UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

The Effect of Retirement on Mental Health: The Role of Social Capital

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Abstract

The purpose of this paper is to empirically evaluate the causal effect of retirement on social capital, and by extension, mental health. Social capital is often divided into different parts. Two common measures are cognitive social capital, for example, "how people feel" and, structural social capital, for example, what they "do" in regards to social interaction. To study the effects of retirement on social capital we use data from the Survey of Health, Ageing and Retirement in Europe (SHARE), which contains a social network module. We use the jump in the probability of retiring that arises when a person reaches the statutory retirement age as an IV for retirement, in a fussy regression discontinuity (FRD) design. Our results, which are robust, suggest that retirement has a positive and significant effect on both structural and cognitive social capital. Retirement increases the probability of having activities and attending social clubs. Retirement also decreases the probability and the frequency of feeling left out. We do, however, not find any effect on loneliness.

Key Words: Retirement, Social Capital, Mental Health, Structural Social Capital, Cognitive Social Capital
JEL Classification: I12, J14, J26

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Josefine Heinevik & Carl Nilsson

1 Introduction

Retirement is a milestone for many individuals. Expectations regarding retirement vary but a gloomy picture often envisioned is that retirees are lonely with few friends and few social activities (Fletcher and Hansson, 1991; Van Solinge and Henkens, 2008). Understanding the effects of retirement, especially in terms of health, is important for several reasons. For individuals, a healthy and happy life increases utility, and health also influences the capacity to engage in activities. The effects of retirement on health are also important from a societal perspective as public health greatly affects health expenditure. With increasing life expectancy across Europe, populations now includes larger proportions of retirees (Lanzieri, 2011). Therefore, it is important, now more than ever, to evaluate the effects of retirement on health.

Overall, there are mixed results regarding the effect of retirement on health. Some studies show positive health effects of retirement (Coe and Zamarro, 2011; Kerkhofs et al., 1997; Midanik et al., 1995) while others find no effect (Hagen et al., 2016) or negative effect (Dave et al., 2006; Kofi Charles, 2004; Sahlgren, 2012; Szinovacz and Davey, 2004). These studies differ in many important aspects, such as the population being studied, measure of health, as well as empirical methodology and there is no clear consensus regarding the effect of retirement on mental health. Because of these mixed results it is important to disentangle how and through which channels retirement affects different aspects of mental health.

Research suggests that one of the channels which retirement affects mental health is through changes in individual's social capital. Social capital has no single definition but can be explained as the networks, norms, shared values, and understandings in society that facilitate social interactions within or among groups (Brian, 2007). Social capital is often divided into two parts, cognitive social capital, for example, "how people feel", and structural social capital, for example, what they "do" in regards to social interaction (such as attending any type of social club) (Harpham et al., 2002). Social capital and mental health is a well-established field of literature and studies document the importance of different measurements of social capital for various indicators of health and well-being. For example, individuals with high levels of social capital are less likely to suffer from mental illness (Ellaway et al., 2001; Kawachi and Berkman, 2001; Ross et al., 2000; Steptoe and Feldman, 2001) or depression specifically (Bullers, 2001; Lin et al., 1999).

The existing literature on the effect of retirement on social capital is rather sparse and empirical research is limited. Our paper contributes to the literature that evaluates the effect of retirement on social capital, which is a determinant of especially mental health (Cohen, 2004). Börsch-Supan and Schuth (2013) suggest that retirement negatively affects the size of social networks, and particularly the number of friends and other non-family contacts. However, their paper mainly focuses on correlation and does not evaluate a causal relationship. Dave et al. (2006), find that complete retirement leads to a decline in mental health. Although, the effect of retirement on social capital is not the main focus in

the paper and it is mainly discussed as a channel through which retirement affects mental health (Dave et al., 2006). Thus the previous research briefly discuss social capital and focus on correlations. Our focus is instead on the causal effect and we aim to extend on previous research and fill the gap that is the causal effect of retirement on social capital.

To analyze the effect of retirement on social capital we are using the Grossman model (Grossman, 1972) and the extended model by Bolin et al. (2003). Theory predicts contradictory effects of retirement on social capital. It could have a positive effect since the increase in leisure time makes it possible to spend more time with friends, family, or grandchildren and engage in social activities, and thus, have greater access to social capital (Peppers, 1976). However, if most of individual's social capital is connected to work, their retirement can result in a break with support networks and friends (Dave et al., 2006). Retirement can also increase the relative time spent alone, without activities or purpose, which negatively affects mental health. Since theory is inconclusive as to how retirement affects social capital the question is an empirical issue.

The purpose of our paper is to empirically evaluate the causal effect of retirement on social capital, and by extension, mental health. Empirically testing this is challenging, as the decision to retire is based on several factors that also are likely to be related to social capital. For example, workers with their social capital connected to their job might choose to retire later while workers with their social capital outside of work might choose to retire early. To estimate a causal relationship we use the jump in probability of being retired that arises when an individual reaches the country-specific statutory retirement age as an instrumental variable (IV) for retirement. We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE) (Abduladze et al., 2013; Börsch-Supan et al., 2013a,b). SHARE is a comprehensive longitudinal cross-country database on socioeconomic status and mental health for Europeans aged 50 and above. We use the fourth wave from 2012 as it includes a social network module. We include Belgium, Denmark, Estonia, France, Germany, Hungary, Italy, The Netherlands, Poland, Sweden, and Switzerland in our analysis. Using a fussy regression discontinuity (FRD) design as a two stage least square model (2SLS) framework we find that retirement has a positive effect on social capital. Retirement positively affects structural social capital and increases the probability of having activities and attending social clubs, and also the frequency of visits to these activities. Retirement also has a positive effect on cognitive social capital. Retirement negatively affects the probability of feeling left out and the frequency of how often individuals feels left out. We do, however, not find any effect on loneliness from retirement. Our findings are robust to different specifications and sub-samples. However, limitations are the lack of panel data and the use of survey data.

The paper proceeds as follows: Section 2 reviews the relevant literature, which helps to establish a background to the choice of theoretical model. Section 3 includes the theoretical framework and the hypotheses based on theory. Section 4 presents the data, our variables, and descriptive statistics. Section 5 presents our empirical method and model. Section 6 includes the results which are discussed in Section 7. Section 8 concludes the paper.

2 Literature review

This paper is related to three strands of literature. In this section we will first present previous research related to social capital and mental health, continuing with findings regarding mental health and retirement, and finally retirement and social capital.

2.1 Social capital and mental health

Social capital and mental health is a well-established field of literature and many studies document the importance of social capital for mental health and well-being. The concept of social capital is very influenced by the work of Robert Putnam (1993), and Richard Wilkinson (1996) who introduced social capital to the public health field. The link between social capital and different mental health outcomes is well established. Most studies do not define whether they look at structural or cognitive social capital. However, the majority of the studies look at the link between what Harpham et al. (2002) defines as structural social capital and mental health. These studies show a positive relationship between social capital and mental health. Individuals with high levels of social capital are less likely to suffer from mental illness (Ellaway et al., 2001; Kawachi and Berkman, 2001; Ross et al., 2000; Steptoe and Feldman, 2001) or depression specifically (Bullers, 2001; Lin et al., 1999). Almedom and Glandon (2008) argue that this effect comes from the psychosocial support gained from social capital. Psychosocial support can be explained as non-therapeutic help and intervention that can come from love, care and protection from a social network, and helps a person cope with stress. Other studies find positive effects on self-reported health (d'Hombres et al., 2010) and physical health, such as decreased mortality (Kawachi et al. 1996; Wilkinson et al. 1996). Social capital also influences healthy behavior through norms promoting a healthy lifestyle (Brown et al., 2006). For example, evidence shows that social capital is negatively associated with smoking (Brown et al., 2006; Lindström et al., 2002; Lindström, 2003). Studies also show that the positive effects of social capital on health are important, especially for older people (Kondo et al., 2007; Sirven and Debrand, 2008, 2012; Veenstra, 2000). The consensus from these studies is that individuals with high levels of social capital enjoy a longer, happier and healthier life than their counterparts with lower levels of social capital.

2.2 Retirement and mental health

This paper relates broadly to the extensive literature that examines the relationship between retirement and health in general, and mental health in particular (as social capital is more related to mental health). Within this literature the focus and results vary. A large share of the literature find positive effects of retirement on physical health (Coe and Zamarro, 2011; Kerkhofs et al., 1997; Midanik et al., 1995) while other papers report no effect (Hagen et al., 2016) or negative effect (Dave et al., 2006). The impact of retirement on mental health is also ambiguous. Wile Dave et al. (2006) find negative mental health effects of retirement others (Drentea, 2002; Midanik et al., 1995) find positive effects.

Research suggests that retirement may influence mental health through different channels. It can have a positive impact on mental health through diminished work stress. Midanik et al. (1995) find that those who choose to retire are more likely to have lower stress levels and to engage in regular exercise more often compared to those who are not retired. However, others find a negative effect on mental health (Dave et al., 2006). Sahlgren (2012) finds a negative long-term impact of retirement on mental health, though he does not discuss the mechanisms through which this effect operates. Other papers describe an increased sense of "feeling old" (Bradford, 1979) and depression (Kofi Charles, 2004; Szinovacz and Davey, 2004) as a mechanism of the negative effect on mental health. These studies differ in many important aspects, for example, the population studied, the measure of health, as well as empirical methodology. The conflicting results could be a consequence of the lack of convincing empirical strategies to deal with endogenous selection into retirement, or data issues. Overall, there is no consensus regarding retirement and mental health. Thus, it is important to disentangle the many simultaneous effects that affect mental health and evaluate how retirement affects specific determinants of mental health (Rocco et al., 2014).

2.3 Retirement and social capital

This paper relates more specifically to the literature that examines the effect of retirement on social capital. Existing literature close to our research is rather sparse and empirical research is limited. Börsch-Supan and Schuth (2013) investigate the relation between retirement, mental health and the size and structure of social networks among older people. They argue that early retirement has negative effects on the retirees' social networks. Their findings suggest that retirement in general, and early retirement in particular, negatively affects the size of social networks, and particularly the number of friends and other non-family contacts. However, their paper was written before the release of the SHARE social network module. Therefore, because of lack of social capital variables they cannot fully analyze the effect and, more importantly, only look at correlations. Dave et al. (2006) find that complete retirement leads to a decline in mental health. Their result further indicates that the decline in mental (and physical) health tend to operate through lifestyle changes such as declines in physical activity and social interactions. However, their findings suggest that the adverse mental health effects are reduced if the individual continues to work part-time after retirement, is married or physically active. A limitation is that Dave et al. (2006) does not have social capital as the main the focus instead they merely discuss the connection between health and social capital.

3 Theory

Social capital is widely discussed in various strands of literature. Theories regarding social capital stems from sociology, but can be incorporated into economic theory using the human capital model. Social capital can be explained as the networks, feelings, norms,

structures and institutions that facilitate social interactions. It can be divided into two parts: Structural social capital, which can be expressed as what people do. An example of this is how often an individual attend a social event. And cognitive social capital, which is what people feel. Examples of this are trust, loneliness and feelings of exclusion (Harpham et al., 2002).

There are at least three reasons why an increase in social capital can be beneficial and directly affect mental health. First, social interaction can contribute to an individual's utility (Bolin et al., 2003). Second, social networks can provide individuals with emotional and informational support. Third, social interaction can impose positive norms and improve the allocation of resources (Brian, 2007). One example of this is a social network's informal or formal attitude towards different health-related behaviors, such as exercise, drinking, and smoking.

There is also the possibility of a negative effect of social capital on health. Structural social capital is activities where individuals have social interactions. Even-though these interactions increase social capital (and in turn mental health); they might have negative health effects. For example, the positive increase in social capital (and thus mental health) from socializing and drinking at a pub or joining a cigars club might be smaller than the negative physical health effects. Furthermore, norms and shared values are can be positive and mental health enhancing, however, not all norms are necessarily positive for an individual's mental health.

To understand the theoretical link between social capital and mental health, and retirement and social capital we use the Grossman model for the demand-for-health (Grossman, 1972). In the original model, the individual is a producer of her own health. There are two aspects of health in the model. The first, the investment aspect, implies that health capital directly increases utility and reduces work loss due to illness. Thus, it increases healthy time and raises earnings. The second, the consumption aspect, implies that health is enjoyed as such. Therefore, an individual both produces and demands its own health. The model assumes that health deteriorates at an increasing rate over time but individuals can make investments in health capital to keep the stock of health capital stable or at the desired level. The choice of lifestyle, medical advice, pharmaceuticals and, doctor visits are all used to produce and restore health. This does not imply that the individual can completely determine their own health state. Factors such as environment, inheritance, and chance may also affect the individual's health. Nevertheless, individuals have an opportunity to influence it's own health (Grossman, 1972).

Bolin et al. (2003) extends the Grossman model to include social capital within a mental health production framework. The extended model shows that social capital is positively related to the level of mental health, and that individuals with higher levels of social capital are healthier compared to individuals with lower levels of social capital. This is because the individual produces social capital and the marginal cost of mental health investments decreases with the stock of social capital. However, depending on whether spouses, partners, and children are substitutes or compliments to social capital

the individual's incentive to invest in social capital and optimal amounts of social capital might change.

When analyzing the effect of retirement using the Grossman model, the model predicts two contradictory mental health effects from retirement. Either, mental health investments decline close to and after retirement. This is because after retirement there is no longer any motive to invest in mental health to raise productivity and earnings. Or, mental health investments increase after retirement. This is because mental health is also a consumption good, and retirees may instead invest more in their mental health after retirement, as the alternative cost now is lower (Dave et al., 2006). In the same sense the model also predicts two contradictory effects of retirement on social capital. The effect of working or not working on social capital can be both positive or negative, depending on whether working time is a substitute or a compliment to social capital (Bolin et al., 2003). Crucially, however, the link between social capital and mental health is unambiguous and an increase in social capital positively affects mental health.

In conclusion, higher levels of social capital positively affect mental health, as investment in social capital is a form of investment in mental health. However, the theoretical framework gives conflicting predictions regarding the effect of retirement on mental health and investment in social capital. Therefore the question remains an empirical issue. The extended Grossman model by Bolin et al. (2003) allows us to interpret the results from our empirical model and evaluate this issue using the following two hypotheses. The first hypothesis is based on theory while the second is based on previous literature.

Hypothesis 1: Retirement will positively affect individual's structural social capital. This as the increase in leisure time makes it possible to attend more activities.

Hypothesis 2: Retirement will negatively affect individual's cognitive social capital as retirement could induce feelings of loneliness and being left out.

4 Data and Descriptive Statistics

4.1 Survey of Health, Ageing and Retirement in Europe (SHARE)

The data we use is the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE is a comprehensive longitudinal cross-country database with the aim of providing micro data on socioeconomic status and health for Europeans aged 50 and above (Abduladze et al., 2013; Börsch-Supan et al., 2013a,b). There are currently five waves with the first from 2004 and the latest from 2015. We use the fourth round of the survey from 2012, which includes the following countries: Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden and Switzerland.[1] The key advantage with this wave is that includes a social network module, which includes variables that can be used as proxies for a person's social capital. The data also includes detailed information on demographics and socioeconomic indicators.

We choose our sample in the following way. First, we remove incomplete survey records and only include individuals who are between 50 and 70 years old. Second, we eliminate all individuals who have never had a job or have not worked since age 50. Third, we have to look at the discontinuity gaps in retirement for the different countries. This since our identification strategy uses the jump in probability of retirement that arise when individuals reaches the country specific statutory retirement age as an IV for retirement. We remove countries that have a continuous function of retirement rather than a discontinuous function around the retirement age, as including these countries would violate the RD design assumption of a non-continuous function (discussed further in section 5.1). We also remove countries where the discontinuity occurs before or after the statutory age of retirement, since their discontinuity in retirement does not come from reaching the statutory retirement age (see Figure 3, Appendix 1). Instead it could depend on some unobserved factor. For instance, in Slovenia it seems as if men opt for early retirement at around the time that most women go into retirement. This could be because the discontinuity to a great extent is attributed to the retirement decision of the wife. However, this does not seem to be a problem when the gap in retirement ages between men and women are smaller or when there is no difference. The countries that are fit for our model and analysis are: Belgium, Denmark, Estonia, France, Germany, Hungary, Italy, The Netherlands, Poland, Sweden, and Switzerland.[2] The final sample size consists of 22 814 individuals.

We also use information on full and early retirement ages from each country. Table 1 presents the statutory retirement ages which vary between countries and gender (OECD, 2011).[3] The earliest normal retirement is at age 59 for women in Italy and the latest is 65 in several countries. Most SHARE interviews were conducted during 2011 (Estonia over 2010-2011, Poland 2011-2012, Germany 2011-2012) and the ages of retirement that

[1] Release 5.0.0 from May 10th 2016.

[2] Please see Figure 2 and 3, Appendix 1.

[3] The main source for this data is OECD (2011). The age of retirement varies slightly between different sources, due to changing retirement ages and transition periods in some of the countries.

are presented in Table 1 are the early and normal statutory retirement ages from the year before the interview. This is to be able to instrument the number of persons retired in 2011 as accurately as possible.[4]

Table 1: Statutory Retirement Ages

Country	Early retirement		Normal retirement	
	Men	Women	Men	Women
Belgium	60	60	65	65
Denmark	60	60	65	65
Estonia	60	60	63	61
France	56-59	56-59	60.5	60.5
Germany	63	63	65	65
Hungary	-	57	60	59
Italy	58	58	59	59
Netherlands	-	-	65	65
Poland	-	-	65	60
Sweden	61	61	65	65
Switzerland	63	62	65	63

Note: This table show the early and normal statutory retirement ages for the included countries. See Appendix 2 for detailed information on statutory retirement for both the included and excluded countries.

4.2 Variables

In this section we go through the different variables we use for our analysis. Most of them are available in SHARE. However, some variables are constructed and detailed information about these variables is available in Appendix 3.

4.2.1 Dependent variables

We use two categories of dependent variables. The first category are structural social capital variables, i.e. activities or contexts where the individual have access to social capital. The second category are cognitive social capital variables, which focus on how people feel (Harpham, 2008).

Structural variables

Size is a count variable that indicates the size of an individual's social network. The respondents were asked *"Over the last twelve months, who are the people with whom you most often discussed important things?"*. The respondents could name between zero and seven people. The wording of the question is to encourage the respondent to consider important people in their lives who are not only family, but also friends, colleagues, neighbors, or other acquaintances (Abduladze et al., 2013).

[4]Some countries have increased the statutory retirement ages. If that is the case using the increased ages could lead to some individuals being instrumented as not retired when they are.

Activities is a constructed dummy variable that indicates if the respondent had attended any activities (for example, social club, sports activities and so on) in the past twelve months. It takes the value 1 if the respondent answered that they had taken part in any activities during the past twelve months and 0 otherwise.

Club is a constructed dummy variable that indicates whether the respondent has gone to a sport, social or other kind of club in the past twelve months. It takes the value 1 if the respondent answered that they had gone to a club during the past twelve months, and 0 otherwise.

Club (How often) is a follow up question to those who responded they had gone to a club in the past twelve months. It indicates how often they went to a club. The respondents were asked how often they go to these types of clubs and the response options were: *1. Less often than almost every month, 2. Almost every month , 3. Almost every week and 4. Almost every day.*

Colleagues in Social Network is a variable that identifies the number of colleagues in the respondents social network. It ranges from 0 to 7 people as this is the maximum number respondents can name in their social network.

Cognitive variables

Left out is a constructed dummy variable that indicates whether the respondent has felt left out in the past twelve months. It takes the value 1 if the respondent answered that they felt left out *often* or *sometimes*, and 0 if they answered *rarely* or *never*.

Left out (How often) is a follow up question to those who responded they had felt left out in the past twelve months. It indicates how often the respondents felt left out. The respondents were asked *"How much of the time do you feel left out?"* and the response options were: *1. Never, 2. Rarely, 3. Sometimes and 4. Often.*

Lonely is a constructed dummy variable that indicates whether the respondent has felt lonely in the past twelve months. It takes the value 1 if the respondent answered that they felt lonely *some of the time* or *often*, and 0 if they answered *hardly ever or never*.

Lonely (How often) is a follow up question to those who responded they had felt lonely in the past twelve months. It indicates how often the respondents felt lonely. The question was *"How much of the time do you feel lonely?"* and the response options were: *1. Hardly ever or never, 2. Some of the time or 3. Often.*

4.2.2 Retirement

Retirement is our explanatory variable of interest. This variable equal to 1 if the respondent replied that their current job situation is retired, and 0 otherwise.

4.2.3 Control variables

In our analysis we include some variables to control for factors that affect social capital. We control for individual effects such as gender and age, as these are all (empirically) documented determinants of social networks (Dave et al., 2006). Age-squared is included to control for non-linear effects of age on social networks. We also include level of education as a socioeconomic control as we expect it to affect social networks. Education is divided into three levels based on the 1997 International Standard Classification of Education (ISCED) codes.[5] *Low education* is defined as having at most nine years of education. *Medium education* is defined as having upper secondary education or post-secondary non-tertiary education. *High education* is defined as the two most advanced levels of education which includes e.g. a doctoral degree. Furthermore, whether the individual lives in an urban or rural area is likely to affect their social network. We therefore include a dummy variable indicating whether an individual lives in an urban or rural area. In the robustness section we include two possibly endogenous controls, household income and marital status. Household income is aggregated on household level and consists of all types of income such as pensions, stocks, alimonies, inheritance, etc. Since household income is skewed, we use transformed *log(income)*. A potential problem when taking the log of income is that log of zero is not defined. However, only 0.4 percent of our sample has stated that they have no household income. We use our lowest non-zero value of 0.00168, as a proxy for zero based on the recommendations from Afifi et al. (2007). The choice of proxy is further discussed in Appendix 3. *Married* is a dummy that take on the value of one if the individual is married and zero otherwise.

4.3 Descriptive statistics

Table 2 and Table 3 present the descriptive statistics for the sample we use in the analysis. Table 2 shows the descriptive statistics for the different dependent and control variables. 39 percent of the respondents are retired and 45 percent are above the statutory retirement ages in their countries. In terms of the size of an individual's social network, the respondents on average have 2.68 people in their social network and nine percent of the respondents have colleagues in their social networks. 91 percent of respondents have attended activities during the past twelve months. 32 percent of respondents have gone to a sport, social or other kind of club during the last twelve months. Among these, respondents have on average gone to these clubs almost every week. In terms of feeling left out, 22 percent of the sample has felt left out during the past twelve months. Among these, they on average *rarely* feel left out (the distribution is centered just below the answer

[5]This is a statistical framework that is administered by UNESCO Institute for Statistics (UIS).

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	N
Retirement					
Retired	0.39	0.49	0	1	22814
Proportion above retirement age	0.45	0.50	0	1	22814
Proportion above early retirement age	0.51	0.50	0	1	22814
Dependent variables					
Size	2.68	1.63	0	7	22814
Activities	0.91	0.28	0	1	22785
Club	0.32	0.47	0	1	22574
Club (How often)	2.77	0.73	1	4	7181
Colleagues in SN	0.09	0.37	0	7	22814
Left out	0.22	0.42	0	1	22436
Left out (How often)	1.80	0.90	1	4	22436
Lonely	0.20	0.40	0	1	17057
Lonely (How often)	1.23	0.49	1	3	17057
Control variables					
Age	60.56	5.53	50	70	22814
Gender	0.54	0.50	0	1	22814
Low education	0.28	0.45	0	1	22259
Medium education	0.45	0.50	0	1	22259
High education	0.26	0.44	0	1	22259
Urban	0.64	0.48	0	1	21779
Household income	45093.23	63666.90	0	1508200	22814
Married	0.74	0.44	0	1	22814

Notes: This table show the descriptive statistics divided into three groups. The first is retirement, which includes *Retired*, which we use to estimate the effect of retirement. The second variable *Proportion above retirement age* is our IV, which we use to instrument *Retired*. The second group is our social capital variables that we use as our dependent variables. The third category includes our control variables.

Table 3: Countries

Country	Frequency	Percent of sample	Proportion Retired	Proportion Women
Belgium	3130	14%	35%	51%
Denmark	1557	7%	28%	52%
Estonia	3798	17%	33%	57%
France	3396	15%	45%	53%
Germany	965	4%	44%	57%
Hungary	1709	7%	53%	54%
Italy	1901	8%	44%	52%
Netherland	1807	8%	31%	54%
Poland	1076	5%	55%	56%
Sweden	1089	5%	46%	56%
Switzerlad	2386	10%	28%	52%
Total	22814	100%	39%	54%

Notes: This table show the amount of observations, the percentage share of observations per country, and the proportion of female retirees for each country.

rarely and the answers never or rarely make up 77 percent of the sample). Furthermore, 20 percent of respondents felt lonely sometimes or often during the past twelve months. They felt lonely on average Hardly ever or never to Some of the time. However, it is important to remember that *Club (How often)*, *Left out (How often)*, and *Lonely (How often)* are categorical variables, and the mean of these variables should therefore be interpreted more as an indicator than something else.

The average age in our sample is 60.56 years. 54 percent of the respondents in our sample are female and 46 percent are male. 28 percent of the respondents have lower level of education, 45 percent have medium level of education, and 26 percent have higher education. 64 percent of the respondents live in an urban area and 36 percent in a rural area. The average level of annual household income is 45 093 Euro. 74 percent of the respondents are married.

Table 3 contains the number of individuals from the eleven countries in our study and the proportion of respondents who are retired and the proportion who are female. The number of observations from each country varies from 905 (4 percent) in Germany to 3798 (17 percent) in Estonia. The proportions of respondents who are retired varies between 28 percent in Denmark and Switzerland to 55 percent in Poland. This difference is mainly due to the difference in statutory retirement ages. Denmark and Switzerland both have among the highest retirement ages and therefor a smaller proportion of the respondents from these countries are retired. The proportion of female to male respondents is fairly similar in the different countries and ranges from 51 to 57 percent of respondents being female.

5 Method

5.1 Econometric model

The methodological challenge with estimating the causal effect of retirement on social capital is that the decision to retire is based on several factors that are likely to also influence social capital. Thus, it is plausible to assume that retirement suffers from endogeneity, an issue that will potentially bias our results if not solved. Two common sources of endogeneity are omitted variable bias (OVB) and reverse causality. Previous literature would suggest that retirement in our theoretical model suffer from both OVB and reverse causality (Coe and Zamarro, 2011; Eibich, 2015). OVB might occur because there are differences in unobserved individual characteristics that influence both an individual's social capital and the decision to retire. Reverse causality occurs when the social capital of an individual affects the retirement decisions instead of retirement affecting social capital. For example, an individual with the majority of their social interactions at work might choose to retire later whereas an individual with the majority of their social interactions outside of work might choose to retire as early as possible. If so, we cannot claim causal interpretation, as a simple OLS would yield biased results. To address the issues of OVB and reverse causality and, to estimate the casual effect of retirement on social capital, we

use an IV approach. The identification that we use is the jump in the probability of retiring that arises when a person reaches the statutory retirement age, which is exogenous to the retirement decision. This is a common Iv for retirement and is previously used by for example, Coe and Zamarro (2011) and Eibich (2015). The different statutory retirement ages creates different country specific cut-offs that we exploit. This also reduces the chance that the effect that we estimate is an age effect, as we now estimate the average effect of retirement at different age thresholds.

Our empirical strategy is to use a regression discontinuity (RD) design that under certain assumptions can be used as a two stage least square model (2SLS). This method is used in similar studies to estimate the casual effect of retirement (Coe and Zamarro, 2011; Eibich, 2015; Insler, 2014; Rohwedder and Willis, 2010). The main idea behind the RD design is that it exploits institutional rules or changes that assigns treatment to some individuals. The assignment variable, a variable that captures this rule or change, has to (at least partly) determine if individuals are treated or not. Those above a specific threshold are treated while individuals below the threshold are not treated. In our study the assignment variable is statutory retirement ages. The assignment should be exogenous and problems, such as self-selection, might arise if assignment is endogenous. Under a set of assumptions (discussed later on in this section) this treatment, that is caused by the assignment variable let us observe the casual effect of treatment (Lee and Lemieuxa, 2010). Which in this case means that under these assumptions, reaching the statutory retirement age will greatly increase the amount of individuals that go into retirement. This jump in probability makes it possible for us to estimate the causal effect.

The ordinary RD design depends on a treatment that is deterministic, which means that if assigned to treatment, individuals are forced to comply. In our case, this would imply forced retirement. However, the countries in our sample do not have a deterministic treatment as individuals can chose to retire (or not) at or after reaching the statutory retirement age. Instead, we use a fussy regression discontinuity (FRD) design, which allows for an assignment variable without a deterministic treatment, but increases the probability of treatment.

The main drawback of using a FRD design instead of a RD design is that the FRD design lack the forced treatment, which creates some degree of self-selection, unlike the RD design that in some cases can estimate the effect almost as good as a randomized experience. Using a large-scale randomized experiment to test the effect of retirement on social capital would be ideal, but is not feasible, as this would require randomized forced retirement ages. Other options are matching and fixed-effects models. However, those only allow for selection on observables, which can result in an unobserved factor causing the retirement, such as a negative health shock. This could bias the results (Dave et al., 2006). The FRD design is therefor advantageous as it does not require a policy change as treatment or a forced treatment. It also have the advantage of not being limited to selection on observables only.

Policy changes regarding retirement are common, however, the changes are rarely made

so that there is a good treatment and a control group. There have been some cases where policy have changed the retirement age for certain occupations (see Appendix 2), these do however allow for self-selection. This makes it hard to capture the effect of the actual treatment and the estimated effect of such a change are likely to be biased as a result of the self-selection.

Our model estimates the contemporaneous local average treatment effect (LATE). It is contemporaneous as we use cross sectional data and only observe each individual at a specific point in time. The effect we observe is also the LATE as we use 2SLS, which only estimate the effect of those treated by our IV (compliers) (Lee and Lemieuxa, 2010). In this case, the estimated effect should be interpreted as the effect on individuals retiring once they have reached the statutory retirement age. This is also the reason that we can use the FRD design as a 2SLS, as these two models estimate the same effect under certain assumptions that are discussed further on.

We start our analysis with a simple OLS model:

OLS:

$$Y_i = \beta_0 + \beta_1 Retired_i + \beta_2 \mathbf{X}_i + Country_c + u_{ijc} \tag{1}$$

We then estimate our IV model, starting with the first stage, where we estimate the effect of our IV on our endogenous variable. Followed by the second stage which estimates the instrumented results of retirement on our social capital variables.

First stage:

$$Retired_i = \alpha_0 + \alpha_1 D(Age_{ic} \geq StatRet_c) + \alpha_2 \mathbf{X}_i + Country_c + v_{ijc} \tag{2}$$

Second stage:

$$Y_i = \gamma_0 + \gamma_1 Retired_i + \gamma_2 \mathbf{X}_i + Country_c + \epsilon_{ijc} \tag{3}$$

Where i is a subscript for individual, j for cohort and c for country. Y_i are different social capital variables, $Retired_i$ is dummy variable which takes the value of 1 if the respondent is retired and 0 otherwise, Age_i is the age of the individual, $StatRet_c$ represents country specific early or normal retirement ages, $D(Age_{ic} \geq StatRet_c)$ is an dummy variable which takes the value 1 if the respondent is above the statutory retirement age in country c, and 0 otherwise. $\mathbf{X}_i$ is a vector with the control variables age, age square, gender, level of education and a dummy that take on the value of 1 if the respondent live in an urban area and 0 otherwise. *Country* is country fixed effects. In the robustness section we also include controls for marital status and household income.

We assume linearity for the categorical variables that we use. This is based on the following. Ferrer-i Carbonell and Frijters (2004) argues that the assumption of cardinality or ordinality of variables related to general satisfaction are relatively unimportant. As our

cognitive social capital variables are general satisfaction questions we assume this applies to our cognitive social capital variables. Furthermore, Bentler and Chou (1987) states that if a categorical variable has more than three categories, it can be treated as a continuous variable and no specific measures needs to be taken. This further argues for the possibility of using linear models. The assumption of linearity will be further discussed and tested in the robustness section (section 6.3).

The coefficient of interest is γ_1. The sign of γ_1 have different implications depending on the nature of the dependent variables. For the structural variables a negative (positive) γ_1 implies that retirement negatively (positively) affects social capital. For example, for the dependent variable *Club*, a negative (positive) γ_1 implies that the probability of an individual attending a social club decreases (increases) after retirement. In contrast, the cognitive social capital variables are in themselves negative for social capital. Therefore, a negative (positive) γ_1 implies that retirement positively (negatively) affects social capital. For example, for *Left out* a negative (positive) γ_1 implies that the probability of an individual feeling left out decreases (increases) after retirement, which positively (negatively) affects social capital.

When using a FRD design as a 2SLS, several assumptions regarding both FRD design and 2SLS must hold. First, two assumptions regarding the validity of our instrument must hold. These are the instrumental relevance and the exclusion restriction assumptions. Instrumental relevance states the instrument must be relevant, which implies that being at or over the statutory retirement age increases the likelihood of retirement. This is also what creates the discontinuity in the likelihood of being retired, which can be seen in Figure 1. This implies that $\alpha_1 \neq 0$ in equation (2). The exclusion restriction states that the IV affects social capital only through retirement. This implies that early and normal retirement age affects social networks only through retirement.

In addition to these assumptions there are four assumptions regarding a FRD design. First, we assume that we can perfectly predict the function of our outcome variable before and after the treatment (retirement). In this case, this means that reaching the statutory retirement age influences the way our retirement variable behaves before and after, and that we have correctly specified the functional form. We assume a linear functional form both before and after treatment based on the RD plot over this relationship and previous literature.

Second, we assume that the outcome variables are continuous before and after. The reason for this assumption is that non-linearity can be mistaken for discontinuities. This causes a bias and violates the assumption of the discontinuity coming from individuals reaching the statutory retirement age (Angrist and Pischke, 2008). If the number of observations is low the risk of a discontinuity arising due to randomness or an unobserved variable increases. The risk increases since an unobserved variable might have a disproportional impact in a small sample. Looking at Figure 1 we see that there is no reason to suspect that we have any non-linear change before or after reaching statutory retirement age.

Third, we assume that the discontinuity in the likelihood of being retired is caused only by reaching the statutory retirement age, and that there are no discontinuities in other individual characteristics. If other discontinuities are present, our results could be driven by a confounder, which would make our identification strategy questionable. We check for this assumption by looking at RD plots over plausible discontinuities that might coincide with the statutory retirement (Figure 5, Appendix 1). We find no signs of other discontinuities, which would suggest that the jump in probability of being retired is mainly due to individuals reaching the statutory retirement age.

Fourth, we assume that people cannot self-select into treatment or in any other way manipulate the treatment. This assumption is plausible, as it seems unlikely that a person could lie about their age, move to a country with a higher or lower retirement age (in order to be able to retire later or earlier), nor is it plausible that they could influence the statutory retirement age.

The main analysis uses a symmetric bandwidth of +/- 5 years from the statutory retirement age. This means that we look at individuals that are between five years before and after the country specific statutory retirement age (See Figure 1). The choice of bandwidth is crucial in an FRD design and the choice of bandwidth is likely to affect the results. The bandwidth should be wide enough to reduce noise, but also narrow enough to make the observations comparable (Lee and Lemieuxa, 2010). This implies that the bandwidth needs to be narrow enough to capture effects from retirement and not something else, for example the effect of aging. Furthermore, it cannot be too narrow, as low number of observations could result in no real effect and only capturing noise. The symmetric bandwidth of +/- 5 years that we use is used in previous studies, for example, Eibich (2015), where it is argued to be not to small and to only capture noise, and not too big and to capture age specific effects. In the robustness section (section 6.4) we test another bandwidth.

The standard errors are robust to correct for potential heteroskedasticity. We cluster the standard errors on the country-by-birth cohort level as Wooldridge (2010) recommend that the cluster is on the same level as the treatment. We also assume that the variance is not random between individuals in certain groups (Angrist and Pischke, 2008). Clustering at the country-by-birth cohort is useful for this issue as well, since there is a likely correlation between individuals born the same year, in the same country. They are likely to have been exposed to the same type of schooling, norms etc.

One possible concern when estimating the effect of retirement is that γ_1 captures age specific effects, i.e. γ_1 captures the effect of aging on social capital. Using several countries that have different retirement ages can alleviate this problem. It is therefore not likely that the effects that we capture are these other effects but the actual effect of retirement.

6 Results

The OLS, First stage and 2SLS results are presented in Table 4. Due to space constraints and for ease of interpretation we only present the coefficient for retirement.[6] All models include the individual controls *age*, *age squared*, *gender*, level of education (*Low education*,*Medium education* and *High education*), and the region control *urban*. The dependent variables *Feel left out*, *Club* and *Activities* are binary variables. In the regressions with these variables as dependent variables we use IV-probit instead of IV regression. These are all marked with ^{p} in the tables to indicate probit. We present the marginal effects from these regressions for ease of interpretation.

6.1 OLS Results

Since retirement is likely to be endogenous we use an IV approach in our preferred model specification. However, this is only an assumption based on similar literature. We therefore, also include the OLS results for comparison. This allows us to see how the estimates change when we instrument retirement. Although, there is no proof that our instrumented results are the true value, it is however more likely close to the true value because of the possibility that retirement is endogenous to social capital. The OLS results are shown in Table 4, column (1). We do not find any significant effect of retirement on the size of individuals social network. For the dependent variables *Activities*, *Club*, and *Club (how often)*[7] the coefficients for retired are all positive and significant at the 1 percent level , except for *Activities* which is significant at a 10 percent level. The coefficient for *Colleagues in SN* is also significant at the 1 percent level, however, this coefficient is negative, although this coefficient is very small. The effects of retirement on our cognitive social capital variables are very small and none of them are significant even at the ten percent level. Therefore, the OLS results suggest that there is a correlation between retirement and structural social capital, but no correlation between retirement and cognitive social capital.

6.2 IV

6.2.1 First Stage Results

It is crucial that the coefficient for our instrument (α_1 in equation 2) is both significant and large for our identification strategy to work. The bigger and more significant α_1 is, the better the IV. This since it indicates if, and how strongly, the IV affects the endogenous variable. In our case this means that the discontinuity gap created by reaching the statutory retirement age is good enough to use as an IV for retirement. Figure 1 indicates evidence of a gap from visual inspection. The results from the first stages are presented in Table 4 column (2). The instrument is significant at the 1 percent level in

[6] All estimates are available upon request.

[7] Coefficients for the categorical variables should be interpreted as indicators, as they are on an ordinal scale.

all specifications. The size of the coefficient ranges between 0.14 and 0.24. The first stage results thus indicate that reaching statutory retirement age is an important predictor of retirement behavior. The lowest F-stat for the models in each column is presented at the bottom of each table. The lowest F-stat we receive from the Kleibergen-Paap Wald test is 13.55 for *Club (How often)*, which is above the rule of thumb threshold of 10 (Staiger and Stock, 1997).

In regards to the exclusion restriction we can only argue that we believe that retirement ages are not correlated with the error term. This since there is no reason to believe that there are any other changes to social capital or retirement that coincide with reaching the statutory retirement age. Furthermore, since our model is just-identified (amount of instruments are equal to the amount of endogenous variables) we cannot use a Sargans J-test to test if the instrument is weak. This since a Sargans J-test requires the model to be over-identified. We do however use a second IV in our robustness section (6.4) where we carry out this test.

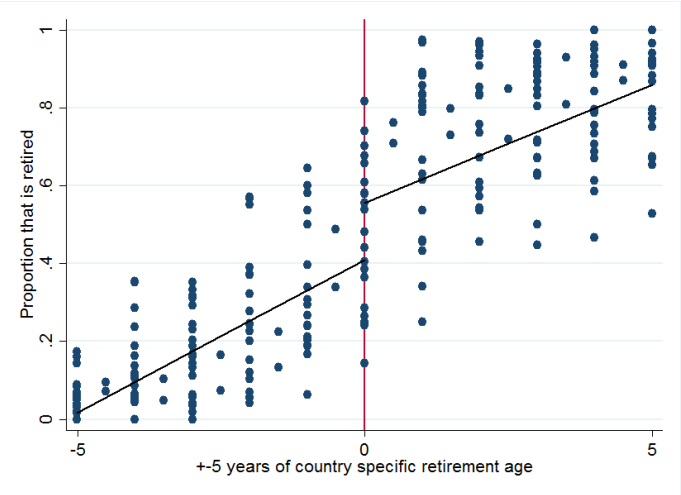

Figure 1: RD plot showing the discontinuity gap

6.2.2 2SLS Results

Column (3) in Table 4 presents our main 2SLS results that corresponds to γ_1 in equation 3. We start by presenting the 2SLS results for the structural social capital variables. These are similar in significance to the OLS results. All significant coefficients for the structural variable are positive, which implies that retirement has a positive effect on structural social capital. We find that retirement increase the probability of having activities during the last twelve months by 42 percent. This is significant at the 10 percent level. We also find that retirement increases in the probability of individuals attending a club by 38 percent. This is significant at the 10 percent level. *Club (How often)* is a categorical variable and the estimate is therefore harder to interpret. However, the positive sign suggests that retirement increases the frequency of visits to clubs. Thus, retirement increases the probability of individuals visiting clubs both at the extensive and intensive margin. There

Table 4: Main Results: 2SLS Estimates

Dependent variable	OLS	IV	
		First Stage	Second Stage
	(1)	(2)	(3)
Structural Social Capital			
Size	0.05	0.23***	-0.16
	(0.03)	(0.03)	(0.11)
Observations	12616	12616	12616
Activities ^{p}	0.01*	0.14***	0.42*
	(0.00)	(0.02)	(0.23)
Observations	12616	12616	12616
Club ^{p}	0.04***	0.14***	0.38*
	(0.01)	(0.02)	(0.19)
Observations	12567	12567	12567
Club (How often)	0.11***	0.16***	0.76***
	(0.03)	(0.04)	(0.22)
Observations	3993	3993	3993
Colleagues in SN	-0.04***	0.23***	-0.02
	(0.01)	(0.03)	(0.05)
Observations	12616	12616	12616
Cognitive Social Capital			
Left out ^{p}	0.00	0.15***	-0.33**
	(0.00)	(0.02)	(0.17)
Observations	12470	12470	12470
Left out (How often)	0.00	0.24***	-0.20*
	(0.03)	(0.03)	(0.11)
Observations	12470	12470	12470
Lonely ^{p}	-0.01	0.15***	0.05
	(0.01)	(0.03)	(0.23)
Observations	9637	9637	9637
Lonely (How often)	-0.01	0.24***	-0.01
	(0.01)	(0.04)	(0.08)
Observations	9637	9637	9637
Country fixed effects	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
Lowest F-stat	-	13.55	13.55

Notes: This table presents the OLS (1), first (2) and second stage (3) estimates and marginal effects (marked with ^{p}) of retirement. The results are shown for seven dependent variables, divided into two categories, structural and cognitive social capital. All columns use country fixed effects, individual controls for age, age squared, gender, education and region (specific definitions can be found in the data section). Robust standard errors are clustered at the country-by-birth cohort level. The lowest F-stat per column is presented below the controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

also seems to be a close to perfect relationship between *Activities* (0.42) and *Club* (0.38) which would suggest that most of the increase in activities is related to clubs. We do not find any significant effect of retirement on the size of individual's social network or an effect on the number of colleagues in individual's social network as proposed by Börsch-Supan and Schuth (2013). It is however consistent with what our theoretical model predict, that you invest more in structural social capital after retirement.

The 2SLS results for the cognitive social capital variables differ somewhat compared to the OLS results, which would suggest that the OLS suffer from endogeneity. The OLS estimates are all close to zero and are not significant at the 10 percent level. Our 2SLS results, however, suggest that retirement decreases the probability of feeling left out by 33 percent. This is significant at the 5 percent level. *Left out (How often)* is a categorical variable and the estimate is therefore harder to interpret. However, the negative sign suggests that retirement decreases how often individuals feel left out. This implies that retirement decreases the probability of feeling left out both at the extensive and intensive margin. The coefficients for *lonely* and *lonely (How often)* are close to zero and not significant. This implies that we cannot see any effect of retirement on loneliness. Our results on cognitive social capital is in contrast to most of the previous literature. Bradford (1979) argue that retirement induces feelings of loneliness and being left out. We find no evidence of this in either our OLS or 2SLS results.

6.3 Robustness

In this section we investigate the robustness of our results by adding extra controls, changing the bandwidth, and include early retirement as an additional IV. The results are presented in Table 5. Column (1) presents the estimates using the preferred main specification for ease of reference.

In the second column we add the potentially endogenous variables *married* and log (*income*). The results in column (2) are very similar to the main specification in column (1). The coefficients have the same signs, significances, and are almost the same size. The results are also robust to different definitions of household income. The coefficients are almost identical when we use the non-logged values, although, the standard errors are as expected larger in the non-log case.[8]

In column (3) we change the bandwidth of years before and after statutory retirement to study how our results change with a different bandwidth. The choice of bandwidth is crucial in a FRD design because there is a variance bias trade-off. An increased bandwidth includes more observations, and in turn, potentially greater precision. However, the trade-off is that when the bandwidth is increased we move further away from the treatment. This increases the risk of introducing a bias, which is an effect that influences our results in one way or another. In the worst case this could lead to results that are driven by something unobserved rather than the actual treatment. For example, if we were to include people over the age of 70, it is possible that the effect from aging would become stronger than

[8]Estimates are available upon request

Table 5: Robustness Tests

Dependent variable	Main	Endogenous Controls	Age: 50-70	2 IV
	(1)	(2)	(3)	(4)
Structural Social Capital				
Size	-0.16	-0.17	0.12	0.15
	(0.20)	(0.20)	(0.11)	(0.11)
Observations	12616	12616	21257	21257
Activities ^{p}	0.42*	0.40*	0.27**	0.22*
	(0.23)	(0.24)	(0.13)	(0.13)
Observations	12616	12616	21257	21257
Club ^{p}	0.38*	0.38*	0.25**	0.25**
	(0.19)	(0.20)	(0.11)	(0.11)
Observations	12567	12567	21174	21174
Club (How often)	0.76***	0.76***	0.32***	0.31***
	(0.21)	(0.22)	(0.09)	(0.09)
Observations	3993	3993	6745	6745
Collegues in SN	-0.02	-0.02	-0.04*	-0.05**
	(0.05)	(0.05)	(0.03)	(0.03)
Observations	12616	12616	21257	21257
Cognitive Social Capital				
Feel left out ^{p}	-0.33**	-0.33**	-0.12*	-0.13**
	(0.17)	(0.17)	(0.06)	(0.06)
Observations	12470	12470	21003	21003
Feel left out (How often)	-0.20*	-0.19*	-0.17*	-0.17*
	(0.11)	(0.10)	(0.09)	(0.10)
Observations	12470	12470	21003	21003
Lonely ^{p}	0.01	0.02	0.01	0.01
	(0.06)	(0.07)	(0.03)	(0.03)
Observations	9637	9637	16042	16042
Lonely (How often)	-0.01	0.00	-0.01	0.00
	(0.08)	(0.08)	(0.04)	(0.04)
Observations	9637	9637	16042	16042
Country	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes
Endogenous controls	No	Yes	No	No
Lowest F-stat	13.55	13.73	57.94	30.97

Notes: This table presents robustness test results and marginal effects (marked with ^{p}) of retirement on seven dependent variables divided into two categories, structural and cognitive social capital. All columns include the controls: Country fixed effects, age, age squared, gender, low-, medium- and high education and a region control. Column (1) is our preferred model and is used as an ease of reference. Column (2) adds plausibly endogenous controls. The first control is 1 if the person is married and 0 otherwise; the second is the log of household income. Column (3) show estimates using the full sample of people aged 50-70. Column (4) show estimates when using the full sample and the two IV's normal retirement and early retirement. Robust standard errors in parenthesis are clustered at the country-by-birth cohort level. The lowest F-stat per column is presented below the controls. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the effect of retirement, which would bias our results. The largest symmetrical bandwidth we can use is five years, as the highest retirement age is 65 and the sample goes up to 70 years. It is, however, not clear which would be the smallest bandwidth that we can use. To investigate what bandwidth to use we studied the RD plots for each country. We found that some individuals go back to work after retirement and that, the countries where retirement is conditional on contribution generally has a smoother curve. In these countries contribution is a probable determinant of retirement, which is the likely cause for the smoother gap. A smaller bandwidth is therefore more likely to be sensitive to these issues and lead to the model estimating noise rather than the real effect. We have tried smaller bandwidths, for example 3 and 4 years, however, the estimates became more volatile the closer we got to zero. This is the main reason as to why we choose the 5 years bandwidth. This bandwidth has also been used in a similar paper by Eibich (2015), where the author argues that a bandwidth of less than five years has too much noise. In Column (3) we instead include the full sample of individuals age 50-70. This creates country and gender specific bandwidths. For example, Belgium gets a bandwidth of -15 and +5 years from retirement since the statutory retirement age is 65. Hungary instead gets a symmetric 10 year bandwidth since the statutory retirement age is 60. When comparing column (3) to our preferred specification in column (1) we see that the significance increase when the bandwidth is increased. This could be explained by the variance-bias trade-off.

In Column (5) we use two instruments, normal and early retirement ages. To be able to include normal and early retirement we use the full sample (age 50-70) as some of the early retirement ages would otherwise fall outside the bandwidth. When using two IV's the coefficients for retired are very similar, both in size and significance compared to the results in column (1). When we use two IV's we have more instruments than we have endogenous variables, which results in an over-identified model. This allows us to use the Sargan-Hansen J-test, a test for weak instruments. The results from these tests are not significant at the 10 percent level. This suggests that our instrument is not weak and adds validity to our instrument.

In our econometric model we assume linearity for all categorical variables. This makes it possible to use the linear models to estimate the effect of retirement. In order to test the linearity assumption and the validity of our results we replace the categorical variables *Club (How often)*, *Left out (How often)*, and *Lonely (How often)* with dummies representing each category.[9] By doing this we can estimate the probability of stating a specific value. For example, for the variable *Club (How often)* we can estimate the probability that a respondent replied that they never visit social clubs, or any of the other three alternatives. This enables us to see the change in probability for each category. The results from these tests were all consistent with our results presented in Table 4 and the answers *Never* or *Rarely* were negative, while *Weekly* or *Daily* were positive. This suggests that our assumption of linearity is plausible, and that our results are robust to

[9]These results are not presented in this paper due to space constraints, all estimates are however available upon request.

different model specifications.

Overall the coefficients for retired do not change drastically in size and significance between the different robustness tests. This implies that the results are robust to changes in the model specification.

6.4 Heterogeneity

Up until now we have assumed that the effect of retirement on social capital is the same for all individuals, and that the estimated effect is the average effect. This is in our case a good thing, as policy makers generally look at the average effect of retirement, and retirement is rarely condition on anything other than age and sometimes gender. It is, however, interesting to further investigate the effect of retirement on social capital for different sub-samples. We look at men and women separately because there are potentially differences in both mental health (Coe and Zamarro, 2011) and social capital (Krishna and Shrader, 1999). It is also interesting as several countries still use different retirement ages depending one gender. We also look at individuals with lower education as there might be differences in social capital among individuals with lower and higher education (Coleman, 1988). This is also interesting as individuals with lower education probably have different jobs than those with higher education. This is something that we would like to observe, but cannot, due to data limitations. The results for the different subsamples are presented in Table 6. It is important to keep in mind that the sample sizes are smaller and no longer randomly selected. This could lead to systematic differences between the groups and the results should be interpreted as indicators rather than the true value of retirement for the different subsamples. Furthermore, some controls are excluded in these models, as we cannot control for e.g. gender when we only look at men or women, this is indicated with a cross in the control section of each table.

Table 6, Column (1) is the main specification and is used as a point of reference. Starting with the structural variables, we know that *No activities*, *Social club* and, *Social club (How often)* are significant in our preferred model. Column (2) and (3) splits the sample into men and women.[10] The significance changes when we split the sample into men and women, which is expected since the sample size is halved. The coefficients for *Social Club* are not significant for either men or women. This could mean that men and women are as likely attending any kind of social club after retirement. However, when it comes to frequency of visits to clubs there seem to be a difference between men and women. *Club (How often)* is not significant for women, but for men it is significant at the 1 percent level, and more than twice the size compared to the main specification. This suggests that the increase in visits to clubs is driven by the increase of men's visits to clubs. There are no other results that indicate any large differences between the genders. This suggests that we can include both genders in the main specification. The sub-sample lower education in column (4) includes individuals with low and medium education.[11] The

[10] An RD plot for men and women is presented in Appendix 1 in order to show that both genders do have a RD gap.

[11] We include both low and medium education in one sub-sample since we want to avoid capturing too

Table 6: Heterogeneity

Dependent variable	Main (1)	Men (2)	Women (3)	Lower Education (4)
Structural Social Capital				
Size	-0.16	-0.17	0.04	-0.20
	(0.20)	(0.39)	0.31	(0.19)
Observations	12616	5939	6677	9465
Activities ^{p}	0.42*	0.28	0.29	0.36*
	(0.23)	(0.47)	(0.43)	(0.21)
Observations	12616	5939	6677	9465
Club ^{p}	0.38*	0.44	0.37	0.42**
	(0.19)	(0.31)	(0.34)	(0.20)
Observations	12567	5910	6657	9428
Club (How often)	0.76***	1.91***	-0.16	0.89***
	(0.21)	(0.87)	(0.29)	(0.26)
Observations	3993	1989	2004	2570
Colleagues in SN	-0.02	-0.12	0.04	-0.07
	(0.05)	(0.10)	(0.07)	(0.05)
Observations	12616	5939	6677	9465
Cognitive Social Capital				
Feel left out ^{p}	-0.33**	-0.11	-0.13	-0.25**
	(0.17)	(0.27)	(0.18)	(0.12)
Observations	12470	5851	6619	9354
Feel left out (How often)	-0.20*	-0.29	-0.24	-0.34**
	(0.11)	(0.37)	(0.29)	(0.17)
Observations	12470	5851	6619	9354
Lonely ^{p}	0.05	0.22	0.18	-0.00
	(0.23)	(0.55)	(0.40)	(0.24)
Observations	9637	4578	5059	7175
Lonely (How often)	-0.01	0.07	0.05	-0.02
	(0.08)	(0.15)	(0.15)	(0.08)
Observations	9637	4578	5059	7175
Country fixed effects	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes†	Yes†	Yes†
Lowest F-value	13.55	29.99	11.53	20.32

Notes: This table presents the estimates and marginal effects (marked with ^{p}) of retirement on seven dependent variables divided into two categories, structural and cognitive social capital for three different sub samples. All columns include the controls: Country fixed effects, age, age squared, gender, low-, medium- and high education and a region control. Column (2) and (3) does not use the gender control and column (4) does not use any education controls, this is indicated by a † in the control section of the table. Column (1) is our preferred model and is included as an ease of reference. Column (2) includes only men. Column (3) includes only women. Column (4) only includes individuals with low and medium education. Robust standard errors in parenthesis are clustered at the country-by-birth cohort level. The lowest F-stat per column is presented below the controls * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

results for the sub-sample lower education in column (4) are similar to the main results and we do not see any specific effects of retirement in this group.

The cognitive social capital variables that are significant in our preferred model (column (1)) are *Left out* and *Left out (How often)*. There are no significant results for the subsamples in column (2) and (3) when we divide the sample into men and women. For the group with lower education (column (4)) the coefficients for *Left out* and *Left out (How often)* are significant. The effect of retirement on *Left out* is somewhat smaller than for the preferred model while the effect on *Left out (How often)* is somewhat larger. However, the difference is small and we do not see any specific effects from retirement for this group.

The results from our different sub-samples are not very different from our main results; except for how often individuals visit clubs. It would thus seem that most groups are affected equally by the retirement decision when it comes to social capital.

7 Discussion

The 2SLS results in Section 6 suggest that there is a positive effect of retirement on social capital, both on structural and cognitive. Our results support the first hypothesis that retirement will positively affect individual's structural social capital, as the increase in leisure time makes it possible to attend more activities. We find that retirement increases structural social capital both by lowering the probability of not attending any social activities, and increasing probability and frequency of attending clubs. However, we do not find any effect on number of friends or colleagues in the social network. There are some possible explanations for this. The structure of individual's social networks is not likely to change drastically from one day to another. Losing touch with friends or colleagues is more likely a gradual and perhaps slow process. Since we only measure up until five years after retirement we might not capture this process. In terms of friends in social network, there is also a possibility that individual's loose some friends after retirement but also gain new ones from going to new activities and so on, resulting in no change in the number of friends in the social network.

Our results do not support our second hypothesis that retirement will negatively affect individual's cognitive social capital as retirement could induce feelings of loneliness and being left out. Previous research suggest that retirement increases loneliness and the sense of feeling old (Coe and Zamarro, 2011). These negative effects of retirement on social capital are often explained as coming from the loss of purpose and sense of belonging. It is therefore possible that even if structural social capital increase i.e. retires "do" more, it is not enough to avoid the loss in cognitive social capital caused by retirement. These are not the results we get. We do not find any effect of retirement on loneliness. We do, however, find that retirement reduces the probability that individuals feel left out and also how often they feel left out. These results suggest that retirement leads to an increase in cognitive social capital. However, the effects on cognitive social capital seems to be sensitive to

much country specific effects, as low education is more common in some countries.

the choice of variable (which is very limited), and the effect that we find is that cognitive social capital increases or is unchanged for retired individuals. One possibility why we find results conflicting with our hypothesis is that the increase in cognitive social capital could perhaps be explained by the large increase in structural social capital that we find. Retirement decreases the probability of feeling left out by 33 percent. At the same time, retirement increases the probability of attending a social club by almost the same amount (38 percent). Retirement also decreases the probability of having activities increases by almost the same amount (42 percent). This increase is evidently enough to compensate for any loss in cognitive social capital from retirement and even increases cognitive social capital by decreasing the probability of feeling left out.

The results in Table 4 seem to be sensitive to the type of model used. For the structural variables the OLS and IV results are similar in significance but the effects are much larger using an IV approach. For the cognitive variable the OLS estimates are all close to zero and not significant while the IV results are larger with significant effects. Because of this and due to the problem with endogeneity, we conclude that the results from the IV approach are more reliable.

There are some potential limitations to our empirical results. First, the social capital variables are self-reported measures. Questions that are perceived as sensitive or personal, for example, if a person feel left out or lonely, can be affected by the phrasing or the order of the questions. One possible bias would be if respondents understate how often they feel lonely, as the bias goes towards the socially desirable level (Tourangeau and Yan, 2007). This type of bias would lower the effect and could lead to deflated results. However, this should not be a problem when self-reported measure are used to compare individuals (Bertrand and Mullainathan, 2001). Furthermore, the phrasing of the questions is most likely not a problem since the questions were asked in the same order regardless of your retirement status.

Second, the choice of variables is important for the analysis. We chose the variables based on both what was available from SHARE, and what is used in previous studies (Putnam, 1995; Coe and Zamarro, 2011; Börsch-Supan and Schuth, 2013; Dave et al., 2006). However, structural social capital is easier to measure and also less ambiguous than cognitive social capital. Cognitive social capital also seems to be more sensitive to the choice of variables; there are also fewer variables to choose from, making it harder to estimate.

Third, we assume that the variables we use are linear. Our robustness evaluation suggests that this assumption is plausible. There is however some drawbacks when using categorical variables, as it limits the amount of information you can extract. It also reduces the power of the test (Harrell, 2015). It would be preferable if we were able to observe exactly how many times and when the individuals attended a club, instead of just how often they tend to go there in general. This is mainly an issue for our variable *Lonely (How often)*, as it only contains three categories which in addition to the loss of power can cause distorted results (Bentler and Chou, 1987). This could be an explanation to why

we do not find an effect on loneliness at the intensive margin. However, we do not have the same problems when estimating the extensive margin, as we use a probit model for the binary variable *Lonely*. This would suggest that our results for *Lonely (How often)* are reliable despite having a low amount of categories.

8 Conclusion

The purpose of this paper is to evaluate the causal effect of retirement on social capital, and by extension, mental health. There is to our knowledge, no consensus on the effects of retirement on mental health and previous research has suggested that it is important to look at the effect of retirement on different aspects of mental health. We focus our study to evaluate the effect of retirement on social capital, a well-documented aspect of mental health (Ellaway et al., 2001; Kawachi and Berkman, 2001; Ross et al., 2000; Steptoe and Feldman, 2001). Previous studies mainly discusses potential effects or look at correlations between retirement and social capital. It is therefore important to try to estimate the causal effects of retirement on social capital and in turn mental health. It is important for several reasons. For individuals, a good mental health is essential for a happy life. Therefore it is important to know what can be expected from retirement in terms of mental health. From a societal perspective its important as the mental health of retirees affect public health expenditure.

In order to estimate the causal effect we use an IV approach and data from SHARE to study this question. The identification that we use is the jump in the probability of retiring that arises when a person reaches the statutory retirement age. By using this IV in a FRD design, we find a positive effect of retirement on social capital, both on structural and cognitive. Retirees have a higher probability of attending social activities and are less likely to feel left out, compared to non-retired. The results also suggest that retirement does not affect the probability of feeling lonely. Our results are robust for different bandwidths, an additional IV, plausibly endogenous controls, and different model specification. We further argue that our results should be valid also for countries in Europe that were not included in our sample, as the included countries cover most parts of Europe. Our results also suggest that there are but one heterogeneous effect. The results indicate that how often an individual visit clubs differs between genders. The increase is mainly driven by men and we find almost no increase for women. The reason behind this falls without the scope of this paper, it could however be interesting for future studies on retirement and social capital.

We conclude that retirement has a positive effect on social capital, and therefore, by extension mental health. Looking at how much an increase in social capital affects mental health is beyond the scope of this paper. The relation is, however, well-established in theory (Bolin et al., 2003) and through previous research (Ellaway et al., 2001; Kawachi and Berkman, 2001; Ross et al., 2000; Steptoe and Feldman, 2001). Our findings can hopefully help to better understand retirement, social capital and mental health. Our results might

not have a big impact on policy alone. However, in combination with previous research on retirement's effects on other aspects of mental health, they can help to understand the effects of retirement on mental health, and thus, lead to better health and retirement policies in the future.

For future research, it would be good to investigate the effect of retirement on a broader array of cognitive variables, and also the effect of social capital on physical health. Further suggestions would also be to use panel data, which allows for a difference-in-difference approach. This would solve the potential problem of weak IV and also any potential bias from choice of bandwidth. A panel would also make it possible to see how an individual's social capital changes over time, as opposed to only estimating the contemporaneous effect. A panel over a longer time-span could help to estimate the long term effect of retirement on for example the size and structure of individuals social networks, as this is more likely to shift over time. This might also be the reason that most of our results are connected to leisure time (such as frequency of club visits), which literally changes over night as you retire.

Notes

"This paper uses data from SHARE Wave 4 (DOI: 10.6103/SHARE.w4.500), see Börsch-Supan et al. (2013) for methodological details.* The SHARE data collection has been primarily funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812) and FP7 (SHARE-PREP: N°211909, SHARE-LEAP: N°227822, SHARE M4: N°261982). Additional funding from the German Ministry of Education and Research, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064) and from various national funding sources is gratefully acknowledged (see www.share-project.org)."

Appendix 1

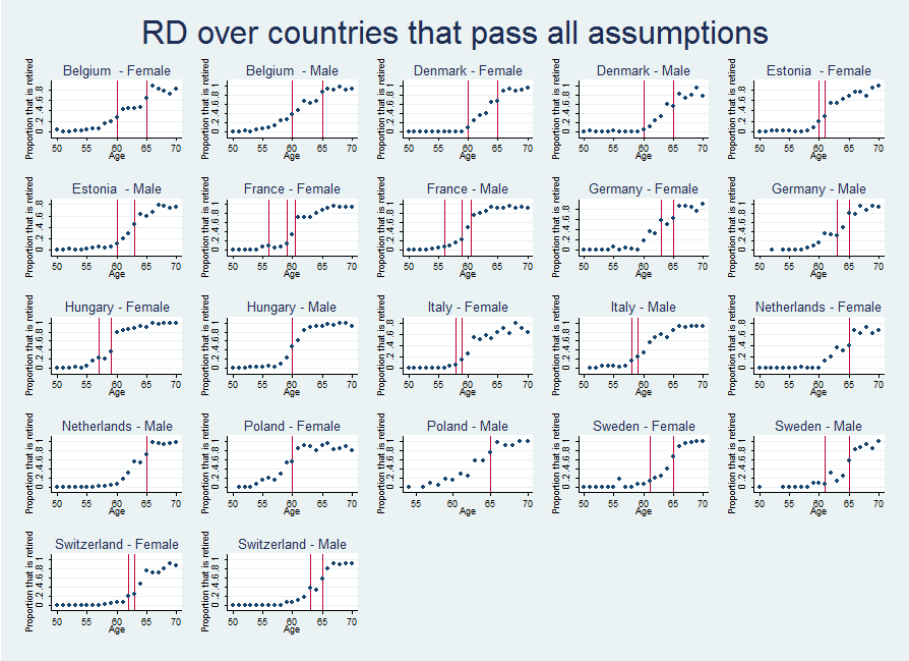

Figure 2: RD plots showing countries that pass all assumptions

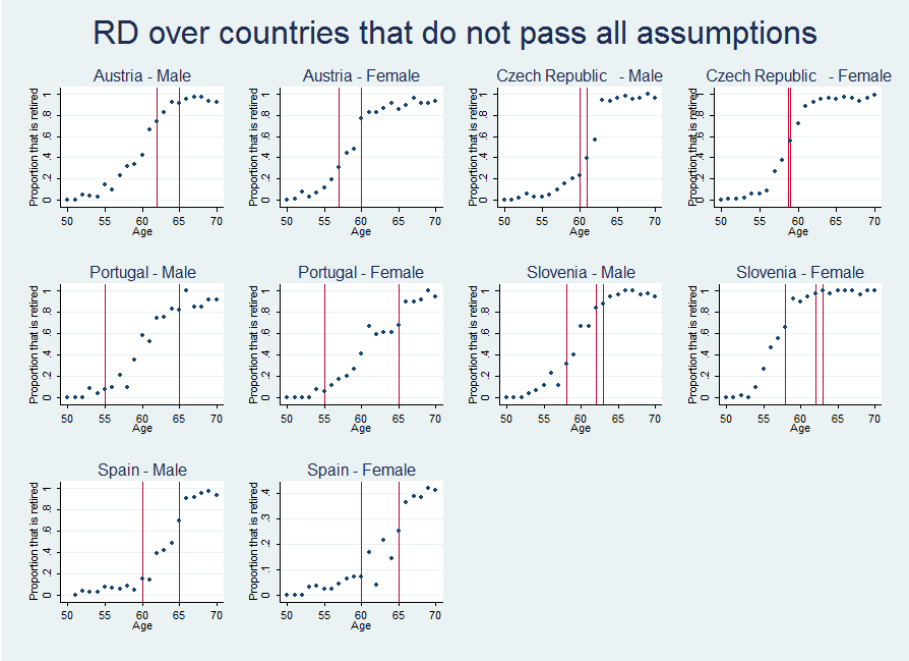

Figure 3: RD plots showing countries that do not pass all assumptions

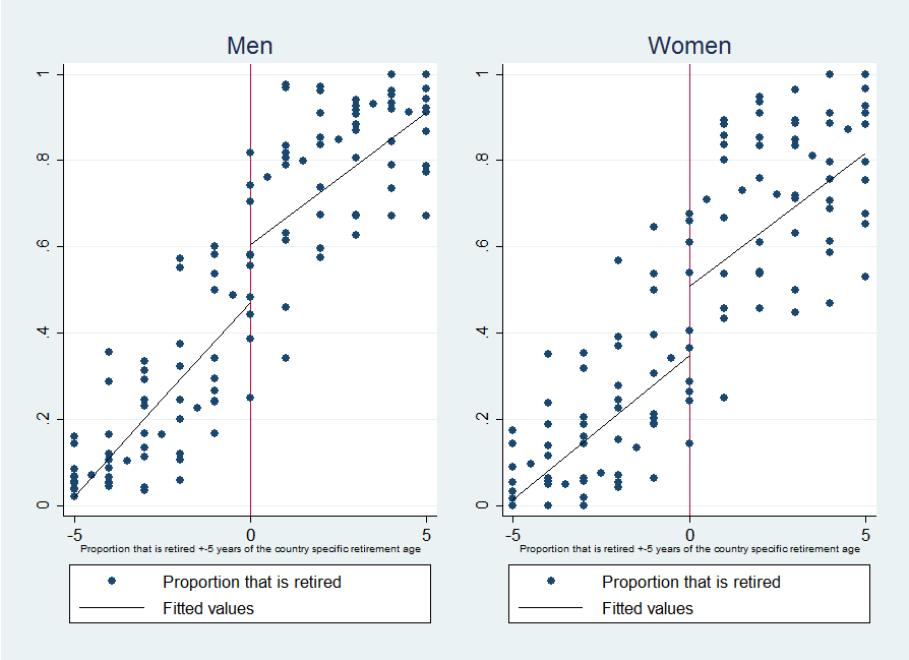

Figure 4: RD plot showing men and women separately

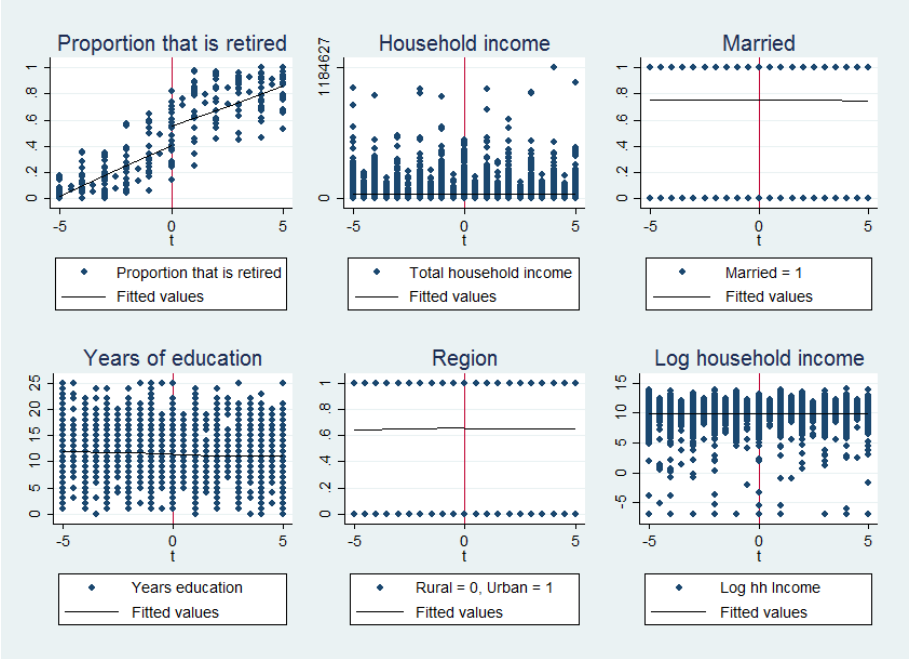

Figure 5: RD plots showing possible discontinuities in other variables

Appendix 2 - Retirement by country

In this Appendix we go through the different pension systems in the countries included in SHARE wave 4. This appendix is based on the OECD report Pension at a Glance 2011 (OECD, 2011). We discuss reasons for including or excluding the different countries. All excluded countries are marked with a *.

Austria*

The retirement age in Austria differ between gender. Women in our sample face a retirement age of 60, while men have a retirement age of 65. One potential reason for the men's continuous function could be that men base their retirement decision on their spouses current employment status. This would suggest that the discontinuity for females also affects men, which leads to a violation of two assumptions; the first that there is a gap, and the second violation is that we assume that no other variable could be the cause of a potential gap.

Belgium

In Belgium the pension age is 65 for both men and women, there is also a requirement of 45 years of contribution. There is also a possibility to retire at the age of 60 if individuals have worked for at least 35 years, this would however lead to a lower pension, unless the individual have managed to accumulate 45 years of contribution by the age of 60. By having both early and normal retirement Belgium has a function that has a smaller discontinuity gap than countries that does not have early retirement. This is because it is divided into two parts, it is also more continuous during this period due to the pension being subject to years of contribution rather than a specific age. However, we still argue that the gap is big enough to include Belgium. This is confirmed as our results are consistent both when we include and when we exclude Belgium in the sample.

Czech Republic*

The Czech Republic is excluded from for various reasons. For example, the function is continuous for females, which violates the assumption that the treatment is actually creating a gap, making our identification weak. The reason behind the continuous function are many. For example, the Czech Republic have experienced many different reforms in the pension system. The retirement ages are also increasing for both females and males, for different cohorts, in different increments. The contribution requirements are also changing, and women can retire earlier depending on how many children they have. Since people in our sample face different retirement ages depending on when they were born, gender, amount of children and so on, it creates a lot of uncertainty around what age is actually the statutory retirement age, and the Czech Republic is therefore excluded.

Denmark

Denmark used to offer an early retirement at 60, which applies to cohorts born before 1 January 1959. Our sample ranges from 1940-1961 and 95 percent of our sample thus qualified for early retirement. This is also seen in the Figure 2 (Appendix 1) where there is a steady and gradual increase from 60 to 65, then a jump at the statutory retirement age of 65. It is not as big a jump as in countries that do not offer early retirement, but as with Belgium, we believe that it is sufficient and Denmark is therefore included in our sample. Denmark also has a requirement of 35 years of residency, however, we do not have data to control for this, although we can see if the person was born in the country or not and this data do not suggest that we have a problem with years of residency.

Estonia

In Estonia there is a different retirement age for men and women, 63 and 61 respectively, making the gender gap small compared to Austria, which has a gap of five years. We believe that we can see a gap in Estonia and not in Austria (even though both countries offer different retirement age) because the relative size of the gap. Estonia also offers early retirement at 60, which reduces pension with 4.8 percent per year of early retirement. We note from Figure 2 (Appendix 1) that Estonia, like other countries that have both a gender gap and early retirement, has a smaller discontinuity gap than the countries that does not have any or both of those types of retirement.

France

France has a general requirement of 40 years of contribution, which is currently increasing, and a retirement age of 60.5. They also offer three different types of early retirement, at 56, 58 and 59, depending on contribution, but also if individuals entered the labor market before 16 or 17. However, looking at Figure 2 (Appendix 1) it seems like most people choose to retire at age 60-61 and the discontinuity gap is large in comparison to the average gap. France therefore pass our assumptions even though they have an above average amount of cutoff points (Treatment years).

Germany

The statutory retirement age in Germany is increasing gradually up to 67, though for cohorts born before 1964 the retirement age is 65. This implies that all individuals in our sample are facing a retirement age of 65. They also apply a rule of at least five years of contribution, which in relation to most other countries is a very short time span and we thus argue that the contribution requirement has a very low impact on the retirement decision in Germany. There is a possibility of early retirement at the age of 63, this does however require a contribution of 35 years and will lower that individuals pension by 3.6 percent per year of early retirement. From our the RD plot in Figure 2 (Appendix 1) we can see that Germany has a discontinuity gap and is fit to be included in our sample.

Hungary

Hungary is increasing their statutory retirement age for both genders and the retirement age is 60 for men and 59 for females in our sample. The increase is however very small for the individuals in our sample. They also apply a 20 years of contribution requirement for full pension and a 15 year for partial. Women were also allowed to retire at the age of 57 in our sample with a penalty of 0.3 percent per month the first year and 0.4 percent per month after the first 12 months. From the RD plot in Figure 2 (Appendix 1) we can see that most individuals in our sample do not seem to choose early retirement and we have a discontinuity gap for both genders. Hungary is therefore included in our sample.

Italy

Italy is increasing their statutory retirement age up to 65 for men and 60 for women, this does not however apply to the cohorts in our sample, were early retirement is 58 for both genders and normal is at 59. There is a requirement of 35 years of contribution for early retirement. However, since we do not have a gender gap or a large gap between early and normal retirement age we get a fairly large discontinuity gap, especially for women, making Italy pass all required assumptions for our model and are therefore included.

Netherlands

The Netherlands has a statutory retirement age of 65 for both genders and they do not offer early retirement, they did however do so before 2005. However, this is not affecting our sample directly, since those that would be able to opt for early retirement would be too old to be included in our sample. We can however see from our RD plot that there are still a lot of people going into retirement starting at the age of 60, which is the old early retirement age. We do still get a fairly large discontinuity gap and we thus choose to include the Netherlands.

Poland

Poland apply different retirement ages for men and women, the retirement age is 65 for men, while it is 60 for women. They do not have early retirement in the general case, though some groups are able to opt for early retirement, such as steel workers born before 1949. This group is however very small and only apply to about 0.7 percent of the population. Therefore, we argue that Poland qualify as a good country, even though they have one of the smaller discontinuity gaps of about 20 - 25 percentage points.

Portugal*

Portugal offer early retirement at the age of 55 and normal retirement at 65, which has led to them having steady increase in the proportion of retired workers. This can be seen in their RD plot in figure 3 (Appendix 1). Therefore Portugal do not fulfill the assumption of non-continuous function and are excluded from our sample.

Slovenia*

Slovenia has several different systems for calculating individuals statutory retirement ages. They have three different thresholds for men depending on years of contribution, making it possible to retire between the ages of 58 to 65. The penalties for early retirement differ mostly depending on years of contribution but also gender, age and cohort. Therefore, there are different incentives for early retirement for most people. We believe this is the driving force behind the continuous shape of its retirement function as can be seen from its RD plot in Figure 3 (Appendix 1). Slovenia is thus excluded from our sample.

Spain*

In Spain the early retirement is 60 for both genders and 65 for normal retirement, there is also a requirement of 15 years of contribution. So even if Spain is stable and seem to fulfill our assumption we still have a problem with only 40 percent of the women being retired at the age of 70. If we compare current job status for Spain with our other countries, we can see that they have three times as many "homemakers" as the other countries, suggesting that especially women seem to transfer from work to homemakers. We thus have a problem to identify who is actually retired and who is not, leading to the exclusion of Spain in our sample.

Sweden

In Sweden there is a possibility to receive early pension at 61, however, a income-tested guarantee pension cannot be claimed prior to 65 and 3 years of residency. Although, to receive the maximum guaranteed pension the individual must have 40 years of residency, decreasing gradually down to a minimum at 3 years of residency. The normal retirement is at 65 and Sweden has a clear discontinuity gap which makes it a good country to include in our study.

Switzerland

In Switzerland normal retirement is 65 for men and 63 for women, with an early retirement at 63 and 62 respectively. A full pension also depends on years of contribution which are 44 for men and 43 for women. This makes Switzerland one of the countries that apply both different retirement ages between genders and also offer early retirement. Because of this they have a smaller discontinuity gap, as with other countries with similar systems. The gap is however over 20 percentage units, which we argue is enough. This is confirmed by testing to exclude Switzerland which did not change the results from including them. We thus choose to include Switzerland.

Appendix 3 - Constructed variables

Activities

The variable *Activities* is constructed from the variable *Naly* which indicates the number of activities the respondent have taken part in during the last twelve months. It ranges from 0-8. *Activities*=1 if *naly*= 1-8 and zero if *naly*=0.

Colleagues in Social Network

Colleagues in Social Network is constructed from the variable *size* in combination with a variable indicating the relation the respondent has to each person in their social network. The number of people in the social network labeled as colleagues are included in this variable.

Left out

Left out is constructed from the variable *Left out (How often). Left out* = 1 if *Left out* = 3 or 4, and zero otherwise.

Lonely

Lonely is a constructed from the variable *Lonely (How often). Lonely* = 1 if *Lonely (How often)* = 2 or 3, and zero otherwise.

Retirement

This variable is equal to 1 if *ep005_* (current job situation) = 1, and zero otherwise.

Low Education

Low education is defined as 1 for ISCED = 0-2, and zero otherwise.

Medium Education

Medium education is defined as 1 for ISCED = 3 or 4, and zero otherwise.[12]

High education

High education is defined as 1 for ISCED = 5 or 6, and zero otherwise.

Log of household income

149 individuals in our sample have stated an income of zero which creates a problem when using the log of income, as the log of zero is not defined. When excluding these individuals result are almost identical. However, excluding people with no income from the analysis violates external validity and therefore, we instead use a proxy set to the closest non-zero value (0.00168) suggested by Afifi et al. (2007).

[12]Code 3-4 are similar according to UNESCO: *"They are often not significantly more advanced than programs at ISCED 3 but they serve to broaden the knowledge of participants who have already completed a program at level 3."* (UNESCO Institute for Statistics 2006).

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