A life change for the better? The health consequence of retirement.

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Abstract

This paper aims at assessing the total effect of retirement on individual health status by focusing on the causal mechanism through which retirement operates on individuals' health. Specifically, lifestyle is suggested to be a mediator channel in the causal chain that associates retirement and individual health status, which can potentially either exacerbate or ameliorate the retirement direct effect. To this end, we use four waves of the SHARE data for ten different European countries. Within a pathway model framework, we show that the total retirement effect nests the indirect one, which runs through the lifestyle channel. Our identification strategy exploits the exogenous variations of the normal and early retirement ages over time and across countries to instrument the retirement status and its duration. All the models are estimated using FE-IV to control for potential reverse causality, varying and time-invariant unobservables that may cause selection into retirement. The overall total effect of retirement is found to be detrimental for general, mental, and cognitive health. Besides, retirement is associated with an overall negative effect on the probability of being engaged in physical activity; an overall beneficial effect on the probability of abusing of alcohol, and a beneficial long-term effect on BMI level. Moreover, we show that the overall indirect effect running through lifestyle exacerbates the detrimental long-term effect of retirement. The models are correctly identifying the status retirement effect and its duration, given that our robustness analysis shows their stability. Heterogeneity effects are found between ERA and NRA compliers: SAH is more endangered after retirement in NRA subsample while cognitive health seems more affected in ERA compliers sample. Besides, the female sample shows a stronger negative effect on cognitive health. Heterogeneity is also detected in size and sign in some IE. Lifestyle changes induced by retirement seems to be particularly beneficial for female cognitive health.

Keywords: *Retirement; Lifestyle; Health; Instrumental Variables; Mediation Analysis*
JEL: *I12, J14, J26*

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1. Introduction

The achieved progress in the health field have improved the increase in life expectancy since the 19th century, and consequently, the global population is ageing rapidly. (DuGoff et al., 2014; OECD/EU, 2016). In European countries, the transition from work to retirement takes place mostly between ages 50 and 69 and affects around 80% of the population. The employment rate for individuals aged 50-69 is around 49%, lower than the rate for workers aged 25-49. However, although the high variability across the countries, on average 16% of old-age pensioners continue working mostly due to financial distress.[1]As a result of these trends, the financial sustainability of pension systems faces a significant challenge in most of the countries. The share of individuals exiting the labour market increases, the time spent in retirement enlarges, and as a consequence, the share of the working population decreases, adding long-run concerns and pressure on governments. Moreover, many incentive schemes of public pension systems have led to early retirement (e.g. In Europe, the highest proportions were reported in Italy (74%), Ireland (69%) and Spain (60%) and the lowest in Bulgaria (5%), the Czech Republic (5%) and Estonia (11%) (Eurostat, 2014)). On the basis of these issues, politicians have started to adjust the *Normal Retirement Ages* and *Early Retirement Ages* (henceforth *NRA* and *ERA*) at which workers can retire and obtain a public pension, to the increase in life expectancy. If from one side, this motivates studies on the financial sustainability of country-specific financial systems (Gruber and Wise, 1998), from the other side it motivates a growing interest in studying the potential effects of retirement on individual well-being, especially in terms of health. Indeed, if detrimental effects on health individual status due to the raising of *ERA* and *NRA* are proven, the financial sustainability of health systems is challenged.

Scholars have been devoting special attention to the association between the role of the health status on the retirement decision for a while. There is an extensive amount of studies on this topic, which provide evidence of a significant effect of the health status on the retirement choice and the early exit from the labour market (Bound et al., 1999; Disney et al., 2006; Roberts et al., 2010; Jones et al., 2010). Retirement is also well recognised as one of the major life-shock that an individual can experience, which affects many habits. For instance, there is substantial evidence of a drop in consumption, and an increase in health care utilisation (Battistin et al.,

[1]EU labour force survey (LFS), Data 2014. Eurostat

2009, Lucifora and Vigani, 2018).

More recently, the health economic literature has been focusing on the effect of retirement on health outcomes, without finding common empirical results. This strand of literature directs attention towards physical health, measured with both subjective (e.g. self-assessed health) and objective (e.g. specific chronic conditions, physical limitations) indicators, mental health indicators (e.g. Euro-D scale), and cognitive abilities (e.g. memory test score).[2]

A first explanation of the mixed results is based on the fact that the health of workers is related to the job characteristics in several ways (e.g. Mazzonna and Peracchi, 2016). Moreover, working conditions may induce unhealthy habits that may further decrease labour productivity and may induce retirement choice (e.g. early retirement). A second explanation is based on the Grossman theoretical framework and the change in investing in health. Indeed, Dave et al. (2008) argue that lifestyle is the channel through which retirement influence health outcomes, namely inducing changes in physical activities and social interaction. Eibich (2015) finds that the retirement effect on health changes when health behaviours are included in the health status function. Thus, the research suggests that by changing lifestyle behaviours, retirement may raise new incentives to invest in health or vice versa.

These differing findings might also relate to retirement definition adopted, sample selection, the health outcome chosen, and the empirical methodology. This gives scope to further investigate mechanisms through which retirement operates on health. However, research focusing on the mechanisms beneath the effect of retirement on health has been sparse.

This paper adds to the empirical health economic literature that links retirement to health and lifestyle, studying within a mediation analysis framework the decomposition of the retirement effect to detect the indirect effect that runs through mediator variables, namely the lifestyle. The goal is twofold, to estimate the status and the long term effects on several health outcomes, and to investigate and identify the mediation role played by the health-related behaviours in the relationship between retirement and health status.

We use the longitudinal data of the Survey of Health, Aging and Retirement in Europe (SHARE) to estimate a model of health and retirement for ten countries. The main empirical challenge is addressing the endogeneity of retirement on individual health status or health-related behaviours.

[2] E.g. Bonsang et al. (2012), Celidoni et al. (2017), Coe and Zamarro (2011), Mazzonna and Peracchi (2012, 2016) and many others.

The relationship between health and retirement may be potentially characterised by reverse causality, given that poor health may induce early retirement because of job inability. Besides, as health-related behaviours strictly interact with health, reverse causality is also likely to affect the retirement association with lifestyle. In addition, the presence of unobservable time-invariant and varying factors (e.g. time preference, personal traits, genetic make-up) may also bias the estimation of the effect of retirement on health outcomes.

Our identification strategy relies on the use of instrumental variables to identify the retirement effect on health status, coupled with the pathway analysis to identify the mediation effect of lifestyle.[3]Furthermore, we address the endogeneity issue exploiting the exogenous variation over time and across gender, type of job and countries of *NRA* and *ERA*. Besides, a fixed effect estimator is used to account for individual-specific unobserved heterogeneity.

The overall total effect of retirement is found to be detrimental for general, mental, and cognitive health. Besides, retirement is associated with an overall negative effect on the probability of being engaged in physical activity; an overall beneficial effect on the probability of abusing of alcohol, and a beneficial long-term effect on BMI level. Moreover, we show that the overall indirect effect running through lifestyle exacerbates the detrimental long-term effect of retirement. The models are correctly identifying the status retirement effect and its duration, given that our robustness analysis shows their stability. Heterogeneity effects are found between ERA and NRA compliers: SAH is more endangered after retirement in NRA subsample while cognitive health seems more affected in ERA compliers sample. Besides, the female sample shows a stronger negative effect on cognitive health. Heterogeneity is also detected in size and sign in some *IE*. Lifestyle changes induced by retirement seems to be particularly beneficial for female cognitive health. The analysis suggests that additional investigations on past occupational status might help for the defining the lifestyle role on specific sub-sample.

The rest of the study is structured as follows: Section 2 outlines the salient literature. Section 3 sketches the conceptual framework of the empirical model. Section 4 describes the data and explains the most relevant variables. The identification strategy and the issues of the empirical model are illustrated in Section 5. Section 6 displays the results of the econometric analysis. Section 7 concludes.

[3]See Tubeuf et al. (2012) the causal path applied to analysis on health, early life condition, lifestyle, and education.

2. Retirement and Health

In health economics literature, many empirical papers focus on the effect of retirement on several health outcomes. Cognitive abilities are found to be particularly endangered post-retirement. Bonsang et al. (2012) show that retirement exerts a detrimental effect on cognitive test scores. Motegi et al. (2017) detect negative or no overall effect on cognitive abilities in the short run, and a detrimental effect for obese workers. Celidoni et al. (2017) find a detrimental effect on cognitive functioning as well, especially when one retires at the full statutory age. Contrarily, Coe, Gaudecker et al. (2012) find a positive relationship for blue collar workers, indicating heterogeneity across different occupation. Thus, although there is no common empirical evidence on the mental-exercise literature, working, especially not physically demanding jobs, appears to decelerate the process of cognitive decline (Salthouse, 2006, Rohwedder and Willis, 2010). Other studies have shown that transition into retirement might be associated with a reduction in daily activities, contact with peers and lack of purpose, which in turn affects individuals' well-being and mental health. For instance, Mazzonna and Peracchi (2012, 2016) find a detrimental long-tern effect of retirement on general and mental health, which leads to a worsening of who worked in physically demanding jobs. Conversely, Heller-Sahlgren (2017) detects no short-term effect and a negative long-term effect on mental health. However, the physical and mental health status may be threatened in case of physically demanding occupation and when workers are exposed to working conditions that might affect their physical and mental health such as safety, rotation shifts, excess of overtime hours, lack of job satisfaction, job worries, lack of support from colleague (Robone et al., 2011, Cottini, Ghinetti et al., 2011, Cottini and Lucifora, 2013). If this is the case, one would expect a beneficial effect on both physical and mental health because it eliminates work-related stress and pressure. Indeed, Barnay and Defebvre (2018) find a beneficial effect on depressive episodes; Coe and Lindeboom (2008) find no negative effect of early retirement on men's health. Findings in Belloni et al. (2016) indicate mental health improvement for men after retirement. Leimer (2017) shows a long-term preserving effect on several health outcomes, like self-assessed health, mobility limitations and so forth; likewise Apouey et al. (2017) provides evidence of a higher probability of having unexpected positive health shocks for males after retirement. On the other hand, Behncke (2012) shows that retirement significantly increases the risk of being diagnosed with chronic condition.

Although the aforementioned studies lead to mixed evidence, they seem to suggest the crucial role played by lifestyle in the beneath mechanism of retirement on health. Moreover, Dave et al. (2008), Eibich (2015), and Atalay et al. (2019) discuss in their studies that a secondary channel through which the retirement effect may run is the lifestyle and the use of the leisure time. Nevertheless, if it is guaranteed that retiring means more leisure time, the fact that individuals would make good use of it by investing in health (e.g. having healthy habits, maintaining social network) it is not assured. The positive role of lifestyle on health status is well-established (e.g. Contoyannis and Jones, 2004) but contrarily to other research fields, the economic literature only provides little empirical investigation on the retirement effect of lifestyle.

2.1. Retirement and Lifestyle

In public health studies, Zantinge et al. (2013) offer a complete review of the effect of retirement on health-related behaviours, although they do not discuss the endogeneity issues. In health economics, only a few studies focus on the association between retirement and lifestyle.

Godard (2016) gives empirical evidence of a 12-percentage point increase in the probability of being obese among men within a 2/4 year period after early retirement. Besides, the study suggests that the result is driven by men retiring physically demanding occupation. Celidoni and Rebba (2017) find that the probability of not practising any activities decreases after retirement, and this effect is stronger for higher educated individuals. Bertoni et al. (2018) show, instead, a short-term protective effect of retirement on muscle strength that is not persistent. Other studies investigate how retirement affect partner's behaviours. For instance, a study by Bertoni et al. (2018) shows how postponing retirement ages stimulates engagement in physical activity, reducing obesity and increasing self-reported satisfaction with health. Another work by Müller and Shaikh (2018) study the response to partner's retirement, finding a significant decrease in physical activities and increases in alcohol consumption.

What emerges from empirical analysis, likewise the relationship between health and retirement, is unclear. From a theoretical perspective, there is no *a priori* assumption on the change in lifestyle once exiting the labour market. Within the Grossman framework, individual health demand is considered a choice variable because it is a source of utility. The health stock level determines the healthy days useful to work, earn income, consume other goods, and enjoy leisure time (Grossman, 1972). Therefore, an agent will invest in health (e.g. through healthy lifestyles and health care utilisation), to the purpose of maximising individual utility. Consequently, the optimal level of health investment is chosen at any time, depending on economic incentives, individual time preference, future expectations, and personal traits.

When becoming a retired, a person may lose the incentive to invest in health because pension replaces the salary and she no longer needs to earn money. Nevertheless, individuals should keep extracting utility from their healthy days even though they lose the monetary incentive thanks to the pension. In fact, one would still expect some level of health investment as opposed to the natural depreciation of the health capital, namely the ageing effect on health.

Thus, the retirement mechanism that operates on the demand for health capital is uncertain. On the one hand, if the individual discount time rate is low, one would expect more investment in health through an increase in healthy behaviours to enjoy more the leisure time (e.g. gain more time to spend with family). On the other hand, a high discount rate for the future would presumably drop the health investment because of the lack of economic incentive (e.g. consuming less healthcare and more bads).

Empirical works as the one by Eibich (2015) gives the intuition on an beneath mechanism of retirement and health in which lifestyle plays the mediator role. Indeed, lifestyle has been recognised more than once as a mediator in effects on health (e.g. Tubeuf et al., 2012, Giorgio Brunello et al., 2016).

In this light, if one aims at investigating the causal path between retirement and health status, one should focus on the mediation role of lifestyle in the causal chain. The status and long-term effect of retirement might both induce changes in lifestyle. Therefore, to understand the total effect on health, one should follow its path through the lifestyle channel.

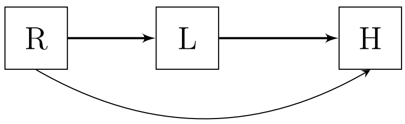
For instance, the elimination of work-related stress might convince a person to quit smoking. If it is the case, one would expect an increase in the probability of having good health due to the elimination of the work pressure, coupled with an additional increase induced by having quitted smoking. The former can be defined as the *direct* effect of retirement, whereas the latter the *indirect* one. Besides, the direct impact of retirement on health and lifestyle is likely to be strictly related to previous job conditions. Especially in psycho-social demanding jobs, thanks to the protective role of work, one would expect a higher investment rate to have more healthy days and stronger opposition to the natural decline in cognitive abilities. As a consequence of exiting the labour force, although the direct effect of leaving the job might be detrimental, the total effect might be mediated by an indirect preserving effect through a healthier lifestyle.

3. Mediation analysis for the retirement effect on health

In this section, we present a model in which lifestyle mediates the impact of retirement on health status within an instrumental variable framework.

The *causal path* model aims to unravel the beneath causal mechanism into an effect running through *mediators*, and through other ways. Mediation analysis literature states that if the mediator and the treatment are exogenous, one can estimate the relationship of the causal path by means of OLS (Robins and Greenland, 1992). If it is not the case, standard IV estimators are not able to unpack the *causal chain*. A range of empirical studies, instead, relies on IV settings for identification (e.g. Frölich and Huber, 2017), but requiring separate instrument for treatment and mediator. More recently, Dippel et al. (2019) develop a mediation model with a single instrument, which exceeds, given some assumptions, the bound of standard IV setting in disentangling the causal chain.

This work proposes a mediation model adapting the approach of Tubeuf et al. (2012) by using the same set of instruments both for the lifestyle and retirement. The type of causal chain might be summarised by the following diagram:



The graph denotes the relationship between *retirement (R)*, *lifestyle (L)* and *health status (H)*. In a mediation analysis framework, one can identify:

- A *Total Effect (TE)* of R on H, namely the total variation of the health outcome due to retirement
- A *Direct Effect (DE)* of R on H, namely the health outcome variation, keeping constant the lifestyle
- An *Indirect Effect (IE)* of R on H, namely the health outcome variation due to the lifestyle variation

Within a general non parametric framework, the causal chain can be written as follows: :

$$
\begin{aligned}
R &= r(\mathbf{L}, \mathbf{v}, \mu) \\
L &= l(\mathbf{R}, \mathbf{X}, \mathbf{u}, \mu) \\
H &= h(\mathbf{R}, \mathbf{L}, \mathbf{X}, \mathbf{e}, \mu)
\end{aligned} \tag{1}
$$

where **R** is the vector of the retirement indicators, which may have different impacts on health status and lifestyle. Previous works describe the retirement effect either as the mere retirement status or a composite effect of the status condition, the time-cumulative impact and the transition effect, which may differ from the cumulative effect.[4] Specifically, this transition impact might be seen as the *honey moon* effect.[5] In this work, we follow Mazzonna and Peracchi (2016) focusing on status and cumulative effect. The vector **L** denotes a set of health-related behaviours, namely mediators, that captures the individual investment in health. The vector **X** represents a set of observable time-invariant and varying individual specific controls, such as age, marital status, household income, and education level. Finally, we split the unobserved heterogeneity between **e**, the *i.i.d* residual terms and μ, the heterogeneity that may be related to other characteristics and determine selection into health, retirement and lifestyle.
Under linearity, the mediator equation is defined as:[6]

$$L = \delta R + u \tag{2}$$

where δ is the effect of retirement on lifestyle.[7] The equation for health is:

$$H = \beta_1 R + \gamma L + e \tag{3}$$

Substituting 2 into 3 we get:

$$
\begin{aligned}
H &= \beta_1 R + \gamma(\delta R + u) + e \\
H &= (\beta_1 + \gamma\delta)R + \gamma u + e
\end{aligned} \tag{4}
$$

[4]See Mazzonna and Peracchi (2016); Celidoni et al. (2017)

[5]Celidoni et al. (2017) suggest the existence of the honeymoon effect, contrarily to Leimer (2017)

[6]For the sake of clarity, below we omit the subscript referring to individual and time, and the control vector of all the notations.

[7]For convenience, here we assume lifestyle as if it was a single indicator. We extend to four indicators in our empirical analysis

$$H = \lambda R + \gamma u + e \tag{5}$$

where λ is the *TE* of retirement. If we indicate $\epsilon = \gamma u + e$, we would refer to the usual health equation used in literature to estimate the retirement effect.[8] When rather estimating a model of the health status, including L, β_0 is capturing the *DE* of retirement:

$$H = \beta_0 R + \phi L + e \tag{6}$$

Thus, to identify the *IE* of retirement or rather, the mediating effect, one should be able to isolate the $\gamma\delta$ that comes from 2 and 5.

Therefore, we define a linear model fo the link between health and retirement as:

$$\begin{aligned} R &= aZ + v_1 \\ TimeR &= bZ + v_2 \\ L &= \delta_1 R + \delta_2 TimeR + u \\ H &= \beta_1 R + \beta_2 TimeR + \gamma \hat{u} + e \end{aligned} \tag{7}$$

The *overall* retirement effect is split into the variable R that indicates the absorbing status of exiting the labour market, whereas $TimeR$ captures the long term effect of spending time in retirement. The overall effect of retirement has to be seen as the sum of the two coefficients. **Z** denotes the set of instruments that determines R and $TimeR$. In L equation, δ_1 and δ_2 refer to the overall effect of retirement on lifestyle. Finally, in the health equation, H, β_1 and β_2 indicate the total effect of retirement; $\hat{u}$ denotes the predicted error term of lifestyle equation and γ is the mediating coefficient that has to be multiply to δ_1 and δ_2 to compute the *IE*.

Thus, our identification strategy relies on the standard IV setting such as:

$$Z \perp (v, u, e) \tag{8}$$

that holds in the mediation model for retirement and health. Under 8, **Z** is a valid set of instruments in a IV setting and makes possible the identification of $\delta_1, \delta_2, \beta_1, \beta_2$, and γ.

[8] See Section 5 for an extensive analysis of all the endogeneity issues linked to the association of health, retirement, and lifestyle.

4. Data

In this section, we firstly describe the data of the empirical analysis and our sample selection criteria. Secondly, we present our main variables and some summary statistics.

4.1. SHARE and sample selection criteria

In this paper, we carry out the empirical analysis using the data from the release 6 of SHARE, which is a multidisciplinary survey including individuals aged at least 50 at the first interview, coming from 20 European country, and Israel .[9] The standard questionnaire includes questions on health, socio-economic status, social and family network and life history of the participants. The third wave, namely SHARELIFE, completely diverges and it is dedicated to the life history; likewise the seventh incorporates both the standard and retrospective questionnaires. Although the availability of seven waves, we pick first, second, fourth, and fifth waves due to missing essential questions for our analysis.

The whole period covers thirteen years whereas the chosen waves regard a time-span of nine years. The selected countries are Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden and Switzerland. As expected in longitudinal data, the attrition rate is significant. Therefore, we consider both baseline and refreshment individuals.

Departing from other works, we only keep records of individuals who declare to be retired, employee and self-employed, observed at least in two continuous waves.[10] The selection avoids confounding effects due to the comparison with permanent sick, home-maker, and unemployed individuals. In fact, the formers never entered in the labour market, and the latter might confound the retirement effect. We also restrict the age window between 50 and 75 to contain ageing effect on poor health and mortality selection. Thanks to these criteria, we observe both the absorbing status of being retired, the transition into the retirement of the individuals who retire during the waves, and the cumulative retirement time.[11] Table 1 provides the sample size by country and wave. Our final sample is composed by 18,308 individuals who stayed in the

[9] In the first wave, all household members had to be born 1954 or earlier. From the second, the age boundary is set only for the selected respondent, although all members are asked to answer.

[10] The sample selection strictly depends on the retirement definition.

[11] We also drop from the sample all the individuals who change from retired to employed, because by definition the status never changes.

survey at least two consecutive waves.

Table 1 about here.

4.2. The definition of retirement

Starting from Lazear (1986), there have been several definitions of the retirement status, and each targets a different sample of individuals. Given the significant impact of observable and unobservable confounders, we focus on the status and long-term effect of retirement on previous workers. Therefore, we only consider who is or has been part of the labour force. Hence, an individual is retired if she 1) declares to be retired and 2) declares not to have had paid jobs in the previous four weeks.[12]. Another inclusion criterium is to have been in labour force at age 50, to avoid noise linked to outlier early-retired. Table 2 presents the sample by tenure status and gender. The self-declared retired, *SD Retired*, are almost 55% of the sample, but according to the adjusted definition, *Retired*, they reduce to 47%. Males tend to have spent slightly more time in retirement than female. *Employed*, which comprise information both on employed and self-employed, is 46% of the sample.[13]

Table 2 about here.

4.3. The health outcomes

We apply our model to three different indicators of health status, indicating physical (general), mental, and cognitive health. The indicators of health stock used in the literature are several. Self-assess health (SAH) is commonly exploited as an indicator of general health, defined as a binary variable that indicates *good health* or as an ordered variable generally evaluated by a 5-point scale from 1 to 5 (*excellent, very good, good, fair, poor*). More objective ways of measuring health, instead, look at single diseases, but they are far to be a general health indicator. Figure 1 displays a bar chart for SAH by retirement status. While the employed distribution is right-skewed, the retired one is left-skewed, indicating that, on average, working individuals declared to be healthier than who is retired.

[12] See also Celidoni et al. (2017); Mazzonna and Peracchi (2016); Behncke (2012)

[13] In the rest of the paper, *retired* would always refer to our definition.

Figure 1 about here.

Regarding mental health, the SHARE database offers the Euro-Depression scale as one of the indicators of mental health.[14] It is a 12-points scale variable, constructed by summing all the contributing items by each. The items are sadness or depression; pessimism; suicidal thoughts; guilt; sleep trouble; lack of interest; concentration; appetite; irritability; fatigue; enjoyment and tearfulness. Table 3 reports some statistics on health outcomes. The average score of the Euro-D scale is 1.88. Retired individuals report more depression items than non-retired, with an average score around 2. Thus, we generate a dummy to measure the probability of suffering from mental health problem after retirement. It takes 1 if the Euro-D scale is larger than 4, which is the common threshold used in literature indicating depression . As shown in Table 3, the share of the depressed individuals is higher among the retired (10%).

The last outcome is built on the basis of the three main variables used to measure the cognitive ability level, which are numeracy, fluency, and memory test scores. The numeracy test consists of a set of numerical calculations (e.g. *If the chance of getting a disease is 10 per cent, how many people out of 1,000 (one thousand) would be expected to get the disease?*) and measures the respondents' mathematical performance. The memory indicator is a 10-words recall test, which aims at assessing cognitive impairment and dementia. The fluency indicator is a test of executive function. Respondents are asked to say as many animals as possible in 60 seconds. On the basis of the neuropsychology literature, we decide to drop the outliers in verbal fluency from the records. The original test score goes from 0 to 100, we cut above 45 and slightly reduces the sample size when using the cognitive indicator in the econometric analysis.[15] Table 3 displays also the main descriptive statistics also of the single cognitive indicators.

To comprise the information of the three different cognitive information, we apply the principal component analysis (PCA) to have a single index of individual cognitive abilities. PCA has been already applied several times to exploit the information of cognitive and non-cognitive test in other works on return to education and wage differentials (e.g. Cawley et al., 2001). All the three test report higher average score for non retired than retired, likewise the cognitive index.

Table 3 about here.

[14]Blazer, 2002; Larraga et al., 2006; Prince et al., 1999.

[15]See also Mazzonna and Peracchi (2016).

4.4. The health-related behaviours

Regarding bad lifestyle, we pick indicators of smoking, drinking, engagement in physical activity, and BMI level. Smoking habit is defined by two binary variables that take 1 if the individual is a current or former smoker, respectively denoted by *Smoker* and *Ex-Smoker*. *BMI* is a dummy that takes 1 when the body mass index (BMI) is higher than 30. Although the BMI variable is not describing a behaviour, we choose the indicator as a proxy of a unhealthy diet. *No activities* is a dummy that takes 1 when the person declares never or seldom practising activities that require at least a moderate level of energy. In SHARE, the alcohol consumption is mainly recorded in terms of drinking days and number of drinks when the individual drinks. To the purpose of building a proxy of excessive alcohol consumption, we construct an indicator of alcohol abuse merging the two different information. Therefore, *Alcohol Abuse* is a dummy that takes 1 if the individual declares to drink at least 5/6 days per week and more than 2 drinks each time her drinks. Table 4 reports the statistics on health-related behaviours. The prevalence of smokers is higher among non-retired, while the retired are more ex-smokers. The share of individuals non engaged in physical activity is higher for retired, likewise for the presence of obese individuals. At last, the incidence of alcohol abuse is higher among retired.

Table 4 about here.

5. Empirical model

In this section, we discuss our identification strategy and present our empirical model. We contribute to the literature with exploiting four waves of SHARE data, providing a first cross-country analysis that focuses on unravelling the direct and indirect effect of retirement on several health outcomes, considering the lifestyle as the mediating channel in the causal path. To this end, we estimate the models for lifestyle and retirement (*Mediator Model*), and the models for health and retirement (*Outcome Model*), adding the error terms of mediators as described in 7.

5.1. Model specification

The *Mediator Model* is estimated by means of the following 2SLS-FE:

$$\begin{aligned}
R_{it} &= \delta_1 AboveERA_{it} + \delta_2 AboveNRA_{it} + \delta_3 DistNRA_{it} + \delta_4 DistERA_{it} + \beta X_{it} + \tau_t + v_{it} \\
TimeR_{it} &= \gamma_1 AboveERA_{it} + \gamma_2 AboveNRA_{it} + \gamma_3 DistNRA_{it} + \gamma_4 DistERA_{it} + \beta X_{it} + \tau_t + e_{it} \\
L_{ijt} &= a_j R_{it} + b_j TimeR_{it} + bX_{it} + u_{ijt} \\
with\ & i = 1, ..., N; t = 1, ..., 4; j = 1, ..., 5.
\end{aligned} \tag{9}$$

where L_{ijt} is the vector of the j health-related behaviours, namely Smoker, Ex-Smoker, Alcohol Abuse, BMI, and No Activities, for each individual i at any wave t. As remarked in Section 3, the retirement is divided into the status, R_{it}, and long-term effects, $TimeR_{it}$. The overall impact is meant to be the sum of the two associated coefficient. In fact, it is more likely that the status effect might change during the retirement years. Ignoring the long-term effect may be one of the reasons for the previous mixed results of the literature, and at last, the heterogeneity may rely on the indirect effect running through the lifestyle channel as well. For instance, if the indirect effect exists and is beneficial, the gained leisure time might encourage more physical activity, better diet, stress reduction, enlarging or mitigating the direct effect. The set of instruments is denoted by $AboveERA_{it}$, $AboveNRA_{it}$, $DistERA_{it}$, and $DistNRA_{it}$. Other controls are age, the logarithm of the household income level, being married, living alone, the number of children, and grandchildren, indicated by X_{it}, and τ_t that denotes the interview date fixed effect.

The *Outcome Model* is estimated, instead, evaluating the following model:

$$\begin{aligned}
R_{it} &= \delta_1 AboveERA_{it} + \delta_2 AboveNRA_{it} + \delta_3 DistNRA_{it} + \delta_4 DistERA_{it} + \beta X_{it} + \gamma_{jk}\hat{u}_{ijt} + \tau_t + v_{it} \\
TimeR_{it} &= \gamma_1 AboveERA_{it} + \gamma_2 AboveNRA_{it} + \gamma_3 DistNRA_{it} + \gamma_4 DistERA_{it} + \beta X_{it} + \gamma_{jk}\hat{u}_{ijt} + \tau_t + e_{it} \\
H_{ikt} &= \beta_{2k} R_{it} + \delta_{2k} TimeR_{it} + \gamma_{jk}\hat{u}_{ijt} + \lambda_k X_{it} + \tau_t + \epsilon_{ikt} \\
with\ & i = 1, ..., N; t = 1, ..., 4; j = 1, ..., 5; k = 1, ..., 3.
\end{aligned} \tag{10}$$

where H_{ikt} are the k health outcomes for each individual i at any wave t. The *Outcome Model* specification differs from the *Mediator Model* only for $\hat{u}_{ijt}$, which are the residual terms of L_{ijt} equations that are no longer including any retirement effect.

Based on 4 and 5, the coefficients associated to *Retired* and *TimeR* indicate the *TE* of retirement and are composed by the *DE* plus the sum of each health-related behaviour *IE*, as follows:

- $\beta_{2k} = (\beta_{1k} + \gamma_{1k}a_{1k} + \gamma_{2k}a_{2k} + \gamma_{3k}a_{3k} + \gamma_{4k}a_{4k} + \gamma_{5k}a_{5k})$ is the total effect of *Retired*;

- $\delta_{2k} = (\delta_{1k} + \gamma_{1k}b_{1k} + \gamma_{2k}b_{2k} + \gamma_{3k}b_{3k} + \gamma_{4k}b_{4k} + \gamma_{5k}b_{5k})$ is the total effect of $TimeR$.

5.2. Identification issues

The main empirical identification challenge is addressing the endogeneity of retirement on individual health status or health-related behaviours. Within our framework, retirement and its duration are clearly endogenous variables, therefore standard OLS estimators will lead to bias estimations.

In fact, the relationship between health and retirement may be potentially characterised by reverse causality, given that poor health may induce retirement because of job inability. Besides, as health-related behaviours strictly interact with health, reverse causality is also likely to affect the retirement association with lifestyle. Another source of bias is the potential correlation of retirement and the unobserved heterogeneity. Indeed, the presence of unobservable time-invariant and varying factors (e.g. time preference, individual personal traits, genetic make-up) may bias the estimation of the effect of retirement on health outcomes.

Therefore, to the end of addressing the endogeneity issues, we use the FE to deal with unobserved invariant heterogeneity, and model our analysis through the IV estimator to correct for the reverse causality and time-varying unobservables. As already recognised by literature as a good instrument for retirement decision, we exploit the exogenous variation over time, across countries, gender, and type of job of the change in the laws of retirement ages. Thanks to the cross-country variation, we are able to disentangle the age effect to the retirement duration comparing individual that at the same age are allowed to retire in some countries but not others. The ERA and NRA have been reconstructed using mixed sources.[16]These are the OECD reports(2007-2015), the MISSOC[17] tables updated at January 2018, and the country-specific social security systems. We have always excluded the rules for ERA due to specific diseases. The appendix provides the details for every country.

In order to instrument our endogenous regressors, we construct four variables, $AboveERA_{it}$ and $AboveNRA_{it}$, which are the dummies that indicate respectively whether the person is above the minimum eligibility and the statutory age, and $DistanceNRA_{it}$ and $DistanceERA_{it}$ that

[16]Although SHARE already provides a specific module for the job history with ERA and NRA of the respondents of the first two waves, we prefer including also wave and refreshment after the third wave to observe a longer period. For that reason, we manually reconstruct the ERA and NRA years for each age and country.

[17]Mutual Information System on Social Protection

are the distance in years to/from ERA and NRA.

- $AboveERA_{it} = \mathbb{I}[Age_{it} \geq Age_{it}^{ERA}]$
- $AboveNRA_{it} = \mathbb{I}[Age_{it} \geq Age_{it}^{NRA}]$
- $DistERA_{it} = Age_{it} - Age_{it}^{ERA}$
- $DistNRA_{it} = Age_{it} - Age_{it}^{NRA}$

Table 5 reports the summary statistics of the overall sample. The share of the sample above ERA is 62% while above NRA is 44%. Given the fact we keep in our sample both individuals who were already retired and who retire during the survey, we can exploit a greater variability of retirement ages.

Table 5 about here.

Figure 2 and 3 show the distributions respectively for male and female of ERA and NRA by country. The red bars indicate the NRA and the empty-black ones the ERA. Although ages 60 and 65 are thresholds for almost every country, the variability arises due to the differences in periods, years of contributions, job sector, gender (especially for ERA).

Figures 2 and 3 about here.

To ensure our results are robust to any endogeneity issue related to age and our set of instrument, we test our model with different age specification. Indeed, we let age differ for each country, to avoid any correlation with country-specific education system and pension eligibility ages (Bingley and Martinello, 2013).

Endogeneity problems can also arise with the inclusion of the lifestyle indicators as regressors in the health outcome equations. FE estimation ensures to control for all the time invariant unobservable factors that may correlate with lifestyle. Moreover, controlling for being married should be taking into account also selection factors into lifestyle, as marriage appears to play a preserving role on health status. Married individuals tend to be happier, less susceptible to psychological disorders, wealthier, and generally more prone at investing in health (Espinosa and Evans, 2008).

Another identification issue might be related to high attrition rates, which is not atypical in surveys. To the purpose of controlling the robustness of our model, we estimate also using the balance sample, which strongly reduce the sample size.

6. Results

In this section, we estimate the *Outcome* and *Mediator Models* to disentangle *IE* from the the *TE* of retirement. Thus, we check the robustness of our model, and finally, look for some heterogeneity effects.

6.1. The retirement effect on health

The estimation results of *Mediator Models* are displayed in Table 6, each column reporting on a different health-related behaviour.[18] The specification of this models is the same we adopt in the *Outcome Models*. We control for the age, the logarithm of the household income, the number of children and grandchildren, being married, living alone and the interview date.[19] At the bottom panel, we report the Kleibergen-Paap F test for weak instruments; the *p-value* of Sargan-Hansen J statistic for overidentification and we can conclude that the choice of our instruments correctly identifies the models.

Column 1 reports the engagement in physical activities. The point estimate of retirement status indicator shows a negative coefficient that reduces the probability of being inactive of -0.055σ, although is not significant. The retirement duration, instead, has a positive impact on the probability on being engaged in physical activities of 0.069σ . Celidoni and Rebba (2017) find a beneficial effect on physical activities without taking into account the retirement duration, which might be causing the difference in findings. Column 2 shows the estimations for the probability of having a BMI greater than 30. The probability of being obese shrinks with each year spent in retirement by -0.038σ, while the status effect is not significant. In Columns 3 and 4, we focus on the association between being a smoker, ex-smoker, and retirement. The effect on smokers is found to be non-significant, which is also quite coherent with Celidoni and Rebba (2017). The probability of becoming a ex-smoker decreases with the retirement duration, instead, by -0.049σ. Finally, with regards to the relationship between the abuse of alcohol and retirement, column 5 provides evidence of the positive effect of the *Retired* coefficient and amounts of 0.015σ. The $TimeR$ coefficient, instead, reduces the alcohol consumption by -0.131σ. Previous works, as Eibich (2015) for Germany and Celidoni and Rebba (2017) for

[18] In A1 we report the common first stage estimation output.

[19] Household income is ppp-adjusted.

Europe, detect an increase in regular alcohol consumption when retiring (short-time effect), but they do not exploit information on how much is daily quantity.

Thus, our findings suggest that the possible beneficial effect of retiring on health-related behaviours is not persistence but shift to damaging, probably speeding physical decline. An analysis on social habits may draw a more complete picture of the overall lifestyle change.

Table 6 about here.

The *Outcome Models* second stage results are presented in Table 8, each three columns reporting on a different health outcome. The displayed results are estimated by means of OLS-FE (each first column, for each outcome) and 2SLS-FE (the remain columns, for each outcome). First stage common results are reported in Table 7.

Table 7 about here.

We provide the F test for excluded instruments and the R-squared of the first-stage regressions for both *Retired* and *TimeR*. Coupled with the Kleibergen-Paap F test for weak instruments, and the *p-value* of Sargan-Hansen J statistic for overidentification reported in the *Outcome Model* results, we can conclude that the choice of our instruments correctly identifies the models. In Table 8 lifestyle indicators enter in the equations as the estimated errors of *Mediator Models*. The first three columns display the SAH model. Given higher values of SAH denote worse health, the fixed effect specification report a non-significant positive status effect, and a negative effect of its duration. When controlling for endogeneity, the point estimates of the two coefficients associated to retirement maintain the same sign, and are significant and stable in magnitude once we add the controls. *Retired* has a beneficial impact that amounts to around -0.34σ while *TimeR* show a detrimental effect of around 0.39σ, which denote an overall negative effect on SAH. With regards mental health, the FE estimation shows a reduction in the probability of being depressed associated to the retirement status and an increase in the probability to its duration. Once controlling for endogeneity, the status effect looses its statistical significance. The retirement duration is associated to an increase in the probability of being depressed of 0.19σ, which remain stable when adding controls. Thus, the overall retirement effect on mental health is found to be negative as well as SAH. Finally, the last three columns refer to cognitive health. Given higher score of the cognitive index denote better cognitive abilities, a negative sign indicates a detrimental effect. The three specification display the same result, namely no significance for the retirement status effect and a negative effect of its duration that amounts of -0.59σ (last column). Thus, as found for the other two outcomes, retirement has an overall total effect that is detrimental for health.

Table 8 about here.

With regards the role of lifestyle, the effects are heterogeneous. The non-engagement in physical activities shows a negative and significant impact for all the three outcomes. Apart from the SAH model, in which also BMI is found to be negative for the health status, all the other lifestyle indicators are not significant. The coefficients associated to the health-related behaviours, are the γ of 5 that we need to unravel the direct to the indirect effect of retirement. Table 13 reports the decomposition between TE and IE, each panel reporting on the three health outcomes both for the main specification and the heterogeneity effects. The decomposition shows that the average IE effects (Main Specification row) maintain the same sign of the TE, namely enlarging the detrimental direct effect on health.

6.2. Robustness checks

Now, we test and show the robustness of our models with several checks. Table 9, and A2 reported in appendix, confirm that our models are robust to different sample and specifications. Firstly, we estimate the model for each health outcome by using the balanced panel. Next, we let the age term interact with the country dummies to check for any possible time varying-effect that may interact with the retirement ages, such education system or more generally, the country specific welfare system (e.g. flexible retirement that we cannot observe; different welfare response to economic cycle). Besides, we estimate the model with different health outcomes.

These first checks show stability in signs and point estimate significance especially for mental and cognitive health. With regards SAH, using the balanced sample $TimeR$ doubles wrt to the initial sample. It may be related to the reliability of the nature of SAH, which is subjective. Indeed, there are several issues linked to the use of SAH and the presence of measurement errors due to the personal perception of individuals. A common bias discussed by the literature is the *justification bias*, which mainly regards people who are not working. Indeed, they tend to declare worse perceived health to justify the lack of a job. Besides, suffering from clinical depression may let people underestimate their strictly physical condition or *vice versa* individuals who have a chronic disease since long time may adapt to the conditions overestimating their level of general health.[20]

To minimise these biases, we adopt the health index proposed by Bound et al. (1999) to be our general health outcome. It is an index that corrects the measurement errors of subjective variables by means of using objective indicators, and it indicates the probability of having good health. It is constructed by estimating the following equation by means of a pooled ordered probit estimated for each country and gender. Separate estimations allow us to control for the difference in perception across countries (Kapteyn et al., 2007) and gender.

$$H_i = \alpha + X\beta_i + \mu_t + \epsilon_i \tag{11}$$

The subjective health stock H is the self-assess health that ranks between 1, *excellent*, and 5, *poor*; $X\beta_i$ is a vector containing the maximum grip, 10 limitation in doing daily activities[21], 13 limitations in doing instrumental activities[22], a dummy for clinical depression (calculated on the basis of the Euro-D scale), 10 chronic conditions, μ_t, which is the interview date fixed effect Then, we predict good health (outcome 3 of the ordered variable) and standardise the prediction between 0 and 1.

Although the other models report almost no variation in the point estimates, it can be argue that using the depression dummy might be bias as the answers are highly subjective and they not include records of the period of the symptoms. For this reason, we test the mental health model by using as dependent variable the Euro-D scale. Finally, we use the single indicators of the index of cognitive abilities, which we have presented in the data section, to test the contribution to the index.

As displayed by the Table A2, using a more objective indicator of general health do not change the qualitative results, likewise the mental health indicator. For the cognitive test, we find significant results of the retirement effect only in model 3. Lifestyle indicators exhibit the same qualitative effect of the baseline models, except for BMI in column 1 that loses the statistical

[20] Cubı-Mollá et al., 2017, Powdthavee, 2009, Groot, 2000
[21] In SHARE are ph048d1-ph048d4, ph048d6-ph048d10
[22] In SHARE are ph049d1-ph049d13

significance.

6.3. Heterogeneity

Our results might be lead by some specific subgroup of individuals, and are not generally expected to be constant as extensively shown by mixed results of literature. We look for each outcome at different effects by gender, low and high skilled individual, and pension rule compliance. Indeed, these characteristics may have a central role in driving the effect. For instance, compliers with NRA are likely to be less engaged in physically demanding jobs or are more likely to be under financial distress. Similarly, the gender difference in labour force participation may be cause of much more selection than men. Thus, the retirement *TE* not only may differ, but also the lifestyle role might contribute in heterogeneous ways.

Table 10 displays heterogeneity estimations for SAH. When using only ERA or NRA rules as instrument, coefficients associated to retirement are not significant in ERA group, which may denote heterogeneity in the complier composition. The NRA compliers show, instead, significant and larger effects wrt the baseline and ERA group. It might indicate a stronger drop in health when retire later. With regards gender differences, retirement duration becomes non-significant, while the status effect does not diverge from the baseline. Finally, high-skilled are more affected by the time spent in retirement than low-skilled.

Heterogeneity for cognitive health is reported in Table 11. The ERA compliers exhibit a much more stronger effect than the baseline, whereas the NRA model shows non significant point estimates of the retirement coefficient. This finding seems confirming the protective role of working. Indeed, the effect for NRA compliers may differ across occupation (e.g. leaving psychosocial demanding job is expected is supposed to produce a stronger effect than physical demanding jobs). Women show a larger detrimental effect than men. Finally, we do not find any heterogeneous skill-based effect, but it is likely that the previous occupation play the central role in cognitive abilities.

Concerning mental health, we do not find any significant result on depression, apart from male and hish-skilled subsamples that confirm the baseline, as shown in Table 12.

Tables 10, 11, 12 about here.

At last, we investigate the heterogeneity in the *IE* effects, both status and duration for each outcome. Table 13 displays the heterogeneity in the composition of the effects. The majority of the *IE* does not show sign heterogeneity wrt the *TE*, namely the IE has the same impact on health status, except for some subsamples.
Male exhibits a positive status *IE* for SAH, meaning it reduces the positive status effect. This result suggests that retirement may worsen, for males, the health declining through unhealthy habits. The same result is found for ERA compliers, low and skilled individuals. For female, instead, the retirement duration *IE* may mitigate the detrimental *DE*; likewise for ERA and NRA compliers, denoting the need to further investigation based on past job. Female reports also a status *IE* on depression that mitigate the increase in the probability of depression; likewise low-skilled individuals.

7. Conclusions

In progress:

- Job heterogeneity and Compliers Type
- Instrument with "maximum age" for retirement

Preliminary results:

- The overall (the sum of the two retirement indicators) total effect of retirement is found to be detrimental for general, mental, and cognitive health.
- The models are correctly identifying the status retirement effect and its duration, given that our robustness analysis shows their stability.
- Heterogeneity effects are found between ERA and NRA compliers: SAH is more endangered after retirement in NRA subsample while Cognitive Health seems more affected in ERA compliers sample. Besides, the female sample shows a stronger negative effect on cognitive health. Heterogeneity is also detected in size and sign in some *IE*. Lifestyle changes induced by retirement seems to be particularly beneficial for female cognitive health. The analysis suggests that additional investigations on past occupational status might help for the defining the lifestyle role on specific sub-sample.

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Tables

Table 1 – *Sample Size by Country and Wave*

Country	Wave 1	Wave 2	Wave 4	Wave 5	Total
Austria	497	537	1,966	1,884	4,884
Germany	809	1,097	791	537	3,234
Sweden	1,212	1,478	1,067	789	4,546
Netherlands	717	1,010	1,230	1,048	4,005
Spain	416	599	930	803	2,748
Italy	680	1,021	1,233	975	3,909
France	906	1,233	2,278	2,024	6,441
Denmark	652	1,209	1,353	1,163	4,377
Switzerland	358	692	1,766	1,625	4,441
Belgium	1,255	1,411	2,067	1,827	6,560
Total	7,500	10,290	14,682	12,673	45,145

Source: SHARE data, our elaborations

Table 2 – *Sample Composition by Employment Status and Gender*

Variable	Overall			Female	Male
	Mean	Std.Dev	Mean	Mean	
Employed	0.46		0.48	0.44	
Retired	0.48		0.46	0.49	
Self-declared Retired	0.54		0.52	0.56	
TimeR	3.81	5.21	3.70	3.91	
Self-declared TimeR	4.06	5.22	3.90	4.20	

Source: SHARE data, our elaborations. Sample size: 45,145. Female: 20,965; Male: 24,180. Self-declared Retired refers to respondents' answers, while Retired restricts the retirement status to who is not also involved in paid activities.

Table 3 – *Health Outcomes Summary Statistics*

Variable	Mean	Std. Dev.	Min	Max	Non-Retired	Retired
Euro-D scale	1.88	1.9	0	12	1.78	1.98
Depression	0.10	0.3	0	1	0.09	0.12
Cognitive Index	0.06	1.29	-4.79	4.46	0.37	-0.28
Fluency	21.86	6.87	0	45	23.19	20.39
Memo	10.07	3.33	0	20	10.79	9.27
Numeracy	3.74	1.00	1.00	5	3.86	3.60

Source: SHARE data, our elaborations. Sample size: 45,145. Non Retired: 23618; Retired: 21527.

Table 4 – *Lifestyles Summary Statistics*

Variable	Mean	Min	Max	Non-Retired	Retired
Smoker	0.20	0	1	0.23	0.17
Ex-Smoker	0.35	0	1	0.34	0.36
No Activities	0.04	0	1	0.02	0.05
BMI	0.17	0	1	0.15	0.2
Alcohol Abuse	0.09	0	1	0.08	0.1

Source: SHARE data, our elaborations. Sample size:45145. Non-Retired: 23618; Retired: 21527

Table 5 – *Eligibility Ages*

Variable	Mean	Std. Dev.	Min.	Max.
ERA	60.10	3.18	36	67
NRA	63.75	2.23	55	67
AboveERA	0.62	0.49	0	1
AboveNRA	0.44	0.5	0	1
DistERA	2.32	8.19	-15.1	38.5
DistNRA	-1.33	7.01	-15.1	20

Source: SHARE Data, our elaboration.

Table 6 – *Estimation results: Mediator Model (9)*

	(1) No Activities	(2) BMI	(3) Smoker	(4) Ex-Smoker	(5) Alcohol Abuse
Retired	-0.005	0.007	-0.007	0.008	0.015**
	(0.005)	(0.006)	(0.007)	(0.007)	(0.007)
TimeR	0.069***	-0.038*	0.036	-0.049**	-0.131***
	(0.018)	(0.021)	(0.023)	(0.022)	(0.024)
Age	2.161**	-0.544	-2.718**	2.985***	0.645
	(0.900)	(1.088)	(1.086)	(1.011)	(1.186)
Children	-0.001	0.020	0.028	0.030	0.065
	(0.045)	(0.052)	(0.050)	(0.048)	(0.056)
Grandchildren	-0.071**	0.023	-0.052	0.027	-0.001
	(0.028)	(0.029)	(0.033)	(0.030)	(0.031)
Live Alone	0.012*	0.008	0.029***	-0.025***	0.010
	(0.007)	(0.009)	(0.009)	(0.008)	(0.008)
Married	0.020*	0.042***	-0.003	0.000	0.001
	(0.011)	(0.014)	(0.013)	(0.013)	(0.014)
Log Income	-0.038	-0.007	0.060**	-0.027	0.101***
	(0.028)	(0.026)	(0.028)	(0.024)	(0.028)
Interview Date	Yes	Yes	Yes	Yes	Yes
KP F					
SH J	18.614	5.888	3.898	0.568	5.643
SH J p-value	0.001	0.208	0.420	0.967	0.227
Individuals	18137	18137	18137	18137	18137
Obs.	45145	45145	45145	45145	45145

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*

Table 7 – *Estimation results: First Stage (10)*

	Retired	TimeR

Above ERA	0.096***	-0.065***
	(0.007)	(0.002)
Above NRA	0.181***	0.036***
	(0.007)	(0.002)
Distance ERA	-0.188**	-0.248***
	(0.078)	(0.024)
Distance NRA	0.094	0.851***
	(0.104)	(0.041)
Controls	Yes	Yes
Interview Date	Yes	Yes
F test		
R2	0.228	0.534
Individuals	18137	18137
Observation	45145	45145

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8 – *Estimation Results: Outcome Model (10)*

	SAH			Depression			Cognitive		
	FE	FE-IV	FE-IV	FE	FE-IV	FE-IV	FE	FE-IV	FE-IV
Retired	-0.024	-0.339***	-0.344***	-0.019***	-0.013	-0.010	-0.001	0.042	0.042
	(0.021)	(0.078)	(0.078)	(0.007)	(0.028)	(0.028)	(0.020)	(0.074)	(0.074)
TimeR	0.227***	0.394**	0.394**	0.104***	0.195***	0.194***	-0.525***	-0.607***	-0.595***
	(0.070)	(0.196)	(0.197)	(0.025)	(0.072)	(0.072)	(0.064)	(0.184)	(0.186)
Age	-9.988***	-10.116***	-10.099***	1.142	1.027	0.936	-7.305**	-7.213**	-7.208**
	(3.566)	(3.589)	(3.590)	(1.335)	(1.336)	(1.335)	(3.340)	(3.348)	(3.349)
Log Income	-0.072	-0.049	-0.053	-0.060**	-0.055*	-0.043	0.155**	0.148*	0.146*
	(0.081)	(0.082)	(0.083)	(0.029)	(0.030)	(0.030)	(0.077)	(0.077)	(0.077)
No Activities	0.196***	0.230***	0.231***	0.053***	0.052***	0.052***	-0.128***	-0.133***	-0.133***
	(0.028)	(0.029)	(0.029)	(0.012)	(0.013)	(0.013)	(0.024)	(0.026)	(0.026)
BMI	0.069***	0.065***	0.065***	-0.011	-0.012	-0.012	0.009	0.010	0.010
	(0.021)	(0.022)	(0.022)	(0.008)	(0.008)	(0.008)	(0.020)	(0.020)	(0.020)
Smoker	-0.056	-0.029	-0.029	-0.023	-0.022	-0.023	0.037	0.033	0.033
	(0.044)	(0.045)	(0.045)	(0.016)	(0.016)	(0.016)	(0.043)	(0.043)	(0.043)
Ex-Smoker	0.000	0.022	0.022	-0.006	-0.006	-0.006	0.013	0.009	0.010
	(0.048)	(0.048)	(0.048)	(0.017)	(0.017)	(0.017)	(0.046)	(0.046)	(0.046)
Abuse Alcohol	-0.018	-0.032	-0.032	-0.001	-0.001	-0.001	-0.030	-0.028	-0.028
	(0.020)	(0.020)	(0.020)	(0.007)	(0.007)	(0.007)	(0.018)	(0.018)	(0.018)
Controls	No	No	Yes	No	No	Yes	No	No	Yes
Interview Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP F		202.683	200.971		202.683	200.971		202.683	200.971
SH J		1.374	1.285		0.082	0.051		6.047	6.019
SH J p-value		0.503	0.526		0.960	0.975		0.049	0.049
Individuals	18137	18137	18137	18137	18137	18137	18137	18137	18137
Obs.	45145	45145	45145	45145	45145	45145	45145	45145	45145

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*

Table 9 – *Estimation Results: Robustness Check (I) (10)*

	SAH		Depression		Cognitive	
	Balanced	Age×Country	Balanced	Age×Country	Balanced	Age×Country
Retired	-0.386***	-0.351***	-0.016	-0.008	-0.001	0.083
	(0.096)	(0.078)	(0.035)	(0.028)	(0.092)	(0.074)
TimeR	0.634***	0.372*	0.203**	0.204***	-0.553**	-0.568***
	(0.234)	(0.190)	(0.084)	(0.073)	(0.229)	(0.180)
No Activities	0.228***	0.229***	0.073***	0.052***	-0.078	-0.139***
	(0.058)	(0.029)	(0.025)	(0.013)	(0.050)	(0.025)
BMI	0.105***	0.065***	-0.036**	-0.011	0.030	0.010
	(0.039)	(0.021)	(0.015)	(0.008)	(0.036)	(0.020)
Smoker	0.054	-0.036	-0.044	-0.023	-0.043	0.025
	(0.083)	(0.046)	(0.034)	(0.016)	(0.080)	(0.043)
Ex-Smoker	0.030	0.014	-0.029	-0.005	-0.029	-0.000
	(0.084)	(0.048)	(0.035)	(0.017)	(0.082)	(0.046)
Alcohol Abuse	-0.066*	-0.026	0.002	-0.000	-0.045	-0.024
	(0.034)	(0.020)	(0.011)	(0.007)	(0.032)	(0.018)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Interview Date	Yes	Yes	Yes	Yes	Yes	Yes
KP F	107.836	204.764	107.836	204.764	107.836	204.764
SH J	0.426	0.636	0.763	0.395	0.133	3.726
SH J p-value	0.808	0.727	0.683	0.821	0.936	0.155
Individuals	2874	18137	2874	18137	2874	18137
Obs.	11496	45145	11496	45145	11496	45145

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*

Table 10 – *Estimation Results: Heterogeneity - SAH Model (10)*

	(1)		(2)		(3)	
	ERA	NRA	Female	Male	Low-Skilled	High-Skilled
Retired	-0.234	-0.464***	-0.348***	-0.298**	-0.375	-0.314
	(0.383)	(0.126)	(0.099)	(0.121)	(0.234)	(0.211)
TimeR	0.427	0.895**	0.402	0.436	-0.334	1.310**
	(0.620)	(0.447)	(0.275)	(0.276)	(0.571)	(0.509)
No Activities	0.217***	0.283***	0.165***	0.290***	0.303***	0.261**
	(0.055)	(0.042)	(0.038)	(0.046)	(0.067)	(0.111)
BMI	0.072**	0.074***	0.047	0.078***	0.104**	-0.003
	(0.035)	(0.022)	(0.032)	(0.029)	(0.046)	(0.056)
Smoker	0.046	-0.090*	-0.042	-0.007	-0.019	0.070
	(0.257)	(0.049)	(0.066)	(0.064)	(0.120)	(0.103)
Ex-Smoker	0.104	-0.027	-0.085	0.097	0.054	0.203*
	(0.273)	(0.051)	(0.071)	(0.067)	(0.128)	(0.107)
Alcohol Abuse	-0.010	-0.050**	-0.027	-0.028	-0.026	0.008
	(0.038)	(0.022)	(0.046)	(0.023)	(0.038)	(0.041)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Interview Date	Yes	Yes	Yes	Yes	Yes	Yes
KP F	21.372	183.177	111.819	97.326	25.350	33.948
SH J	0.000	0.000	0.489	6.022	0.025	5.471
SH J p-value			0.783	0.049	0.988	0.065
Individuals	18137	18137	8479	9658	5847	5833
Obs.	45145	45145	20965	24180	14588	14737

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*

Table 11 – *Estimation Results: Heterogeneity - Cognitive Model (10)*

	(1)		(2)		(3)	
	ERA	NRA	Female	Male	Low-Skilled	High-Skilled
Retired	-0.791**	-0.003	0.033	0.052	-0.004	-0.106
	(0.375)	(0.114)	(0.097)	(0.110)	(0.197)	(0.209)
TimeR	-1.905***	-0.301	-0.841***	-0.342	-0.758	0.349
	(0.583)	(0.404)	(0.262)	(0.256)	(0.517)	(0.505)
No Activities	-0.028	-0.121***	-0.118***	-0.156***	-0.152***	-0.117
	(0.053)	(0.037)	(0.033)	(0.041)	(0.057)	(0.100)
BMI	0.069**	0.009	0.018	0.003	0.039	-0.038
	(0.033)	(0.020)	(0.029)	(0.027)	(0.042)	(0.055)
Smoker	0.574**	0.028	0.065	0.008	0.039	0.025
	(0.252)	(0.046)	(0.065)	(0.058)	(0.104)	(0.084)
Ex-Smoker	0.585**	0.006	0.076	-0.045	-0.041	-0.019
	(0.267)	(0.048)	(0.069)	(0.063)	(0.111)	(0.091)
Alcohol Abuse	0.042	-0.032	-0.042	-0.020	0.008	-0.035
	(0.037)	(0.021)	(0.039)	(0.021)	(0.034)	(0.041)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Interview Date	Yes	Yes	Yes	Yes	Yes	Yes
KP F	21.372	183.177	111.819	97.326	25.350	33.948
SH J	0.000	0.000	0.796	6.287	3.332	0.750
SH J p-value			0.672	0.043	0.189	0.687
Individuals	18137	18137	8479	9658	5847	5833
Obs.	45145	45145	20965	24180	14588	14737

*Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*

Table 12 – *Estimation Results: Heterogeneity - Depression Model (10)*

	(1)		(2)		(3)	
	ERA	NRA	Female	Male	Low-Skilled	High-Skilled
Retired	-0.050	-0.013	0.010	-0.038	0.039	-0.073
	(0.154)	(0.050)	(0.042)	(0.036)	(0.074)	(0.059)
TimeR	0.139	0.200	0.182	0.193**	0.258	0.287**
	(0.251)	(0.207)	(0.117)	(0.085)	(0.191)	(0.140)
No Activities	0.056**	0.054***	0.049***	0.057***	0.072***	0.081**
	(0.023)	(0.018)	(0.019)	(0.017)	(0.028)	(0.035)
BMI	-0.010	-0.011	-0.018	-0.007	-0.005	-0.020
	(0.014)	(0.008)	(0.015)	(0.010)	(0.016)	(0.018)
Smoker	-0.006	-0.026	-0.040	-0.004	0.045	-0.058*
	(0.104)	(0.018)	(0.026)	(0.020)	(0.047)	(0.032)
Ex-Smoker	0.011	-0.008	-0.027	0.014	0.075	-0.060*
	(0.110)	(0.018)	(0.030)	(0.021)	(0.047)	(0.033)
Alcohol Abuse	0.000	-0.001	0.010	-0.004	0.009	-0.009
	(0.015)	(0.009)	(0.020)	(0.008)	(0.014)	(0.012)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Interview Date	Yes	Yes	Yes	Yes	Yes	Yes
KP F	21.372	183.177	111.819	97.326	25.350	33.948
SH J	0.000	0.000	0.945	0.639	0.333	0.547
SH J p-value			0.624	0.726	0.847	0.761
Individuals	18137	18137	8479	9658	5847	5833
Obs.	45145	45145	20965	24180	14588	14737

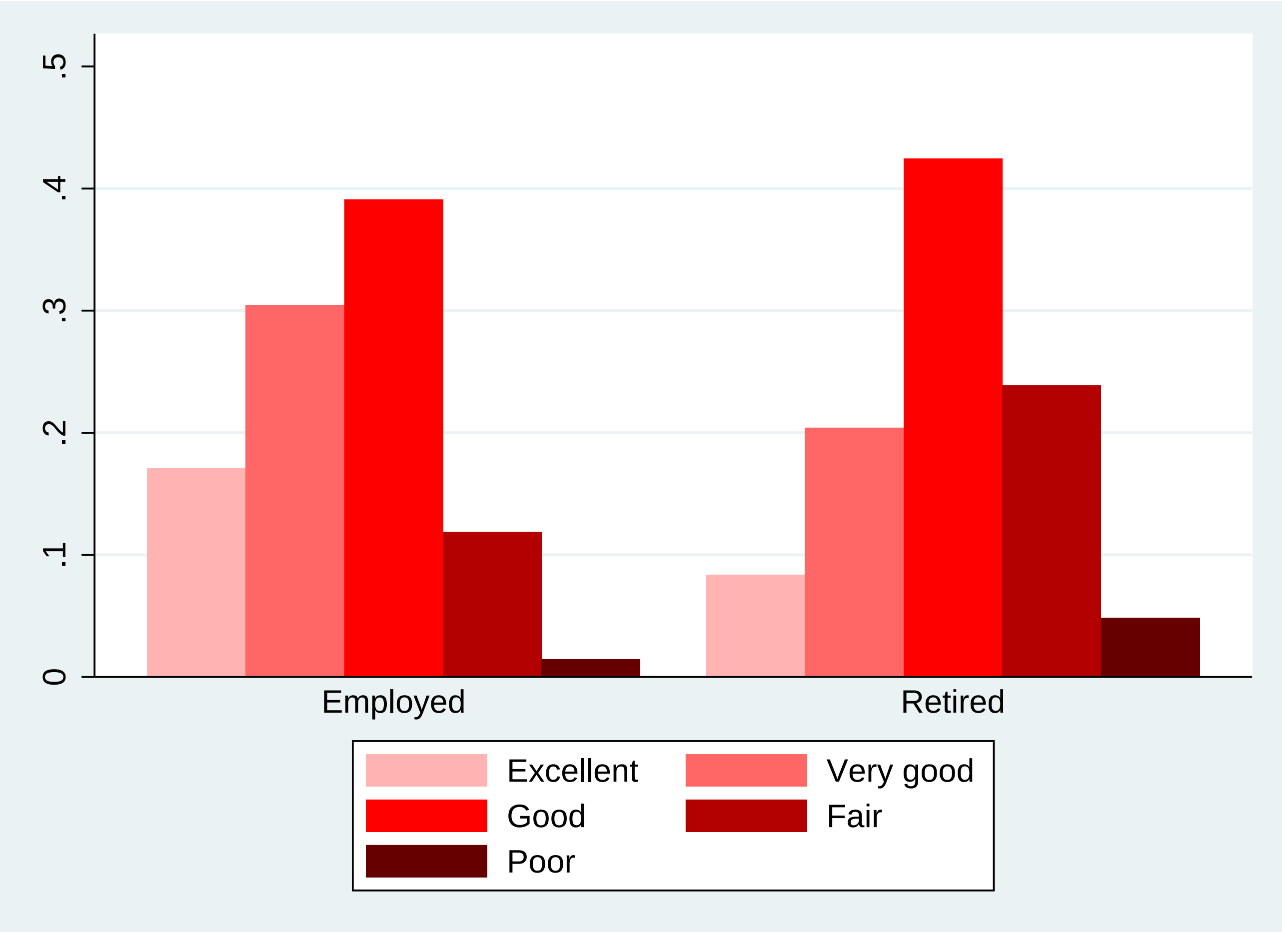
*Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*

Table 13 – *The decomposition of the Retirement Effect*

Model	Retired IE	Retired TE	TimeR IE	TimeR TE
		SAH Model		
Main Specification	-0.016	-0.344	0.015	0.394
Female	-0.005	-0.348	0.040	0.402
Male	0.003	-0.289	0.117	0.436
NRA	-0.102	-0.464	0.375	0.895
ERA	0.031	-0.234	0.071	0.427
Low-Skilled	0.001	-0.375	0.103	-0.334
High-Skilled	0.001	-0.314	0.115	1.310
		Cognitive Model		
Main Specification	0.007	0.042	-0.008	-0.595
Female	0.010	0.033	0.022	-0.841
Male	0.010	0.052	-0.005	-0.342
NRA	-0.017	-0.003	0.093	-0.301
ERA	0.021	-0.791	0.026	-1.905
Low-Skilled	0.010	-0.004	-0.033	-0.758
High-Skilled	0.006	-0.106	0.028	0.349
		Depression Model		
Main Specification	-0.003	-0.010	0.006	0.194
Female	-0.003	0.010	0.000	0.182
Male	-0.002	-0.038	0.020	0.193
NRA	-0.003	-0.013	0.003	0.200
ERA	-0.002	-0.050	0.006	0.139
Low-Skilled	-0.002	0.039	0.030	0.258
High-Skilled	-0.007	-0.073	0.014	0.287

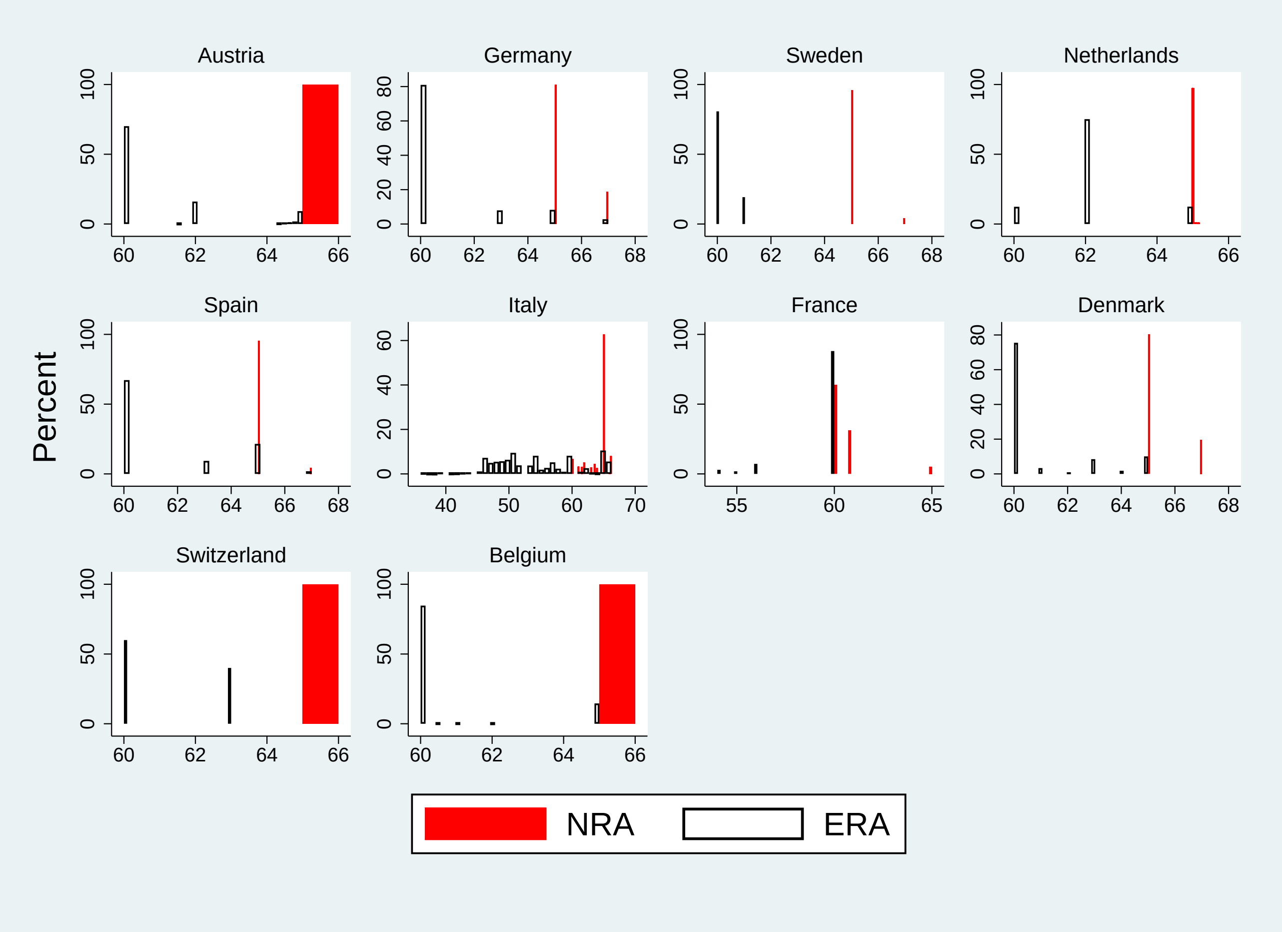
Figures

Figure 1 – *SAH distribution by retirement status*



Source: SHARE data, our elaboration

Figure 2 – *Distribution of male ERA and NRA by country*



Source: SHARE data, our elaboration

Appendix

A1. Retirement Rules

Overall, the NRA and the ERA have been reconstructed by means of OECD reports (Pensions at Glance 2005, 2007, 2011, 2014, 2015), MISSOC Tables (Update January 2018) and country-specific social security systems.

Austria

- **Normal Retirement Age** is fixed at 65 for men and 60 for women, as long the individual has 15 insurance years in the last 30 years or 15 years of contribution (AlterPension). (Staubli and Zweimüller, 2013; PensionsVersicherungsanstalt, updated on February 2018)
- **Early Retirement Ages** are regulated by different retirement schemes. One of them is the "Vorzeitige Alterspension wegen langer Versicherungsdauer", and it concerns early retirement due to long contributions. This pension fixed at 60 for men and 55 for women until the 31st September 2000. Then, it has been reformed in 2000 and in 2003. Specifically, for men born from the fourth quarter in 1940 until the second quarter in 1942, ERA increased by 2 months for every birth quarter (2000-reform) and it was followed by an

Figure 3 – *Distribution of female ERA and NRA by country*

Source: SHARE data, our elaboration

increase of 1 month for each quarter until the last quarter of 1952 cohort (2003-reform). The same increase was applied for women born between 1945 and 1948 during the 2000-reform, and, until the 1957 cohort during the 2003-reform (See Staubli and Zweimüller, 2013 for details on this reforms). However, other pensions exist. In 2000-reform they also introduced a new pension, named "Langzeitversicherungspension" long insurance pension. This ERA starts from 60 and 55 respectively for men and women who reach 45 and 40 years of contributions until they reach 62 for both of them, according to birth cohort. It can be seen as an exception of the reforms. Nevertheless, Austrian government provides for other two type of pension. One dedicated to heavy jobs and and other one, Korridorpension. Since we do not have enough information to model these last two, we only pick the Vorzeitige Alterspension before and after the reforms and its exceptions.

Belgium

- **Normal Retirement Ages** from 1961 to 1998 were fixed at 65 for men and 60 for women, and, for men it has actually never changed. Instead, women age have increased until reaching 65 since 2009. The increases were 61 until 2001; 62 until 2003; 63 until 2005, 64 until 2009. (Social Protection (MISSOC), January 1, 2018 version;Bongaarts, 2016; OCDE, 2013; Whitehouse and Queisser, 2007; Queisser and Whitehouse, 2005)
- **Early Retirement Ages** were introduced in 1966. Then, ERA are set to 60 for men and 55 for women until 1986; 60 for both after 1986 until 1997, without any contribution constraints. From 1998 until 2012, it is fixed at 60 with 35 years of contribution. Since

then, it has been gradually increased both the age and the years of contribution[23] to 62. (Angelini et al., 2009 + the other references)

Denmark

- **Normal Retirement Age** was fixed at 67 before 2003. From 2004, it is set to 65.
- **Early Retirement Age** was not provide until 1976. Indeed, from 1976 to 1978, it was 60 for both men and women. Then, it became 60 with 30 years of contributions until 2007. For individuals born after 1954 the ERA increases by 6 months for each 6-month cohort, until it reaches 62.5 for whom is born before the 30th of June 1965. Moreover, it increases to 63 years for individuals born between July 1956 and December 1958; to 63.5 for individuals born in the first semester of 1959 and to 64 for those born after July 1959. (Social Protection (MISSOC), January 1, 2018 version OECD(2005, 2007, 2011, 2013, 2015); Social Security Program-SSA.gov)

France

- **Normal Retirement Age** was 65 years old until 1994. Then, from 1995 to 2012, it was 60. Since 2012, it has started a gradual increase.
- **Early retirement Ages** are linked to long careers and heavy jobs. Before 1994, it was 60 for every individuals. Then, it becomes 56. For individuals who worked in heavy sectors(transport and energy) is set to 55 years old. (Social Protection (MISSOC), January 1, 2018 version; Angelini et al., 2009; Leimer, 2017)

Germany

- **Normal Retirement Age** was fixed at 65 until 2007. From 2008 it is 67.
- **Early retirement Ages** was not feasible for men until 1973 while it was 60 with 15 years of contributions for women. Then, from 1973 to 2007, 63 with 35 years of contributions for men and 60 with 15 years of contributions for women. Now, ERA are 63 for men and 60 for women with 35 years of contribution. (Börsch-Supan et al., 2013 Social Protection (MISSOC), January 1, 2018 version; Angelini et al., 2009)

Spain

- **Normal Retirement Age** was fixed at 65 until 2011, and from 2012 it was added the contribution constraint of 38.6. Otherwise, it is 67.
- **Early Retirement Age** is considered only for voluntary retirement. Before 2011, it was 60. Between 2011 and 2013, it was set to 61. At the moment, it is possible with 36 years of contribution from 2 years before the NRA. (Social Protection (MISSOC), January 1, 2018 version; Angelini et al., 2009; Seguridad Social Española)

Sweden

- **Normal Retirement Age** was 67 from 1961 to 1994. Then, it decreased to 65, both for men and women.
- **Early Retirement Age** was 60 both for men and women until 1997; from 1998 to 2007, 61 both for men and women.Social Protection (MISSOC), January 1, 2018 version; OECD; Angelini et al., 2009)

[23]The years of contribution vary between 32-36 years depending on the birth cohorts.

The Netherlands

- **Normal Retirement Age** was 65 years both for men and women until 2013. It has started increasing by 1 months each year.
- **Early Retirement Age** is 60 for people born before 1950. In the period between 1975 and 1995 was 60 with minimum 10 years of contribution. Then, it has been set to 62 with at least 35 years of contribution.

Switzerland

- **Normal Retirement Ages** were until 1974 65 and 63 respectively for men and women. For men, it never changed. For women, it shrinks at 62 between 1974 and 2003, then it increased again to 63 in 2004 and 64 from 2005.
- **Early Retirement Ages** did not exist before 1990. Then, for men, were fixed at 62 until 2006 and to 63 from 2007. For women, it was 59 until 1997; 60 until 2004; 61 until 2006 and 62 since 2007.

Italy

- **Normal Retirement Ages** have been changing quite often since 1961. The differences are based on job sector(public or private), gender and type of job (employees or self-employed). From 1961 to 1993, NRA were for men working in private (public) 60 (65) and 55 (60) for women; in 1994, 61 for men and 56 for women; in 1995, 61.5 for men and 56.5 for women; in 1996, 62 for men and 57 for women; in 1997, 63 for men and 58 for women; in 1998, 63.5 for men and 58.5 for women; in 1999, 64 for men and 59 for women; from 2000 to 2007, 65 for men and 60 for women (both private and public sector); in 2012, 66 for men with at least 20 years of contribution, both for employees and self-employed; 62 for women employees, 63.5 for self-employed and 66 for both man and women in public sector; from 2013, all the previous ages for 2012 have been increased by 3 months. (INPS; Angelini et al. 2009; Brugiavini et al; Belloni et al.)
- **Early Retirement Ages** have been provide since 1965. Until 1995, 35 years of contributions (25 in the public sector) both for men and women, without age constraints; from 1996 to 1997 in the private and public sector 52 with 35 years of contribution (or 36 years of contribution independently of age), for self-employed 56 with 35 years of contribution both for men and women; in 1998 the age is 53 for the public sector, 54 for the private sector and 57 for self-employed; in 1999 the age is 53 for the public sector, 55 for the private sector and 57 for self-employed; in 2000, 54 for the public sector, 55 for the private sector, 57 for self-employed; in 2001, 55 for the public sector, 56 for the private sector, 58 for self-employed; in 2002, 55 for the public sector, 57 for the private sector, 58 for self-employed; in 2003, 56 for the public sector, 57 for the private sector, 58 for self-employed; from 2004 to 2007, 57 for both the private and public sector, 58 for self-employed; from 2008 to 2009, 58 (59) for employees (self-employed) with 35 years of contribution; in 2010, 59 (60) for employees (self-employed) with 36 years of contribution; in 2011, 60 (61) for employees (self-employed) with 35 years of contribution. Moreover, since 2008, with 40 years of contribution, there is no age constraint. In 2012, the years of contribution are 42.1 (41.1) for men (women) and is increasing every year (+4 months in 2013, +1 month from 2014 to 2016) [Angelini et al., 2009; INPS]

A2. Table

Table A1 – *Estimation results: First Stage (9)*

	Retired	TimeR
Above ERA	0.096***	-0.065***
	(0.007)	(0.002)
Above NRA	0.181***	0.036***
	(0.008)	(0.002)
Distance ERA	-0.188**	-0.248***
	(0.078)	(0.025)
Distance NRA	0.109	0.853***
	(0.107)	(0.039)
Controls	Yes	Yes
Interview Date	Yes	Yes
F test	232.644	875.476
R2	0.219	0.533
Individuals	18137	18137
Observation	45145	45145

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2 – *Estimation Results: Robustness Check (II) (10)*

	(1) Health Index	(2) Euro-D Scale	(3) Memory	(4) Fluency	(5) Numeracy
Retired	0.043***	-0.146	0.454*	-0.445	0.000
	(0.014)	(0.163)	(0.271)	(0.518)	(0.053)
TimeR	-0.098***	1.011**	-3.179***	-1.026	0.092
	(0.035)	(0.411)	(0.672)	(1.282)	(0.127)
Age	0.334	-3.641	-16.556	-53.683**	0.538
	(0.626)	(7.357)	(12.292)	(23.585)	(2.282)
Log Income	-0.001	0.090	0.202	1.419***	-0.020
	(0.013)	(0.167)	(0.273)	(0.517)	(0.053)
No Activities	-0.071***	0.441***	-0.339***	-0.639***	-0.034*
	(0.007)	(0.067)	(0.096)	(0.177)	(0.018)
BMI	0.003	-0.048	0.070	-0.057	0.005
	(0.005)	(0.044)	(0.073)	(0.139)	(0.013)
Smoker	0.004	0.065	-0.192	0.487	0.047
	(0.008)	(0.093)	(0.155)	(0.320)	(0.029)
Ex-Smoker	-0.001	0.198**	-0.373**	0.624*	0.040
	(0.009)	(0.099)	(0.167)	(0.334)	(0.032)
Abuse Alcohol	0.005	0.047	-0.056	-0.117	-0.015
	(0.003)	(0.040)	(0.064)	(0.122)	(0.015)
Controls	Yes	Yes	Yes	Yes	Yes
Interview Date	Yes	Yes	Yes	Yes	Yes
KP F	200.971	200.971	200.971	200.971	200.971
SH J	3.694	2.192	2.789	7.358	0.113
SH J p-value	0.158	0.334	0.248	0.025	0.945
Individuals	18137	18137	18137	18137	18137
Obs.	45145	45145	45145	45145	45145

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Estimations use individual fixed effect. Standard errors are robust to clustering at the individual level.*