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Influence of Social Networks on the Effect of Retirement on Cognition

Felizia Hanemann

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Abstract:

This paper examines the role of social networks as a potential mechanism in the relationship between retirement and cognitive decline. In a first step, I analyze the effect of retirement on different social network characteristics using novel panel data of 19,999 respondents on social networks from wave 4 and wave 6 of the Survey of Health, Ageing and Retirement in Europe (SHARE). In a second step, I estimate the effect of retirement on cognition under consideration of changing social network sizes. Applying instrumental variable fixed effects regressions based on country-specific statutory eligibility ages allows controlling for unobserved individual heterogeneity and endogeneity of the retirement decision. The results suggest that retirement leads to an increase in the number of close family members named as confidants indicating that the social network becomes more kin-oriented after retirement. However, adding close family members to the social network does not have a significant effect on cognition. In turn, adding non-family members like friends or colleagues to the social network has a positive impact on the cognitive performance. Since I do not find that retirement impacts the number of friends or colleagues significantly, I cannot claim social networks to be the explaining underlying mechanism in the relationship between retirement and cognitive decline.

Zusammenfassung:

Ich untersuche die Rolle von sozialen Netzwerken als möglichen Mechanismus in dem Zusammenhang zwischen Ruhestand und dem Rückgang kognitiver Fähigkeiten. Im ersten Schritt analysiere ich den Effekt von Ruhestand auf verschiedene Eigenschaften des sozialen Netzwerkes mithilfe von Längsschnittdaten 19.999 Befragten des Survey of Health, Ageing and Retirement in Europe (SHARE). Im zweiten Schritt untersuche ich den Effekt von Ruhestand auf Kognition unter Berücksichtigung der Größenänderung des sozialen Netzwerkes. Durch die Anwendung eines Paneldatenmodells mit fixen Individualeffekten und durch den Einsatz von Instrumentvariablen kann für Endogenitätsprobleme kontrolliert werden. Die Ergebnisse zeigen, dass Ruhestand zu einem Anstieg in der Anzahl der nahen Familienmitglieder im sozialen Netzwerk führt. Allerdings hat dieser Anstieg keinen signifikanten Einfluss auf die kognitiven Fähigkeiten. Im Gegensatz dazu finde ich einen signifikant positiven Effekt auf Kognition, wenn Nicht-Familienmitglieder wie Freunde oder Kollegen neu in das soziale Netzwerk aufgenommen werden. Allerdings ist dieser Anstieg von Nicht-Familienmitgliedern nicht mit dem Eintritt in den Ruhestand verbunden, sodass ich die sozialen Netzwerke nicht als den erklärenden Mechanismus zwischen Ruhestand und Kognition herausstellen kann.

Keywords:

retirement, cognition, social networks

JEL Classification:

I12, J14, J24, J26

Influence of Social Networks on the Effect of Retirement on Cognition

Felizia Hanemann
Affiliation: Department of Economics and Policy, Technical University of Munich (TUM)
Address: Munich Center for the Economics of Aging, Amalienstraße 33, 80799 Munich
Email: felizia.hanemann@tum.de
Phone: +49 89 38602 303

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Introduction

The effect of retirement on health and on cognition has become a contentious topic in economics and social sciences. The empirical results in this context vary depending on the data, the retirement definition and the model specification. While some studies find positive effects of retirement on cognition (Coe et al. 2012), most studies find no significant effect or even negative effects (Rohwedder and Willis 2010; Bonsang et al. 2012). The focus of recent empirical analyses shifted to the investigation of the mechanisms behind the relationship between retirement and cognition, such as the post-retirement behavior (Insler 2014; Zantinge et al. 2014; Celidoni and Rebba 2016). Understanding these mechanisms is important to disentangle the heterogeneous effects of retirement depending on individual characteristics or external circumstances. This in turn helps policy makers to introduce measures against the cognitive decline targeted for specific risk groups.

One potential mechanism behind the effect of retirement on cognition refers to the social network of an individual. Social networks are strongly related to health and cognition of an individual (Litwin and Stoeckel 2012; Rafnsson et al 2015; Barnes et al. 2004; Sörmann et al. 2016). If retirement has a significant effect on the social network composition, this could well be an underlying mechanism through which retirement impacts cognition. The research question of the present paper therefore is: What is the role of the social networks in the complex interplay between retirement and cognitive performance?

Börsch-Supan and Schuth (2014) study this relationship using SHARE data, which offers extensive information on the social networks for respondents in wave 4. By applying an instrumental variable approach, they find that (early) retirement reduces the size of social networks because especially the number of colleagues and other non-family contacts decreases. The authors relate this reduction of the social network to different measures of mental health and cognition and conclude that the cognitive decline after retirement can partly be explained by the social network changes.

The recently published data from wave 6 of the SHARE survey contains an update of the module on social networks, which allows monitoring the changes in social network size and characteristics on the individual level over time. Following up on the analysis of Börsch-Supan and Schuth (2014), I make use of this panel data to study the relationship between retirement, social networks and cognitive health in a longitudinal setting based on 39,998 observations. More specifically, I first study descriptively how the size and composition of social networks change between wave 4 (2011) and wave 6 (2015) depending on the labor market status. The analytical part of the study takes into account potential endogeneity problems by applying a panel instrumental variable identification strategy. I start the analytical part by looking at the effect of retirement on social networks and find

that retirement leads to a significant increase in the number of close family members in the social network. No significant effect was found for the change in non-family members such as friends or (ex-)colleagues. The second part of the analysis concentrates on the causal identification of the effect of retirement on cognitive health and the impact of the social network as one possible mechanism. The results suggest that retirement has a negative, but insignificant effect on cognition. An increase in the number of friends or colleagues has potential positive effects on cognition, however it cannot be concluded that social networks are the explaining mechanism behind the effect of retirement on cognition since the number of friends and colleagues are not significantly influenced by retirement.

Literature Review

Retirement and cognition

The first strand of literature that is related to my project covers the debate about the effects of retirement on cognition. Some studies find positive effects of retirement on cognition (Coe et al. 2012), most studies find no significant effect or even negative effects (Rohwedder and Willis 2010; Bonsang et al. 2012). Fonseca et al. (2016) give an extensive overview of the empirical studies in this context. They find that the results vary much depending on the model specification that is used for the analysis. Also, it becomes clear that the effects are heterogeneous with respect to different influences like the type of the job (Mazzonna and Peracchi 2016). Recent studies concentrate on exploring the mechanisms behind the effect of retirement such as the post-retirement behavior (Celidoni and Rebba 2016). My paper contributes to this recent development by taking into account social networks as potential mechanism.

Retirement and social networks

Another related strand of literature addresses the question how retirement affects the social network size and composition. Ertel et al. (2009) argue that retirement could lead to a decrease in social network size because of a lack of contact opportunities at the workplace. On the other hand, retirees might be able to devote more time in sustaining and developing social contacts and to engage in social activities. Empirical work by van Tilburg (1992, 2003) compares the social networks of men before and after retirement. The results show that the average size of the networks did not change over time; however, the number of colleagues in the networks decreased. Kalmijn (2012) studies – among other life events – the effect of employment transitions. For men, retirement decreases the contacts with friends but increases the contacts with neighbors, indicating a shift to a more local network. Women also increase the contact frequency to neighbors after retirement, but they manage to keep up the contacts with friends at the same time. Fletcher (2014) uses SHARE data and does not find causal effects of

retirement on different social network characteristics by applying an instrumental variable approach. Patacchini and Engelhardt (2016) study the impact of work and retirement on different social network characteristics. The authors exploit the panel data from the American National Social Life, Health and Aging Project and combine a fixed-effects estimation strategy with instruments based on the statutory eligibility ages. They find that retirement lowers the size and density of social networks.

Social networks and cognition

Available empirical evidence suggests a positive association between social contacts and cognition (Béland et al. 2005; Ertel et al. 2008; Barnes et al. 2004). Most of these studies examine an indirect measurement of social contacts by assessing the marital status, the degree of social integration and social engagement or contact frequency with children. Similar to our study design, Sörmann et al. (2016) concentrate on direct measurements of the social network and find that there is a positive correlation between network size and different cognitive abilities studying individuals aged 40-60. Another finding that is relevant for my study context is presented in the work of Glei et al. (2005), who conclude that social contacts outside the family have a bigger impact on cognition than social contacts with family members.

Retirement, social networks and cognition

The preceding literature review summarized the relations in the triangle of retirement, social networks and cognition. Since all components have been shown to be connected somehow, it is reasonable to bring them together and to study the relationship between them in a single model. To the best of my knowledge, only one empirical study takes into account social networks as a mechanism behind the relationship of retirement and cognition. Börsch-Supan and Schuth (2014) use cross-sectional SHARE data and relate retirement first to the development of social networks and in a next step to different indicators of cognitive and mental health. Their finding suggests that normal and early retirement reduce the total size of the social network, especially the number of colleagues, but also the number of friends and non-family members. This negative effect of (early) retirement on social networks partly explains the cognitive decline that can be observed after retirement. The authors instrument both the retirement decision and the social networks to address potential endogeneity problems.

The present paper is connected to the work of Börsch-Supan and Schuth (2014) in terms of the research question and data. I contribute to the existing literature by using the newly available follow-up data on the social networks in the wave 6 of SHARE that allows to exploit the variation in social networks over time and to apply instrumental variable panel data models as identification strategy.

Theory and Hypotheses

The convoy model postulates that each person is accompanied by a set of persons ("convoy") who move with them throughout the life course (Kahn and Antonucci 1981). This set of persons is arranged in three concentric circles around the focal person depending on the closeness of the relationship. The inner circle is characterized by persons who are close to the focal person based on emotional attachment (e.g. partner, children, and close friends). These relationships are relatively stable over the life span and constitute the most important providers of emotional and practical support. In contrast, the relationship to persons in the outer circle are grounded in specific roles that the network members have (e.g. co-workers, neighbors). Since the social contacts in the outer circle are role-guided, the duration of the relationships is often tied to the role setting and ends with the resolution of the specific situation, for instance with retirement, change of workplace or house moving (Antonucci and Akiyama 1987). I derive my first hypothesis for this paper based on the social convoy model: *Retirement leads to a decrease in social network size because it becomes less likely that relationships with colleagues are continued outside the role-setting circumstances at work.*

New analytic strategies and data allow recent literature to add more levels of complexity to the basic convoy model and to identify different network types by considering the ratios of the different network circles of a person. The four common network types that have been found in empirical literature are "diverse", "family-focused", "friend-focused" and "restricted" networks (Litwin and Stoeckel 2013). Different studies show that the network type patterns vary with cultural context (Antonucci et al. 2014; Fiori et al. 2008). For Europe, there is evidence that family-focused networks are especially common in Southern European countries whereas networks in Northern and Western countries are often friend-focused (Litwin and Stoeckel 2013). Similar to the convoy model, the social network type can change over lifetime and respond to specific life events. According to the socio-emotional selectivity theory (Carstensen et al. 1999), social interaction is mainly driven by two goals: acquisition of knowledge and regulation of emotions. With increasing age and approaching death, the importance shifts from the long-term goal of knowledge-seeking to the short-term goal of emotional regulation. As a consequence, peripheral network members, who formerly acted as information givers, are more likely to be excluded from the social network. Instead, greater attention is given to closer network members in expectation of higher emotional support. Based on this theory it is expected that networks change from friends-focused to family-focused with increasing age. In contrast, individuals with a family-focused network probably experience more stability in their social network composition. Retirement as a life event in old age might intensify the effect since the withdrawal from the labor force gives a sudden disincentive to invest in relationships that serve the acquisition of knowledge (e.g. co-workers). Based on these reflections, the second hypothesis is: *Social networks*

become more familiar and emotionally closer after retirement. This effect is especially expected in Northern and Western European countries. The prevalent network types in the Southern European countries are family-focused throughout the life course and therefore remain stable after retirement.

Based on the human capital model (Grossman 1972) cognition is regarded as human capital stock that can be improved by continuous investments. Being active in the labor force gives incentives to invest in cognition to increase productivity. The lack of these labor market incentives after retirement can lead to a drop in the cognitive abilities in addition to the age-induced cognitive decline. Further, working provides intellectual stimulation not only through the daily tasks and challenges but also through the regular interactions with other persons. Social cognitive neuroscience has shown that complex cognitive processes are needed for social interactions (Ybarra et al. 2008). The loss of social contacts induced by retirement can thus be another reason for a worse cognitive performance, leading to the third hypothesis: *A reduced social network after retirement intensifies cognitive decline.*

Summing up, the analyses of this paper aim at the investigation of the following hypotheses:

1. Retirement leads to a decrease in social network size.
2. Social networks become more familiar and emotionally closer after retirement, especially in Northern and Western European countries.
3. A reduced social network after retirement intensifies cognitive decline.

Data

I use data from the Survey of Health, Ageing and Retirement in Europe (SHARE). This multidisciplinary, cross-national panel dataset contains information on health, socioeconomic status, work history and social networks (Börsch-Supan et al. 2013; Börsch-Supan 2017a, 2017b). The first wave of SHARE was conducted in 2004 in 11 European countries with an initial sample of more than 22,000 individuals aged 50 and over. In subsequent, biennially conducted waves more countries joined the project so that wave 7 will cover 28 European countries.

In wave 4, SHARE implemented a social network module to gather extensive information on the social interactions of older people. The respondents were asked to name up to seven persons with whom they often discuss important things. By answering several follow-up questions, the specific role (partner, friend etc.) and gender of the person as well as the emotional closeness, residential proximity and contact frequency were gathered. The resulting pattern is called an ego-network, meaning that the respondents themselves report the immediate social relationships that surround them. In wave 6, the social network questions were asked again to the same respondents. Additionally, the social network composition of wave 4 was compared to the composition

of wave 6. If a member of the social network was not named again as an important relationship in wave 6, it was asked why this person is not mentioned anymore. Thanks to this strategy, the changes in the social network pattern can be reconstructed in detail and it is possible to relate them to different life events (e.g. health shocks, house moving). For my analysis, I use data from wave 4 and wave 6 of SHARE. The newly available panel data on social networks allows studying the impact of retirement on different characteristics of the social network (size, satisfaction etc.) and relating this change of the social networks to a range of cognitive and mental health measures available in SHARE.

Sample

The key variables for my analyses are measured in wave 4 and wave 6 of SHARE; therefore, I restrict the analysis to individuals that participated in both waves (34,800 respondents, 69,600 observations). As common in the literature I only keep respondents aged between 50 and 75 (53,210 observations). I further restrict the sample to persons that are either working or retired and I eliminate persons who have never done paid work in their life or who have not worked since the age of 50 (47,718 remaining observations). After excluding observations with missing values for the main variables, the resulting sample covers 19,999 individuals and 39,998 observations from the following countries: Austria, Germany, Sweden, Spain, Italy, France, Denmark, Switzerland, Belgium, Czech Republic, Poland, Portugal, Slovenia and Estonia.

Variables

In the first part of the analysis I examine whether retirement has an influence on the social network. I categorize someone as being **retired** if the self-reported labor market status is “Retirement” and if this person has not done any paid work in the last month. I alter this definition of retirement in the robustness checks by taking into account only the self-reported status or by indicating whether someone has at least spend one year in retirement. The instruments for the retirement variable are generated by examining the country-specific legislations concerning the eligibility ages for social security. I exploit as much variation as possible over time (by considering reforms and changes in the regulations) and within countries (by evaluating the eligibility based on individual characteristics like gender, year of birth, number of children).

The data offers various characteristics of the respondents’ social networks (SN). I first start by using the change in the **total SN size** as the dependent variable and then amplify the analysis by splitting the social network into different groups: number of **close family members** in SN (partner, parents, siblings, children), number of **distant family members** in SN (e.g. aunt, niece, grandchildren and other relatives), number of **colleagues and**

friends in SN, number of **non-family members** in SN. Besides the pure size of social networks, I also consider other characteristics like the closeness, contact frequency, distance and satisfaction regarding the social network.

For the pooled regressions, I include socio-demographic indicators such as gender, age, whether someone is living together with a partner, the number of years of education, whether the household has financial problems and the number of activities. I further include a scale measuring the quality of life (CASP) and several health indicators such as grip strength, number of limitations in (instrumental) activities of daily living (ADL/IADL), a global activity limitation index (GALI) and whether the respondent is suffering from long-term illness. More details about these variables are presented in the summary statistics in Table 2.

The second part of the analysis uses **cognition** as the dependent variable. Cognition is measured by a memory recall test where respondents should repeat a list of ten words immediately after it is read to them and unannounced again after about 20 minutes. The resulting cognition measure combines the scores from the immediate and delayed recall test and ranges from 0-20. Additionally, I construct a variable to account for the learning effect in the memory recall measurement. In general, panel data on cognitive abilities might suffer from the fact that the respondents take the test several times. Although there are two years in between the surveys, it could be that the respondents anticipate the test and adapt their behavior, especially for the delayed recall test (Ferrer et al. 2004; Rabbitt et al. 2001). This learning effect would lead to better scores in follow-up waves compared to the results when the test was taken the first time. In the present case, this effect could influence the results since many countries added refreshment samples in wave 4 (Malter and Börsch-Supan 2013). Figure 6 in the appendix suggests that the refreshment respondents who participate in SHARE for the first time in wave 4 have higher learning effects than the panel respondents in wave 4, therefore it is important to control for this effect in the regression model.

Methodology

The two main relationships that I study in this paper can be described by the following OLS regressions:

$$SN_{ic} = \beta_1 + \beta_2 R_{ic} + \beta_3 \boldsymbol{X_{ic}} + \beta_4 C_c + u_{ic} \qquad (1)$$

$$COG_{ic} = \beta_1 + \beta_2 R_{ic} + \beta_3 SN_{ic} + \beta_4 \boldsymbol{X_{ic}} + \beta_5 C_c + u_{ic} \qquad (2)$$

The first regression (1) measures the relationship between retirement and social networks, where individual *i* in country *c* has a certain network characteristic *SN* (e.g. size, satisfaction, closeness of social network). *R* is a dummy variable indicating whether someone is working (0) or retired (1). ***X*** contains a set of individual characteristics such as gender, age, living status, education, financial situation, number of activities, quality of

life and several health indicators (grip strength, long-term illness, number of ADL/IADL, limitation index). C represents the country level fixed effects and u the error term. The coefficient of interest is β_2, which measures the marginal impact of retirement on the social network characteristic. In the second regression (2) the dependent variable measures cognitive health COG_{ic}. I am interested in the effects of retirement R_{ic} and social networks SN_{ic} on cognition, controlling for individual characteristics $\boldsymbol{X}_{ic}$ and country level fixed effects. Although controlling for a set of individual observable characteristics, both OLS regressions might not reveal causal relationships mainly for two reasons: 1) Reverse causality and 2) Differences in unobservable characteristics.

One could think of different bidirectional relations in the triangle of retirement, social networks and cognition leading to the problem of reverse causality. For example, it has been shown that retirement affects social networks (Kalmijn 2012; Fletcher 2014), but in turn that social networks can also influence the retirement decision (Lancee and Radl 2012). Accordingly, there is evidence that retirement accelerates cognitive decline (Börsch-Supan and Schuth 2014), but it could well be that worse cognitive performance impacts the labor market participation. Further, there could be unobserved components that simultaneously influence retirement, social networks and cognition, such as personality traits, preferences or external circumstances like moving to another city or health shocks. These examples show that both the retirement decision and the social network characteristics are endogenous, which complicates the identification of causal effects.

Reverse causality

To address the concern of reverse causality, I apply an instrumental variable approach. Based on solid literature in the economics of ageing (Coe and Zamarro 2011; Bonsang et al. 2012; Mazzonna and Peracchi 2016; Fonseca et al. 2016), I use the exogenous variation in statutory eligibility ages to instrument the retirement decision. The first stage can then be described as:

$$R_{ic} = \propto_1 I(age_{ic} \geq eligibility_{ic}) + \propto_3 \boldsymbol{X}_{ic} + \propto_4 C_c + \varepsilon_{ic} \qquad (3)$$

The retirement variable R_{ic} is modeled as a function of statutory eligibility ages based on country-specific regulations taking into account individual characteristics such as year of birth, gender, number of children. The second stage of the instrumental variable estimations (IV) is equivalent to (1) and (2) but using the predicted values $\hat{R}_{ic}$ from the first stage instead of the observed R_{ic}:

$$SN_{ic} = \beta_1 + \beta_2 \hat{R}_{ic} + \beta_3 \boldsymbol{X}_{ic} + \beta_4 C_c + u_{ic} \qquad (4)$$

$$COG_{ic} = \beta_1 + \beta_2 \hat{R}_{ic} + \beta_3 SN_{ic} + \beta_4 \boldsymbol{X}_{ic} + \beta_5 C_c + u_{ic} \qquad (5)$$

Unobserved heterogeneity

The second source of endogeneity are unobserved components that might simultaneously affect cognition and the social networks. Typical examples for such characteristics are genetics, personality traits or individual preferences that cannot be measured in a survey. Since it is very difficult to find valid instruments for the social network size of an individual, and even more for the other network characteristics like distance, closeness, contact frequency, I take advantage of the available panel data and apply individual level fixed effects. The error term u_{ic} in (1) and (2) contains all unsystematic, unobserved influences and is modeled as $u_{ic} = \gamma_t + \theta_i + \omega_{it}$, where γ_t is a time effect, θ_i represents time-invariant unobserved heterogeneity and ω_{it} an idiosyncratic error term. Applying individual level fixed effects estimations (FE) allows controlling for time-consistent unobserved characteristics, by differencing the values of two time periods:

$$\Delta SN_{it} = \Delta\beta_t + \beta_2 \Delta R_{it} + \beta_3 \Delta A_{it} + \Delta\omega_{it} \qquad (6)$$

$$\Delta COG_{it} = \Delta\beta_1 + \beta_2 \Delta R_{it} + \beta_3 \Delta SN_{it} + \beta_4 \Delta A_{it} + \Delta\omega_{it} \qquad (7)$$

In both regressions (4) and (5), the Δ prefix denotes the difference between wave 4 and wave 6. Instead of using the full set of individual characteristics X_{ic}, I now limit the covariates since most of the characteristics are time invariant and drop out of the regression. In a first specification, I only use age and age squared (A_{it}) as additional covariates as common in the literature for individual fixed-effects estimations. As robustness check I extend the covariates in (7) by time varying covariates that could possibly influence both social networks and cognition and would therefore lead to identification problems (living with a partner, financial problems, number of activities, moving).

Combining both identification approaches leads us to Fixed-Effects Instrumental Variable Models (IV-FE), which are described by:

$$\Delta SN_{it} = \Delta\beta_t + \beta_2 \Delta\hat{R}_{ic} + \beta_3 \Delta A_{it} + \Delta\omega_{it} \qquad (8)$$

$$\Delta COG_{it} = \Delta\beta_1 + \beta_2 \Delta\hat{R}_{ic} + \beta_3 \Delta SN_{it} + \beta_4 \Delta A_{it} + \Delta\omega_{it} \qquad (9)$$

Under the premise that the instruments are valid, I expect the IV-FE model in (9) to yield unbiased and consistent two-stage least-squares estimators that reveal the causal effect of retirement on social networks and cognition. The validity of the instruments has been discussed intensively in previous literature (Coe and Zamarro 2011; Bonsang et al. 2012; Mazzonna and Peracchi 2016; Fonseca et al. 2016), claiming that the instruments fulfil the exclusion restriction. In the present case, this means that the instruments influence social networks only through the direct effect of retirement. It is unlikely that the statutory eligibility ages of a country are correlated

with the social network sizes on the individual level. Nevertheless, I apply country-level fixed effects to account for any systematic differences in the institutional background. To prove the relevance of the instruments, Table 1 shows the first stage regression demonstrating that the statutory eligibility ages have a significant effect on retirement. Having reached the early retirement age increases the probability of retirement by 3 percentage points and being over the normal eligibility age increases the probability of being retired by 10 percentage points. All additional test statistics show that the instruments are strong and valid instruments and that the model is well identified.

Table 1: First stage

VARIABLES	Being retired
Age above legal normal eligibility age (0 1)	0.10***
	(0.008)
Age above early retirement age (0 1)	0.03***
	(0.007)
Age at the time of the interview (50-75)	-0.01
	(0.010)
Age squared	0.00***
	(0.000)
Constant	0.44
	(0.621)
Observations	39,998
Number of ID	19,999
R-squared	0.07
Year/Country FE	YES
F	262.1
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	
F test of excluded instruments	105.52
	(0.000)
Kleibergen-Paap rk LM statistic	205.71
	(0.000)
Kleibergen-Paap rk Wald F statistic	105.52
	(0.000)
Hansen J statistic	0.029
	(0.864)

Descriptives

Summary statistics

I restrict the description of the summary statistics to the variables used in the main specification, details on the other variables can be found in Table 2. Due to the sample restriction, the age in my sample ranges from 50 to 75 and the average age amounts to 63.5 years. 46% of or sample are still working and 54% are already retired based on the self-reported employment status and work activity in the last four weeks. On average, 10 out of 20 words can be named in the combined immediate and delayed memory recall test. The total network size contains on average 2.7 close confidants.

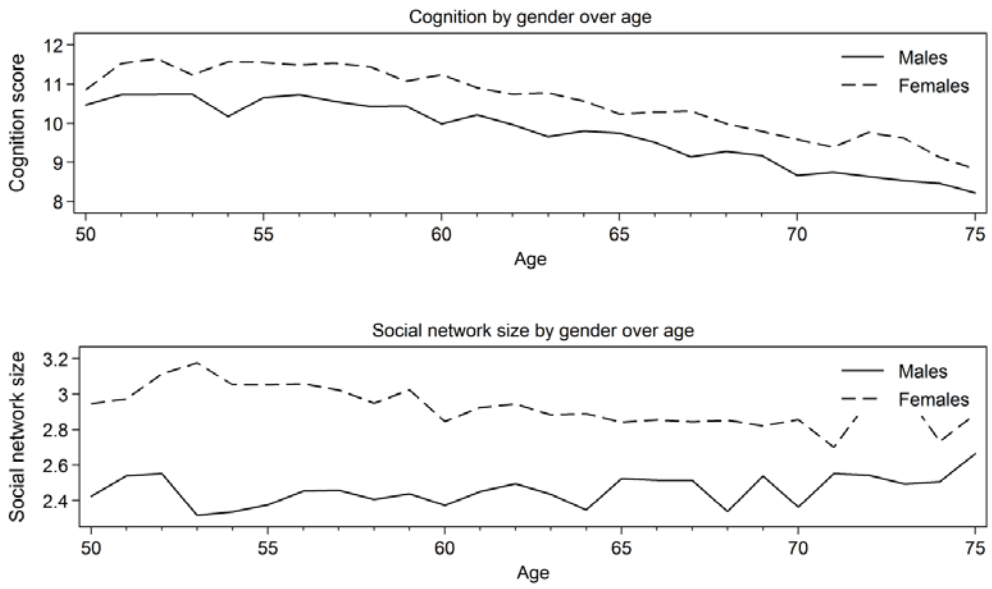
Table 2: Summary statistics for pooled sample

		mean	sd	min	max
Demographics	Age at the time of the interview (50-75)	63.54	6.16	50	75
	Status: Working (0 1)	0.46	0.50	0	1
	Female (0 1)	0.56	0.50	0	1
	Years of education (0-25)	11.33	4.32	0	25
	Household has financial problems (0 1)	0.33	0.47	0	1
	Living together with a partner (0 1)	0.69	0.46	0	1
	Number of activities (0-5)	1.07	1.11	0	5
Health	Number of ADL (0-10)	0.11	0.51	0	6
	Number of IADL (0-15)	0.16	0.65	0	9
	Limited in activities (0 1)	0.40	0.49	0	1
	Long-term illness (0 1)	0.48	0.50	0	1
	Grip strength (0-100)	35.76	11.46	3	98
Mental health	Quality of life - CASP12 (12-48)	38.32	5.83	12	48
	Depressed (0 1)	0.23	0.42	0	1
	Memory recall score (0-20)	10.17	3.41	0	20
Social networks	No. of social network persons	2.71	1.61	0	7
	SN satisfaction	8.90	1.33	0	10
	SN distance	3.25	1.60	1	8
	SN contact	1.90	0.92	1	7
	SN closeness	3.27	0.60	1	4

Descriptive evidence – pooled data

Figure 1 describes how cognition and social networks develop with increasing age based on a pooled sample of wave 4 and wave 6. The graph shows a decline in the cognition score, which is parallel for males and females. Females have a higher cognition score at all ages. Females also have a bigger social network that slightly decreases with age. The social networks of male persons remain relatively stable also at older age. The pattern for both males and females does not indicate a strong relation between age and social network size.

Figure 1: Change in cognition and social networks over age



Source: Own calculations based on weighted data from SHARE wave 4 and wave 6.

Taking into account retirement as a life-changing event in old-age, Table 3 compares the means of selected variables for the persons that are retired with the means of the working population. This comparison is based on a pooled sample from wave 4 and wave 6 and reveals that retirees on average have a lower total network size than working persons. Both the number of close family members as well as the number of non-family contacts including friends or colleagues is lower for retired persons. In contrast, retirees name more distant family members as their confidants. The overall satisfaction with the social network is not significantly different for the two groups. The mean value for the emotional closeness is higher for the retirees, supporting the socio-emotional selectivity theory. Further, the lower means in geographical distance and contact frequency indicate that the social networks become closer and more local after retirement.

Table 3: Comparison of means

	(1) working mean	sd	(2) retired mean	sd	(3) difference b	t
No. of social network persons	2.82	1.65	2.62	1.58	-0.20***	(-12.44)
Close family in SN	1.85	1.23	1.79	1.22	-0.06***	(-5.10)
Distant family in SN	0.15	0.44	0.21	0.54	0.06***	(12.33)
Friends/colleagues in SN	0.74	1.08	0.52	0.94	-0.23***	(-22.18)
Non-family in SN	0.79	1.12	0.60	1.00	-0.19***	(-18.16)
SN satisfaction	8.90	1.27	8.89	1.39	-0.01	(-0.61)
SN closeness	3.24	0.59	3.29	0.61	0.05***	(7.38)
SN distance	3.32	1.61	3.20	1.58	-0.13***	(-7.99)
SN contact	1.93	0.92	1.86	0.92	-0.07***	(-7.51)
Observations	18389		21609		39998	

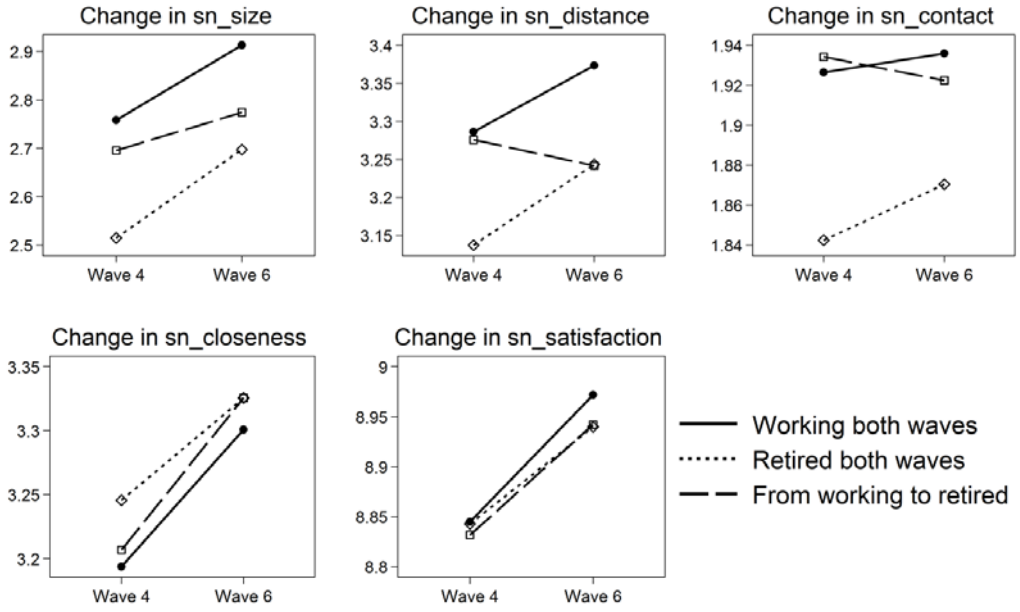
Descriptive evidence – panel data

Thanks to the existing panel data I can observe how the social networks evolve over time and whether retirement is associated with the change in social networks. For the descriptive analysis, I form three different groups based on their employment status: working in both waves (always-workers), retired in both waves (always-retirees) and transitioning from working to retirement between wave 4 and wave 6 (transitioners). Figure 2 illustrates how different social network characteristics change between the observed waves for the three different groups.

The first panel shows the change in total social network size. Although starting from different levels, I find an increasing network size for all three groups. Both the geographical distance and the contact frequency decrease when transitioning from working to retirement. At the same time, the closeness to the social network members increases. The change in distance and closeness support the hypothesis that the network becomes more local and more emotional close after retirement. Overall satisfaction with the social network increases for all three groups between the waves. The groups of always-workers and always-retirees have parallel, increasing trends in the change of the social network characteristics in all panels. The increasing trend could be influenced by period

effects or method effects. It could also reflect the fact that social networks gain emotional closeness with age and therefore more persons are named as close confidants in wave 6 according to the socio-emotional selectivity theory.

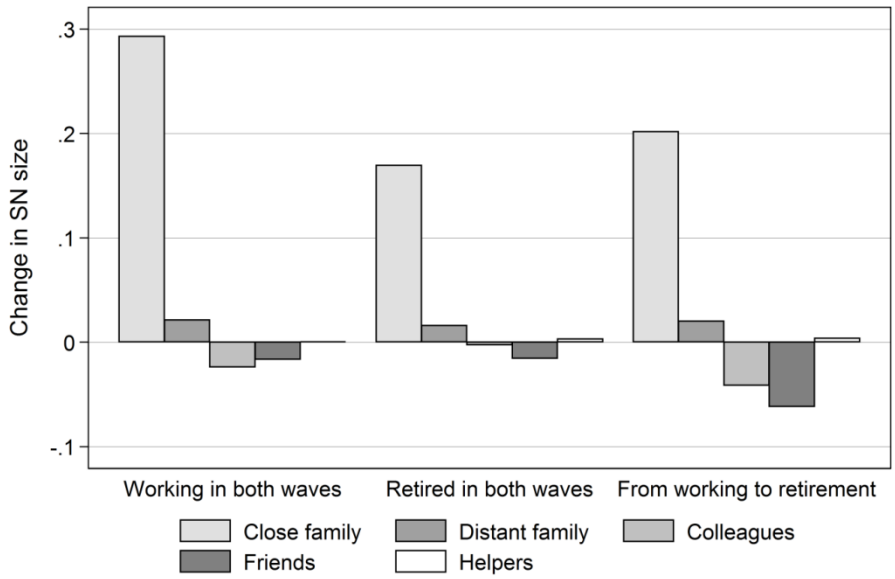
Figure 2: Change in social network characteristics across waves



Source: Own calculations based on weighted data from SHARE wave 4 and wave 6.

Based on the descriptive evidence from the pooled and the panel data, I can conclude that person who transition from working to retirement have a smaller and geographically closer social network compared to the control group. This is an interesting descriptive finding; however, I cannot claim that retirement has a causal negative effect on the social network size since retirement as the treatment variable is endogenous.

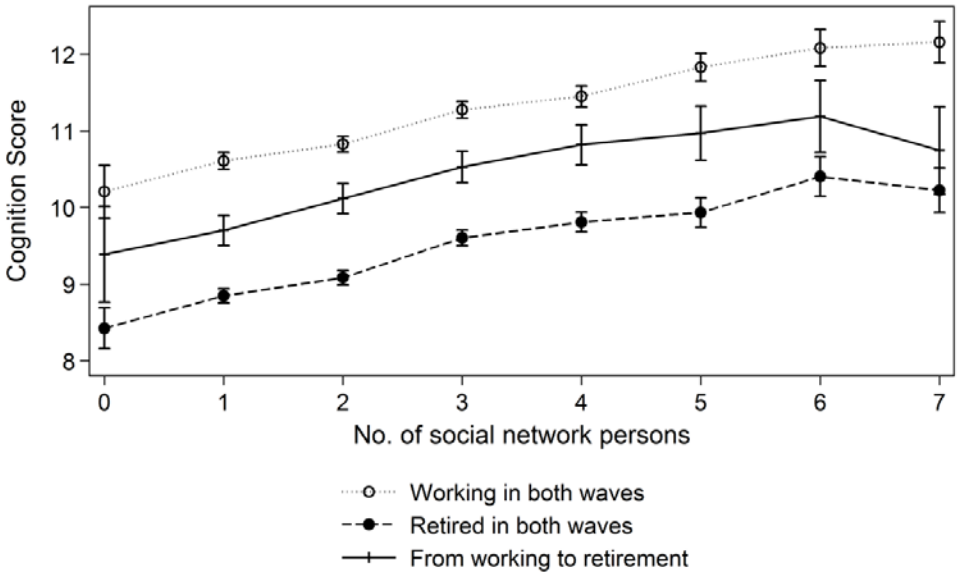
Figure 3: Change in SN subgroups between waves



Source: Own calculations based on weighted data from SHARE wave 4 and wave 6.

To descriptively motivate the second hypothesis (social networks become more familiar and emotionally closer after retirement), I present the change in different subgroups of the social networks between wave 4 and wave 6 in Figure 3. Surprisingly, the always-workers have the highest increase in the number of close network members and also the always-retirees and transitioners name more close family members. The other subgroups remain quite stable for the always-workers and always-retirees, however a decline in the number of colleagues and the number of friends is visible for those who transition from working to retirement. This decline descriptively supports my hypothesis that the networks become less friends-focused after retirement. Figure 4 shows the relationship between the number of social network members and the cognition score for the different groups. Independent of the social network size, the always-workers have the highest predicted cognition score, followed by the transitioners and then the always-retirees. The graph further shows a positive relationship between the number of social network persons and the cognition score, supporting the hypothesis that a reduced social network leads to cognitive decline.

Figure 4: Relationship between social network, cognition and retirement



Source: Own calculations based on weighted data from SHARE wave 4 and wave 6.

To sum up, descriptive evidence shows that the social network size reduces when transitioning from working to retirement, especially due to a decrease in the number of friends and colleagues named as close confidants. The additional social network characteristics show that the social network becomes more local and emotionally closer after retirement. Cognition declines with age and with retirement status; and a low number of social network persons is related to a lower cognitive score. So far, the descriptive evidence supports my three hypotheses. However, the endogeneity problem is not accounted for in the descriptive analyses; therefore, no causal relationship can be claimed so far. The subsequent analytical part will address the endogeneity problem and identify the effect of retirement on social networks and cognition.

Estimation results

Effect of Retirement on Social Networks

I start the empirical analysis by looking at the effect of retirement on the total size of social networks, presented by different models in Table 4. All models include year and country fixed effects (cancelling out for the individual-level fixed effects regressions) to control for country-specific time trends and unobserved cultural or institutional differences that potentially influence retirement ages, social networks and cognition.

Table 4: Effect of Retirement on Social Networks

	Total size of social network			
	(1)	(2)	(3)	(4)
VARIABLES	Pooled OLS	Pooled IV	FE	IV-FE
Retired (0 1)	-0.12***	0.07	-0.12***	0.46
	(0.023)	(0.153)	(0.036)	(0.325)
Female (0 1)	0.52***	0.51***		
	(0.026)	(0.028)		
Age at the time of the interview (50-75)	-0.04	-0.07**	-0.23***	-0.24***
	(0.026)	(0.032)	(0.056)	(0.056)
Age squared	0.00*	0.00**	0.00*	0.00*
	(0.000)	(0.000)	(0.000)	(0.000)
Living together with a partner (0 1)	0.13***	0.12***		
	(0.019)	(0.020)		
Years of education (0-25)	0.02***	0.02***		
	(0.003)	(0.003)		
Household has financial problems (0 1)	-0.02	-0.03		
	(0.019)	(0.020)		
Number of activities (0-5)	0.24***	0.24***		
	(0.009)	(0.009)		
Grip strength (0-100)	-0.00	-0.00		
	(0.001)	(0.001)		
Long-term illness (0 1)	0.23***	0.22***		
	(0.019)	(0.020)		
Quality of life - CASP12 (12-48)	0.02***	0.02***		
	(0.002)	(0.002)		
Number of ADL (0-10)	0.03	0.03		
	(0.020)	(0.020)		
Number of IADL (0-15)	0.02	0.02		
	(0.016)	(0.016)		
Limited in activities (0 1)	0.05**	0.04**		
	(0.020)	(0.021)		
Constant	2.52***	3.11***	16.05***	
	(0.811)	(1.128)	(3.062)	
Observations	39,998	39,998	39,998	39,998
R-squared	0.11	0.11	0.01	-0.00
Year FE	YES	YES	YES	YES
Country FE	YES	YES		
F	147.2	145.8	48.41	46.14

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The first model estimates a pooled OLS regression including covariates mainly covering demographic and health information. The results in column (1) indicate that retirement has a significant negative effect on the

total network size. However, as soon as possible reverse causality is taken into account by instrumenting the retirement variable; the coefficient for retirement in column (2) turns positive and insignificant. Similar effects can be found when comparing column (3) with column (4). According to the individual fixed-effects regression, retirement has a significant negative effect on the social network size (3). When including the statutory retirement ages as instruments, the obtained coefficient for the fixed-effects two-stage least-squares (2SLS) estimator turns positive and insignificant (4). It is normal that the standard errors for instrumental variables are larger than those obtained by OLS regressions (Wooldridge 2002). However, the change in sign from negative to positive when estimating the IV strategy indicates that the OLS results might be driven by unobserved heterogeneity or reverse causality and therefore it is necessary to control for this cause of endogeneity. For this reason, I rely on the IV-FE model despite the insignificance of the effect and present the following subanalyses based on the same model specifications as presented in column (4).

Table 5 presents the effect of retirement on different subgroups of the social networks to investigate the second hypothesis which postulates a change in social network composition from friends-focused to family-focused. The first column repeats the 2SLS estimator for the effect of retirement on total network size as already presented in Table 5. Colum (2) shows that retirement has a significant positive effect on the number of close family members that are named as confidants in the social network. Similar to Börsch-Supan and Schuth (2014), who claim that retirement leads to a decrease in the number of friends/colleagues or other non-family members, I find negative coefficients in column (3) and (4) although they are insignificant. In accordance to the descriptive part these results suggest that the social network becomes more familiar after retirement.

Table 5: Effect on Retirement on subgroups of social network

VARIABLES	(1) Total size of SN IV-FE	(2) Close family IV-FE	(3) Friends/colleagues IV-FE	(4) Non-family IV-FE
Retired (0 1)	0.46	0.50**	-0.19	-0.11
	(0.325)	(0.242)	(0.193)	(0.205)
Age at the time of the interview (50-75)	-0.24***	-0.09**	-0.08***	-0.07**
	(0.056)	(0.044)	(0.030)	(0.032)
Age squared	0.00*	-0.00**	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	39,998	39,998	39,998	39,998
R-squared	-0.00	-0.00	-0.00	0.00
Year FE	YES	YES	YES	YES
F	46.14	76.08	6.804	4.763

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To consider possible heterogeneous effects, I run the IV-FE specification separately for male and female respondents and present the related coefficients in Table 6. I find that retirement has a significant positive effect

on the social network size for male persons, mainly due a significant increase in the number of close family members in the social network. In contrast, female persons experience a decrease in the total size of the social network after retirement although this effect is not significant. I further run separate regressions for different geographical regions[1] to investigate whether the trend from friends-focused networks to family-focused networks is especially found in the Northern European countries, but no clear effect can be found due to insignificance.

Table 6: Heterogeneous effects of retirement on social networks

		Gender		Region			
Dependent var		Male	Female	Northern	Central	Eastern	Southern
Total size of SN	Retired (0 1)	1.01*	-0.16	-0.11	0.57	0.58	0.53
		(2.25)	(0.35)	(0.19)	(0.94)	(0.50)	(1.04)
	F statistic	29.98	18.06	10.98	8.39	17.08	19.57
	Adj R^2	-1.08	-0.99	-0.97	-1.02	-1.03	-1.00
	Year FE	YES	YES	YES	YES	YES	YES
Close family	Retired (0 1)	0.88**	0.06	0.50	0.36	-0.01	0.69
		(2.61)	(0.19)	(1.22)	(0.84)	(0.01)	(1.77)
	F statistic	51.36	28.29	16.93	15.53	23.57	38.41
	Adj R^2	-1.08	-0.98	-1.01	-1.00	-0.97	-1.00
	Year FE	YES	YES	YES	YES	YES	YES
Friends/colleagues	Retired (0 1)	-0.05	-0.37	-0.72	-0.14	0.20	-0.16
		(0.19)	(1.37)	(1.87)	(0.36)	(0.33)	(0.54)
	F statistic	2.91	4.54	2.59	2.80	3.22	2.19
	Adj R^2	-1.00	-1.02	-1.06	-1.00	-1.03	-1.00
	Year FE	YES	YES	YES	YES	YES	YES
Non-family	Retired (0 1)	-0.04	-0.15	-0.65	0.04	0.28	-0.11
		(0.13)	(0.52)	(1.62)	(0.09)	(0.43)	(0.35)
	F statistic	2.08	3.20	2.48	2.17	2.22	1.09
	Adj R^2	-1.00	-1.00	-1.05	-1.00	-1.04	-1.00
	Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Effect of Retirement and Social Networks on Cognition

In the second part of the empirical analysis I estimate the effect of retirement on cognition controlling for changes in the size of the social network. Column (1) in Table 7 presents the results of an instrumental variable fixed effects estimation with cognition score as dependent variable and retirement, age, age squared as basic covariates. Further, the dummy controlling for the retesting effect was added. I find a negative, but small and insignificant effect of retirement on cognition when controlling for age and age squared. Taking the memory recall test for the first time in wave 4 and being retested again in wave 6 has a significant positive effect on the cognitive score compared to those taking a repeated test already in wave 4, indicating a learning effect. In columns (2) to (4) I successively add social network characteristics to the base model, namely the total size of social network, the number of close family members and the number of friends or colleagues in the social

[1] Northern (Denmark, Sweden), Central (Austria, Germany, Switzerland, Belgium), Eastern (Czech Republic, Poland, Slovenia, Estonia), Southern (Spain, Italy, France, Portugal)

network. First of all, adding additional covariates to the model does not change the main effect of retirement on cognition. Concerning the network effects, an increase in the total number of network size and an increase in the number of friends and colleagues have a significant positive effect on cognition. A higher number of close family members in the social network however does not reveal a significant effect on cognition. Column (5) additionally takes into account changes in other variables that could potentially influence the effect of retirement on cognition. The main effect is not affected by the inclusion of the additional covariates. A change in the living status and in the financial situation has no significant effect. An increase in the number of activities though has a significant positive effect on cognition indicating that an active lifestyle is associated with the cognitive performance.

Table 7: Effect of retirement and social networks on cognition

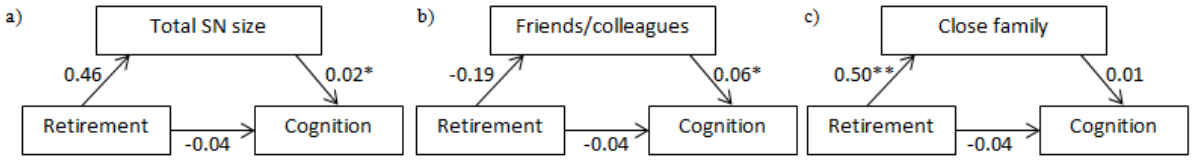
VARIABLES	(1) Cognition IV-FE	(2) Cognition IV-FE	(3) Cognition IV-FE	(4) Cognition IV-FE	(5) Cognition IV-FE
Retired (0 1)	-0.04	-0.05	-0.04	-0.03	-0.05
	(0.637)	(0.635)	(0.636)	(0.636)	(0.637)
Age at the time of the interview (50-75)	0.89***	0.89***	0.89***	0.89***	0.89***
	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)
Age squared	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Retesting (0 1)	0.18**	0.18**	0.18**	0.18**	0.19**
	(0.075)	(0.075)	(0.075)	(0.075)	(0.075)
Total size of SN		0.02*			
		(0.014)			
Close family in SN			0.01	0.01	0.01
			(0.018)	(0.018)	(0.018)
Friends/colleagues in SN				0.06***	0.06**
				(0.022)	(0.022)
Living together with a partner (0 1)					0.15
					(0.125)
Household has financial problems (0 1)					0.06
					(0.053)
Number of activities (0-5)					0.07***
					(0.024)
Observations	39,998	39,998	39,998	39,998	39,998
R-squared	0.01	0.01	0.01	0.01	0.01
Number of ID	19,999	19,999	19,999	19,999	19,999
Year FE	YES	YES	YES	YES	YES
F	29.92	25.55	25.00	22.50	16.83

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A summary of the results from Table 5 and Table 7 is presented in Figure 5. An increase in the total social network size and in the number of friends and colleagues positively influences the cognitive performance as shown in a) and b). However, since retirement does neither have a significant effect on the total network size nor on the number of friends and colleagues, I cannot claim that the interaction with (external) social network

members buffers the negative effect of retirement on cognition. Retirement has a significant positive effect on the number of close family members in the social network (c), but these in turn do not affect cognition significantly.

Figure 5: Summary of analytical results



If I had found a significant effect of retirement on the number of friends and colleagues, the buffering effect of external social network members on cognition would be arguable. To illustrate this, I run separate regressions for those respondents with a decrease in the number of friends and colleagues between wave 4 and wave 6 and for those with an increase.

Table 8: Effect on cognition dependent on change in social networks

	Friends/Colleagues		Total size of SN		Close family	
	decrease	increase	decrease	increase	decrease	increase
	(1)	(2)	(3)	(4)	(5)	(6)
	Cognition	Cognition	Cognition	Cognition	Cognition	Cognition
	IV-FE	IV-FE	IV-FE	IV-FE	IV-FE	IV-FE
Retired (0 1)	-1.91*	2.49*	-0.04	1.19	0.76	-0.44
	(1.152)	(1.480)	(1.097)	(1.040)	(1.337)	(1.062)
Age (50-75)	0.02	0.84**	0.57***	1.08***	0.74***	1.17***
	(0.324)	(0.374)	(0.219)	(0.234)	(0.254)	(0.238)
Age squared	-0.00**	-0.01***	-0.00***	-0.00***	-0.00***	-0.00***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Retesting	0.09	0.27	0.26**	0.19	0.25	0.07
	(0.152)	(0.184)	(0.128)	(0.127)	(0.164)	(0.132)
Observations	8,498	7,494	12,882	15,944	10,408	14,012
R-squared	-0.05	-0.06	0.01	-0.00	-0.00	0.00
Number of ID	4,249	3,747	6,441	7,972	5,204	7,006
Year FE	YES	YES	YES	YES	YES	YES
F	4.145	9.583	9.143	14.37	8.236	11.59

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column (1) in Table 8 shows that retirement has a significant negative effect on cognition for those with a shrinking social network size in terms of friends or colleagues. Thus, the loss of intellectual stimulation through friends or colleagues induced by retirement can lead to faster cognitive decline, as already found by Börsch-Supan and Schuth (2014). In contrast, if the number of friends or colleagues increases, retirement has a significant positive effect on cognition as shown in column (2). This supports the hypothesis that an active lifestyle and social interactions with an extended network can buffer the cognitive decline also after retirement.

I do not find significant effects if I reduce the sample to those who experience an increase (3) or decrease (4) in the total size of social network or in the number of close family members (5 and 6).

Robustness Checks

As presented in the work of Fonseca et al. (2016), the results for the health effect of retirement depend strongly on the model specification and the definition of retirement. Table 9 and Table 10 in the appendix present the estimation results based on different retirement concepts. The first alternative specification defines retirement on the basis of self-reported retirement, without taking into account whether someone has done any other paid work in the last four weeks (2). The next two specifications account for the "honeymoon phase" after retirement by replacing the retirement dummy with dummy variables indicating whether someone has been in retirement for at least one year (3) or two years (4) respectively. The last specification (5) considers the time spent in retirement since it has been shown in the literature that the time someone has been exposed to the conditions in retirement can have an important effect. When revising the effects of retirement on social network size for the different specifications it is shown that the positive effect of retirement on the number of close family members remains stable for the first two alternative specifications. The effect becomes insignificant under the constraint of at least two years in retirement and even negative, but also insignificant, for the time spent in retirement. Therefore, the increase in the number of close family members is rather an immediate response to the new situation after retirement and could be connected with the quest for spousal support after retirement. The results for the effect of retirement and social networks on cognition remain stable across the different retirement definitions and the different estimation strategies.

Conclusion

Based on the literature and on socio-psychological theories, I formulized three hypotheses to be tested in the empirical analysis. The first hypothesis states that retirement leads to a decrease in social network size. The descriptive statistics and graphs supported this hypothesis. Also, the OLS and the FE regressions indicated a significant negative effect or retirement on the total social network size. However, after including instruments to account for potential endogeneity problems, I find positive, but insignificant effects of retirement on the social network size. Therefore, I cannot confirm the first hypothesis based on the empirical results. I further investigated the effect of retirement on different subgroups of the social network. I find that retirement significantly increases the number of close family members mentioned as social network members, especially for male respondents. I do not find significant differences between European regions. Therefore, I can only confirm the first part of the second hypothesis ("Social networks become more familiar and emotionally closer

after retirement, especially in Northern and Western countries"). The third hypothesis argues that a reduced social network after retirement intensifies the cognitive decline. Although the descriptive statistics suggest a cognitive decline after retirement, I do not find a significant negative effect of retirement on cognition, mainly due to the large standard errors in the IV-FE specification. The results suggest that an increase in the total social network size and in the number of friends and colleagues positively influences the cognitive performance. However, since retirement does neither have a significant effect on the total network size nor on the number of friends and colleagues, I cannot claim that the interaction with (external) social network members buffers the negative effect of retirement on cognition. Reversely, I cannot say that a reduction in the number of friends or colleagues induced by retirement intensifies the cognitive decline; therefore, the third hypothesis cannot be confirmed.

The present paper is a follow-up study of the work done by Börsch-Supan and Schuth (2014) who find that (early) retirement reduces especially the number of non-family members in the social network. They conclude that this reduction could be a possible mechanism that may explain the negative effect of (early) retirement on cognition. This study was based on cross-sectional data from SHARE wave 4. My study extends this former work by adding the newly available panel data on the social networks in SHARE and by estimating instrumental variable fixed-effects regressions to causally identify the effect of retirement and social networks on cognition. The results are not as straightforward as expected since I do not find a significant reduction in the number of friends or colleagues after entering retirement. Therefore, I cannot claim the change in social networks to be an underlying mechanism for the negative effect of retirement on cognition.

The lack of significant results can on the one hand be attributed to the identification strategy since large standard errors are obtained when using an instrumental variable strategy. On the other hand, the way of measuring the social networks in SHARE might fail to provide enough variation in the change of social network size. The concept allows to name up to seven close persons and by definition this might exclude social relations beyond the inner circle of a person. These external relations however are expected to be most affected by the retirement transition and at the same time they are shown to be the most influential contacts regarding cognitive stimulation. The measured network size can therefore only be seen as a proxy measure for the changes in external social relationships. Future updates on the social network data might offer more variation in the magnitude of the social network changes and might also cover a broader time span so that the mechanism of the social networks in the context of the effect of retirement on cognition can be identified more explicitly.

Nevertheless, the analysis of the panel data on social networks has revealed interesting insights into the

development of social network characteristics for older adults. On the one hand, it was found that the number of close family members in the social network increases after retirement. On the other hand, the results indicate that the contact to non-family members like friends and colleagues provides intellectual stimulation and has a positive impact on cognition. Like other studies (Salthouse 2006; Scarmeas and Stern 2003; Fratiglioni et al. 2004) I find that an active lifestyle - measured by the number of activities – positively affects cognitive functioning. Taking part in social programs or other stimulating activities can therefore helpful to preserve cognitive abilities in old age. Future research should concentrate on analyzing heterogeneous effects based on educational differences, job characteristics and cultural habits so that the intervention programs can be specifically targeted.

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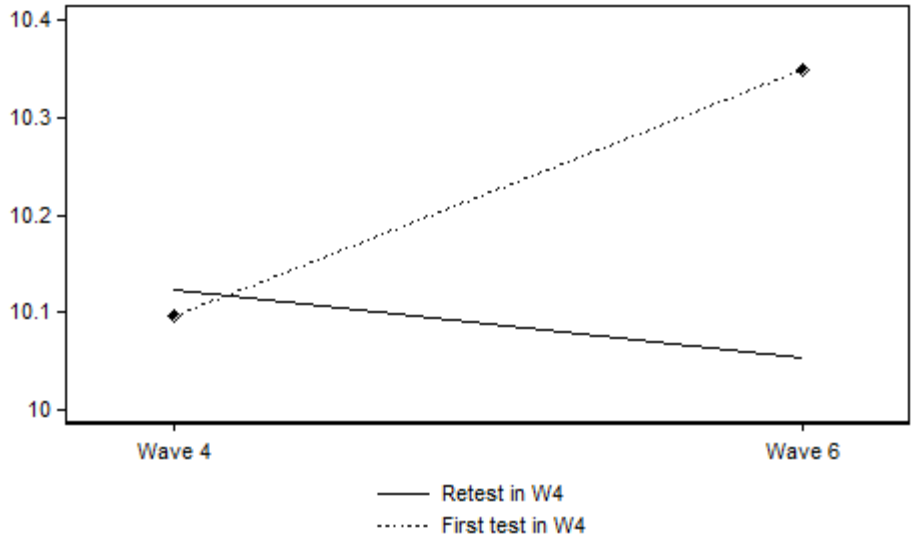
APPENDIX

Figures

Figure 6: Learning effect of memory recall test



Source: Own calculations based on weighted data from SHARE wave 4 and wave 6.

Tables

Table 9: Robustness checks for effect on social network

		Total SN size	Close family	Friends/colleagues	Non-family
		IV-FE	IV-FE	IV-FE	IV-FE
Normal specification	Retired (0 1)	0.46	0.50**	-0.19	-0.11
		(0.33)	(0.24)	(0.19)	(0.21)
	F statistic	46.14	76.08	6.804	4.763
	Adj R-squared	-0.00	-0.00	-0.00	0.00
	Year FE	YES	YES	YES	YES
One year in retirement	Retired (0 1)	0.23	0.31*	-0.14	-0.09
		(1.14)	(2.00)	(1.13)	(0.68)
	F statistic	46.60	77.02	7.03	4.88
	Adj R-squared	-0.99	-0.99	-1.00	-1.00
	Year FE	YES	YES	YES	YES
Two years in retirement	Retired (0 1)	0.11	0.12	-0.06	-0.03
		(0.59)	(0.87)	(0.57)	(0.23)
	F statistic	46.43	76.46	6.76	4.75
	Adj R-squared	-0.99	-0.97	-1.00	-1.00
	Year FE	YES	YES	YES	YES
Self-reported retirement	Retired (0 1)	0.22	0.24*	-0.08	-0.04
		(1.39)	(2.01)	(0.88)	(0.41)
	F statistic	46.64	77.12	6.75	4.74
	Adj R-squared	-0.99	-0.98	-1.00	-1.00
	Year FE	YES	YES	YES	YES
Time spent in retirement	Retired (0 1)	-0.03	-0.05	0.01	0.01
		(0.68)	(1.34)	(0.37)	(0.26)
	F statistic	46.34	74.56	5.80	4.09
	Adj R-squared	-0.98	-0.98	-1.00	-1.00
	Year FE	YES	YES	YES	YES

Table 10: Robustness checks for effect on cognition

		(1)	(2)	(3)	(4)
		Cognition POLS	Cognition IV	Cognition FE	Cognition IV-FE
Normal specification	Retired (0 1)	-0.28**	-0.51	0.03	-0.02
		(6.19)	(1.70)	(0.47)	(0.04)
	Friends/colleagues in SN	0.17**	0.16**	0.06**	0.06**
		(9.99)	(9.28)	(2.73)	(2.67)
	F statistic	344.49	342.49	26.20	26.14
	Adj R-squared	0.25	0.25	0.01	-0.98
	Year/Country FE	YES	YES	YES	YES
One year in retirement	Retired (0 1)	-0.28**	-0.49	0.02	0.00
		(6.27)	(1.86)	(0.39)	(0.00)
	Friends/colleagues in SN	0.17**	0.16**	0.06**	0.06**
		(10.03)	(9.60)	(2.72)	(2.71)
	F statistic	344.39	342.70	26.18	26.14
	Adj R-squared	0.25	0.25	0.01	-0.98
	Year/Country FE	YES	YES	YES	YES
Two years in retirement	Retired (0 1)	-0.28**	-0.41	0.02	-0.09
		(6.27)	(1.60)	(0.39)	(0.26)
	Friends/colleagues in SN	0.17**	0.16**	0.06**	0.06**
		(10.03)	(9.68)	(2.72)	(2.68)
	F statistic	344.39	342.94	26.18	26.15
	Adj R-squared	0.25	0.25	0.01	-0.98
	Year/Country FE	YES	YES	YES	YES
Self-reported retirement	Retired (0 1)	-0.24**	-0.35	0.07	0.02
		(4.89)	(1.73)	(1.02)	(0.06)
	Friends/colleagues in SN	0.17**	0.17**	0.06**	0.06**
		(10.15)	(10.02)	(2.72)	(2.72)
	F statistic	344.11	342.93	26.36	26.14
	Adj R-squared	0.25	0.25	0.01	-0.98
	Year/Country FE	YES	YES	YES	YES
Time since retirement	Retired (0 1)	-0.02**	-0.03	0.00	0.23**
		(5.61)	(0.90)	(0.18)	(2.58)
	Friends/colleagues in SN	0.17**	0.17**	0.06**	0.07**
		(10.05)	(9.86)	(2.60)	(2.97)
	F statistic	330.87	329.88	26.75	27.49
	Adj R-squared	0.24	0.24	0.01	-1.04
	Year/Country FE	YES	YES	YES	YES