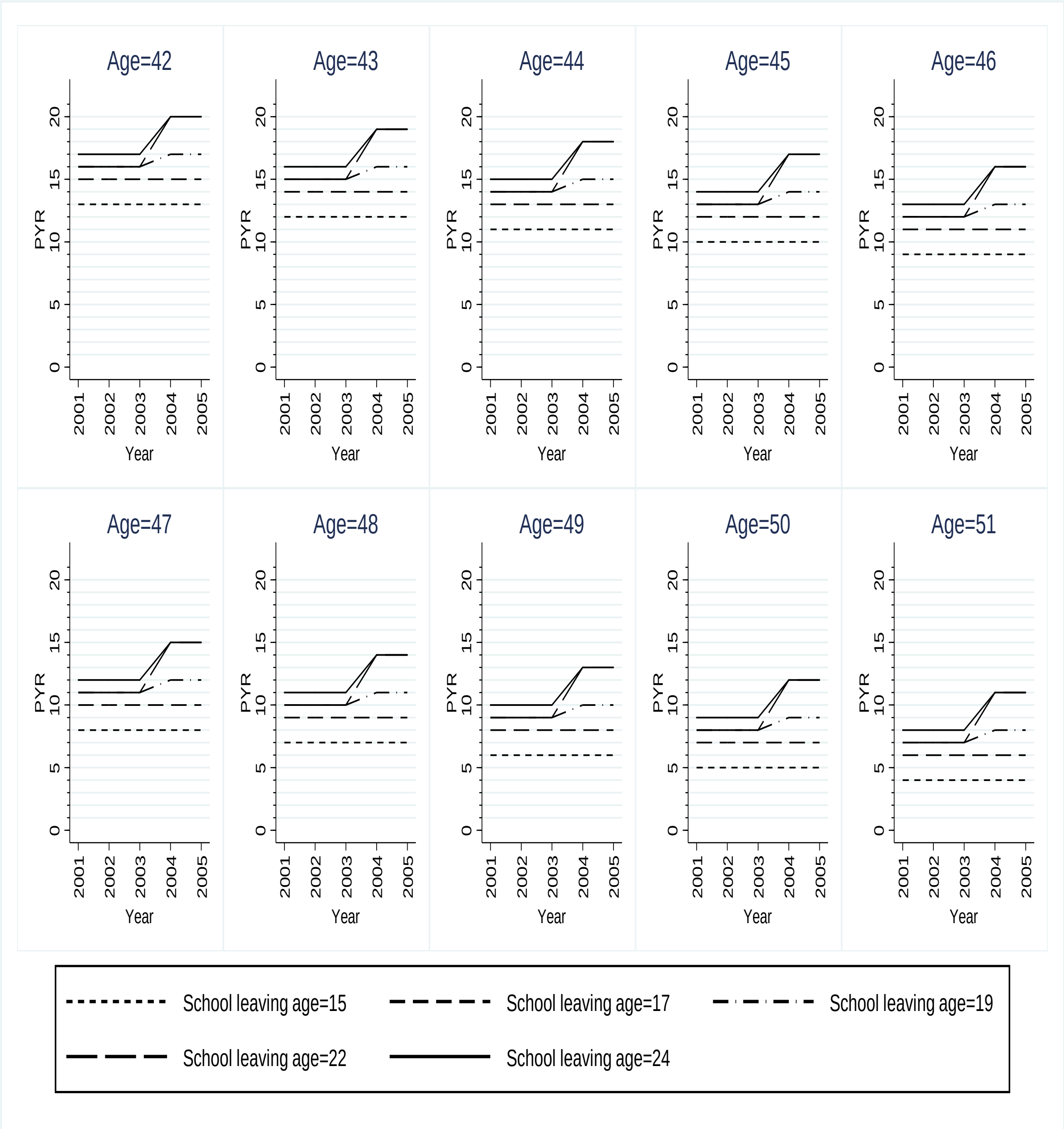
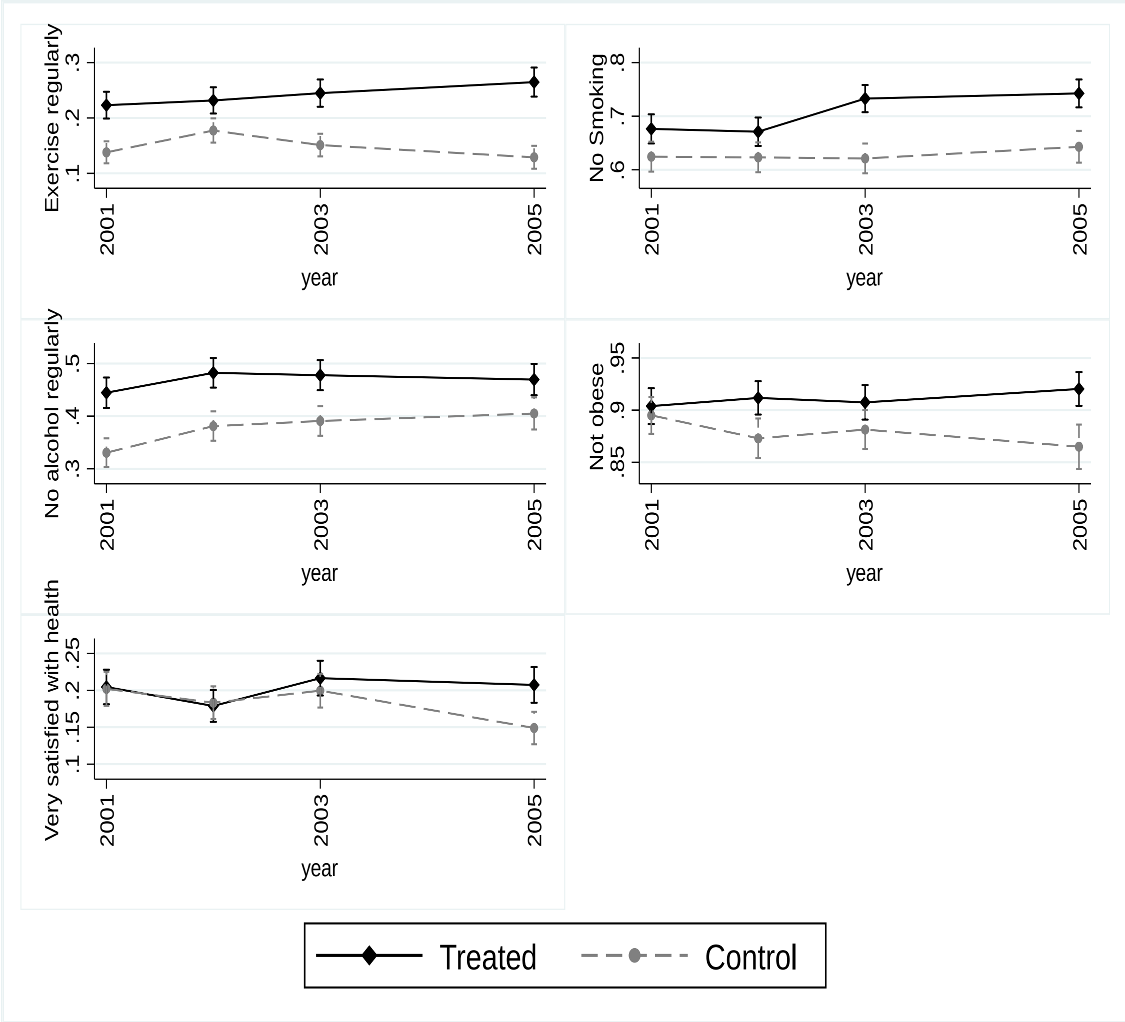


Figure 2. Healthy behaviors and very high health satisfaction by year and treatment group



Notes: the figure reports the mean value of each healthy behavior and of health satisfaction, by treatment group and year.

Table 1. Descriptive statistics

	Mean	Std. Dev.
YR	14.50	4.75
PYR	10.88	2.95
Outcomes:		
Exercises regularly	0.20	0.40
Does not smoke	0.67	0.47
Does not drink alcohol regularly	0.43	0.49
Not obese	0.90	0.31
Very satisfied with health	0.19	0.39
Does not eat red meat at least once a day	0.83	0.38
Eats fruit or vegetables at least once a day	0.85	0.36
Does not drink soft drinks at least once a day	0.87	0.33
Other covariates:		
Age	45.85	2.71
Survey year	2002.6	1.45
Birth year	1956.8	3.06
School leaving age	17.81	2.98
Public employee	0.22	0.42
Self-employed	0.34	0.48
No kids	0.18	0.38
Married	0.85	0.35
Works in physically demanding job	0.29	0.45

Notes: Data on YR are from the Bank of Italy SHIW survey – 2000/06; data on the remaining variables are from the ISTAT AVQ survey – 2001/05. Both samples include male workers aged 42 to 51 who do not have missing values in the variables used in the analysis and belong to cells with no change in PYR during 2001 to 2003. Total number of observations in SHIW: 3,670. Total number of observations in AVQ: 9,093. YR is the actual work horizon, or the number of years before becoming eligible to retire according to the rules in place at the time of the interview and using the observed number of years of social security contributions. PYR is the potential work horizon, computed using the potential number of years of social security contributions. The excluded occupational sector is "private employee". Descriptive statistics are not reported for the type of accommodation (6 categories) and macro-area of residence (northern, central or southern Italy).

Table 2. The effect of the reform - induced increase in potential years to retirement (PYR) on actual years to retirement (YR). OLS estimation. Linear probability model.

	(1)
	Actual years to retirement (YR)
Panel A. With age by school leaving age by sector dummies and year dummies	
Reform induced	0.292***
increase in PYR	(0.110)
Panel B. Panel A + additional controls	
Reform induced	0.274***
increase in PYR	(0.103)
Mean of outcome, treated group, before 2004	13.70

Notes: the table reports the estimated effects of a one-year reform induced change in PYR on actual years to retirement (YR). Bank of Italy SHIW data for years 2000, 2002, 2006. Total number of observations: 3,760. All models include cell (age by school leaving age by sector) dummies and survey year dummies. Additional controls are: macro-area dummies, a dummy for having kids, a dummy for being married. Standard errors clustered by cell in parentheses. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level

Table 3. Placebo estimates to test the assumption of parallel trends. OLS estimation – linear probability models.

	(1)	(2)	(3)	(4)	(5)
	Exercise regularly	No Smoking	No alcohol regularly	Not obese	Very satisfied with health
Panel A: Moving the introduction of the reform from 2004 to 2002					
Reform induced increase in PYR	-0.007 (0.009)	0.009 (0.011)	-0.012 (0.013)	0.008 (0.008)	0.001 (0.010)
Panel B: Moving the introduction of the reform from 2004 to 2003					
Reform induced increase in PYR	0.015 (0.011)	0.026** (0.010)	-0.013 (0.009)	-0.003 (0.007)	0.009 (0.010)

Notes: the table reports the estimated effects of a one-year reform-induced change in *PYR* on the outcome listed at the top of each column when we fictitiously move the introduction of the reform to 2002 (Panel A) or 2003 (Panel B). Only data for the pre-reform period are used. Total number of observations: 7,013. All models include cell (age by school leaving age by sector) dummies and survey year dummies. Additional controls are: macro-area dummies, a dummy for having kids, a dummy for being married, a dummy for working in a physically demanding job, dummies for type of accommodation. Standard errors clustered by cell in parentheses. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.

Table 4. ITT effects of a reform-induced increase in potential years to retirement (PYR) on healthy behaviors. OLS estimation – linear probability models.

	(1)	(2)	(3)	(4)	(5)
	Exercise regularly	No Smoking	No alcohol regularly	Not obese	Very satisfied with health
Panel A. With cell (age by school leaving age by sector) dummies and year fixed dummies					
Reform induced increase in PYR	0.032*** (0.007)	0.008 (0.010)	-0.013 (0.010)	0.017** (0.008)	0.029*** (0.009)
Panel B. Panel A + additional controls					
Reform induced increase in PYR	0.032*** (0.007)	0.076 (0.010)	-0.0130 (0.010)	0.016** (0.008)	0.027*** (0.009)
Outcome mean, treated group, before 2004	0.23	0.69	0.46	0.91	0.20

Notes: the table reports the estimated effects of a one-year reform-induced change in *PYR* on the outcome listed at the top of each column. Total number of observations: 9,093. All models include cell (age by school leaving age by sector) dummies and survey year dummies. Additional controls are: macro-area dummies, a dummy for having kids, a dummy for being married, a dummy for working in a physically demanding job, dummies for type of accommodation. Standard errors clustered by cell in parentheses. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.

Table 5. ITT effects of a reform-induced increase in potential years to retirement (PYR) on indicators of nutritional habits. OLS estimation – linear probability models.

	(1) No red meat at least once a day	(2) Fruit or vegetables at least once a day	(3) No soft drinks at least once a day
Panel A. With age by school leaving age by sector dummies and year fixed dummies			
Reform induced increase in PYR	-0.002	0.006	0.006
	(0.010)	(0.009)	(0.007)
Panel B. Panel A + additional controls			
Reform induced increase in PYR	-0.002	0.006	0.005
	(0.010)	(0.009)	(0.007)
Outcome mean, treated group, before 2004	0.87	0.86	0.89

Notes: the table reports the estimated effects of a 1-year reform-induced change in *PYR* on the outcome listed at the top of each column. Total number of observations: 9,093. All models include cell (age by school leaving age by sector) dummies and survey year dummies. Additional controls are: macro-area dummies, a dummy for having kids, a dummy for being married, a dummy for working in a physically demanding job, dummies for type of accommodation. Standard errors clustered by cell in parentheses. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.

Table 6. The effects of potential years to retirement (PYR) on health behaviors. Robustness tests.

	(1)	(2)	(3)	(4)	(5)
	Exercise regularly	No Smoking	No alcohol regularly	Not obese	Very satisfied with health
Panel A. Includes age-specific time trends					
Reform induced increase in PYR	0.032***	0.009	-0.013	0.016**	0.024***
	(0.007)	(0.010)	(0.010)	(0.008)	(0.009)
Panel B. Replaces age by school leaving age by sector cell dummies with a dummy equal to 1 for those belonging to the treated group - $1(\Delta PYR_c > 0)$ – and to 0 otherwise. .					
Reform induced increase in PYR	0.032***	0.017	-0.006	0.017**	0.023**
	(0.007)	(0.010)	(0.010)	(0.008)	(0.010)
Panel C. Replaces treatment intensity with a dummy equal to 1 for those belonging to the treated group - $1(\Delta PYR_c > 0)$ – and to 0 otherwise					
$1(t \geq 2004) \times 1(\Delta PYR_c > 0)$	0.058***	0.025	-0.030	0.031*	0.054***
	(0.015)	(0.021)	(0.022)	(0.017)	(0.018)
Panel D. Includes also individuals belonging to cells with positive changes in PYR in the pre-reform period (N=10,672)					
Reform induced increase in PYR	0.031***	0.010	-0.016*	0.013*	0.023**
	(0.007)	(0.011)	(0.009)	(0.007)	(0.009)
Panel E. Adjusts p-values for multiple hypothesis testing using Romano and Wolf (2005) stepdown method					
Reform induced increase in PYR	0.032***	0.076	-0.0130	0.016	0.027**
	p<.001	p=0.439	p=0.304	p=0.107	p=0.012
Panel F. Considers only workers aged 47-51 (N=3,536)					
Reform induced increase in PYR	0.029**	-0.005	-0.016	0.017	0.042**
	(0.012)	(0.013)	(0.013)	(0.011)	(0.017)

Notes: the table reports the estimated effects of a one-year reform-induced change in *PYR* on the outcome listed at the top of each column. Total number of observations: 9,093. All models include cell (age by school leaving age by sector) dummies and survey year dummies. Additional controls are: macro-area dummies, a dummy for having kids, a dummy for being married, a dummy for working in a physically demanding job, dummies for type of accommodation. Standard errors clustered by cell in parentheses. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.

Table 7. Heterogeneous effects of potential years to retirement (PYR) on healthy behaviors. OLS estimation. Linear probability model.

	(1)	(2)	(3)	(4)	(5)
	Exercise regularly	No Smoking	No alcohol regularly	Not obese	Very satisfied with health
<u>*Panel A*</u>. Non-linear effects by the size of the reform-induced change in PYR					
$\Delta\, PYR_c = 1$	0.007	0.041	-0.032	0.023	0.056*
	(0.025)	(0.031)	(0.053)	(0.028)	(0.023)
$\Delta\, PYR_c \geq 2$	0.072***	0.023	-0.032	0.033*	0.053***
	(0.015)	(0.022)	(0.020)	(0.017)	(0.019)
Test of difference in the coefficients (p-value)	*0.020*	*0.585*	*0.991*	*0.695*	*0.918*
<u>*Panel B.*</u> Heterogeneous effects by type of job (physically demanding or not)					
Physically demanding jobs	0.008	0.020	-0.010	0.011	0.042**
	(0.015)	(0.020)	(0.014)	(0.014)	(0.019)
Other jobs	0.035***	0.005	-0.013	0.017**	0.025**
	(0.007)	(0.010)	(0.010)	(0.007)	(0.010)
Test of difference in the coefficients (p-value)	*0.074*	*0.488*	*0.893*	*0.620*	*0.421*
<u>*Panel C.*</u> Heterogeneous effects by age					
Aged 42 to 46	0.033***	0.017	-0.022*	0.013	0.011
	(0.009)	(0.014)	(0.013)	(0.009)	(0.009)
Aged 47 to 51	0.030***	-0.003	-0.004	0.020**	0.044***
	(0.009)	(0.012)	(0.011)	(0.008)	(0.013)
Test of difference in the coefficients (p-value)	0.849	0.194	0.197	0.395	0.012
<u>*Panel D.*</u> Heterogeneous effects by sector of employment					
Public sector	0.033***	-0.002	-0.017	0.012	0.020*
	(0.011)	(0.016)	(0.014)	(0.009)	(0.011)
Private sector (including self-employed)	0.031*** (0.008)	0.012 (0.011)	-0.011 (0.010)	0.018* (0.008)	0.031*** (0.011)
Test of difference in the coefficients (p-value)	*0.849*	*0.194*	*0.197*	*0.395*	*0.012*

Notes: the table reports the estimated heterogeneous effects of a one-year reform-induced change in *PYR* on the outcome listed at the top of each column. Total number of observations: 9,093. All models include cell (age by school leaving age by sector) dummies and survey year dummies. Additional controls are: macro-area dummies, a dummy for having kids, a dummy for being married, a dummy for working in a physically demanding job, dummies for type of accommodation. Standard errors clustered by cell in parentheses. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.
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Appendix

1. An illustrative model

Following Galama et al., 2013, we consider an individual in his forties who intends to spend his residual lifetime partly at work and partly in retirement. In each period before retirement, his utility is given by

$$U_{wt} = U_w(C_t, H_t) \quad \text{(A.1)}$$

where *C* is consumption and *H* is the health stock in period *t*.[28]

Let B_t be a strictly positive measure of health investment (or healthy behavior) and p_t its unit cost.[29] For instance, this investment can be an healthy diet or physical exercise. The relationship between health and health investment is given by the following law of motion

$$\frac{\partial H_t}{\partial t} = \mu B_t - \sigma H_t \quad \text{(A.2)}$$

By increasing B_t, the individual can compensate the natural decay of health. Using (A.2) we can write health at time *t* as a function of initial health and of the entire history $0 \leq t' < t$ of health investment $B_{t'}$

$$H_t = H_0 e^{-\sigma t} + \int_0^t \mu B_x e^{-\sigma(t-x)} dx \quad \text{(A.3)}$$

In the optimization problem, we consider the entire prior history of health investment $B_{t'}$ (Galama et al., 2008, p.5), that affect current health.

Denoting assets with A_t, the inter-temporal budget constraint is given by

$$\frac{\partial A_t}{\partial t} = \delta A_t + Y(H_t) - C_t - p_t B_t \quad \text{(A.4)}$$

[28] Leisure is assumed equal to L_0 during work and to τL_0 during retirement, with $\tau > 1$. The utility function is separable so that $U(C_t, H_t, L_0) = g(L_0)U(C_t, H_t) = U_w(C_t, H_t)$ during work, and $U(C_t, H_t, \tau L_0) = g(\tau L_0)U(C_t, H_t) = U_r(C_t, H_t)$ during retirement. Letting $\gamma = \frac{g(\tau L_0)}{g(L_0)} > 1$, $U_r = \gamma U_w(C_t, H_t)$, where $\gamma > 1$ indicates that "…a dollar with leisure – while retired – is better than a dollar that is only had together with work…" (Stock and Wise, 1990, p.213).

[29] We broadly interpret the unit cost as including both monetary and non-monetary costs. We assume that there are no corner solutions in the optimal choice of health investments. See Galama et al., 2013, for a discussion.

where income Y is equal to yearly earnings $W(H_t)$ before retirement and to Γ (pension benefits) after retirement. $W(H_t)$ is an increasing and concave function of *H*, the health stock. Better health affects earnings both by raising productivity and by increasing the probability of being gainfully employed. As in Galama et al., 2013, we do not distinguish further between these two channels.

Changes in minimum retirement age R_{min} affect individual choice only if R_{min} is binding, that is, if optimal retirement age is lower than or equal to R_{min}. We shall focus on this case. Moreover, we shall only consider the optimization problem faced by the individual before his retirement, as this is the situation studied in the current paper. The individual chooses consumption and healthy behaviors to maximize the following inter-temporal utility

$$\max_{C_t, B_t} \int_s^{R_{min}} [U_{wt}(C_t, H_t)] e^{-rt} dt + \int_{R_{min}}^{T} [\gamma U_{wt}(C_t, H_t)] e^{-rt} dt \qquad \text{(A.5)}$$

subject to (A.3) and (A.4), where T denotes total lifetime, that we assume to be independent of health, as in Galama et al., 2013, *s* is initial age and *r* is the interest rate. Following Galama et al., 2008, this is equivalent to maximizing

$$\max_{C_t, B_t} \int_s^{R_{min}} [U_{wt}(C_t, H_t)] e^{-rt} dt + \int_{R_{min}}^{T} [\gamma U_{wt}(C_t, H_t)] e^{-rt} dt$$

$$+ \lambda_0 \int_s^T [\delta A_t + Y(H_t) - C_t - p_t B_t] e^{-\delta t} dt \qquad \text{(A.6)}$$

where $\lambda_t = \lambda_0 e^{-\delta t}$ is the co-state variable associated to (A.4).

The first order necessary condition for optimal $B_{t'}$ when $t' \le R_{min}$ is

$$\int_{t'}^{R_{min}} [\frac{\partial U_{wt}}{\partial H_t} \frac{\partial H_t}{\partial B_{t'}}] e^{-rt} dt + \int_{R_{min}}^{T} [\gamma \frac{\partial U_{wt}}{\partial H_t} \frac{\partial H_t}{\partial B_{t'}}] e^{-rt} dt$$

$$-\lambda_0 \int_{t'}^{T} \left[p_t - \frac{\partial Y(H_t)}{\partial H_t} \frac{\partial H_t}{\partial B_{t'}} \right] e^{-\delta t} dt = \phi(B_{t'}, C_{t'}, \lambda_0, R_{min}, p_t) \qquad \text{(A.7)}$$

For consumption, the first order condition is

$$\frac{\partial U_{wt'}}{\partial C_{t'}} - \lambda_0 e^{(r-\delta)t'} = 0 = \chi(B_{t'}, C_{t'}, \lambda_0) \qquad \text{(A.8)}$$

Finally, by differentiating (A.7) with respect to λ_0 we obtain

$$\int_{s}^{T}[\delta A_t - C_t - p_t B_t]e^{-\delta t}dt + \int_{s}^{R_{min}}[Y(H_t)]e^{-\delta t}dt$$

$$+ \int_{R_{min}}^{T}[\Gamma_t]e^{-\delta t}dt = \theta(B_{t'}, C_{t'}, R_{min}) = 0 \qquad \text{(A.9)}$$

At the optimum, health investment when $t' \leq R_{min}$ equalizes the marginal benefits during both active working life $\int_{t'}^{R_{min}}[\frac{\partial U_{wt}}{\partial H_t}\frac{\partial H_t}{\partial B_{t'}}]e^{-rt}dt$ and after retirement $\int_{R_{min}}^{T}[\gamma\frac{\partial U_{wt}}{\partial H_t}\frac{\partial H_t}{\partial B_{t'}}]e^{-rt}dt$ to the net marginal costs $\lambda_0\int_{t'}^{T}[p_t - \frac{\partial Y(H_t)}{\partial H_t}\frac{\partial H_t}{\partial B_{t'}}]e^{-\delta t}dt$.

Since the contribution of health to wages ends with retirement, we can re-write (A.7) as follows

$$\int_{t'}^{R_{min}}[\frac{\partial U_{wt}}{\partial H_t}\frac{\partial H_t}{\partial B_{t'}}]e^{-rt}dt + \lambda_0\int_{t'}^{R_{min}}\frac{\partial Y(H_t)}{\partial H_t}\frac{\partial H_t}{\partial B_{t'}}]e^{-\delta t}dt$$

$$+ \int_{R_{min}}^{T}\left[\gamma\frac{\partial U_{wt}}{\partial H_t}\frac{\partial H_t}{\partial B_{t'}}\right]e^{-rt}dt - \lambda_0\int_{t'}^{T} p_t e^{-\delta t} = \phi(B_{t'}, C_{t'}, \lambda_0, R_{min}, p_t)$$

Totally differentiating (A.7), (A.8) and (A.9) with respect to $R_{min}, B_{t'}, C_{t'}$ and λ_0 we obtain

$$\phi_1 dB_{t'} + \phi_2 dC_{t'} + \phi_3 dR_{min} + \phi_4 d\lambda_0 = 0$$
$$\chi_1 dB_{t'} + \chi_2 dC_{t'} + \chi_3 d\lambda_0 = 0$$
$$\theta_1 dB_{t'} + \theta_2 dC_{t'} + \theta_3 dR_{min} = 0$$

where $\phi_i = \frac{\partial\phi}{\partial Z_i}$, $\chi_i = \frac{\partial\chi}{\partial Z_i}$ $\theta_i = \frac{\partial\theta}{\partial Z_i}$ and Z is either for R_{min} or for $B_{t'}$, λ_0 and $C_{t'}$.

By Cramer's rule, we get that

$$\frac{\partial B_{t'}}{\partial R_{min}} = \frac{\phi_3\theta_2\chi_3 + \theta_3(\chi_2\phi_4 - \chi_3\phi_2)}{\Delta} \qquad \text{(A.10)}$$

where the determinant of the bordered Hessian Δ is positive because of the second order conditions. We know that χ_3, θ_2, χ_2 and ϕ_4 are negative and that θ_3 is positive. Assuming that ϕ_2 is also positive, the second term on the right hand side of (A.10) is positive. Since $\theta_3 = (Y(H_t) - \Gamma_t)e^{-\delta t}$, this term is the effect of a higher minimum retirement age on health behaviors that operates via higher income. The sign of $\frac{\partial B_{t'}}{\partial R_{min}}$ depends on the sign of ϕ_3. A sufficient condition for this sign to be positive is

$$\phi_3 = \lambda_0 \frac{\partial Y(H_{R_{min}})}{\partial H_{R_{min}}} e^{(r-\delta)R} - \frac{\partial U_{wR_{min}}}{\partial H_{R_{min}}}(\gamma - 1) > 0$$

In words, postponing minimum retirement age increases optimal healthy behaviors before retirement if the benefits of a longer working life induced by better health are higher than the costs in terms of leisure due to a shorter retirement period. Since the second term on the right hand side of the above expression is positive, a sufficient condition for healthy behaviors to increase with minimum retirement age is that better health before retirement positively affect earnings, for instance because it increases the probability of being gainfully employed.

2. Figures and Tables

Figure A1. Nutritional behaviors by year and treatment group

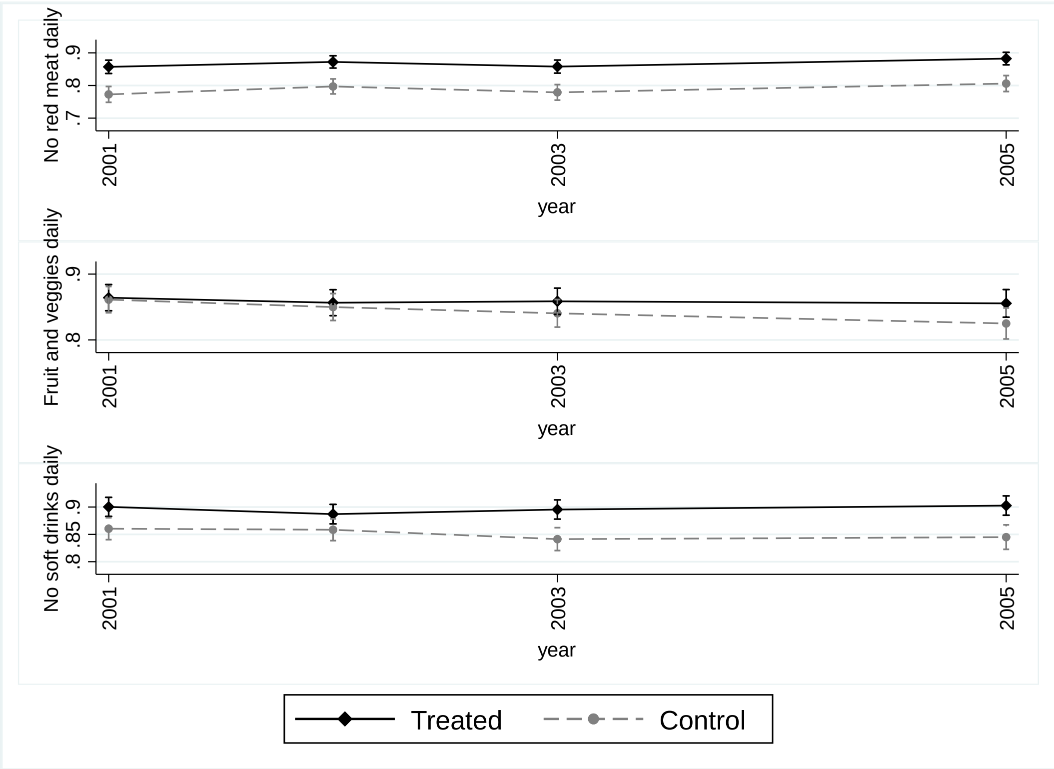

Figure A2. Healthy behaviors and very high health satisfaction by year and treatment intensity

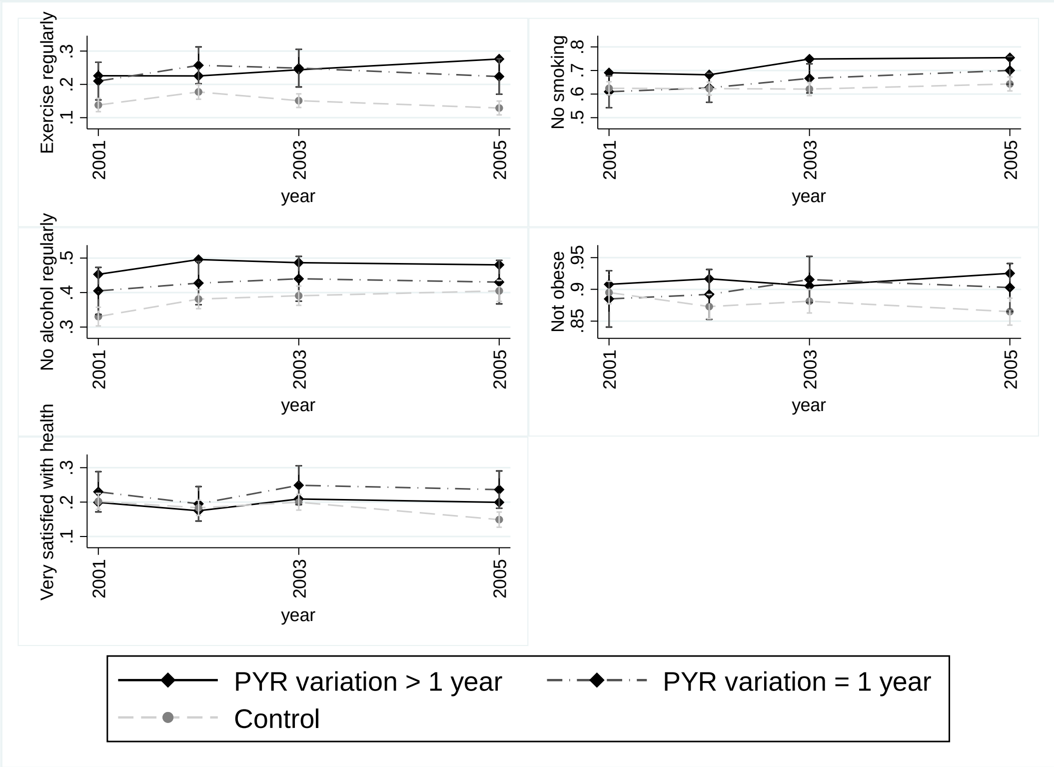

Table A1. Seniority pension eligibility, Italy 2004-2007

a. Maroni reform, August 2004.

Sector:	Private		Public		Self-employed	
Retirement year:	Age & YContr	Only YContr	Age & YContr	Only YContr	Age & YContr	Only YContr
2004	57&35	38	57&35	38	58&35	40
2005	57&35	38	57&35	38	58&35	40
2006	57&35	39	57&35	39	58&35	40
2007	57&35	39	57&35	39	58&35	40
2008	60&35	40	60&35	40	61&35	40
2009	60&35	40	60&35	40	61&35	40
2010 onwards	61&35	40	61&35	40	62&35	40

b. “Prodi bis” reform, December 2007. Years of application: 2008 onwards

Sector:	Private		Public		Self-employed	
Retirement year:	Age & YContr & (Age+ YContr)	Only YContr	Age & YContr & (Age+ YContr)	Only YContr	Age & YContr & (Age+ YContr)	Only YContr
2008	58&35	40	58&35	40	59+35	40
2009	59&35&95	40	59&35&95	40	60+35, 96	40
2010	59&35&95	40	59&35&95	40	60+35, 96	40
2011	60&35&96	40	60&35&96	40	61+35, 97	40
2012	60&35&96	40	60&35&96	40	61+35, 97	40
2013 onwards	61&35&97	40	61&35&97	40	62+35, 98	40

Notes: The requirement in terms of (age+ YContr) only applies since 2009. YContr: minimum number of years of contributions.

Table A2. Differences between treated and control group

	(1) Treated group	(2) Control group	(3) Difference (1) – (2)
Age	46.34	45.35	0.99***
School leaving age	20.30	15.29	0.99***
Public employee	0.33	0.11	0.22***
Self-employed	0.28	0.41	-0.13***

Notes: See Table 1 in the main text. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.

Table A3. Differences between subjects in the sample and subjects excluded for having positive changes in PYR in the pre-reform period

	(1) Final sample	(2) Excluded group	(3) Difference (1) – (2)
Age	45.85	49.60	-3.75***
School leaving age	17.82	15.13	2.69***
Public employee	0.22	0.19	0.03**
Self-employed	0.35	0	0.35***

Notes: See Table 1 in the main text. ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level.

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