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Mental retirement and schooling

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ABSTRACT

We assess the validity of differences in eligibility ages for early and old age pension benefits as instruments for estimating the effect of retirement on cognitive functioning. Because differences in eligibility ages across country and gender are correlated with differences in years of schooling, which affect cognitive functioning at old ages, they are invalid as instruments without controlling for schooling. We show by means of simulation and a replication study that unless the model incorporates schooling, the estimated effect of retirement is negatively biased. This explains a large part of the "mental retirement" effects which have recently been found.

1. Introduction

In many countries people are living longer and retiring earlier than in previous decades. They are spending a larger proportion of their lifetime in retirement, depending on earlier savings or pension benefits to finance consumption. Populations are aging and the burden of risk and provision of old age income security is shifting from public collective to private individual. Cognitive ability is important for both decision making in general and financial planning (Christelis et al., 2010) and senior saving behavior (Banks et al., 2010) in particular. Differences in cognitive performance amongst the elderly will increasingly determine their future consumption possibilities and drive inequality.

Although there is a great deal of heterogeneity in individual trajectories, cognitive ability usually increases at a declining rate until middle age and declines afterwards. It is becoming increasingly recognized (Hertzog et al., 2008) that different cognitive ability profiles in later life are associated with different behaviors from pre-school (Case et al., 2009), through compulsory school (Glymour et al., 2008), choice of leisure activities (Scarmeas and Stern, 2003) and age of retirement (Adam et al., 2007). If cognitive ability is malleable and some of these relationships are causal then cognitive ability can be usefully thought of as a form of human capital (Ben-Porath, 1967) or health capital (Grossman, 1972).

Cunha and Heckman (2007) develop a model of cognitive and non-cognitive skill acquisition through schooling investments, where the effect of schooling on cognitive ability is unambiguously positive. The relationship between retirement and cognitive functioning in a Grossman-like model is ambiguous. Bonsang et al. (2010) set up a standard Grossman model where individuals with higher cognitive functioning may perform work tasks and leisure activities more effectively. Work and leisure can involve different types of investment in cognitive functioning. Pension eligibility increases the cost of work relative to leisure investments. The net effect of retirement on cognitive functioning will depend on relative marginal productivities.

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Rohwedder and Willis (2010) follow instead the insights of the "use it or lose it" hypothesis, and the suggestions from psychological literature that cognitive ageing can be delayed by engaging in cognitively demanding activities. They argue that during retirement the brain is not stimulated to the same extent as while working in the labour market, and thereby loses cognitive ability. This argument is consistent with evidence from psychological literature if retirement from the labour market is associated with reduced mental exercise.

Empirical evidence for retirement effects on cognitive functioning is mixed and depends on how cognitive abilities are measured and on the source of identification used. Coe et al. (2012) use employer-provided early pension benefit windows in the US to provide variation in retirement ages and find no effect on word recall and numeracy, or if anything a positive effect for blue collar workers. Several papers use cross-country variation in pension eligibility ages to find significant detrimental effects of retirement on short term memory or word recall (Bonsang et al., 2010; Rohwedder and Willis, 2010; Mazzonna and Peracchi, 2012).

In this paper we study the correlation between cross-country variation in pension eligibility ages and educational attainment, and the consequences of this for estimating the effect of retirement on cognitive functioning. In Section 2 we describe our data, which resembles as closely as possible that used in the cross-country studies discussed above. Section 3 states the arguments for instrument validity, illustrates the correlations of interest and presents a bias simulation. Section 4 presents a replication study and extension of Rohwedder and Willis. Section 5 concludes.

2. Data description

In order to replicate the large effects found in Rohwedder and Willis (2010), we use the 2004 waves from the English Longitudinal Study of Ageing (ELSA), the U.S. Health and Retirement Survey (HRS) and the Survey of Health, Ageing and Retirement in Europe (SHARE), for a total of thirteen countries. We apply the sample selection as described by the authors. In particular, we keep only people aged between 60 and 64 at the time of interview. As we include schooling achievement in our analysis, compared to Rohwedder and Willis (2010) we additionally drop people for whom we have no information about their education.

However, while they draw their results from a sample of 8828 observations, our sample amounts to 8734 observations, 8702 of whom have non-missing values for education achievement. This difference is unlikely to cause large differences during estimation: as we show in Section 4 we find similar results when we replicate their analysis.

We define cognitive functioning and retirement status consistently with previous literature. We define retirement as not having worked for pay in the last four weeks, and we use a word recall test as a consistent measure of cognitive functioning across countries. During the test, the interviewer reads out a list of 10 words at a fixed speed. Right afterwards the respondent repeats as many words as can be remembered (immediate recall). Other questions about cognitive functioning follow. Then the interviewer asks the respondent to repeat as many words from the original list as can still be remembered (delayed recall). The sum of words correctly recalled immediately and after the delay together gives the total word recall measure, ranging 0–20.

Even though the surveys used are highly comparable, they code the education variables in slightly different ways. While HRS asks directly the highest grade of school or year of college attended, in SHARE and ELSA respondents declare their highest completed level of education. As a consequence ELSA and SHARE impute years of schooling as the minimum number of years required in order to achieve the declared educational qualification.

We take pension eligibility ages from the laws in force in 2004. Table 1 is a reproduction from the online appendix to Rohwedder and Willis (2010), which shows early and old age pensionable ages by gender for the thirteen countries in our sample.

3. Instrument validity

Instrumental variable estimation is useful to uncover causal effects, though often limited to a Local Average Treatment Effect (LATE) interpretation, as it solves bias arising from endogeneity of the explanatory variable. When studying the effect of retirement on cognitive functioning, endogeneity arises because of individuals retiring sooner as a consequence of faster deterioration of cognitive functioning. Therefore, retirement may be negatively correlated with cognitive functioning, even if retirement does not have any effect. Formally, given a population model

$$y = \mathbf{x}\boldsymbol{\beta} + u, \tag{1}$$

we have that $E(\mathbf{x}'u) \neq 0$, thus introducing endogeneity bias.

Instrumental variable estimation methods, such as 2SLS, provide a way to solve this problem given a suitable set of instruments $\mathbf{z}$. The consistency of the two-stage least squares estimator $\hat{\beta}_{2SLS}$ relies on assumptions

(A) $E(\mathbf{z}'u) = 0$,

(B) $\text{rank}(\mathbf{z}'\mathbf{z}) = L \geq \text{rank}(\mathbf{z}'\mathbf{x}) = K$,

Table 1
Pensionable ages.

Country	Women		Men	
	Early	Normal	Early	Normal
United States	62	65	62	65
England	60	60	65	65
Austria	56	60	61	65
Germany	60	65	60	65
Sweden	61	65	61	65
Netherlands	60	65	60	65
Spain	60	65	60	65
Italy	57	60	57	65
France	60	60	60	60
Denmark	60	65	60	65
Greece	55	57	60	62
Switzerland	62	63	63	65
Belgium	60	63	60	65

Source: Rohwedder and Willis (2010).

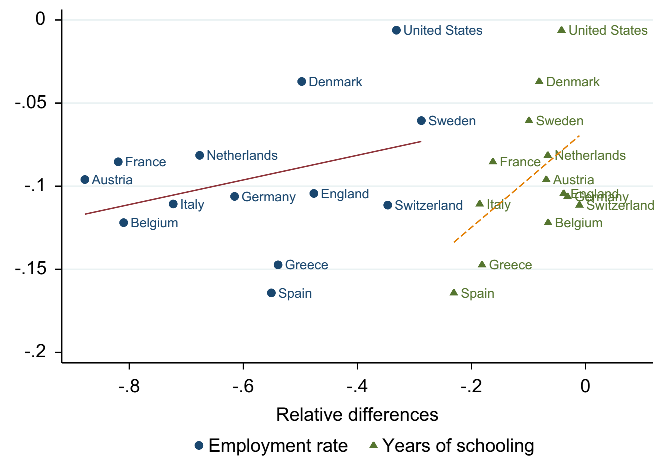

Fig. 1. Relative drop in cognitive performance.

where vector **z** typically includes the exogenous variables in **x** as their own instruments. In particular,

$$E(\hat{\beta}_{2SLS}) = \beta + [E(\mathbf{x}'\mathbf{z})[E(\mathbf{z}'\mathbf{z})]^{-1}E(\mathbf{z}'\mathbf{x})]^{-1}E(\mathbf{x}'\mathbf{z})[E(\mathbf{z}'\mathbf{z})]^{-1}\underbrace{E(\mathbf{z}'u)}_{=0}, \tag{2}$$

where the second term in the right hand side, the bias, is zero by assumption (A), which states that the instruments chosen for the endogenous variables do not have any effect on the outcome variable but through the endogenous (instrumented) variables themselves. If assumption (A) is violated, the instrumental variable estimator is biased.

Most of the papers studying the effect of retirement on cognitive functioning use cross-country pension eligibility age variation as instruments for retirement status, or age. The appeal of using differences across country, gender or cohorts in pension eligibility ages is that they are unlikely to directly affect cognitive functioning at old ages except through retirement. However, these differences may be correlated with other determinants of cognitive functioning and this would invalidate their use as instruments without appropriate controls.

We focus on schooling achievement, which is recognized as a major determinant of cognitive functioning (Cunha and Heckman, 2007; Falch and Massih, 2011; Banks and Mazzonna, 2012), using ELSA data, estimate that an additional year of schooling accounts for 0.2–0.5 additional words out of twenty remembered in a short-term memory test of the elderly. We illustrate the relationship between word recall, schooling achievements and retirement in Fig. 1, which reproduces and extends the main descriptive figure of Rohwedder and Willis (2010).

Fig. 1 shows the correlation between word recall, schooling and employment differences around potential retirement age for the cross-section of 13 countries in 2004 considered by Rohwedder and Willis. The vertical axis shows by country the difference in mean number of words recalled out of twenty in a test of memory between ages 60-64 and 50-54, standardized

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by the average word recall score of the latter group. The figure comprises two parts. The scatter of circles to the left plots mean relative differences in employment rates, with a continuous linear regression line, following the insight in Bonsang et al. (2010). This first part reproduces the stylized fact that countries with the greatest fall in employment between these ages also have the greatest reduction in word recall. The scatter of triangles to the right plots mean differences in years of schooling, with a dashed linear regression line. This second part shows a similar gradient in schooling and word recall: countries with the biggest increase in schooling across cohort groups have the greatest increase in word recall.

Because years of schooling positively affect word recall at old ages, a sufficient condition for breaking condition (A) in the setup of Rohwedder and Willis (2010) is that differences across countries, gender or cohorts in retirement policies correlate with differences in years of schooling. Fig. 2 shows that eligibility age for both early and old-age pension benefits correlates positively with years of schooling. In the left pane (a) we group observations according to their early pensionable age; in the right pane (b), to their old-age pensionable ages.

The dots in the upper part of the panes represent the average values of residuals from a regression of years of schooling on a full set of age dummies for each of the groups that pension eligibilities define. The use of residuals allows us to filter the effects of age differentials across groups. The graph shows a striking correlation between schooling and pensionable ages: the higher are minimal ages for pension benefits, the higher is the level of education.

The bars in the bottom part of the panes represent average compulsory years of schooling for each of the pension eligibility groups. We derive compulsory years of schooling from the country-specific schooling laws to which our cohorts of interest were subject. As we do not have information on compulsory schooling laws in Switzerland for the cohorts considered (147 observations), we omit the bar for the group with early pensionable age of 63, which consists only of Swiss women. Variation across average compulsory schooling predicts a considerable fraction of the variation in the years-of-schooling residuals. This close relationship suggests that part of the correlation between years of schooling and retirement eligibility ages is due to correlations between institutional factors, varying across cohorts and countries.

In a cross-sectional setup, instrumenting retirement with pension eligibility, defined as whether an individual is older than the institutional eligibility threshold, means using three sources of variation, namely country, gender, and cohort differences. Table 2 shows that the number of years of schooling is correlated with both early and old-age retirement eligibility, for any given source of variation but age.

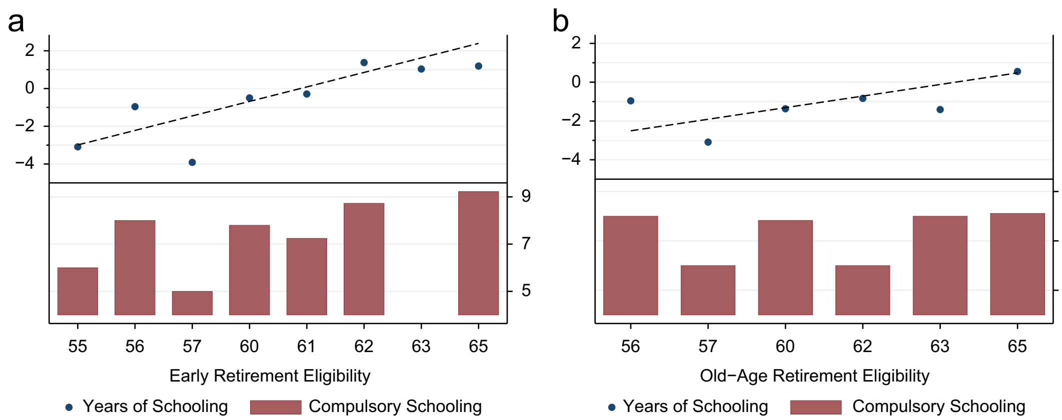

Fig. 2. Instrument validity for pension eligibility alone. (a) Early retirement, (b) Old age retirement. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this paper.)

Table 2
Correlations between schooling and retirement eligibility.

	Eligible for early retirement			
Years of schooling	−0.0175***	−0.0153***	−0.00293**	−0.00194
	(0.00113)	(0.00101)	(0.00103)	(0.00113)
	Eligible for old-age retirement			
Years of schooling	−0.0250***	−0.0215***	−0.00719***	−0.00198*
	(0.00118)	(0.00112)	(0.000942)	(0.000801)
Country	No	No	Yes	Yes
Gender	No	Yes	No	Yes
Age	No	Yes	Yes	No
Observations	8702	8702	8702	8702

Standard errors in parentheses. Estimated coefficients from separate OLS regressions of years of schooling on a dummy variable indicating eligibility to retirement benefits in the year of observation and a set of controls listed in the lower pane. Coefficients in the upper pane are from regressions on early pension eligibility and in the middle pane are from regressions on old age pension eligibility.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$.

In Table 2 we regress years of schooling on either early or old-age pension eligibility. In the first column we find that the correlation between years of schooling and being older than the pensionable ages is negative, mirroring the positive correlation between years of schooling and eligibility ages shown in Fig. 2. In the second column, we control for a full set of age dummies and a gender indicator, thus leaving only cross-country differences as a source of exogenous variation. Similarly, in the third and fourth column we leave respectively only gender and age differences as sources of exogenous variation.

Only when age differences are the sole source of variation, are years of schooling uncorrelated with early retirement eligibility and weakly correlated with old-age retirement eligibility. Overall, Table 2 shows that, unless the distribution of schooling achievement in the population is properly taken into account, neither gender nor country fixed effects restore assumption (A).

3.1. Bias simulation

The violation of assumption (A) explains at least part of the negative effect of retirement found through pension eligibility age variation. Namely, with respect to the model in (1), we have that

$$u = \gamma e + \varepsilon, \quad \mathrm{E}(\mathbf{z}'e) = \delta < 0, \tag{3}$$

where e is years of schooling, negatively correlated with the instruments $\mathbf{z}$.[1] Therefore,

$$\mathrm{E}(\mathbf{z}'u) = \mathrm{E}(\mathbf{z}'\varepsilon + \mathbf{z}'\gamma e) = \mathrm{E}(\mathbf{z}'\varepsilon) + \gamma \mathrm{E}(\mathbf{z}'e) = 0 + \gamma\delta, \tag{4}$$

which is negative if γ, the effect of education on cognitive functioning, is positive. Because $\mathrm{E}(\mathbf{z}'x)$ is positive (being eligible for retirement enhances the probability of being retired), we expect $\hat{\beta}_{2SLS}$ to be negatively biased from (2).

The raw correlation between years of schooling and early and old-age retirement eligibility in our data are -0.16 and -0.22 respectively. These values are not trivial for the distribution of the 2SLS estimator. In order to illustrate the relative magnitude of the bias given the distribution of β_{2SLS}, we simulate a simple linear model for cognitive functioning, education and retirement. In the simulated model, while schooling positively affects cognitive functioning and the retirement instrument increases the probability of retirement, retirement has no effect on cognitive functioning. The retirement instrument and the schooling variable are jointly normally distributed and negatively correlated.[2]

Fig. 3 shows the estimated distributions of the 2SLS estimator for the simulated model. In Fig. 3(a) the solid line shows that controlling for schooling provides an unbiased estimator of the retirement effect in a model where the retirement instruments and the schooling variable have a correlation of -0.22, as $\mathrm{E}(\mathbf{z}'u|e) = 0$. The dashed line plots the distribution of the estimator for which we do not control for schooling. The estimator is negatively biased, and almost always estimates a negative effect of retirement.

The endogeneity bias is proportional to the correlation between schooling and the retirement instruments. Fig. 3(b) shows the scatterplots of the simulated estimated effects of retirement when schooling is not accounted for, by the correlation between the retirement instrument and schooling. The circle shows the effect we find in our data, given the correlation between eligibility and years of schooling of -0.22. Fig. 3(b) shows that the smaller the correlation left between the instrument and education, the smaller the bias in the estimator.

4. Replication study

In this section we use pension eligibility to instrument for retirement status, and estimate the bias occurring due the invalidity of the instrument if the distribution of years of schooling in the population does not enter the model. Table 3 shows the extent of the bias due to the correlation between the retirement eligibility rules and years of schooling by the comparison between the top and bottom panes. The top pane shows the estimated coefficients from a 2SLS estimator, where years of schooling do not enter the model. The bottom pane shows the estimated coefficients from a 2SLS estimator that accounts for covariance between schooling and the instruments. All models include age dummies.[3]

As our primary goal is to isolate variation in cross-country retirement eligibility rules, in the first and second columns of Table 3 we split our sample by gender, while in the third we pool the data, but we allow for differences in means controlling for gender. In this way, we control for variation coming from gender differences in retirement eligibility rules, and we focus on the cross-country margin. The coefficient estimated for retirement in the model shown in the third column of the top pane is comparable to the effect reported in Rohwedder and Willis (2010), who do not control for gender.[4]

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[1] For ease of notation, we consider e and $\mathbf{z}$ as demeaned.

[2] While some of the parameters of the simulated model stem from the data or the pre-existing literature (as the effect of schooling on cognitive functioning in retirement, taken from Banks and Mazzonna, 2012), we arbitrarily assigned the rest of them, as the simulation has only illustrative purposes. The codes for the simulations are available upon request.

[3] The main results remain unchanged if we do not include age dummies: the age variation is limited across only six cohorts.

[4] The estimated direction of the bias, as expected from the partial correlations estimated in Table 2, is unchanged if we do not control for gender.

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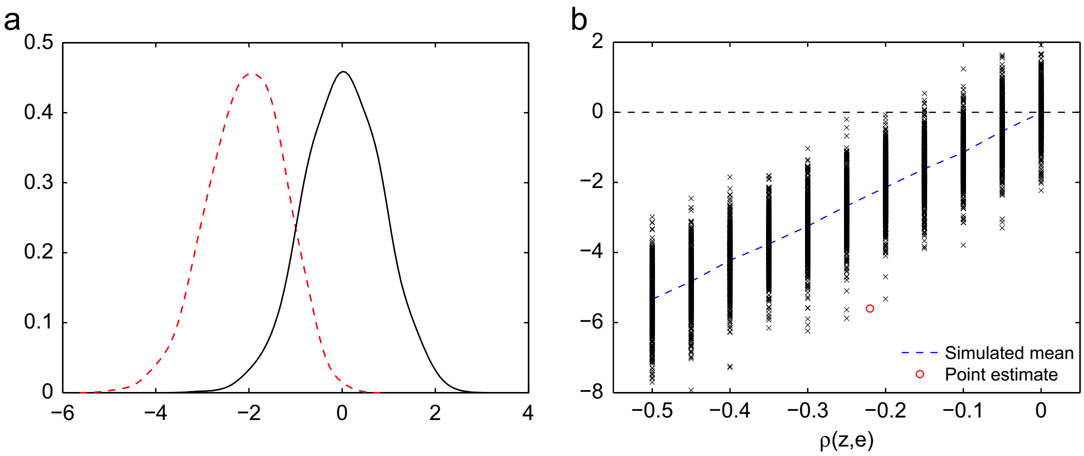

Fig. 3. Simulated distributions of β_{2SLS}. (a) $\rho(z,e) = -0.22$. (b) By $\rho(z,e)$.

Table 3
Estimated bias when ignoring schooling.

	Males	Females	All
	Model without schooling		
Retirement	-7.644^{***}	-4.514^{***}	-5.604^{***}
	(0.822)	(0.475)	(0.414)
Male			-1.635^{***}
			(0.101)
	Model with schooling		
Retirement	-5.485^{***}	-1.607^{**}	-3.014^{***}
	(0.854)	(0.510)	(0.430)
Years of schooling	0.227^{***}	0.358^{***}	0.302^{***}
	(0.0252)	(0.0188)	(0.0144)
Male			-1.483^{***}
			(0.0862)
Observations	3830	4872	8702
Wald test statistic	57.49	122.7	188.0

Standard errors in parentheses. Wald test statistic $\sim \chi_1^2$. Estimated coefficients from separate instrumental variables regressions of word recall on retirement status and a set of age dummies (not shown). Excluded instruments are eligibility to pension benefits. In the lower pane schooling is included as a covariate and in the upper pane it is omitted.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Independently of the specified model, the effect of retirement shrinks significantly as we control for a linear function of years of schooling in the bottom pane, reflecting the bias highlighted in Section 3. We perform a Wald linear test in a stacked model in order to assess the difference between the two estimated coefficients for each specified model. The Wald test statistic is well above the threshold of the 99th percentile of a χ^2 distribution with one degree of freedom in all columns. In the third column, the estimated effect of retirement is a weighted average of those found in columns one and two, but the higher number of observations reduces the variance of the estimation, thus giving more power to the Wald test.

Overall, table 3 shows that the magnitude of the bias due to the correlation of cross-country policies with education is important, and can lead to significant overestimation of the effect of retirement on cognitive functioning.

5. Conclusions

The relationship between retirement and cognitive functioning at older ages is ambiguous from a theoretical perspective, and empirical work has produced mixed results, but the weight of evidence from cross-country studies has found that retirement has a negative effect on cognitive functioning. We show that cross-country variation in pension eligibility ages are invalid instruments for retirement, unless the empirical model takes differentials in schooling levels into account. Ignoring the distribution of schooling levels across instrument-determined groups partly explains the large negative estimates in the influential study of Rohwedder and Willis (2010).

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Our study is about the empirical analysis of the effect of retirement on cognitive functioning, but our findings are of more general relevance for other studies that use similar identification arguments and where schooling may be a confounder. Studies that exploit cross-country or cross-state policy variation in other contexts may have otherwise good arguments for instrument validity which are undone because schooling is an omitted explanatory of the outcome of interest. Conversely, other studies of the effect of retirement on cognitive functioning that use different identification strategies or different instruments, (as Bonsang et al. (2012), who exploit panel variation and social security eligibility in the U.S. for identification) do not suffer from this particular bias.

Throughout the paper we have considered the consequences of omitting education as an exogenous variable. Mazzonna and Peracchi (2012) suggests that the endogeneity of education may also be a concern. If cognitive functioning at old ages correlates with determinants of schooling level, as Banks and Mazzonna (2012) find, then controlling for education may not eliminate the endogeneity bias, and the estimation of a causal effect would require accounting simultaneously for the endogeneity of both education and retirement. This is left for future work.

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