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Retirement and Cognitive Functioning: International Evidence

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Abstract

We survey the recent literature on the effects of retirement on cognitive functioning at older ages. We describe results from studies using similar data sets (HRS, SHARE and ELSA), definitions of cognition, and instruments to capture causal effects. The studies yield widely varying results. Most papers find that being retired leads to a decline of cognition, controlling for different specifications of age functions and other covariates. However, richer specifications using fixed effects, dynamic specifications, or alternative specifications of instrumental variables often lead to large changes in the size and significance of the estimated effects. We replicate several of these results using the same data sets. We discuss the factors that are likely causing the differences across specifications, including endogeneity of right hand side variables, and heterogeneity across gender, occupation or skill levels.

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Retirement and Cognitive Functioning: International Evidence

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The topic of how retirement affects cognitive function has attracted much interest over the last decade. The subject is of interest for at least two key reasons. First is the desire for a better understanding of the effect of prolonging working life at older ages on well-being. Second is interest in the policy implications of these effects on how countries deal with underfunded retirement plans and aging populations. Encouraging individuals to delay retirement could have significant financial and non-financial (e.g., health and well-being) implications for individuals and societies. Given the importance of this topic, this chapter surveys the recent literature on the effects of retirement on cognitive functioning at older ages, and assesses the robustness of estimates of the effect of retirement on cognitive capability.

It is fair to say that there is no clear consensus in the literature on the effect of retirement on cognitive functioning. Some studies find that being retired leads to a decline in cognition, but richer specifications (i.e., including fixed effects, dynamic specifications, or alternative specifications of instrumental variables) often lead to large changes in the size and significance of the estimated effects. Other papers find a negative effect of retirement on cognition (e.g., Rohwedder and Willis 2010; Bonsang et al. 2012; Mazzonna and Peracchi 2012, 2014), while still other studies find small or even positive effects, especially when these are disaggregated by different types of occupations (e.g., Coe et al. 2012; Bianchini and Borella 2014). Other papers find significant effects only for women (Coe and Zamarro 2011).

The present study uses datasets across several countries—namely the US Health and Retirement Study (HRS), the English Longitudinal Study of Ageing (ELSA), and the Survey of Health, Ageing and Retirement in Europe (SHARE)—to replicate several of these analyses. Our goal is to get a better understanding of the sources of the different effects found in the literature. We show that results are very sensitive to differences in econometric specifications. In particular, the use of country fixed effects to control for unobserved country differences tends to reduce the estimated effect of retirement on cognition dramatically, suggesting that unobserved

differences across countries affect both retirement ages and cognitive decline. This remains true for different subgroups including blue-collar/white-collar jobs; physically demanding jobs; or high-skilled jobs.

In what follows, we first survey the empirical literature on aging and cognitive functioning. Second, we summarize results found in prior empirical literature on the effect of retirement on episodic memory. We focus on studies using similar datasets (HRS, SHARE, and ELSA), definitions of cognition, and instrumental variables to capture causal effects. Third, we replicate several of these results using the same datasets. We discuss the factors that appear to explain differences found across papers that use different specifications, including the endogeneity of right-hand side variables, and heterogeneity across gender, occupation, or skill levels. Finally, we conclude.

Measuring Cognitive Function and its Determinants

Our goal is to understand whether being retired affects cognitive functioning. In this section, we first briefly describe the different measures of cognitive functioning used in the literature we survey. Second, we summarize the main findings in the literature on aging and cognition, as well as the main factors affecting cognitive ability and its decline.

Cognitive Functioning

Following the psychological theory on cognition (Cattell–Horn–Carroll theory),[1] we identify two types of cognitive functioning: fluid intelligence and crystallized intelligence. Fluid intelligence involves processes related to recall, in particular, episodic memory, i.e., working memory, including long-term memory and how fast we process information (perceptual speed).[2] Crystallized intelligence relates to our knowledge and verbal learning, primarily affected by education. Crystallized intelligence seems to be rather stable over time and can even improve with age (Hertzog et al. 2008; Dixon et al. 2004; Park et al. 2002; Schaie 1994), while fluid intelligence is more likely to decline with age (Anderson and Craik 2000; Prull et al. 2000). The environment can also affect memory at older ages, as well as the intellectual stimulus individuals face routinely (Salthouse 2006, 2009; Small 2002; van Praag et al. 2000). Most economic studies on cognitive function focus on fluid abilities likely to affect dementing illnesses such as memory or attention (Morris et al. 2001; Adam et al. 2007b). The decline in fluid cognition may affect individual decision making and adversely affect well-being. The papers discussed in the following all use similar measures of cognitive functioning, namely on immediate and delayed recall.

Prior Evidence on Cognitive Functioning, Aging, and Factors other than Retirement

To better understand how the process of aging can affect cognitive functioning, we describe findings across several disciplines including psychology, epidemiology, gerontology, neuroscience, and economics. Schaie (1989), who reviewed findings from the Seattle Longitudinal Study on adult cognitive development, found an important decline in cognitive functioning at later ages. This decline in cognitive abilities with age was also documented by Hertzog et al. (2008), Bäckman et al. (2005), Dixon et al. (2004), Peterson et al. (2002), Anderson and Craik (2000), Prull et al. (2000), and Schaie (1994), among others. Demographic variables such as gender may correlate with cognitive functioning as well, although results in the literature are mixed. Lei et al. (2012) found lower cognitive functioning for women than for men; Johnson and Bouchard (2007) reported better memory among women than among men; and Halpern (2012) showed small or no evidence of cognitive functioning differences by gender.

Cognitive reserve refers to the phenomenon that people whose brains show extensive Alzheimer's pathology may have manifested very little clinical cognitive impairment when alive. Evidence suggests that education, activities, and occupation can affect people's cognitive reserve (e.g., Stern 2002, 2003). The role of education in cognition has been studied by Banks and Mazzonna (2012), Maurer (2010), McFadden (2008), and Evans et al. (1993), among others. Other factors, such as leisure activities, lifestyle, behavior, and social networks, may also affect cognitive functioning and have also been studied in the literature.[3]

Does Retirement Affect Cognitive Functioning?

A main reason economists seek to evaluate whether retirement affects cognitive functioning is that they try to understand how retirement might affect well-being at older ages and possibly to extend employees' working lives. During recent decades, many countries have increased retirement eligibility ages for public pensions and/or are switching from defined benefit to defined contribution pension systems. These reforms can have different effects upon countries and individuals, including people's employment decisions. If employment status were to have an effect on individuals' cognitive functioning, the implications for policymaking would differ depending on the direction of the effect. For instance, if staying longer in the labor market were thought to be protective of memory capacity, encouraging workers to work longer would support pension system financial sustainability (Dave et al. 2008; Bonsang et al. 2012). It could also potentially

reduce health care and long-term care expenditures, assuming that implied memory loss is related to increased risk of dementia and increases in disability (Albert et al. 2002; Lyketsos et al. 2002; Tabert et al. 2002). It would further aid autonomy and the capacity for sound financial decisions, including saving decisions (Christelis et al. 2010; Banks et al. 2010; Brown et al. 2012), and more generally it would enhance well-being and quality of life at later ages (OECD 2013).

Prior studies reach conflicting conclusions on the effects of retirement on memory, both with respect to the sign and size of the effect. The studies we review here use comparable measures of cognitive abilities, although they differ in their definitions of retirement. Commonly used datasets are (1) the Health and Retirement Study (HRS) for the US; (2) the English Longitudinal Study of Ageing (ELSA) for England; and (3) the Survey of Health, Ageing and Retirement (SHARE) for Europe.[4]

One of the first studies of the effect of retirement on cognitive function was by Adam et al. (2007a). Using HRS, SHARE, and ELSA data for the year 2004, they reported a negative effect of retirement on a word recall test. They used the sum of the number of correct answers on an immediate ten-item word recall test and the number of correct answers to the same list of items, about 10 minutes later. They considered both individual retirement status and how long the person had been retired. Their analysis did not provide a causal interpretation of the impact of retirement on cognitive abilities.

Table 4.1 summarizes nine recent studies on the same topic. As one can see, the studies differ with respect to the number of countries used in the analysis; whether the analysis was solely based on a cross-section of countries, or whether longitudinal data were used; the age range considered; and whether men and women were analyzed separately. Some studies differentiated between blue- and white-collar jobs before retirement (i.e., Mazzonna and Peracchi 2014; Bianchini and Borella 2014).

All the studies in the table defined cognitive functioning with the measure used by Adam et al. (2007a), i.e., the sum of immediate and delayed recalled words from a list of ten words. We denote this variable simply as 'word recall' from now on, and it ranges from 0 to 20.[5, 6]

Three main definitions of retirement can be identified. The first focuses on self-reported labor force status. Sometimes this definition also takes into account whether individuals are receiving old age pension benefits. 'Retired' is generally defined as a (0, 1) dummy variable. A second definition follows Lazear (1986) by equating being retired as not working for pay. The third definition is a continuous variable related to retirement duration.[7] Most authors measure retirement duration as the elapsed time between the individual's retirement date and interview date (Coe et al. 2012) and/or the elapsed time since the last job ended (Bonsang et al. 2012).

TABLE 4.1 Dataset, samples, dependent and independent variables in the reviewed papers

Authors	Countries	Dataset	Year	Sample	Cognitive abilities	Retirement	Explanatory variables
Rohwedder and Willis (2010)	United States, England, and 11 European countries	HRS, SHARE, and ELSA	2004	Men and women together (60–64 years)	Memory test scores (recall summary score 20)	Retired (dummy)	Different age forms
Coe and Zamarro (2011)	Europe 11 countries	SHARE	2004	Men (50–69 years old)	1. Memory test scores (recall summary score 20) 2. Verbal fluency	Retired (dummy) (cond. working age 50)	Demographic; SES; health and country dummies
Coe et al. (2012)	US	HRS	1996–2008	1. Blue- and white-collar workers 2. 50–70 years old 3. Men and women together	1. Self-rated memory 2. Immediate, delayed, and total word recall 3. Working memory 4. Numeracy	Retirement duration (years in retirement) continuous variable	Demographic; education; wave dummies
Bonsang et al. (2012)	US	HRS	1998–2008	Men and women together (51–75 years old) working at 50	Memory test scores (recall summary score 20)	Retirement duration (non-parametric specification) after one year of retirement	Different age forms
Mazzonna and Peracchi (2012)	Europe 11 countries	SHARE	2004–2006	1. 50–70 years old 2. Men and women separately	1. Immediate memory 2. Delay memory 3. Orientation in time 4. Verbal fluency 5. Numeracy	Retirement duration (years in retirement) continuous variable	Demographic; SES; country, cohort, and regional dummies

Mazzonna and Peracchi (2014)	Europe 10 countries	SHARE	2004–2006	Men and women separately. Occupations: physical demanding job	1. Memory test scores (recall summary score 20) 2. Verbal fluency 3. Numeracy 4. Cognitivity Index (PCA)	Retired (dummy) and retirement duration (years in retirement) continuous variable	Demographic; SES; health
Celidoni et al. (2013)	Europe	SHARE	2004–2010	Men and women separately and all together	Memory test scores (recall summary score 20)	Lag of retired dummy + retirement duration	Demographic; SES; health
Bingley and Martinello (2013)	US, England, and 11 European countries	HRS, SHARE, and ELSA	2004	Men and women separately and all together	Memory test scores (recall summary score 20)	Retired (dummy)	Different age forms and years of schooling
Bianchini and Borella (2014)	Europe	SHARE	2004–2010	Men and women together, 50–70 working at age 50. Blue-/white-collar workers	Memory test scores (recall summary score 20)	Retired (dummy) and retirement duration	Demographic; SES; health; behavior; learning and contextual factor

Source: Authors' computations.

All studies control for age in some form. While Rohwedder and Willis (2010) and Bonsang et al. (2012) did control for age, they did not explore the effects of other covariates. By contrast, as Table 4.1 shows, other studies included a large number of other covariates including years of schooling, demographic, socio-economic status (SES hereafter), health, country dummies, wave dummies, cohort, and regional dummies.

Some authors allow for what is called a 'honeymoon phase' (Atchley 1976, 1982), which refers to the fact that, when people first retire, they often spend more time engaging in activities that they lacked time for when working. These activities could have a positive effect on their cognitive abilities or delay their decline. Though this phase does not last long (Ekerdt et al. 1983; Gall et al. 1997; Mein et al. 2003; Mojon-Azzi et al. 2007; Westerlund et al. 2010), it must be taken into account when analyzing the relationship between retirement and cognition (Bonsang et al. 2012; Mazzonna and Peracchi 2012, 2014; Bianchini and Borella 2014). Occupational characteristics such as being a blue-collar worker or having a physically demanding job can also affect cognitive functioning differently from those associated with being a white-collar worker or having an intellectually engaging job (Jorm et al. 1998; Potter et al. 2008). Several studies (Coe et al. 2012; Mazzonna and Peracchi 2014; Bianchini and Borella 2014) have evaluated how occupation can mediate the effect of retirement on cognitive functioning.

Retirement and Cognitive Function: Causal or Not?

Most authors begin with a descriptive analysis showing correlations of retirement and cognition. For instance, Rohwedder and Willis (2010) and Adam et al. (2007a) documented a positive relationship between working and cognitive functioning. Both studies compared the employment rates of men age 60–64 and 50–54, and they noted a fall in the number of words recalled by men age 60–64 relative to men age 50–54 across a number of SHARE countries, England, and the US. When Adam et al. (2007a) controlled for occupational activities, they found that not working was negatively and significantly correlated with recall. Rohwedder and Willis (2010), using working for pay versus not working as their retirement variable, found that retired individuals' memory scores decreased by an average of 4.9 words (on a 0–20 scale) with retirement.

Coe and Zamarro (2011) used a broad retirement definition, including as retirees: retired, homemakers, and disabled and sick individuals out of the labor force. This variable was conditioned on having been working for pay at age 50. Their study confirmed a significant but small negative association between retirement and cognition when demographics, SES, and health

controls were included (the estimated coefficient implied a 0.28 reduction in the number of words recalled out of twenty, significant at 5 percent). Effects of retirement on verbal fluency were found to be insignificant. The cross-country analyses undertaken in these three papers were based exclusively on data from 2004.

Coe et al. (2012) and Bonsang et al. (2012) focus only on US HRS panel data, and they used a continuous retirement duration variable as an explanatory variable instead of the retirement dummy. Coe et al. (2012) found no significant correlation of word recall and retirement for blue-collar workers, but they did find a highly significant small negative correlation for white-collar workers (–0.04 fewer words recalled on a 0–20 scale). They also explored other cognitive function indicators such as numeracy and self-rated memory, and found similar results. Mazzonna and Peracchi (2012) separately examined immediate and delayed recall as well as an 'orientation in time' variable, and verbal fluency and numeracy. They found a significant but small negative correlation of retirement duration on both immediate recall and delayed recall (–0.010* to –0.018*** fewer words on a 0–10 scale).

These results are interesting but cannot be interpreted as causal because cognitive endowments could affect both cognitive functioning outcomes and retirement decisions. For instance, less educated individuals or people with more physically demanding jobs might retire earlier than highly educated individuals or individuals with more intellectually challenging jobs (Glymour et al. 2008; Evans et al. 1993; Jorm et al. 1998; Potter et al. 2008). Additionally, common factors like preferences, behavior, or health could affect both retirement and cognitive abilities (Frederick 2005; Benjamin et al. 2006; Dohmen et al. 2007). To address these issues, some authors also analyzed the effect of retirement on cognition using instrumental variable (IV) approaches. Eligibility ages for both early and full pension benefits were typically used as instruments, derived from the institutional information in *Pensions at a Glance* (OECD 2011) and/or provided by the US Social Security Administration (2014). The instruments used capture the timing of eligibility for public pensions, and most of the studies used these policy variables in relation to the interview date and the respondent's age. An exception is Coe et al. (2012) who used as an instrument the early retirement windows offered by employers as reported in the HRS.

To be suitable instruments, these variables must be correlated with retirement but affect cognition only through their effect on retirement, and not vice versa. Earlier studies on the effect of retirement on health have shown that these proposed instruments are very strong predictors of retirement behavior (Charles 2004; Coe and Lindeboom 2008; Neuman 2008; Bound and Waidmann 2007).

The studies reviewed in Table 4.2 offer a less clear-cut conclusion. We summarize the various approaches in Table 4.2.

TABLE 4.2 Instrument and different instrumental approaches: results

Authors	Countries	Year	Dependent variable	Instruments	Empirical strategy	Results
Rohwedder and Willis (2010)	US, England, and 11 European countries	2004	Words recalled out of 20	Eligible age for early and for full pension benefits	IV	Ret. Dum. −4.666***
Coe and Zamarro (2011)	Europe 11 countries	2004	Words recalled out of 20	Eligible age for early and for full pension benefits	IV	Ret. Dum. −0.0390
Coe et al. (2012)	US	1996–2008	Words recalled out of 20	The offering of an early retirement window	IV	Ret. Dur. 0.37845*** (blue- collar) 0.00521 (white-collar)
Bonsang et al. (2012)	US	1998–2008	Words recalled out of 20	Eligible age for early and for full pension benefits	IV–FE	Ret. Dur. −1.021***
Mazzonna and Peracchi (2012)	Europe 11 countries	2004–2006	1. Im. 2. Delay	Eligible age for early and for full pension benefits	IV	Ret. Dur. M. −0.025*** (im.) 0.009 (del.) W. −0.055*** (im.) −0.029*** (del.)
Mazzonna and Peracchi (2014)	Europe 10 countries	2004–2006	Cognitivity index (PCA)	Eligible age for early and for full pension benefits	IV–FE	Ret. Dur. −0.06*** M. −0.069*** W. −0.057***
Celidoni et al. (2013)	Europe	2004–2010	Words recalled out of 20	Eligible age for early and for full pension benefits	IV–FE	Ret. Dur. −0.2***
Bingley and Martinello (2013)	US, England, and 11 European countries	2004	Words recalled out of 20	Eligible age for early and for full pension benefits. Controlled for years of schooling	IV	Ret. Dum. M. −5.485*** W. −1.607** −3.014***
Bianchini and Borella (2014)	Europe	2004–2010	Words recalled out of 20	Eligible age for early and for full pension benefits	IV–FE	Ret. Dur. 0.3919***

Source: Authors' computations.

To overview the instrumental variable results, Rohwedder and Willis (2010) found a significant reduction of 4.67 words on a scale of 0 to 20 with retirement (significant at the 1 percent level). However, this effect disappeared when Coe and Zamarro (2011) controlled for country dummies. Coe et al. (2012) showed a significant and positive effect for US blue-collar workers, with a coefficient of about 0.38 additional words. Bingley and Martinello (2013) showed that the effect of retirement on cognition declined when they controlled for years of schooling (–3.0 versus –5.6 reduction in words recalled). When estimating the model for men and women separately, they found a lower effect of retirement on word recall for women than for men. Mazzonna and Peracchi (2012) accounted for attrition, cohort effects, and learning effects, and they found a small significant negative effect of retirement duration on cognitive abilities (–0.025 words per year in retirement in immediate memory recall for men, and –0.055 words per year in retirement for women in immediate recall).

To deal with unobserved heterogeneity across individuals, some authors have adopted a fixed effect (FE) approach in the instrumental variable setting. For instance, Bonsang et al. (2012) reported a significant and negative retirement coefficient of –1.01 words in a baseline model using fixed-effect methods. After controlling for different age specifications and retirement durations, they found less robust results. Using principal components analysis, Mazzonna and Peracchi (2014) constructed a cognitive capability index based on various cognition measures. They analyzed a dummy for retirement similar to that in Rohwedder and Willis (2010), and they also analyzed the effect of retirement duration as in Mazzonna and Peracchi (2012). They found a small negative effect of retirement duration with their cognitive index, so that more time in retirement implied a larger decrease in cognitive functioning. They also found a positive effect of immediate retirement on cognition for white-collar jobs, and no significant effect for blue-collar jobs, as well as a negative effect of retirement duration for both groups. When only using fixed effects and controlling for age and time dummies, Celidoni et al. (2013) found a positive but small effect on the retirement dummy (–0.4) and a small negative and significant coefficient for retirement duration (–0.10). People recalled –0.13 fewer words per year in retirement (on a 0–20 scale), depending on the specification of age. The authors also found a small negative effect of –0.2 words per year in retirement on cognition with a combined IV–FE approach and excluding the retirement dummy from the regressions. Bianchini and Borella (2014) interacted the number of years in retirement with the retirement dummy for individuals who actually retired during the sample period, so that they were observed both when working and retired. Interestingly, using a similar approach to Celidoni et al. (2013), they found the opposite result: a significant small positive effect of retirement duration on cognition (with an

estimated increase in words recalled on a 0–20 scale equal to 0.39 per year in retirement).

In summary, most studies reported small and sometimes insignificant effects of retirement on cognition. The exceptions were Rohwedder and Willis (2010), Bonsang et al. (2012), and Bingley and Martinello (2013) who found significant negative effects of retirement on words recalled (about –3 and –5 words on a scale of 0 to 20 words for Rohwedder and Willis (2010) and Bingley and Martinello (2013), respectively, and about –1 word per year in retirement for Bonsang et al. (2012).

Disaggregating Cognitive Abilities and Reconciling Results

To better understand the sources of differential effects of retirement on cognition documented in the prior literature, we also use the HRS, ELSA, and SHARE surveys from 2004 to 2012. We also focus on countries with at least three waves (thirteen countries).[8] (Descriptive statistics for the baseline samples appear in Appendix A and Appendix Tables 4A.1 and 4A.2.)

Our goal is to reconcile the divergent results in the literature by evaluating different econometric specifications and operationalizations of retirement. In particular we estimate effects of retirement on cognitive ability using Ordinary Least Squares (OLS), Instrumental Variable Methods, Fixed Effects and Instrumental Variable Fixed Effect (IV–FE) methods, for all surveys combined.[9]

We also present specifications using a variety of control variables. A first specification includes none at all, while a second specification adds age, cohort, and gender. Note that by controlling for age, we account for the natural decline of memory with age. Therefore, our estimates of the effect of retirement capture changes in the age trajectory due to retirement. The third specification adds country fixed effects to the set of controls. The final two specifications include as controls demographic information (marital status and level of education), and health outcomes (self-reported health, number of limitations with activities, and medical conditions). We are aware that the last two specifications could raise endogeneity issues. For instance, in the former specification, marital status could affect cognitive abilities via social activities as part of the family network. In the latter specification, one might be concerned that health is affected by cognition, while health could also be affected by retirement. We have conducted various robustness checks including incorporating income, wealth, and other social network control variables. Since the results do not differ much, they are reported in Appendix A.

Our first retirement definition is based on self-reports of current job status (SR_Ret). The second definition includes homemakers with those who say they are sick or disabled in the set of retirees, but we condition on working at the age of 50 (NW1_Ret), as in Coe and Zamarro (2011). Our third definition of retirement is the most inclusive and defines as retired all those not working now (NW2_Ret), as in Rohwedder and Willis (2010).

To address the potential endogeneity of retirement (i.e., that cognitive decline may affect when someone retires), we instrument using two variables that indicate whether the respondent was eligible for full or early retirement public pensions using the country- and gender-specific pension-eligibility ages described in Appendix B.[10]

Pooled Results

Table 4.3 presents the estimates for all surveys pooled together. Overall, the Ordinary Least Square (OLS) estimates reveal a significant negative correlation between retirement and cognition scores (on a 0–20 scale) ranging from –1.28 words for specifications without controls, to –0.28 words with more detailed controls. The more controls we add, the lower the estimated coefficient. The size of the effect does vary depending on the definition of retirement used: for instance, the definition based on the respondent reporting not working (NW2_Ret) generates the highest estimated negative effects, followed by NW1_Ret and self-reported retirement status (SR_Ret) (similar results appear in Appendix Tables 4A.3–4A.8).

The IV estimates are mostly larger than the OLS results,[11] but results change dramatically when country fixed effects are included. Excluding country controls means that our estimates are based on variation within and across countries. Hence cognition levels of those above retirement age are compared with cognition levels of those below. Including country fixed effects changes the sources of identification and interpretation of the estimated retirement effects. Specifically, with country effects, retirement impacts are estimated by comparing individuals in the same country above and below retirement eligibility age (Coe and Zamarro 2011). In most cases, combining country fixed effects with IV restores the estimated negative effect of retirement on cognition, but the effects become mostly small and often insignificant.

Heterogeneity across Individuals

If the causal effect of retirement on cognition is heterogeneous across respondents, then the estimated effect recovered by IV will be a weighted average of the effects for those individuals induced to change their decisions

TABLE 4.3 Effects of retirement on cognition for all countries

	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−1.19***	−2.18***	0.05	−0.23*	−1.18***	−2.28***	0.02	−0.34***	−1.27***	−2.74***	−0.08**	−0.41**
	(0.02)	(0.02)	(0.03)	(0.09)	(0.02)	(0.03)	(0.02)	(0.09)	(0.02)	(0.03)	(0.02)	(0.13)
2. Years, cohorts, gender	−0.83***	−5.68***	0.006	−0.78	−0.97***	−6.19***	−0.007	−0.78	−1.12***	−8.77***	−0.09***	−1.19
	(0.02)	(0.20)	(0.03)	(0.52)	(0.02)	(0.23)	(0.03)	(0.46)	(0.02)	(0.39)	(0.02)	(1.02)
3. 2 + Country fixed effects	−0.60***	−0.70**	0.006	−0.78	−0.69***	−0.61*	−0.007	−0.09***	−0.88***	−0.70	−0.78	−1.19
	(0.02)	(0.26)	(0.03)	(0.52)	(0.02)	(0.26)	(0.03)	(0.02)	(0.02)	(0.44)	(0.46)	(1.02)
4. 3 + Demographics	−0.44***	−0.70**	0.007	−0.80	−0.46***	−0.48	−0.005	−0.77	−0.61***	−0.61	−0.09**	−1.09
	(0.02)	(0.25)	(0.03)	(0.52)	(0.02)	(0.26)	(0.03)	(0.46)	(0.02)	(0.42)	(0.03)	(0.99)
5. 4+ Health controls	−0.28***	−0.75**	0.007	−0.65	−0.28***	−0.57*	−0.008	−0.08**	−0.41***	−0.81*	−0.65	−0.90
	(0.02)	(0.23)	(0.03)	(0.47)	(0.02)	(0.24)	(0.03)	(0.02)	(0.02)	(0.36)	(0.43)	(0.86)

Notes: Ordinary Least Squares (OLS); Instrumental Variable Methods (IV); Fixed Effects (FE); Instrumental Variable Fixed Effect Methods (IV–FE). Retirement definitions: SR_Ret is based on self-reports of current job status; NW1_Ret includes homemakers along with those who say they are sick or disabled into the set of retirees, but conditions on working at the age of 50; NW2_Ret defines as retired all those who are not working now.

Source: Authors' computations.

because of the instrument. In our case, the instruments are based on retirement eligibility, so the issue is which labor force participants are induced to retire once they reach the eligibility age. This is what is known as the local average treatment effect (LATE; Imbens and Angrist 1994; Angrist and Pischke 2015). Accordingly, studies that estimate the same model with different IVs or use samples from different populations may obtain very different estimates of the causal effects.

Average cognitive scores differ between men and women. Men recall 9.58 words on average while women recall 10.39 words. These numbers are quite stable over the period studied. Figure 4.1 shows that the averages vary across countries, but women always score better than men. Moreover, Table 4.4 shows results of OLS estimates by gender, which are seen to be similar. In the IV specifications, results for women mostly retain significant and negative coefficients even controlling for all covariates, while for men the coefficients of interest lose significance once we control for country fixed effects. The IV–FE estimates for men are statistically insignificant, while for women,

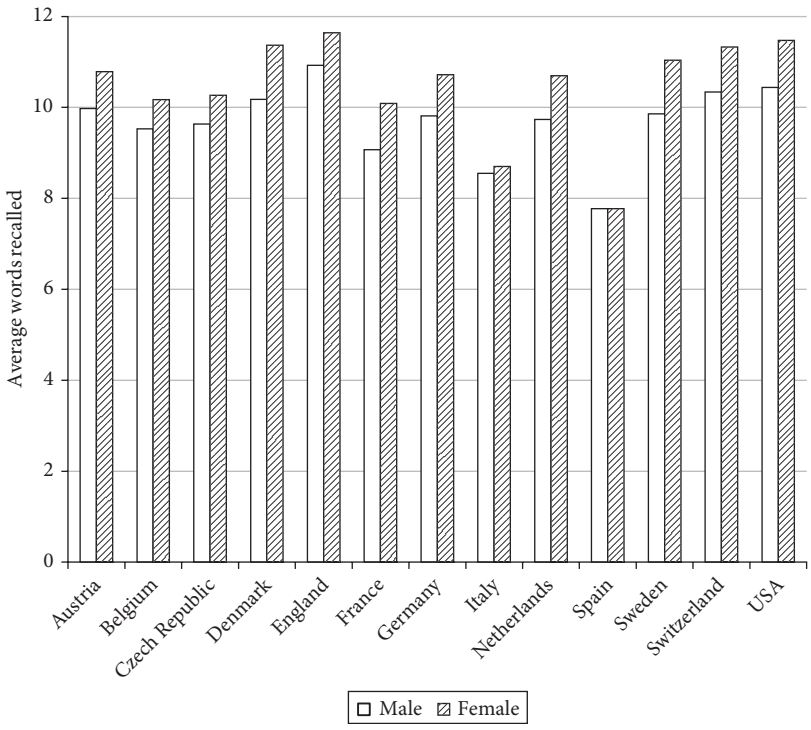

Figure 4.1. Cognitive functioning and gender differences
Source: Authors' computation.

TABLE 4.4 Effect of retirement on cognition for all countries by gender

Men	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−1.28***	−2.18***	0.03	0.04	−1.21***	−2.09***	−0.001	−0.19	−1.34***	−2.58***	−0.10**	−0.19
	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.05)	(0.04)	(0.18)
2. Years, cohorts, gender	−0.89***	−4.86***	−0.04	0.24	−0.89***	−4.76***	−0.04	−0.20	−1.07***	−6.87***	−0.13**	−0.17
	(0.04)	(0.25)	(0.05)	(0.65)	(0.04)	(0.26)	(0.05)	(0.59)	(0.03)	(0.42)	(0.04)	(1.12)
3. 2 + Country fixed effects	−0.65***	0.05			−0.69***	0.11			−0.92***	0.49		
	(0.04)	(0.33)			(0.04)	(0.32)			(0.03)	(0.48)		
4. 3 + Demographics	−0.48***	0.01	−0.01	0.28	−0.49***	0.11	−0.03	−0.15	−0.66***	0.38	−0.10*	−0.05
	(0.04)	(0.32)	(0.05)	(0.64)	(0.04)	(0.32)	(0.05)	(0.59)	(0.03)	(0.46)	(0.04)	(1.09)
5. 4 + Health controls	−0.32***	0.04	−0.02	0.34	−0.28***	0.10	−0.01	−0.08	−0.43***	0.29	−0.09*	0.17
	(0.04)	(0.31)	(0.05)	(0.59)	(0.04)	(0.31)	(0.05)	(0.55)	(0.03)	(0.43)	(0.04)	(1.01)
Women	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−1.16***	−2.18***	0.08	−0.51***	−1.29***	−2.44***	0.05	−0.49***	−1.40***	−2.89***	−0.06	−0.61**
	(0.03)	(0.04)	(0.04)	(0.15)	(0.03)	(0.05)	(0.04)	(0.14)	(0.03)	(0.05)	(0.04)	(0.19)
2. Years, cohorts, gender	−0.77***	−6.60***	0.05	−2.13*	−1.04***	−7.79***	0.01	−1.46*	−1.17***	−10.02***	−0.07*	−3.05
	(0.04)	(0.35)	(0.05)	(0.83)	(0.04)	(0.41)	(0.04)	(0.71)	(0.03)	(0.65)	(0.04)	(1.88)
3. 2 + Country fixed effects	−0.56***	−1.62***			−0.66***	−1.52**			−0.85***	−2.51**		
	(0.04)	(0.44)			(0.03)	(0.47)			(0.03)	(0.88)		
4. 3 + Demographics	−0.4***	−1.57***	0.04	−2.24**	−0.42***	−1.27**	0.01	−1.54*	−0.57***	−2.13**	−0.08*	−2.89
	(0.04)	(0.41)	(0.05)	(0.84)	(0.03)	(0.45)	(0.04)	(0.72)	(0.03)	(0.79)	(0.04)	(1.81)
5. 4 + Health controls	−0.25***	−1.58***	0.03	−1.83*	−0.26***	−1.39***	−0.005	−1.29	−0.38***	−2.17***	−0.08	−2.38
	(0.04)	(0.37)	(0.05)	(0.73)	(0.03)	(0.42)	(0.04)	(0.66)	(0.03)	(0.64)	(0.04)	(1.44)

Notes: Ordinary Least Squares (OLS); Instrumental Variable Methods (IV); Fixed Effects (FE); Instrumental Variable Fixed Effect Methods (IV–FE).
Retirement definitions: SR_Ret is based on self-reports of current job status; NW1_Ret includes homemakers along with those who say they are sick or disabled into the set of retirees, but conditions on working at the age of 50; NW2_Ret defines as retired all those who are not working now.

Source: Authors' computations.

the estimated effects of retirement on cognition remain negative and mostly statistically significant even when country fixed effects and covariates are included.

As Bingley and Martinello (2013) argued, the differences in eligibility ages across gender could be correlated with education level. Table 4.5 provides a breakdown of results for two different education levels. Here, the OLS and IV estimates are similar across the two groups, although the coefficients are smaller for better-educated than lower-educated individuals. The IV–FE models generate generally insignificant results for both groups.

It is also of interest to differentiate results by occupation. One variable we use measures physical effort in the current job directly, while a second variable is constructed by matching people's reported occupations to administrative classifications (ISCO coding for continental Europe, SOC2010 for England, Census coding for the US) to distinguish between blue-collar and white-collar jobs. (More details about the variables can be found in Appendix A.) We find that people working in physically demanding jobs recall about 10 words, while those in less physically demanding jobs recall about 11. Similar differences arise when comparing blue-collar jobs and white-collar jobs. Table 4.6 summarizes results according to the physically demanding job definition.

To sum up the results, our analysis shows that the estimated effects of retirement on cognition are quite sensitive to model specification. In particular, results are especially sensitive to the inclusion of country fixed effects used to control for unobserved country differences. When these are controlled for, estimated effects of retirement on cognition are small and mostly insignificant.

Conclusions

In this chapter we have reviewed the empirical literature estimating the effects of retirement on cognitive function. We use several internationally comparable datasets and show there is wide variation in outcomes. In particular, estimates are very sensitive to econometric specifications, and the use of country fixed effects in particular dramatically reduces the estimated effect of retirement on cognition. This is also true for population subgroups distinguished by blue-collar/white-collar, physical demands, and job skill level. The upshot of our work is therefore that previous studies' findings must be considered quite fragile. It should be pointed out that our IV strategy aims to identify a sharp immediate effect of retirement on cognition, rather than considering the effect of retirement duration on

TABLE 4.5 Effect of retirement on cognition for all countries by skill education

Middle and low-skilled workers	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−1.07***	−1.91***	0.07	0.05	−1.05***	−2.07***	0.06	−0.04	−1.09***	−2.45***	−0.05	−0.01
	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.05)	(.0.03)	(0.18)
2. Years, cohorts, gender	−0.73***	−2.5***	0.03	−0.09	−0.86***	−2.64***	−0.01	−0.03	−0.95***	−3.01***	−0.03	−0.26
	(0.03)	(0.60)	(0.05)	(0.51)	(0.03)	(0.13)	(0.04)	(0.49)	(0.03)	(0.15)	(0.49)	(1.13)
3. 2 + Country fixed effects	−0.52***	−0.62*			−0.61***	−0.39			−0.73***	−0.45		
	(0.03)	(0.28)			(0.03)	(0.30)			(0.03)	(0.51)		
4. 3 + Demographics	−0.04	−0.21	−0.04	−0.21	−0.01	−0.16	−0.01	−0.16	−0.09**	−0.43	−0.09**	−0.43
	(0.05)	(0.53)	(0.05)	(0.53)	(0.04)	(0.50)	(0.04)	(0.50)	(0.04)	(1.13)	(0.03)	(1.13)
5. 4 + Health controls	−0.04	−0.16	−0.04	−0.16	−0.35***	0.08	−0.35***	0.08	−0.56***	0.37	−0.56***	0.37
	(0.05)	(0.49)	(0.05)	(0.49)	(0.04)	(0.62)	(0.04)	(0.62)	(0.04)	(1.14)	(0.04)	(1.14)
Higher-skilled workers	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−0.70***	−1.54***	0.04	−0.66***	−0.60***	−1.51***	−0.02	−0.74***	−0.68***	−1.92***	−0.11*	−0.95***
	(0.04)	(0.05)	(0.05)	(0.16)	(0.03)	(0.05)	(0.04)	(0.15)	(0.04)	(0.07)	(0.04)	(0.19)
2. Years, cohorts, gender	−0.39***	−1.55***	0.08	−2.27	−0.36***	−1.69***	0.03	−1.6	−0.55***	−2.09***	−0.07	−2.19
	(0.05)	(0.16)	(0.05)	(1.56)	(0.04)	(0.17)	(0.05)	(1.05)	(0.04)	(0.24)	(0.05)	(2.30)
3. 2 + Country fixed effects	−0.39***	−0.03			−0.35***	0.08			−0.56***	0.37		
	(0.05)	(0.75)			(0.04)	(0.62)			(0.04)	(1.14)		
4. 3 + Demographics	−0.39***	−0.06	0.07	−2.27	−0.35***	0.03	0.01	−1.63	−0.55***	0.24	−0.08	−2.02
	(0.05)	(0.75)	(0.05)	(1.57)	(0.04)	(0.61)	(0.05)	(1.05)	(0.04)	(1.11)	(0.05)	(2.21)
5. 4 + Health controls	−0.26***	−0.34	0.07	−2.04	−0.19***	−0.24	0.01	−1.7	−0.39***	−0.34	−0.06	−2.19
	(0.05)	(0.64)	(0.06)	(1.32)	(0.04)	(0.56)	(0.05)	(0.97)	(0.04)	(0.88)	(0.05)	(1.93)

Notes: Ordinary Least Squares (OLS); Instrumental Variable Methods (IV); Fixed Effects (FE); Instrumental Variable Fixed Effect Methods (IV–FE). Retirement definitions: SR_Ret is based on self-reports of current job status; NW1_Ret includes homemakers along with those who say they are sick or disabled into the set of retirees, but conditions on working at the age of 50; NW2_Ret defines as retired all those who are not working now.

Source: Authors' computations.

TABLE 4.6 Effect of retirement on cognition for all countries by physically demanding job

Physically demanding job	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−0.33***	−1.81***	−0.19*	−0.32	−0.24**	−1.61***	−0.18*	−0.44**	−0.30***	−2.84***	−0.15*	−0.55**
	(0.09)	(0.18)	(0.08)	(0.17)	(0.08)	(0.16)	(0.07)	(0.16)	(0.08)	(0.29)	(0.07)	(0.19)
2. Years, cohorts, gender	−0.47***	−2.86***	−0.18	0.13	−0.31***	−2.81***	−0.13	−0.37	−0.48***	−4.77***	−0.09	1.28
	(0.10)	(0.35)	(0.10)	(1.30)	(0.57)	(0.34)	(0.09)	(1.14)	(0.10)	(0.25)	(0.09)	(2.92)
3. 2 + Country fixed effects	−0.17	2.28			−0.07	1.87			−0.34***	3.61		
	(0.11)	(1.93)			(0.09)	(1.50)			(0.10)	(4.32)		
4. 3 + Demographics	−0.14	2.69	0.13	−0.19	−0.05	−0.23*	−0.37	−0.13	2.11	3.21	1.28	−0.09
	(0.11)	(2.17)	(1.30)	(0.10)	(0.09)	(0.10)	(1.14)	(0.09)	(1.59)	(3.16)	(2.92)	(0.09)
5. 4 + Health controls	−0.03	1.39	−0.17	−0.35	0.05	−0.10	−0.11	−0.75	1.04	4.95	−0.05	−0.07
	(0.11)	(1.79)	(0.11)	(1.33)	(0.09)	(0.10)	(0.10)	(1.14)	(1.43)	(4.10)	(0.09)	(2.46)
Not physically demanding job	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−0.37***	−1.87***	0.10*	−0.08	−0.29***	−1.61***	0.07*	−0.20*	−0.25***	−3.01***	−0.02	−0.26**
	(0.04)	(0.09)	(0.04)	(0.08)	(0.04)	(0.08)	(0.03)	(0.08)	(0.05)	(0.16)	(0.04)	(0.10)
2. Years, cohorts, gender	−0.56***	−3.33	0.14**	0.35	−0.42***	−3.28***	0.12**	0.29	−0.47***	−5.52***	0.02	2.23
	(0.05)	(0.18)	(0.05)	(1.05)	(0.23)	(0 .17)	(0.04)	(0.69)	(0.07)	(0.34)	(0.04)	(2.94)
3. 2 + Country fixed effects	−0.20***	−0.39			−0.15**	0.12			−0.36***	7.07		
	(0.05)	(0.90)			(0.05)	(0.71)			(0.05)	6.27		
4. 3 + Demographics	−0.19***	−0.51	0.13*	0.45	−0.12**	0.33	0.12**	0.32	−0.28***	(9.11)	0.03	2.36
	(0.05)	(0.93)	(0.05)	(1.12)	(0.04)	(0.71)	(0.04)	(0.70)	(0.05)	6.65	(0.04)	(2.85)
5. 4 + Health controls	−0.14**	−0.75	0.12*	0.32	−0.07	−0.10	0.11*	0.22	−0.21***	3.05	0.02	3.70
	(0.05)	(0.78)	(0.05)	(0.90)	(0.04)	(0.66)	(0.04)	(0.62)	(0.05)	(3.18)	(0.05)	(3.49)

Notes: Ordinary Least Squares (OLS); Instrumental Variable Methods (IV); Fixed Effects (FE); Instrumental Variable Fixed Effect Methods (IV–FE). Retirement definitions: SR_Ret is based on self-reports of current job status; NW1_Ret includes homemakers along with those who say they are sick or disabled into the set of retirees, but conditions on working at the age of 50; NW2_Ret defines as retired all those who are not working now.

Source: Authors' computations.

cognitive decline. Our review of the literature suggests that the effects of those estimates are equally fragile.

Appendix

Appendix A: Data Description

We use data from several longitudinal surveys of the over-50 population: the Health and Retirement Study (HRS) for the US, the English Longitudinal Study of Ageing (ELSA) for England, and the Study of Health, Ageing and Retirement in Europe (SHARE). Since SHARE was introduced in 2004, we focus our analysis on the year 2004 and subsequent waves of all surveys through 2012. We analyze five waves for HRS and ELSA, and four waves for SHARE (wave 3 of SHARE collects life histories and does not contain cognitive abilities variables). HRS, ELSA, and SHARE all cover a wide range of topics including demographics (age, gender, and education), labor supply, income, pension benefits, wealth, health, and cognitive function. They contain identical question wordings whenever possible.

Cognitive Functioning Variables

All three surveys ask several questions about cognitive functioning. Their measures of cognitive abilities are comparable and follow similar interview procedures. Here we describe the construction of the word recall variable for each survey.

HRS: The interviewer read a list of ten nouns (e.g., lake, car, army, etc.) to the respondent. Immediate word recall: After reading the list, individuals were asked to recall as many words as possible. The list could be given in any order. Between waves, the list of nouns may have changed. Delayed word recall: After approximately five minutes of being asked other survey questions (e.g., about other cognition items), individuals were asked to recall the list again in any order. The sum of the outcomes of both Immediate Word Recall (10 words) and Delayed Word Recall (10 words) is used to build a recall summary score. Values range from 0 to 20.

ELSA: A list of ten nouns could be read from a computer screen or by the interviewer if there were technical issues. Respondents were given the following instructions:

> The computer will now read a set of 10 words. I would like you to recall as many as you can. We have purposely made the list long so it will be difficult for anyone to recall all the words. Please listen carefully to the set of words as they

> cannot be repeated. When it has finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear?

After several other questions were asked, the respondent was asked to recall the words again. The summary test recall score is the sum of both immediate and delayed word recall for a maximum of 20. Values range from 0 to 20.

SHARE: As in ELSA, a list of ten nouns could be read from a computer screen. At the beginning of the immediate word recall exercise, the interviewer read this message:

> Please listen carefully, as the set of words cannot be repeated. When I have finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear?

As in the HRS, for the delayed word recall the respondent was asked to recall the words again after several questions were asked about other cognitive abilities. The summary test recall score is again the sum of both the immediate and delayed word recall for a maximum of 20. A drawback of SHARE is that all respondents in the household in waves 1 and 2 could receive the exact same test each time. The survey corrected this issue in waves 4 and 5.

Retirement

All three surveys ask similar questions about current work status and retirement status.

HRS measures self-reported work status by asking: (1) working now, (2) unemployed and looking for work, (3) temporarily laid off, on sick or other leave, (4) disabled, (5) retired, (6) homemaker, (7) other (specify). For the salaried workers, there is a follow-up question whether individuals are currently working for pay.

ELSA measures self-reported work status by asking: (1) retired, (2) employed, (3) self-employed, (4) unemployed, (5) permanently sick or disabled, (6) looking after home or family, (7) other, and (8) spontaneous: semi-retired.

SHARE measures self-reported work status by asking: (1) retired, (2) employed or self-employed (including working for family business), (3) unemployed and looking for work, (4) permanently sick or disabled, (5) homemaker, (6) other (renter, living off own property, student, doing voluntary work).

We define three binary measures of retirement: SR_Ret is based on self-reported current work status; NW1_Ret also includes as retired homemakers, sick or disabled, and those non-temporarily away from the labor

force (if respondents declared they worked at age 50); NW2_Ret includes all those who are not working now.

Other Covariates

Demographic variables include age, age-squared, female, being married or in a couple, and interactions with being female. Other controls include as cohort, years and country dummies, and three education levels (tertiary, secondary, and primary).

Several health variables are used. A binary indicator is included for having at least one major chronic condition from a list including cancer, lung disease, heart attack, and stroke. A second indicates having at least one minor chronic condition from a list including hypertension, diabetes, and arthritis. Self-reported health is also included (= 1 if the individual reports bad or poor health and 0 otherwise). Impairment indicators (ADLA and iADLA) for limitations with daily activities are also considered. Similar questions are asked in all surveys about difficulties in five basic activities: bathing, dressing, eating, getting in and out of bed, and walking across a room. Individuals are classified as having any ADL limitation if they reported limitations with one or more of the five activities. Those who reported having some difficulty with preparing meals, shopping, making phone calls, taking medications, and managing money are classified as having an iADL limitation.

Physically demanding jobs are coded as follows. ELSA distinguishes four categories: sedentary occupation, standing occupation, physical work, and heavy manual work. We set the variable 'physically demanding job' equal to 1 for the last two categories, and 0 otherwise. HRS asks directly if the current job requires physical effort 'whether all/almost all the time', 'most of the time', 'some of the time', and 'none/almost none of the time'. We set a 'physically demanding job' variable equal to 1 for 'all/almost all the time', and 0 otherwise. In SHARE, individuals are asked: 'My job is physically demanding. Would you say you "strongly agree", "agree", "disagree" or "strongly disagree"?' In our analyses the 'physically demanding job' variable is set to 1 for 'strongly agree', and 0 otherwise. Our blue-collar and white-collar definitions are based on SHARE's ISCO coding and the HRS 1980 and 2000 census coding. For ELSA we use the categories in the SOC2010 volume 3: the National Statistics Socio-Economic classification (NS-SEC rebased on SOC2010). Blue-collar jobs are defined as those that involve routine or manual work; white-collar jobs are defined as managerial and professional occupations or intermediate occupations.

TABLE 4A.1 Descriptive statistics

Variable	ALL COUNTRIES					SHARE				
	Obs.	Mean	Std. dev.	Min.	Max.	Obs.	Mean	Std. dev.	Min.	Max.
Words recalled (0–20 scale)	169,487	10.36	3.38	0	20	91,485	9.86	3.41	0	20
SR_Ret	142,545	0.47	0.50	0	1	75,733	0.51	0.50	0	1
NW1_Ret	157,945	0.52	0.50	0	1	84,831	0.56	0.50	0	1
NW2_Ret	173,559	0.49	0.50	0	1	92,422	0.52	0.50	0	1
Age	174,395	60.51	5.70	50	70	93,061	60.29	5.73	50	70
Female	174,395	0.55	0.50	0	1	93,061	0.54	0.50	0	1
Married	171,965	0.79	0.41	0	1	90,653	0.82	0.39	0	1
Education	167,031	1.84	0.72	1	3	89,422	1.91	0.63	1	3
Skill: 1 Unskilled	167,031	0.64	0.48	0	1	89,422	0.75	0.43	0	1
Bad health	168,452	0.24	0.43	0	1	93,061	0.26	0.44	0	1
ADLAs	173,896	0.08	0.28	0	1	92,679	0.06	0.23	0	1
IADLAs	173,888	0.03	0.17	0	1	92,679	0.02	0.13	0	1
Minor conditions	173,884	0.56	0.50	0	1	92,623	0.46	0.50	0	1
Major conditions	173,836	0.22	0.41	0	1	92,623	0.17	0.37	0	1
Physically demanding job	54,202	0.22	0.41	0	1	19,141	0.20	0.40	0	1
Occupation: 1 Blue-collar	62,516	0.39	0.49	0	1	18,115	0.47	0.50	0	1
Variable	ELSA					HRS				
	Obs.	Mean	Std. dev.	Min.	Max.	Obs.	Mean	Std. dev.	Min.	Max.
Words recalled (0–20 scale)	30,567	11.33	3.30	0	20	47,435	10.70	3.18	0	20
SR_Ret	26,900	0.44	0.50	0	1	39,912	0.42	0.49	0	1
NW1_Ret	29,965	0.49	0.50	0	1	43,149	0.47	0.50	0	1
NW2_Ret	31,609	0.48	0.50	0	1	49,528	0.44	0.50	0	1
Age	31,630	60.57	5.42	50	70	49,704	60.89	5.77	50	70

(*continued*)

Table 4A.1 Continued

Variable	ELSA					HRS				
	Obs.	Mean	Std. dev.	Min.	Max.	Obs.	Mean	Std. dev.	Min.	Max.
Female	31,630	0.54	0.50	0	1	49,704	0.57	0.50	0	1
Married	31,622	0.78	0.41	0	1	49,690	0.74	0.44	0	1
Education	27,917	1.96	0.89	1	3	49,692	1.64	0.73	1	3
Skill: 1 Unskilled	27,917	0.58	0.49	0	1	49,692	0.49	0.50	0	1
Bad health	25,687	0.21	0.41	0	1	49,704	0.23	0.42	0	1
ADLAs	31,612	0.12	0.33	0	1	49,605	0.11	0.31	0	1
IADLAs	31,612	0.03	0.16	0	1	49,597	0.05	0.22	0	1
Minor conditions	31,621	0.55	0.50	0	1	49,640	0.74	0.44	0	1
Major conditions	31,621	0.23	0.42	0	1	49,592	0.31	0.46	0	1
Physically demanding job	11,612	0.28	0.45	0	1	23,449	0.20	0.40	0	1
Occupation: 1 Blue-collar	19,851	0.39	0.49	0	1	24,550	0.33	0.47	0	1

Notes: The following are the variables listed in the above table: Survey of Health, Ageing and Retirement in Europe (SHARE), English Longitudinal Study of Ageing (ELSA), and US Health and Retirement Study (HRS).

Source: Authors' computations.

Appendix B: *Early and Full Retirement Ages*

TABLE 4A.2 Early and full retirement ages across the OECD nations

Early and full retirement ages (full retirement ages in parentheses)

Country	2004		2006		2008		2010		2012	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Austria	65(65)	60(60)	65(65)	65(65)	65(65)	65(65)	62(65)	60(65)	62(65)	62(65)
Belgium	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	62(65)	62(65)
Czech Republic	60(65)	58(63)	60(65)	58(63)	60(65)	60(64)	60(65)	60(64)	64(69)	64(69)
Denmark	65(65)	65(65)	65(65)	65(65)	65(65)	65(65)	67(67)	67(67)	67(67)	67(67)
France	60(60)	60(60)	60(60)	60(60)	61(61)	61(61)	56–60(65)	56–60(65)	60(67)	60(67)
Germany	63(65)	63(65)	63(65)	63(65)	63(67)	63(67)	63(67)	63(67)	63(67)	63(67)
Italy	60(65)	60(65)	60(65)	60(60)	60(65)	60(60)	61(65)	60(60)	62(67)	62(67)
Netherlands	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	65(65)	65(65)	67(67)	67(67)
Spain	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	61(65)	61(65)	65(67)	65(67)
Sweden	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)
Switzerland	63(65)	62(64)	63(65)	62(64)	63(65)	62(64)	63(65)	62(64)	63(65)	62(64)
England	65(65)	65(65)	68(68)	68(68)	68(68)	68(68)	68(68)	68(68)	68(68)	68(68)
United States*	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)

*Full retirement age depends on birth year.

Sources: OECD *Pensions at a Glance* several years.

Appendix C: First State Estimations

TABLE 4A.3 First-stage results, pooled data

	Dependent variables	SR_Ret	NW1_Ret	NW2_Ret
			First stage	
1. No controls	*Above full retirement age*	0.25***	0.22***	0.20***
		(0.003)	(0.003)	(0.003)
	Above early retirement age	0.42***	0.38***	0.29***
		(0.003)	(0.003)	(0.003)
2. Years, cohorts, gender	*Above full retirement age*	0.48***	0.04***	0.04***
		(0.004)	(0.004)	(0.004)
	Above early retirement age	0.14***	0.12***	0.08***
		(0.003)	(0.003)	(0.003)
3. 2 + Country fixed effects	*Above full retirement age*	0.031***	0.025***	0.022***
		(0.004)	(0.004)	(0.004)
	Above early retirement age	0.10***	0.10***	0.05***
		(0.003)	(0.003)	(0.003)
4. 3 + Demographics	*Above full retirement age*	0.035***	0.025***	0.024***
		(0.004)	(0.004)	(0.004)
	Above early retirement age	0.10***	0.10***	0.05***
		(0.003)	(0.003)	(0.003)
5. 4 + Health controls	*Above full retirement age*	0.05***	0.04***	0.08***
		(0.004)	(0.004)	(0.19)
	Above early retirement age	0.12***	0.11***	0.03
		(0.003)	(0.003)	(0.02)

Notes: The following are the variables listed in the above table: self-reports of current job status (SR_Ret), homemakers with those who say they are sick or disabled (NW1_Ret), and all those who are not working now (NW2_Ret).

Source: Authors' computations.

TABLE 4A.4 First-stage results by skill group, pooled data

	Dependent variables	SR_Ret	NW1_Ret	NW2_Ret	SR_Ret	NW1_Ret	NW2_Ret
		First stage: unskilled workers			First stage: middle and skilled workers		
1. No controls	*Above full retirement age*	0.22***	0.19***	0.18***	0.30***	0.27***	0.23***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.45***	0.39***	0.29***	0.34***	0.35***	0.25***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2. Years, cohorts, gender	*Above full retirement age*	0.04***	0.04***	0.04***	0.03***	0.03***	0.02*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.16***	0.13***	0.08***	0.06***	0.07***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
3. 2 + Country fixed effects	*Above full retirement age*	0.03***	0.03***	0.02***	0.03***	0.02**	0.02**
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.12***	0.11***	0.06***	0.05***	0.07***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4. 3 + Demographics	*Above full retirement age*	0.03***	0.02***	0.02***	0.03***	0.01**	0.02*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	012***	011***	0.06***	0.06***	0.07***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
5. 4 + Health controls	*Above full retirement age*	0.04***	0.03***	0.03***	0.04***	0.03***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.13***	0.11***	0.06***	0.06***	0.08***	0.05***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: The following are the variables listed in the above table: self-reports of current job status (SR_Ret), homemakers with those who say they are sick or disabled (NW1_Ret), and all those who are not working now (NW2_Ret).

Source: Authors' computations.

TABLE 4A.5 First-stage results by physically demanding jobs groups, pooled data

	Dependent variables	SR_Ret	NW1_Ret	NW2_Ret	SR_Ret	NW1_Ret	NW2_Ret
		First stage: physically demanding job			First stage: more intellectual job		
1. No controls	*Above full retirement age*	0.25***	0.23***	0.13***	0.28***	0.27***	0.14***
		(0.014)	(0.01)	(0.01)	(0.007)	(0.007)	(0.006)
	Above early retirement age	0.24***	0.26***	0.14***	0.20***	0.25***	0.13***
		(0.011)	(0.01)	(0.01)	(0.005)	(0.005)	(0.005)
2. Years, cohorts, gender	*Above full retirement age*	0.024***	−0.03**	0.01	0.08***	0.05***	−0.01
		(0.017)	(0.02)	(0.02)	(0.008)	(0.006)	(0.08)
	Above early retirement age	0.07***	0.01	0.09***	0.03***	0.06***	−0.001
		(0.011)	(0.01)	(0.01)	(0.005)	(0.006)	(0.005)
3. 2 + Country fixed effects	*Above full retirement age*	0.01***	0.00	−0.03	0.06***	0.04***	−0.007
		(0.016)	(0.004)	(0.02)	(0.008)	(0.009)	(0.008)
	Above early retirement age	0.05***	0.07***	0.01	0.03***	0.06***	0.01
		(0.013)	(0.01)	(0.01)	(0.006)	(0.007)	(0.006)
4. 3 + Demographics	*Above full retirement age*	−0.006	0.014	0.05***	0.06***	0.04***	−0.009
		(0.01)	(0.02)	(0.02)	(0.009)	(0.009)	(0.008)
	Above early retirement age	0.06***	0.07***	0.01	0.03***	0.06***	0.01
		(0.01)	(0.014)	(0.01)	(0.006)	(0.007)	(0.006)
5. 4 + Health controls	*Above full retirement age*	0.01***	−0.00	−0.03	0.07***	0.05***	0.002
		(0.02)	(0.02)	(0.02)	(0.009)	(0.009)	(0.008)
	Above early retirement age	0.06***	0.07***	0.02*	0.04***	0.07***	0.02***
		(0.01)	(0.01)	(0.01)	(0.006)	(0.007)	(0.006)

Notes: The following are the variables listed in the above table: self-reports of current job status (SR_Ret), homemakers with those who say they are sick or disabled (NW1_Ret), and all those who are not working now (NW2_Ret).

Source: Authors' computations.

TABLE 4A.6 First-stage results by blue-collar jobs and white-collar jobs, pooled data

	Dependent variables	SR_Ret	NW1_Ret	NW2_Ret	SR_Ret	NW1_Ret	NW2_Ret
		First stage: blue-collar jobs			First stage: white-collar jobs		
1. No controls	*Above full retirement age*	0.27***	0.26***	0.13***	0.27***	0.26***	0.14***
		(0.01)	(0.01)	(0.009)	(0.008)	(0.008)	(0.007)
	Above early retirement age	0.25***	0.28***	0.16***	0.18***	0.23***	0.11***
		(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.005)
2. Years, cohorts, gender	*Above full retirement age*	0.05***	0.03**	−0.04***	−0.26***	0.05***	−0.003
		(0.012)	(0.013)	(0.012)	(0.012)	(0.01)	(0.009)
	Above early retirement age	0.08***	0.10***	0.02***	0.002***	0.04***	−0.02***
		(0.008)	(0.008)	(0.008)	(0.000)	(0.007)	(0.006)
3. 2 + Country fixed effects	*Above full retirement age*	0.03***	0.02	−0.04***	0.06***	0.04***	0.001
		(0.012)	(0.013)	(0.012)	(0.01)	(0.01)	(0.009)
	Above early retirement age	0.06***	0.08***	0.03***	0.02***	0.05***	−0.02
		(0.009)	(0.01)	(0.009)	(0.007)	(0.008)	(0.007)
4. 3 + Demographics	*Above full retirement age*	0.016	0.009	−0.05***	0.06***	0.03***	−0.003
		(0.01)	(0.01)	(0.012)	(0.01)	(0.01)	(0.009)
	Above early retirement age	0.06***	0.08***	0.03***	0.02*	0.05***	−0.03
		(0.009)	(0.01)	(0.009)	(0.007)	(0.008)	(0.007)
5. 4 + Health controls	*Above full retirement age*	0.02**	0.02	−0.03**	0.07***	0.05***	0.008
		(0.013)	(0.013)	(0.012)	(0.01)	(0.01)	(0.009)
	Above early retirement age	0.06***	0.09***	0.03***	0.03***	0.06***	0.005
		(0.009)	(0.01)	(0.009)	(0.008)	(0.008)	(0.007)

Notes: The following are the variables listed in the above table: self-reports of current job status (SR_Ret), homemakers with those who say they are sick or disabled (NW1_Ret), and all those who are not working now (NW2_Ret).

Source: Authors' computations.

Appendix D: Disaggregate Estimates for Each of the Three Surveys: HRS, ELSA, and SHARE

TABLE 4A.7 Effect of retirement on cognition by survey

HRS	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−1.05***	−1.56***	−0.46***	−1.81***	−0.89***	−1.39***	−0.38***	−1.76***	−1.01***	−1.95***	−0.35***	−2.34***
	(0.04)	(0.06)	(0.06)	(0.16)	(0.04)	(0.06)	(0.05)	(0.13)	(0.04)	(0.08)	(0.04)	(0.17)
2. Years, cohorts, gender	−0.89***	−0.30	−0.12	0.20	−0.73***	−0.12	−0.08	−0.08	−0.98***	0.25	−0.13**	0.35
	(0.05)	(0.45)	(0.06)	(0.5)	(0.05)	(0.43)	(0.05)	(0.43)	(0.04)	(0.73)	(0.05)	(0.70)
3. 2 + Demographics	−0.65***	0.23	−0.12	0.19	−0.53***	0.48	−0.08	−0.09	−0.66***	1.18	−0.13**	0.35
	(0.05)	(0.45)	(0.06)	(0.49)	(0.04)	(0.42)	(0.05)	(0.43)	(0.04)	(0.76)	(0.05)	(0.70)
4. 3 + Health controls	−0.37***	0.14	−0.10	0.18	−0.28***	0.29	−0.06	−0.08	−0.40***	0.77	−0.11*	0.29
	(0.05)	(0.43)	(0.06)	(0.49)	(0.04)	(0.40)	(0.05)	(0.43)	(0.04)	(0.67)	(0.05)	(0.69)
ELSA	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−0.74	−2.54***	0.03	−1.14*	−0.79***	−2.75***	0.04	−1.64***	−0.90***	−2.94***	0.0002	−1.43**
	(0.05)	(0.1)	(0.06)	(0.48)	(0.05)	(0.11)	(0.05)	(0.50)	(0.05)	(0.12)	(0.05)	(0.46)
2. Years, cohorts, gender	−0.83***	−5.68***	0.04	0.03	−0.98***	−6.19***	0.06	0.42	−1.13***	−8.77***	0.01	0.34
	(0.02)	(0.20)	(0.07)	(0.66)	(0.02)	(0.23)	(0.06)	(0.71)	(0.03)	(0.34)	(0.06)	(0.86)
3. 2 + Demographics	0.07	−1.62*	0.07	−0.18	−0.19**	−1.80	0.08	0.16	−0.34***	−2.29*	0.03	0.11
	(0.07)	(0.76)	(0.07)	(0.70)	(0.06)	(0.94)	(0.06)	(0.75)	(0.06)	(1.14)	(0.06)	(0.90)
4. 3 + Health controls	0.15*	−1.97	0.06	−0.33	−0.28***	−2.49	0.06	−0.15	−0.41***	−3.24	0.05	−0.30
	(0.07)	(1.20)	(0.08)	(0.83)	(0.02)	(1.50)	(0.07)	(0.87)	(0.02)	(1.85)	(0.07)	(1.10)

SHARE	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−1.29***	−1.84***	0.38***	0.91***	−1.33***	−2.02***	0.32***	0.99***	−1.43***	−2.31**	0.13**	1.93***
	(0.03)	(0.04)	(0.05)	(0.12)	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)	(0.04)	(0.22)
2. Years, cohorts, gender	−0.75***	−2.13***	−0.04	−0.189	−1.04***	−2.38***	−0.02	0.12	−1.15***	−2.49***	−0.07	0.39
	(0.04)	(0.19)	(0.05)	(0.38)	(0.03)	(0.25)	(0.05)	(0.43)	(0.03)	(0.26)	(0.05)	(0.89)
3. 2 + Country fixed effects	−0.52***	−0.84***			−0.75***	−0.57			−0.83***	−0.65		
	(0.04)	(0.24)			(0.03)	(0.30)			(0.03)	(0.37)		
4. 3 + Demographics	−0.31***	−0.65**	−0.04	−0.19	−1.03***	−2.38***	−0.01	0.12	−1.15***	−2.49***	−0.07	0.39
	(0.04)	(0.24)	(0.05)	(0.38)	(0.03)	(0.25)	(0.05)	(0.43)	(0.03)	(0.26)	(0.04)	(0.88)
5. 4 + Health controls	−0.21***	−0.66**	−0.04	−0.28	−0.75***	−0.56	−0.01	−0.03	−0.83***	−0.65	−0.06	0.09
	(0.04)	(0.23)	(0.056)	(0.40)	(0.03)	(0.30)	(0.05)	(0.45)	(0.03)	(0.37)	(0.04)	(0.89)

Notes: The following are the variables listed in the above table: self-reports of current job status (SR_Ret), homemakers with those who say they are sick or disabled (NW1_Ret), and all those who are not working now (NW2_Ret).

Source: Authors' computations.

Appendix E: Comparing Blue-Collar and White-Collar Jobs

TABLE 4A.8 Effect of retirement on cognition, pooled data by occupation

Blue-collar workers	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−0.27***	−1.46***	0.02	−0.003	−0.23***	−1.37***	0.03	−0.13	−0.20**	−2.40***	0.02	−0.16
	(0.06)	(0.12)	(0.06)	(0.11)	(0.06)	(0.11)	(0.05)	(0.11)	(0.06)	(0.20)	(0.05)	0.13)
2. Years, cohorts, gender	−0.35***	−2.51***	−0.04	0.06	−0.21***	−2.23***	0.03	−0.33	−0.35***	−5.48***	0.03	0.56
	(0.07)	(0.37)	(0.07)	(0.84)	(0.06)	(0.32)	(0.06)	(0.68)	(0.07)	(1.01)	(0.06)	(1.59)
3. 2 + Country fixed effects	−0.18*	0.034			−0.08	0.90			−0.27***	0.65		
	(0.07)	(0.38)			(0.06)	(0.32)			(0.07)	(0.74)		
4. 3 + Demographics	−0.16*	0.10	−0.003	−0.25	−0.08	0.25	0.06	−0.62	−0.17*	1.80	0.05	−0.07
	(0.07)	(1.28)	(0.07)	(0.89)	(0.07)	(0.89)	(0.06)	(0.70)	(0.07)	(1.91)	(0.06)	(1.54)
5. 4 + Health controls	−0.10	−0.04	0.002	0.13	−0.04	0.06	0.04	−0.32	−0.09	1.59	0.06	−0.26
	(0.07)	(1.12)	(0.08)	(0.84)	(0.07)	(0.85)	(0.07)	(0.67)	(0.07)	(1.96)	(0.07)	(1.56)
White-collar workers	SR_Ret				NW1_Ret				NW2_Ret			
	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE	OLS	IV	FE	IV–FE
1. No controls	−0.35***	−2.16***	0.03	−0.26*	−0.27***	−1.76***	−0.01	−0.37***	−0.28***	−3.42***	−0.12**	−0.49***
	(0.05)	(0.11)	(0.05)	(0.10)	(0.05)	(0.09)	(0.04)	(0.10)	(0.05)	(0.19)	(0.04)	(0.12)
2. Years, cohorts, gender	−0.48***	−3.45***	0.13*	0.96	−0.33**	−3.35***	0.09	0.85	−0.50***	−5.44***	−0.05	−1.37
	(0.06)	(0.21)	(0.06)	(1.79)	(0.05)	(0.19)	(0.05)	(1.05)	(0.06)	(0.39)	(0.05)	(4.81)
3. 2 + Country fixed effects	−0.15*	0.23			−0.09	1.02			−0.30***	−4.29		
	(0.06)	(1.19)			(0.05)	(0.98)			(0.06)	(0.48)		
4. 3 + Demographics	−0.16**	−0.25	0.10	0.75	−0.08	1.03	0.06	0.97	−0.32***	−12.51	−0.04	0.44
	(0.06)	(1.28)	(0.06)	(1.96)	(0.05)	(1.01)	(0.05)	(1.09)	(0.06)	(24.73)	(0.05)	(5.16)
5. 4 + Health controls	−0.09	−0.76	0.10	−0.20	−0.02	0.06	0.07	0.29	−0.23***	−2.47	−0.04	21.33
	(0.06)	(1.02)	(0.06)	(1.35)	(0.05)	(0.90)	(0.05)	(0.91)	(0.06)	(7.75)	(0.05)	(56.33)

Notes: The following are the variables listed in the above table: self-reports of current job status (SR_Ret), homemakers with those who say they are sick or disabled (NW1_Ret), and all those who are not working now (NW2_Ret).

Source: Authors' computations.

Notes

1. See Cattell (1941), Horn (1965), Horn and Cattell (1967), and Carroll (1993) for details.
2. We need to keep in mind possible measurement errors in using these variables and the context in which cognitive tests are conducted (Morris et al. 1999). These include retesting effects: performance tends to improve when individuals repeat cognitive tests (Ferrer et al. 2004; Rabbitt et al. 2001; Schaie 1996; McArdle and Woodcock 1997).
3. Leisure activities, lifestyle, and social networks are thought to affect cognitive functioning. The idea behind this is that engaging in activities that stimulate an individual's brain may maintain or repair cognitive functioning. Some evidence for the importance of social contacts at older ages can be found in Hertzog et al. (2008), Salthouse (2006), Scarmeas and Stern (2003), Fratiglioni et al. (2004), and Börsch-Supan and Schuth (2013) among others. Some studies relate personality traits like patience and risk aversion to cognition (e.g., Frederick 2005; Benjamin et al. 2006; Dohmen et al. 2007; Midanik et al. 1995).
4. More details about the datasets and variables can be found in Appendix A.
5. See Appendix A for details.
6. Adam et al. (2007a) exclude from the analysis the respondents that cannot recall any words.
7. Adam et al. (2007a) use five dummy variables to define the retirement status in order to capture the retirement duration. The category of working variables was their reference variable and the other variables were ranges as < 5 years retired, [5–9], [10–15], more than 15 years retired and having never worked.
8. The thirteen countries are: Austria, Belgium, Czech Republic, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, US, and UK.
9. We also run the models separately for each of the three surveys HRS, ELSA, and SHARE. Results can be found in Appendix D. The OLS estimates confirm the same results through the different surveys. The IV and IV–FE results vary somewhat across surveys but generally retirement is only found to have a significant negative effect on cognition in the models without country fixed effects.
10. The ages for the US refer to Social Security-claiming ages rather than retirement ages; 62 is the earliest age at which one can claim Social Security. For comparison purposes we treat the US early-claiming age and full retirement age similar to the treatment of early and full retirement ages in the European countries.
11. First-stage estimates are presented in Appendix C and show that the instruments are positively related to the retirement variables. These estimates show that the instruments in general continue to be good predictors of retirement despite the multiple definitions of retirement and the alternative specifications. Their coefficients decrease when controls are introduced but they remain significant at 1 percent in almost all cases.

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