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Labor market inactivity and health in old age:

What role do institutional, occupational and social factors play?

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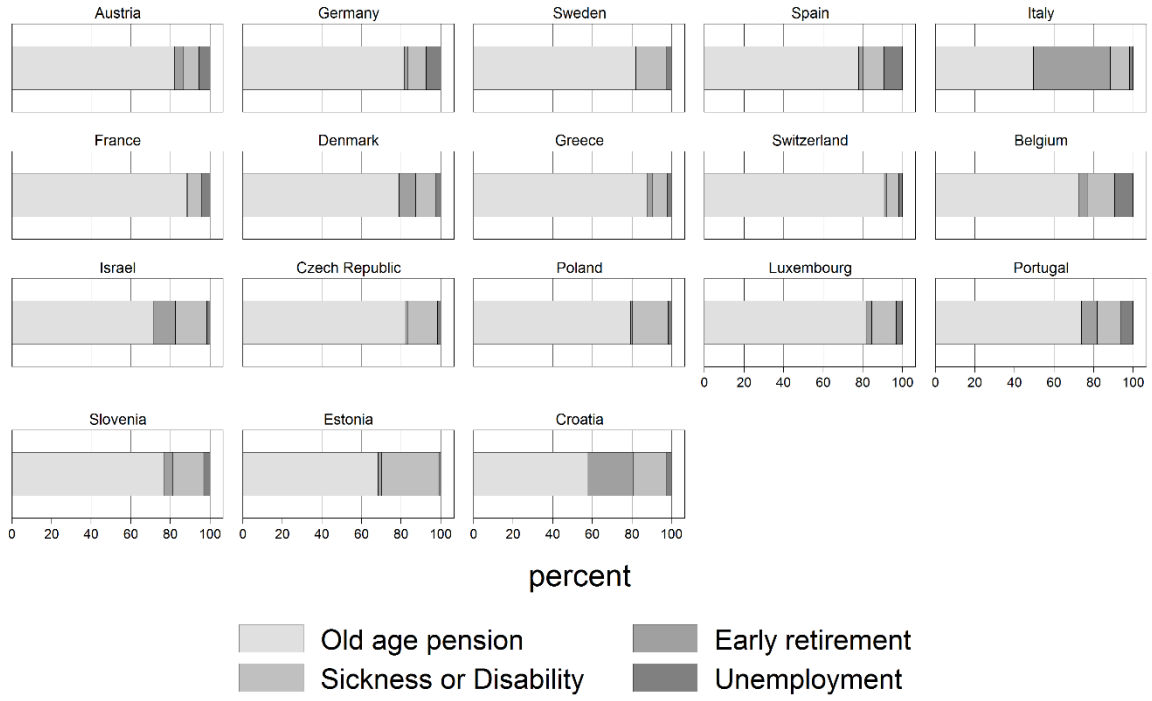
1.1 General Introduction

"Man, through the use of his hands as they are energized by mind and will, can influence the state of his own health." (Mary Reilly, 1962)

Work is an important part of the lives of most people. While work primarily served for earning a living in former times, these days work is increasingly perceived as an opportunity to realize personal interests and participate in social life. Up to a certain physical and mental stress level, the daily challenges in work help us to remain active and cognitively stimulated (van Domelen et al. 2011, Smart et al. 2014). Occupational psychology defines five latent consequences of employment as beneficial for health: 1) It imposes a time structure on the working day; 2) It implies shared experiences and contacts with persons outside of one's immediate family; 3) It links individuals to goals and purposes that transcend their own; 4) It defines aspects of personal status and identity; and 5) It enforces activity (Jahoda 1982). Based on these positive aspects, employment is regarded as psychologically supportive, even when the working conditions are bad. A systematic review of empirical studies on the relationship between employment and health supports this theoretical hypothesis and shows that employment in general is beneficial for health (van der Noordt et al. 2014). In particular, employment reduces the risk of depression and improves general mental health. The effects on physical health and the impact of working conditions however are ambiguous and still debated (van der Noordt et al. 2014). Given the positive aspects of employment, stopping work can, in turn, have negative consequences on different areas of life. The loss of income as one of these consequences can be buffered by savings or assistance from the social security system. The benefits of work regarding the social, physical and cognitive aspects however are more difficult to compensate. Research on the relationship between unemployment and health has become more sophisticated in the last decade. A systematic review of theoretical approaches and empirical studies concludes that unemployment reduces the psychological and physical health of individuals (Wanberg 2012). This dissertation focuses on labor market inactivity and health in old age and therefore

considers types of inactivity other than unemployment. In old age, the most common pathways into labor market inactivity are sickness or disability and the transition into early or normal retirement. The shares of the respective pathways are illustrated in Figure 1.1 for different European countries.

Figure 1.1: Labor market inactivity of population 50+ in Europe

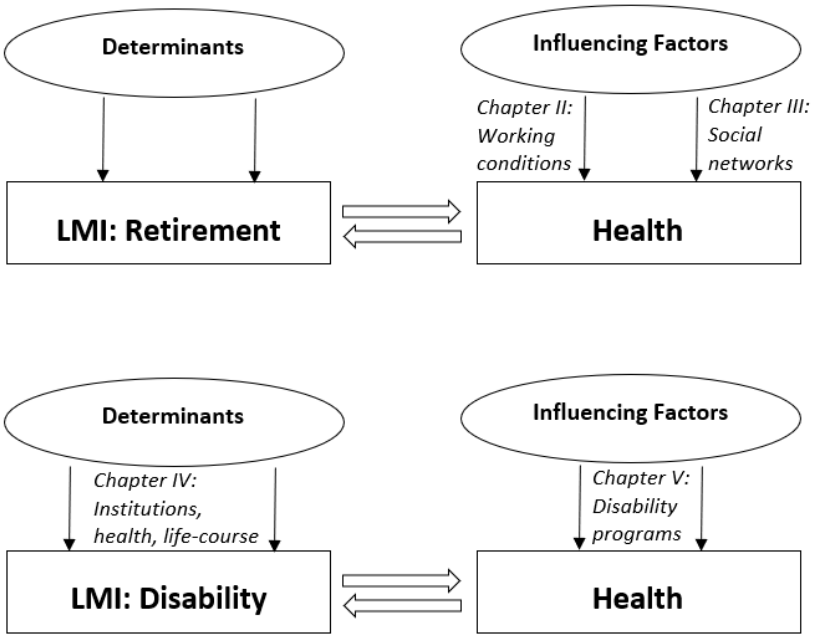


Source: Own elaboration based on data from SHARE Wave 6, Release 6.0.0

As illustrated in Figure 1.2, Chapter 2 and Chapter 3 of this dissertation examine the health consequences of labor market inactivity in terms of early retirement and old age pension. In all countries, receiving old age pension or early retirement benefits constitutes the highest share of labor market inactivity beyond the age of 50. Studying the impact of retirement on is therefore relevant for a large group of individuals. The analysis of the effect of retirement on health and cognition has been prominent in the economic literature on aging and demographic change in the last decades. Some studies have shown a negative impact of labor force withdrawal on cognition (Rohwedder and Willis 2010, Bonsang et al. 2012, Mazzonna and Peracchi 2012, Fonseca et al. 2016), while other studies have shown a positive effect on physical health (Coe and Zamarro 2011, Insler 2014). On the one hand, the results may vary depending on the model specification. On the other hand, the results may differ between data and study group compositions, reflecting the

heterogeneity of the effects. It is therefore necessary to further explore the different mechanisms and causes for the observed heterogeneous effects. Chapter 2 of this study evaluates the influence of working conditions on the effect of retirement on health and cognition, whereas Chapter 3 examines how changes in the social network after retirement influence cognitive health.

Figure 1.2: Research design for the effect of labor market inactivity (LMI) on health



Source: Own illustration

The second part of this dissertation addresses labor market inactivity due to disability – a pathway that has not been given much attention in the empirical literature. The share of individuals receiving disability benefits according to Figure 1.1 varies between 4% in Switzerland and 26% in Estonia and is therefore much lower than the share of persons receiving old age pensions. Nevertheless, disability insurance is a substantial part of public social expenditures and an important part of the social safety net of all developed countries (OECD 2003, 2010). Furthermore, there have been incisive reforms to reduce the generosity of the DI systems in many countries in the last 20 years to cope with the challenges of population aging. Against this background, it is interesting to study the determinants and consequences of becoming disabled and receiving disability insurance payments in different countries. Chapter 4 investigates the cross-country variation in disability rates that can be observed in Figure 1.1. This variation is primarily explained by differences in the disability insurance systems

and partly explained by individual health and life course conditions. Chapter 5 assesses the consequences of labor market inactivity due to disability on health and financial well-being. In particular, the aim is to assess whether and to what extent disability programs can buffer the negative effects of labor market inactivity.

1.2 Empirical Approach and Data

The complexity of the relationship between labor market inactivity and health requires sophisticated model specifications. The endogeneity problems in this context primarily result from self-selection into retirement and reverse causality. Causal identification can be achieved by a combination of panel data methods and the application of instrumental variables. This requires longitudinal individual level data that provide sufficient variation over time and over individuals. To capture the influence of external factors, the dataset should be internationally comparable and offer a wide range of variables across different areas of life. In the last two decades, the data basis for old age population studies has significantly developed. The challenges of demographic change call for evidence-based policy decisions and therefore a solid database reflecting the situation and experiences of the population over the age of 50. Several longitudinal surveys have been established in different countries to fulfill the need for data and empirical investigations. This subsection presents the Survey of Health, Ageing and Retirement in Europe (SHARE) as the primary data source used for the analyses of this dissertation, as well as the harmonization of additional sister surveys from the UK and the US and of further contextual data.

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

All chapters of this dissertation are based on datasets of the Survey of Health, Ageing and Retirement in Europe (SHARE). This multidisciplinary, cross-national panel dataset contains information on the health, socioeconomic status, work history and social networks of individuals aged 50 and older (Börsch-Supan et al. 2013). The first wave of SHARE was conducted in 2004 in 11 European countries (Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Greece, Italy, Netherlands, Sweden and Israel) with an initial sample of more than 22,000 individuals aged 50 or over. The

second wave followed in 2006, and three additional countries joined the survey (Czech Republic, Ireland, and Poland). The third wave conducted in 2008 was different since the regular SHARE questionnaire was not used, but instead retrospective information on the respondents' life course was collected starting from childhood up to the time of the interview. In the subsequent biennial waves, more countries joined the project: Estonia, Hungary, Portugal, Slovenia in Wave 4; Luxembourg in Wave 5; and Croatia in Wave 6. Until recently, the data of these six waves are available with more than 120,000 respondents and over 297,000 interviews. The fieldwork of the latest wave 7 has just been completed in October 2017 with eight additional countries (Bulgaria, Cyprus, Finland, Latvia, Lithuania, Malta, Romania, and Slovakia), and the next data release of SHARE will cover 27 European countries plus Israel.

The questionnaire of the regular SHARE waves is divided into different modules covering the following areas concerning the current situation of the respondents: demographics, children, physical health, behavioral risks, mental health, health care, employment and pensions, computer use, social support, financial transfers, housing, household income, consumption, assets, activities and expectations. The questions of the respective module were asked in a computer-assisted-personal-interview (CAPI). Additionally, the interviewer performed different tests with the respondent to assess the cognitive functioning and physical conditions (e.g., grip strength, walking speed, chair stand, and peak flow). The core questionnaire remained stable over time to facilitate panel analyses. However, some specific modules have been added in certain waves to enable innovative research. Chapter 3 of the dissertation exploits the availability of a special module on the social networks of older people. This module was initiated in Wave 4 and includes extensive information on individuals who are important to the respondents and on the relationships between these people. The module was implemented again in Wave 6 and offers a longitudinal dimension by specifically asking about the changes within a person's social network.

The broad range of topics covered by the SHARE study show great research potential in the area of the economics of aging. Particularly the availability of the administrative data and the retrospective

life history of the respondents are unique in European old age studies. The combination of the different datasets offers a solid database for the analysis of the interplay between labor market inactivity and health. The multitude of variables enables the consideration of influencing factors within this interplay. Additionally, the SHARE dataset offers the application of a longitudinal research design as well as the comparison of the effects between countries and societies within Europe. Moreover, the SHARE survey has been closely modeled after the Health and Retirement Study (HRS) in the USA, and several sister studies around the world have followed this example. Therefore, the cross-country analyses can be extended to countries outside of Europe by harmonizing the different datasets. Three chapters of this dissertation are based on harmonized datasets and the next subsection provides more information on the respective harmonization process.

1.2.2 Harmonization of Surveys

The Health and Retirement Study (HRS) was initiated in the U.S. in 1992 and therefore pioneered the global population studies on aging and demographic change. Currently, 12 waves of HRS data are available and offer wide opportunities for panel analyses and comparably high sample sizes.

On the basis of the HRS survey, the English Longitudinal Study of Ageing (ELSA) was implemented in 2002, and the SHARE survey followed in 2004 as the first cross-national panel study. More studies were implemented worldwide[1], however I concentrated on the harmonization of the HRS, ELSA and SHARE studies. This decision was motivated by three reasons: First, most other studies have only recently been implemented and do not offer sufficient data for longitudinal analyses. Second, the harmonization process is not only complex and time-consuming, but constrains the variable selection of the overlapping variables. Using additional surveys would increase the overall sample size and the comparability between different societies, but decreases the number of variables and measures that can be used for analysis. Third, the empirical analysis of the effects of retirement on health is in itself complex. Europe and the U.S. are comparable to a certain extent regarding the Western lifestyle, basic institutional settings and cultural backgrounds. Adding other countries from Asian or South

[1] The Irish Longitudinal Study on Ageing (TILDA) since 2009, Chinese Health and Retirement Survey (CHARLS) since 2011, Estudo Longitudinal de Saúde do Idoso (ELSI-Brasil) since 2015, The Japanese Study of Aging and Retirement (JSTAR) since 2007, The Korean Longitudinal Study of Aging (KLoSA) since 2006, The Longitudinal Aging Study in India (LASI) since 2010 (pilot), and the Mexican Health and Aging Study (MHAS) since 2001.

American areas would add another layer of complexity because the differences in the cultural and political background would have to be considered in all analyses. Although a cross-cultural comparison would be interesting, such a comparison is beyond the scope of this dissertation.

Both ELSA and SHARE were designed as comparable to the data from the HRS survey based on the ex-ante harmonization of the questionnaire. Approximately two-thirds of the variables in SHARE are identical to variables in ELSA and HRS, and most of the remaining variables are closely comparable. Nevertheless, the questions must be adapted to the regional circumstances, leading to subtle differences in variable definitions. The harmonization of these variables involves extensive data manipulation, including the merging of several categories or combining information from different questions. The respective adaptions have been extensively documented, and the interpretation of these variables is conducted with caution.

The projects of Chapter 2 and Chapter 5 require panel methods; therefore, harmonization was performed not only across the three different surveys but also across all available waves of the survey. The resulting dataset is a unique collection of panel data enabling comparisons across different countries of Europe and the U.S. The focus of the project in Chapter 4 is based on a life cycle approach. The main work was to enhance the harmonized regular waves of SHARE, ELSA and HRS by information on the life course of the respondents. The SHARE life histories have been modeled in close cooperation with the ELSA life histories and offer detailed information on socioeconomic status in childhood, illnesses during childhood and adulthood and the employment history of the respondents. HRS does not yet feature such structured life histories, but the normal questionnaire covers some retrospective variables describing early childhood conditions and salient events in adult life, which permit cross-walking between SHARE, ELSA and HRS.

Overall, harmonization is a challenging and time-consuming task that requires detailed knowledge of the questionnaire content and background and profound data management skills. The use of harmonized datasets is a major contribution of this dissertation. Harmonized datasets offer potential for cross-country comparisons that have not yet been fully exploited since only a few studies have exploited the availability of different population studies on aging (e.g., Rohwedder and Willis 2010;

Crimmins et al. 2011; Siegrist et al. 2012; Vries et al. 2014).

1.2.3 Contextual Data

Adding contextual data to the individual level survey data enables taking into account the role of institutional factors and macroeconomic circumstances. The statutory eligibility ages for public pension claims play a major role in different projects since they are used as instrumental variables. The eligibility ages depend on the pension system of a country. Often, these eligibility ages cannot be generalized to a single number per country because they vary depending on the birth cohort, the occupational group, gender, number of children and years of contributions. Therefore, different national sources are used to gather this contextual information on the legal background of the eligibility ages. Further sources for contextual data in this dissertation are reports and statistics by the Organisation for Economic Co-operation and Development (OECD). For instance, we used extensive information on the institutional settings of disability insurance systems across countries offered by the OECD (2003). Further details on the contextual data used in the analyses are provided in the respective chapters. Table 1.1 summarizes this chapter by providing an overview of the different datasets and data sources used in the different projects.

Table 1.1: Overview of the datasets used in the chapters

	Regular SHARE Waves	**Special SHARE datasets**	**Additional surveys**	**Contextual data**
Chapter 2	1, 2, 3, 4, 5		HRS, ELSA	Retirement ages
Chapter 3	4, 6	Social network modules		Retirement ages
Chapter 4	5	SHARELIFE	HRS, ELSA	Disability policy indicators (OECD), Job strain index (OECD), Index for adaptability of labor market (Boeri et al. 2002)
Chapter 5	1, 2, 3, 4, 5		HRS, ELSA	Disability policy indicators (OECD)

1.3 Summary of Chapters

1.3.1 Chapter 2: Working Conditions, Retirement and Health

Objective: Retirement can have different effects on health. On the one hand, retirement is associated with a loss of income, status and social networks. These stress factors can lead to higher illness vulnerability and a poor overall health status. On the other hand, the health status might improve after retiring if harmful aspects of work are overcome and leisure time can be spent on health-preserving activities. The aim of this chapter is the empirical investigation of the effect of retirement on health and cognition. Special focus is set on the effect heterogeneity depending on the working conditions in the last job.

Dataset: I constructed a harmonized dataset using all available waves of HRS, ELSA and SHARE data, which enabled me to conduct comparative cross-country panel analyses. Different health measures were constructed to assess physical and cognitive health during the transition from work to retirement. I further included harmonized measures of working conditions to examine the role of the quality of work within the framework of the health effects of retirement.

Methodology: By applying instrumental variables fixed effects regressions, I was able to control for individual heterogeneity and endogeneity of the retirement decision by using the public pension benefit claiming ages for the respective countries as source of variation.

Main findings: My results suggest that retirement has a positive effect on physical health and a negative effect on cognitive health. Retiring from a job with low work quality intensifies the positive effect on physical health, while the effect on cognition is not significant.

This chapter has been published as a MEA Discussion Paper (available at www.mea.mpisoc.mpg.de) and has been submitted to a scientific peer-reviewed journal, currently with the status "Revise & Resubmit".

1.3.2 Chapter 3: Influence of Social Networks on the Effect of Retirement on Cognition

Objective: The previous chapter and current literature (e.g., Rohwedder and Willis 2010; Bonsang et al. 2012) showed the negative effects of retirement on cognition. This chapter examines the role of social networks as a potential mechanism in the relationship between retirement and cognitive decline. First, I analyzed the effect of retirement on different social network characteristics. Second, I

estimated the effect of retirement on cognition while considering changing social network sizes.

Dataset: I used novel panel data of 19,999 respondents on social networks from waves 4 and 6 of the Survey of Health, Ageing and Retirement in Europe (SHARE).

Methodology: Unobserved individual heterogeneity and endogeneity of the retirement decision can be controlled by applying instrumental variable fixed effects regressions based on country-specific public pension benefit claiming ages.

Main findings: The results suggest that retirement leads to an increase in the number of close family members named as confidants, indicating that the social network becomes more kin-oriented after retirement. However, adding close family members to the social network does not have a significant effect on cognition in old age. In turn, adding non-family members, such as friends or colleagues, to the social network has a positive effect on cognitive performance. However, I did not find that retirement significantly affects the number of friends or colleagues; therefore, I cannot claim social networks as the underlying mechanism that explains the relationship between retirement and cognitive decline.

A previous version of this chapter has been published as a MEA Discussion Paper (available at www.mea.mpisoc.mpg.de).

1.3.3 Chapter 4: Early Determinants of Work Disability in an International Perspective

Joint work with Axel Börsch-Supan and Tabea Bucher-Koenen

Objective: Work disability is defined as the (partial) inability to engage in gainful employment due to physical or mental illness, resulting in early retirement and/or uptake of disability insurance benefits. This study juxtaposes health measures of work disability (WD) with the uptake of disability insurance (DI) benefits in the US and Europe. The core of the paper relates reported WD status and DI benefit receipt on country-specific DI, pension and labor market policies. We also evaluated the efficiency of DI systems by comparing how well they provide benefits to individuals in need without being misused by individuals who are healthy.

Dataset: The analysis is based on an internationally harmonized data set assembled from SHARE, ELSA and HRS. Particular attention is paid to life-time health using life history data from SHARE and

ELSA plus comparable early childhood and life-course data from HRS.

Methodology: The analysis is divided into two parts. We first studied different determinants of the within-country variation in WD and DI benefit receipt by performing probit and linear regression analyses. Second, we presented counterfactual simulations to explain the between-country variation of WD and DI benefit receipt.

Main findings: We observed that while our large set of health measures explains a substantial share of the within-country variation in WD and DI, this finding is not the case for the variation across countries. Rather, most of the variation between countries is explained by differences in DI policies.

This chapter has been published as a MEA Discussion Paper (available at www.mea.mpisoc.mpg.de).

1.3.4 Chapter 5: Does Disability Insurance Improve Health and Well-being?

Joint work with Axel Börsch-Supan and Tabea Bucher-Koenen

Objective: The previous chapter focuses on the factors influencing the uptake of DI benefits. This follow-up chapter investigates the health, finances, and life satisfaction of an individual after the uptake of DI benefits. In a first step, we describe the characteristics of DI benefit recipients, including health, financial status, activities and life satisfaction. In a second step, we used these descriptive results to evaluate whether the objectives of disability insurances (prevent deteriorating health and income losses) are achieved in different European countries.

Dataset: This paper takes advantage of internationally harmonized panel data and the differences across DI programs in Europe and the United States, as well as their changes over time.

Methodology: We use several econometric approaches to account for the potential endogeneity of DI enrollment and sample selectivity.

Main findings: Sequence analyses showed that work disability and the uptake of DI benefits are closely correlated with labor market inactivity. Regarding the effects on health, we observed that self-reported health stabilizes after DI benefit receipt. Mental health is improved more for DI benefit recipients compared to that of non-recipients relative to the beginning of DI benefit receipt. This effect is stronger in countries with more generous DI systems. The effects on objective health measures are positive but largely insignificant.

1.4 General Conclusions

This dissertation examines the relationship between labor market inactivity and health in old age under consideration of institutional, occupational and social factors. This research contributes to the existing literature by 1) investigating underlying mechanisms in the relationship between retirement and health; 2) examining disability as an underexplored pathway into retirement; 3) harmonizing extensive panel datasets for international comparisons; and 4) using sophisticated model specifications for causal identification. The results showed that the complexity of the relationship does not allow a generalization of the results because the direction and size of the effect of labor market inactivity on health depend on different influencing factors. For individuals with bad initial conditions, labor market inactivity can be a relief and lead to an improvement of the personal situation. Chapter 2 illustrates this by showing that individuals with bad working conditions in the job prior to retirement experience a stronger positive development of physical health after retirement than individuals with good working conditions. The relief effect is particularly distinct for people with severe physical or mental illnesses leading to work disability and inactivity in the labor market (see Chapter 5). Special programs, such as disability insurance payments, can support this positive development after becoming inactive in the labor market.

However, for individuals with good initial conditions, labor market inactivity can have negative effects on physical health and cognition, unless the positive latent aspects of employment can be compensated by other activities after stopping work. Chapter 3 shows that social factors, such as the size of social networks, can influence cognition after retirement. These results suggest that socializing outside the inner family circle can be beneficial for cognitive performance.

Finally, institutional factors such as the generosity level of pension and DI benefits determine the timing of retirement and therefore influence the health effect of labor market inactivity. As shown in Chapter 4, institutional factors explain most of the variation in DI rates and therefore strongly influence the individual possibilities on the labor market.

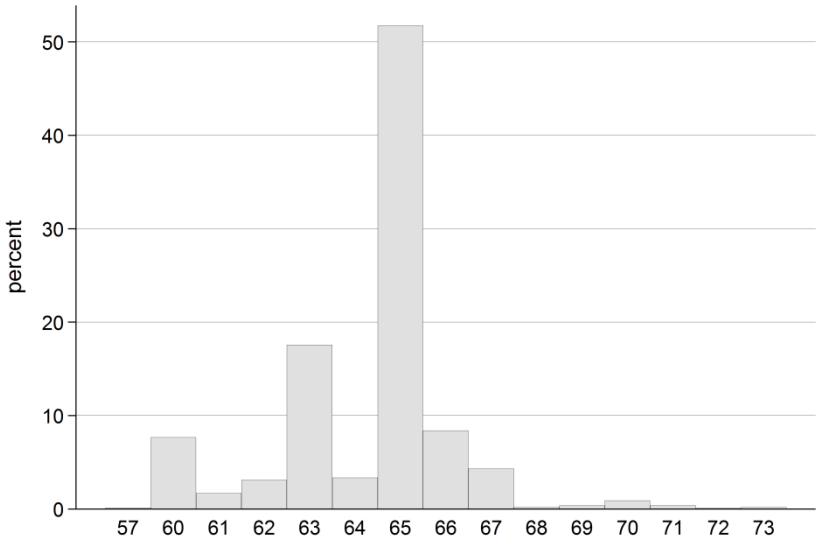
What do these findings mean for the design of public pension systems and labor market policies in

times of demographic change? To cope with the challenges of population aging, many countries have introduced reforms to increase the eligibility age for public pension benefits. Additionally, the generosity of disability insurance schemes has been reduced in many countries to prevent the misuse of this pathway as an early retirement option (OECD 2010). Nevertheless, it is important that individuals with severe impairments or physically harmful jobs are provided the opportunity to adapt their situation so that work remains fruitful and health-preserving. DI programs should be adapted further in a way that they do not only offer monetary compensation, but also different measures for a successful reintegration into the labor market. The flexibility of the labor market for persons over the age of 50 is an important requirement to keep individuals active in the workforce. Being old or being work disabled should not be equated to being "unable to work" in general (OECD 2003), but should be regarded as a (temporary) condition that rules out certain job performances. In other words, the labor market must offer sufficient and adequate jobs that make it possible or even attractive to continue working in old age and/or with a work disability. This possibility can be achieved by adapting positions in a way that implies less physical burden or mental stress. Special mentoring systems, where older workers teach and train career starters, generate benefits for both the companies and the older employees. The company benefits from the long experience of the older worker and prevents unused capacity. At the same time, the older worker feels needed and appreciated for his knowledge, and can absorb all positive latent consequences of work. Special workplace programs for older workers can alleviate the transition process from working to retirement and promote and active and social lifestyle in old age.

In addition to adapting the labor market policies and DI programs, it is important to initiate a change in societal thinking. In a study on working pensioners in Germany, we examined the expectations of workers regarding their retirement phase (Börsch-Supan et al. 2015). Figure 1.3 shows the distribution of the answers to the question: "At what age do you yourself expect to start collecting this pension payment for the first time?" More than 50% of the currently employed individuals expect to receive public pension benefits at the age of 65. Approximately 17% expect to retire at age

63 and 8% expect to retire at age 60. Working after the age of 67 is considered only in rare cases.

Figure 1.3: Expected retirement age in Germany



Source: Börsch-Supan et al. 2015

The peaks at the different eligibility ages show that these age limits are firmly rooted in people's minds. It is important to overcome the psychological effect of "reaching retirement age" or "becoming eligible for public pension benefits" and to increase the social acceptability or even desirability to work beyond this perceived anchoring point of retirement entry. In Japan, 25% of the population between 70-74 years of age are still active in the labor market, while in Germany, only 6.2% of the population are active in this age range. Preliminary results from international comparisons show that the attractiveness of working longer is affected by institutional incentives. In addition, the lack of an early retirement culture and the intrinsic motivation to work in Japan explains the differences in retirement patterns.[2] Further international comparisons can help to understand how differences in culture, society, labor markets and pension systems influence the retirement behavior of older people and the related health consequences. Learning from each other helps to convert the challenges of population aging into opportunities.

[2] The international comparisons are part of a long-term project on the "Retirement Effects on Health" initiated by the International Longevity Centers. The project is led by Prof. Axel Börsch-Supan and Prof. Dr. Ursula Staudinger, with country-specific contributions from Lia Deichman (Argentina), Brian Beach (UK), Frank Schalkwijk (Netherlands), Didier Halimi (France), Felizia Hanemann (Germany), Iva Holmerova (Czech Republic), Sara Carmel (Israel), Sebastiana Kalula (South Africa), Susana Harding (Singapore), and Daisuke Watanabe (Japan). The results have not yet been published, but are available upon request.

2. Working Conditions, Retirement and Health

This paper is single-authored. It has been published as MEA Discussion Paper (available at www.mea.mpisoc.mpg.de) and has been submitted to a scientific peer-reviewed journal, currently with the status "Revise & Resubmit".[3]

2.1 Introduction

Occupationally active years take up half of our lives. Work plays an important role not only in our livelihoods but also in personal fulfillment and self-identification. Furthermore, going to work gives structure to a daily routine and stimulates mental and physical activity (van Domelen et al. 2011, Smart et al. 2014). These positive aspects of work are lost when leaving the labor market; therefore, the transition from work to retirement usually causes drastic changes in different areas of life. In this way, the transition can have different effects on health. Retirement is often connected with a loss of income, status and social networks, which can lead to higher illness vulnerability and poor overall health. On the other hand, one's health status might improve after retiring if harmful aspects of work are abandoned, with leisure time in retirement devoted to health-preserving activities (Insler 2014, Celidoni and Rebba 2016). The aim of this paper is to analyze the effect of entering retirement on the physical and cognitive health of retirees.

Analyzing the consequences of the transition from work to retirement is especially important in times of demographic change. Longer life expectancy and reduced fertility rates have caused (financial) problems in the social security systems of several countries. In order to countervail these problems, older workers are expected to stay in the workforce longer and postpone

[3] Acknowledgments:
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

This paper uses data from SHARE Waves 1, 2, 3 (SHARELIFE), 4 and 5 (DOIs: 10.6103/SHARE.w1.500, 10.6103/SHARE.w2.500, 10.6103/SHARE.w3.500, 10.6103/SHARE.w4.500, 10.6103/SHARE.w5.500). See Börsch-Supan et al. (2013) for methodological details. The SHARE data collection was primarily funded by the European Commission through the 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: °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 various national funding sources is gratefully acknowledged (see www.share-project.org).

ELSA data were made available through the UK Data Archive. ELSA was developed by a team of researchers based at the NatCen Social Research, University College London and the Institute for Fiscal Studies. The data were collected by NatCen Social Research. Funding was provided by the National Institute of Aging in the United States and a consortium of UK government departments coordinated by the Office for National Statistics. The developers and funders of ELSA and the Archive do not bear any responsibility for the analyses or interpretations presented here.

The HRS (Health and Retirement Study) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan.

retirement. Postponing retirement, and therefore possible negative or positive effects on health, might be beneficial and harmful respectively not only for individuals but for society as a whole.

I extend existing literature on this topic by providing additional cross-country evidence on the relation between health and retirement status, with a special focus on the panel dimension. By applying instrumental variables fixed effects regressions, I can control for individual heterogeneity and endogeneity of the retirement decision by using the claiming ages for public pension benefits of the respective countries as instrumental variables. I construct a harmonized dataset using all available waves of the HRS (Health and Retirement Study), ELSA (English Longitudinal Study on Ageing) and SHARE (Survey of Health, Ageing and Retirement in Europe). This harmonization enables me to conduct comparative cross-country panel analyses over a long period of time. Furthermore, the large sample size of the harmonized data offers variability and high statistical power that allow robust analyses. I include harmonized measures of working conditions to evaluate the role of the quality of work within the framework of the health effects of retirement.

2.2 Literature

Recent literature on the effects of retirement focuses mainly on cognition or subjective well-being. Rohwedder and Willis (2010) study the effect of retirement on cognitive decline by combining the HRS, ELSA and SHARE data. In a cross-sectional analysis, they find that early retirement has a negative effect on cognition. Bonsang et al. (2012) confirm this finding in a panel study using HRS data. Mazzonna and Peracchi (2012) use SHARE data; in considering the time spent in retirement, their results suggest an increasing decline of cognition after retirement, which is explained by reduced investments in cognitively stimulating activities. In a study with data on social networks offered by SHARE wave 4, Börsch-Supan and Schuth (2014) conclude that early retirement leads to a decline in cognitive abilities due to the reduction of the size of social networks after early retirement.

These studies show evidence of accelerated cognitive decline with time spent in retirement. However, they ignore the complex interplay of different health components. Therefore, little is known about the overall evolution of health after individuals stop working. Coe and Zamarro (2011)

exploit a wide range of health measures by constructing a health index; they find a positive long-lasting effect of retirement on health. Insler (2014) uses a weighted sum of both objective and subjective health variables to determine health status, detecting a significant positive effect of retirement on health. He further analyses the channels through which retirement affects health and finds that the effect may be based on behavior after retirement, e.g., smoking or exercising. Another important aspect that might influence the effects of retirement on health is employment characteristics. Mazzonna and Peracchi (2016) take heterogeneity across occupations into account by building an index of the level of physical burden associated with each job. They find that retirement has a significant negative effect on both mental and overall health. However, if they concentrate on those working in physically demanding jobs, the effect turns positive.

Besides job classification, it is possible to measure work quality by using indicators for working conditions such as effort, reward, control and demand of an occupation. Dal Bianco et al. (2014) use these working conditions to ascertain whether these indicators play a role in the retirement decision. They find that low work quality induces people to retire as early as possible. To the best of my knowledge, the link between working conditions and health after retirement has not yet been made.

I extend the literature on this topic by 1) combining data from the HRS, ELSA and SHARE, which allows me to conduct international panel analyses in Europe and the US; 2) using an advanced econometric modeling of panel fixed effects; 3) constructing health as an all-encompassing measure taking into account different aspects of physical health; 4) estimating the effects for physical and for cognitive measures using identical methodology to disentangle different consequences of retirement on physical and cognitive health; and 5) including working conditions as an explanatory factor for different health effects of retirement.

2.3 Data

I use data from three old-age surveys: the Health and Retirement Study (HRS, see Juster and Suzman 1995), the English Longitudinal Study of Ageing (ELSA, see Marmot et al. 2003) and the Survey of Health, Ageing and Retirement in Europe (SHARE, see Börsch-Supan et al. 2013). All datasets are

multidisciplinary household panel surveys including detailed information on health, socioeconomic status, work history and social networks. The first wave of the HRS was initiated in 1992, and the subsequent waves were conducted biennially. The initial sample included 12,652 individuals living in the United States between 51 and 61 years of age, as well as their spouses or partners. Today, 11 waves of HRS data are available.

On the basis of the HRS survey, a longitudinal old-age survey was implemented in England in 2002. The baseline sample contains 12,099 persons representing the population aged 50 and older. Further refreshment samples were added in subsequent waves. Today, 6 waves of ELSA data are available. The SHARE survey began in 2004 as a European cross-national panel study. The first wave included eleven European countries and more than 22,000 individuals aged 50 and older. In subsequent waves, which are conducted biennially, more countries joined the project. In the most recent wave available (wave 5), 19 European countries conducted at least one SHARE wave.

Both the ELSA and SHARE were designed to be comparable to the data from the HRS survey. Therefore, ex-ante harmonization of questions and items was an important prerequisite for the implementation of the ELSA and SHARE. The potential to combine these datasets for cross-country comparisons between Europe and the US has not yet been fully used, with only a few studies striving to harmonize the datasets (e.g., Rohwedder and Willis 2010; Crimmins et al. 2011; Siegrist et al. 2012; Vries et al. 2014). I exploit this opportunity for high sample sizes and cross-country variation by harmonizing the relevant health and retirement variables and combining them in one single dataset, an approach that enables me to conduct comparative analyses for different regions in Europe, the UK and the USA.

2.3.1 Sample

I use all available waves of the HRS (waves 1-11), as well as the ELSA (waves 1-6) and SHARE (waves 1-5). Only wave 3 of SHARE is not used in this analysis because it contains retrospective life history data and does not include our relevant variables. Due to the combination of datasets, I am able to analyze the health effects of retirement in 21 countries: the USA, the UK, Austria, Germany, Sweden,

the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Israel, Czech Republic, Poland, Slovenia, Ireland, Hungary, Portugal and Estonia. The harmonization of three datasets allows me to exploit a sample size of initially 164,402 individuals and 467,653 observations.

I restrict the sample to individuals between 50 and 75 years old (350,737 remaining observations). Since I am interested in the health effect of the transition from full-time work to full-time retirement, I do not count homemakers and unemployed individuals as retired, nor those reporting part-time retirement (283,096 remaining observations). I further eliminate individuals who have never done paid work in their life or who have not worked since reaching the age of 50 (271,289 remaining observations). I drop individuals who re-enter the labor market after having reported their retirement in a previous wave (252,921 remaining observations). After excluding individuals who participated in the survey only once and after disregarding observations with missing values for the relevant health measures, the remaining sample consists of 48,060 individuals and 156,449 observations. Within this sample, I observe 10,314 individuals transitioning from work to retirement.

2.3.2 Retirement Definition

In all three surveys, the respondents are asked about their current employment status. I define those individuals as being retired who self-report the category "Retired" as their current employment status and additionally control that no paid work has been done during the previous four weeks.

2.3.3 Health Definition

I exploit the richness of the datasets by using several health measures to study the complex interplay of different health components.

Self-assessed health (SAH): I use the self-assessed health status[4] as a dependent variable for a general impression of one's health status. Self-assessed health may be subject to different bias factors, possibly leading to measurement errors. The main concern in this context is reporting bias, in that individuals with the same health status but from different population groups report different health assessments because they interpret the question in their own specific context (Lindeboom

[4] The self-assessed health status is rated on a categorical five-point scale with the answers of excellent (5), very good (4), good (3), fair (2) and poor (1).

and Doorslaer 2004). This behavior poses a threat that has to be taken into account, especially in the context of a multinational study where the different reference levels are influenced by the culture and language of the different countries (Jürges 2007). In our model framework, this threat is partly absorbed by the use of individual fixed effects. Self-assessed health can also contain measurement errors provoked by social desirability. In our context, it is possible that individuals underreport their health status in order to justify their early exit from the labor market (justification bias). Kalwij and Vermeulen (2008) stress the need to control for objective health indicators when analyzing the relation between health status and labor force participation. This is especially true for panel studies because the observed changes of the health status of an individual might be overestimated (Bound et al. 1999). Given the aforementioned reasons, I include further health information, which is available in the data in different forms.

Health index: Objectively reported health information (such as the number of chronic diseases) contains information that has not been judged subjectively but diagnosed by a doctor. Another type of objective health information is represented by performance-based measures, such as grip strength. These objective health measurements complement the health information reported by respondents. In order to take advantage of all available health information, I apply an indexing technique to combine several measures into one single index variable. I construct a health index via a principal component analysis as suggested by Poterba et al. (2010). It is assumed that latent health status is reflected by the information on health questions answered by the respondent. I use all available information[5] to calculate the first principal component of these health indicators. The estimate for the first principal component represents the weighted averages of the health indicators and is therefore used as a synthetic health index that combines different measurements into one single variable. For a better presentation of the results, I form country-specific percentile scores of this health distribution and group the respondents into quintiles in which a higher quintile

[5] The following health measures were used: whether a doctor has diagnosed the respondent with high blood pressure/hypertension, stroke, diabetes/high blood sugar, chronic lung disease, arthritis, cancer or heart trouble; whether a respondent has difficulty walking 100 meters, sitting two hours, getting up from chair, climbing one flight of stairs, stooping/kneeling/crouching, reaching or extending arms above shoulder, pulling or pushing large objects, lifting or carrying weights over 5 kilograms or picking up a small coin from a table; body mass index (weight and height reported by respondent); and number of limitations in activities of daily living.

corresponds to better health.

Cognition: In order to account for the interplay between physical and cognitive health, I add a cognition measure as a dependent variable. All three surveys assess cognitive functioning by reading a random list of ten common words (house, tree, river, etc.) to the respondent. The respondents are then asked to recall as many words as possible in an immediate recall test. After continuing with the questionnaire for approximately five minutes, the respondents were again asked to recall as many words as possible in a delayed recall test. The combined cognition measure includes the aggregated scores from both the immediate and delayed recall test, ranging from 0-20.

2.3.4 Working Conditions

Some studies analyze the effect of retirement on health for different occupational groups or for those individuals retiring from a physically demanding job (Coe et al. 2012; Mazzonna and Peracchi 2016). However, stress and strain have become important factors for work-related health problems. Therefore, it is not enough to take the degree of physical demand into account; one must also consider the psychosocial work environment. I apply two models describing the relation between the psychosocial characteristics of work and the health of a worker.

According to the Karasek and Theorell (1991) demand-control model, the combination of a low level of control in a job with strong demand represents a risk for health, as observed by a higher prevalence of symptoms of heart disease. According to Karesek et al. (1998), the control measure has higher predictive power than the demand measure and it is sufficient to include the control dimension as an indicator for the job strain given the efficiency aims of multi-disciplinary questionnaires. Our harmonized dataset offers two statements measuring the level of control in the main job[6]. Both statements are ranked on a 4-point scale ranging from “strongly agree” to “strongly disagree”. The total assessment of control ranges between 2 and 8, with high numbers reflecting lower control and therefore more psychosocial stress. Referring to previous empirical work (Siegrist and Wahrendorf 2011; Siegrist et al. 2012), I calculate country-specific tertiles and use a binary variable to indicate whether a participant is in the upper tertile of the low control measure and

[6] “I have very little freedom to decide how I do my work” and “I have an opportunity to develop new skills”.

therefore exposed to a stressful work environment.

The main idea behind the Siegrist (1996) effort-reward imbalance model is that an imbalance between effort and reward leads to high psychological stress, which in turn can result in serious health problems (Bosma et al. 1998; Pikhart et al. 2004; Ostry et al. 2003). With respect to the effort-reward model, the harmonized surveys contain two statements to measure effort (physical demand, time pressure) and five statements to measure reward (support, recognition, salary, promotion, job security). With these statements, I construct the effort-reward imbalance index (ERI), which is a weighted ratio of the number of effort rankings and the reward rankings. Again, I calculate country-specific tertiles for this measure and build a binary variable where the value one reflects a higher imbalance between effort and reward and therefore more psychosocial stress.

Taking both models together I create a binary variable with the value of one for bad work quality (either in the upper tertile of the control measure or of the ERI measure) and the value of zero for good work quality (neither in the upper tertile of the control measure nor of the ERI measure).

2.4 Empirical Strategy

An instrumental variable fixed effects (IV-FE) approach is used to address endogeneity problems. Dependent on valid instruments, consistent estimates are obtained by a two-stage least-squares method. The basic aim of this study is to determine the effect of retirement on different measures of health. In this context, endogeneity complicates the identification of the causal effect. Retirement is not random among the individuals in the sample, but the decision of retirement is a function of different factors. People might self-select into retirement on the basis of individual preferences. For example, individuals who are least satisfied with their job or least healthy are more likely to retire earlier. Thus, I have to consider and address two causes of endogeneity problems. Firstly, there could be unobserved individual variables that influence both the current health status and the retirement decision. I exploit the panel dimension of the data in order to account for unobserved time invariant characteristics, which cancel out when applying individual fixed effects estimations.

Secondly, retirement and health may be endogenous. The retirement decision may be determined by

the health status, and reverse causality causes endogeneity problems. In order to solve this issue, I include exogenous variables to instrument the endogenous retirement variable. The instrumental variable must strongly influence the retirement decision and must not be correlated with the individual's health or all unobserved determinants of health and retirement–in other words, with the error term. For this purpose, I exploit country-specific claiming ages for public pension benefits, a widely accepted strategy in empirical retirement studies (Coe and Zamarro 2011; Bonsang et al. 2012; Fonseca et al. 2014; Mazzonna and Peracchi 2012). In this context, retirement is assumed to be a function of age, and the probability of retiring is expected to change discontinuously at the respective early and normal claiming ages of a country.

In our case, the definition of the instrument is complex in the sense that I have to take into account public pension rights in 21 different countries. Within these countries, I differentiate between the institutional settings for different cohorts and for men and women. With this elaborated classification of individuals that are eligible for social security benefits, I can define a precise instrumental variable reflecting whether the respondent has reached his personal early or normal statutory claiming age. I gain variation of the claiming ages depending on age, gender and the influence of policy reforms within each country. According to Bonsang et al. (2012), it is plausible that the effects of retirement on health occur with a short time lag. For a robustness check, I follow the approach of Bonsang et al. (2012), defining our instrumental variable as reaching the statutory claiming age plus one year. I therefore measure the effect of having spent at least one year in retirement on different health outcomes and can distinguish between the short-term and long-term effect of retirement on health.

2.5 Descriptive Aspects

Table 2.1 shows the sample size for each country considered in the analysis. Most respondents are from the HRS; therefore, the US is overrepresented with a sample size of 78,228 person-wave-observations. The ELSA contains 24,551 person-wave-observations that are relevant in our study design. The other European countries covered by the SHARE study vary in sample size between 994

(Greece) and 5,847 (France) person-wave-observations. I will address the differences in sample sizes per country as part of the robustness checks.

Table 2.1: Sample sizes per country

Country	Observations	Percent	Persons	Percent	Average observations
UK	24,551	15.69	7,071	14.71	3.88
Austria	4,847	3.10	2,265	4.71	2.23
Germany	2,360	1.51	923	1.92	2.73
Sweden	3,381	2.16	1,318	2.74	2.74
Netherlands	3,032	1.94	1,230	2.56	2.64
Spain	2,235	1.43	946	1.97	2.52
Italy	3,680	2.35	1,466	3.05	2.69
France	5,847	3.74	2,525	3.25	2.46
Denmark	3,747	2.40	1,491	3.10	2.67
Greece	994	0.64	497	1.03	2.00
Switzerland	3,673	2.35	1,622	3.37	2.38
Belgium	5,416	3.46	2,255	4.69	2.58
Israel	1,454	0.93	645	1.34	2.34
Czech	4,946	3.16	2,250	4.68	2.27
Poland	1,132	0.72	566	1.18	2.00
USA	78,228	50.00	17,527	36.47	5.70
Slovenia	1,828	1.17	914	1.90	2.00
Estonia	5,098	3.26	2,549	5.30	2.00
Total	156,449	100.00	48,060	100.00	2.66

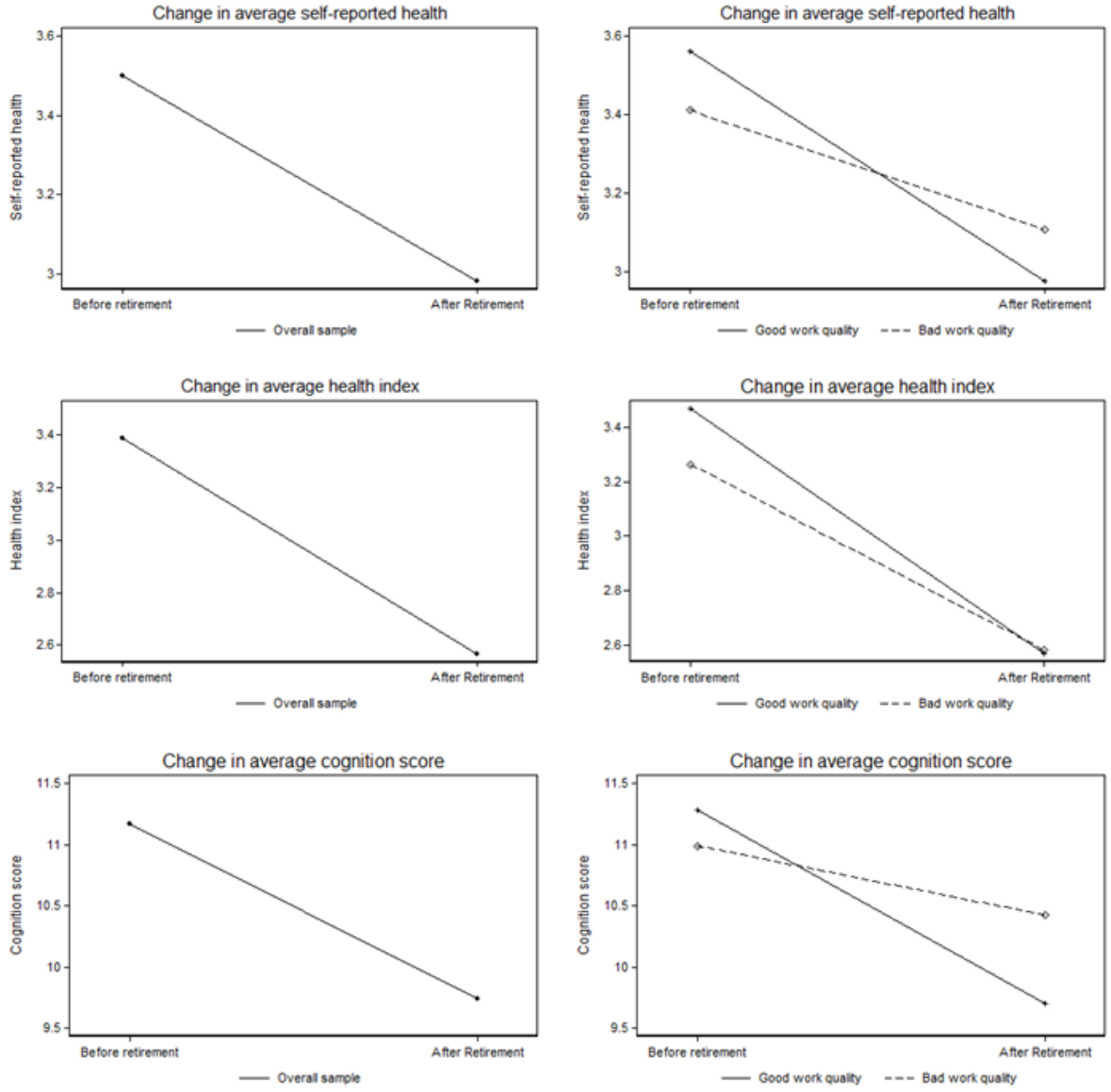
Table 2.2: Summary statistics for pooled sample

Variable	N	Mean	SD	Min	Max
Female	156,449	0.53	0.50	0.00	1.00
Status: Working	156,449	0.52	0.50	0.00	1.00
Status: Retired	156,449	0.48	0.50	0.00	1.00
Living with a partner	156,449	0.63	0.48	0.00	1.00
Age at interview	156,449	63.00	6.70	50.00	75.00
Number of children	156,449	2.36	1.92	0.00	21.00
Over early claiming age	156,449	0.65	0.48	0.00	1.00
Over normal claiming age	156,449	0.45	0.50	0.00	1.00
Self-reported health	156,449	3.25	1.06	1.00	5.00
Health index	156,449	2.98	1.40	1.00	5.00
Cognition	156,449	10.48	3.35	0.00	20.00
Low control at work	70,144	0.30	0.46	0.00	1.00
Effort-reward imbalance at work	70,341	0.71	0.45	0.00	1.00

Table 2.2 shows some descriptive statistics of the full sample of 156,445 person-wave-observations. A total of 53% of the sample is female, and 52% are working, whereas 48% are retired. The average age in our sample is 63 years. In total, 63% are living with a partner, and the average number of

children is 2.36. Overall, 65% have reached the country-specific early claiming age, and 45% have reached the normal claiming age. The average self-assessed health status (ranging from 1 to 5) is 3.25; the average score of the latent Poterba index (ranging from 1 to 5) is 2.98. On average, 10.48 words are remembered in the cognitive functioning test (out of 20). A total of 30% report having low control over the tasks of their main occupation, and 33% express an imbalance between the effort they give and the reward they receive in their main occupation. Previous literature on the health effect of retirement has shown that it is important to consider the heterogeneity of the effects depending on occupational characteristics.

Figure 2.1: Changes in health for overall sample and for work quality groups



Source: Own calculations based on SHARE data

The graphical illustration in Figure 2.1 shows the average health of individuals both before and after transitioning from working to retirement. The left panel of Figure 2.1 represents the change in average health measurements for the overall sample, indicating a health decline after retirement. I reproduce the change in average health scores separately for those participants with good work quality and those with bad work quality and show the results for the different health measures in the right panel of Figure 2.1. For those with a good working environment, the change in average health resembles the change for the overall sample. Those individuals exposed to bad working conditions start off with a lower average health before retirement. At the same time, the line is flatter than for those with good working conditions for all three measures, indicating that the health status changes less after retirement for individuals with bad working conditions. This could be explained by the hypothesis that retirement provides relief in particular for those exposed to bad working conditions. In contrast, retirement leads to a loss of cognitive and physical stimulation for those in jobs with high responsibility and high control levels; therefore, I find a steeper health decline for those who worked in good conditions. However, since the graphs do not control for endogeneity problems and do not differentiate between short- and long-term effects, I refrain from interpreting the pattern in the change of health in detail, instead I consider the graphs as descriptive evidence to motivate separate empirical analyses depending on work quality.

2.6 Empirical Analysis

2.6.1 Main results

The instrument relevance assumption requires a strong first stage, which means that the statutory claiming ages must have significant effects on the propensity to retire. Table 2.3 shows the results of an individual fixed effects estimation of the first stage relationship, indicating the probability of retirement, given the statutory claiming ages and respondents' age as further control variables. The results indicate that the statutory claiming ages have predictive effects on retirement behavior. Having reached the early claiming age increases the probability of being retired by 9 percentage points, and having reached the normal statutory claiming age increases the probability of being

retired by 13 percentage points at a 1% significance level.[7]

Table 2.3: First stage: The effect of reaching the claiming age on retirement probability

VARIABLES	Retirement
Normal claiming age	0.13***
	(0.004)
Early claiming age	0.09***
	(0.004)
Age	0.03
	(0.017)
Age^2/10	-0.00**
	(0.000)
Constant	-1.09
	(0.832)
Observations	156,449
Number of ID	48,060
R-squared	0.29
Year FE	YES
F	632.8

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

Table 2.4 shows the instrumental variable fixed effects (IV-FE) and individual fixed effects (FE) estimations as the main results of my analysis. I include age and second-order polynomials of age as covariates to account for the effect of the normal aging process on health status. In the IV-FE estimation results I find that retirement is associated with better physical health, as measured by the self-assessed health (SAH) and the health index. On the other hand, retirement has a negative effect on cognition, represented by the memory recall test. These results suggest that retirement has a positive effect on the overall physical health status but a negative effect on cognition.

[7] The Kleibergen-Paap rk Wald F statistic is used as a weak identification test, since we use clustered robust standard errors. With a value of 286.08, our instruments are confirmed to have predictive power for retirement status. According to the Kleibergen-Paap rk LM statistic, our model is well identified, since the null hypothesis of underidentification can be rejected with a p-value of 0.0087. The Hansen J statistic is applied as an over-identification test of all instruments (being older than the early and normal claiming ages). The joint null hypothesis is that the instruments are valid and uncorrelated with the error term. With a p-value of 0.2891, the null hypothesis is not rejected.

Table 2.4: Main results: The effect of retirement on health and cognition

	IV-FE estimation			FE estimation		
VARIABLES	(1) SAH	(2) Health index	(3) Cognition	(1) SAH	(2) Health index	(3) Cognition
Retirement	0.33***	0.24***	-0.38**	-0.07***	-0.15***	-0.13***
	(0.041)	(0.061)	(0.153)	(0.010)	(0.012)	(0.031)
Age	0.00	-0.07	0.44***	0.01	-0.06	0.44***
	(0.027)	(0.049)	(0.079)	(0.037)	(0.069)	(0.101)
Age^2/10	-0.00*	0.00**	-0.04***	-0.00**	0.00***	-0.04***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Observations	156,449	156,449	156,449	156,449	156,449	156,449
R-squared	0.01	0.13	0.03	0.03	0.16	0.03
Number of ID	48,060	48,060	48,060	48,060	48,060	48,060
Year FE	YES	YES	YES	YES	YES	YES
F	360.2	568.2	245.5	127.9	608.0	144.6

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

For comparison, I also perform individual fixed effects (FE) estimations without including statutory claiming ages as instruments. The fixed effects estimators are significantly negative for all dependent variables, indicating that retirement leads to worse health both in terms of physical and cognitive health. Thus, the effect on the physical health measures changes from negative to positive when taking into account the endogeneity of the retirement decision by including the instrument. One explanation for this could be that the individual fixed effects only absorb the endogeneity problems caused by unobserved individual heterogeneity. These estimations do not account for the fact that health may induce retirement. Thus, the negative results may be driven by those individuals retiring because of health problems. Controlling for this cause of endogeneity reveals the Local Average Treatment Effect (LATE), and our results suggest that retirement has a positive average short-term effect on health for those individuals who retire at the statutory claiming ages. This could also explain why the direction of the effect does not change for the cognitive functioning measure. Due to occurring symptoms and feelings of pain or discomfort, the awareness of physical health is much higher than the awareness of mental health. Thus, being physically ill is more likely to cause one to retire than the decline of the cognitive functioning. Therefore, individuals retiring due to health problems are more of a threat to the results for physical health than cognition measures.

2.6.2 Working Conditions

As shown in the descriptive part of the paper, it is interesting to analyze the role of working conditions within the framework of the causal effect of retirement on health. I use two different assessments of working conditions: low control at work and an imbalance of effort and reward at work.

Information on working conditions is not available for all waves, which leads to a reduction in sample size to 70,545 observations. I repeat the instrumental individual fixed effects (IV-FE) estimations for the reduced sample size to avoid misinterpretation of the working conditions due to a different sample composition. The estimation results become more distinct in size and remain significant for the physical health measurement. Concerning cognitive assessment, the coefficients are positive but insignificant for this sample.

Table 2.5: Effect of retirement on health and cognition considering working conditions (IV-FE)

	Bad working conditions			Good working conditions		
VARIABLES	(1) SAH	(2) Health index	(3) Cognition	(1) SAH	(2) Health index	(3) Cognition
Retirement	0.60***	0.30*	0.55	0.20	0.33	0.45
	(0.198)	(0.171)	(0.429)	(0.206)	(0.257)	(0.746)
Age	0.14***	-0.06	0.57***	0.12***	0.24***	0.63***
	(0.048)	(0.071)	(0.128)	(0.032)	(0.046)	(0.123)
Age^2/10	-0.01***	-0.00	-0.06***	-0.00	-0.01	-0.06***
	(0.003)	(0.004)	(0.009)	(0.003)	(0.004)	(0.014)
Observations	36,893	36,893	36,893	33,652	33,652	33,652
R-squared	-0.02	0.14	0.02	0.02	0.16	0.02
Number of ID	11,348	11,348	11,348	10,643	10,643	10,643
Year FE	YES	YES	YES	YES	YES	YES
F	43.17	47.01	1.420	25.91	173.9	102.9

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

I run two separate regressions for persons with bad working conditions and for those with good working conditions in Table 2.5. The coefficients for the physical health measurements are positive and highly significant; indicating that retiring from a job with bad working conditions is associated with better health in terms of physical assessment. Similar to the results for the reduced sample, the coefficient measuring the effect of retirement on cognition is positive but insignificant. For those

with good working conditions the coefficients for all health measures are positive but insignificant.

2.6.3 Delayed Effect of Retirement

I redefined the instrument as being at least one year over the normal claiming age. As mentioned earlier, the instantaneous effect of retirement on health might underestimate or overestimate the true effect since the behavior and the overall condition of an individual directly after the transition from work to retirement might be different than after some time when the individual adapt to the new situation. The results taking into account the year spent in retirement are shown in Table 2.6.

Table 2.6: Effect on health and cognition after one year in retirement (IV-FE)

	(1)	(2)	(3)
VARIABLES	SAH	Health index	Cognition
Retirement	0.12	0.23***	-1.44***
	(0.104)	(0.074)	(0.219)
Age	-0.00	-0.14***	0.58***
	(0.009)	(0.020)	(0.051)
Age^2/10	-0.00***	0.00**	-0.05***
	(0.001)	(0.001)	(0.003)
Observations	156,449	156,449	156,449
R-squared	0.02	0.14	0.01
Number of ID	48,060	48,060	48,060
Year FE	YES	YES	YES
F	79.56	778.2	280.0
Fp	2.80e-07	0	6.07e-10

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

The effect of retirement on self-assessed health is insignificant, whereas the effect on the physical health index remains stable in size and significance level. The effect of retirement on the cognitive outcome gets bigger after one year in retirement, suggesting that the cognitive decline after retirement continues. This is in line with findings from previous studies on the effect of retirement on cognition (Rohwedder and Willis 2010; Bonsang et al. 2012; Mazzonna and Peracchi 2012).

2.6.4 Robustness Checks

I include different functions of age (linear, quadratic, cubic, quartic terms) and age dummies as further robustness checks. Since the results are insensitive, I conclude that there is no underlying relationship between age and health that our model fails to capture.

As previously mentioned, I also control for the differences in sample sizes between the countries. The main concern is that the results are driven by the effect of retirement on health observed in the US, since the US represents around half of our sample. As a robustness check, I draw random samples from the HRS respondents. I stepwise reduce the sample to 50%, 25%, 10% and 5% and monitor whether the results change. Since the UK is also overrepresented compared to other European countries, I perform the same procedure for the ELSA respondents. Table 2.7 shows the results for a random 5% sample from HRS and a random 20% sample from ELSA. With 3,911 respondents from the HRS and 4,910 respondents from the ELSA, the samples are comparable to the sample sizes in Europe, which vary between 994 in Greece and 5,847 in France.

Table 2.7: Robustness check for random 5% HRS and 20% ELSA sample (IV-FE)

	(1)	(2)	(3)
VARIABLES	SAH	Health index	Cognition
Retirement	0.28**	0.50***	0.34
	(0.127)	(0.100)	(0.236)
Age	0.04	0.03	0.52***
	(0.030)	(0.045)	(0.081)
Age^2/10	-0.00**	-0.01***	-0.05***
	(0.001)	(0.001)	(0.003)
Observations	56,726	56,726	56,726
R-squared	0.01	0.04	0.01
Number of ID	24,872	24,872	24,872
Year FE	YES	YES	YES
F	1156	107.9	320.1

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

The magnitude of the effects and the standard errors change after the reduction of sample sizes, although the effect of retirement on health is still positive overall. The effect on cognition is positive but insignificant. I also run separate analyses for the three subsamples of HRS, ELSA and SHARE, which reveal no significant differences in the direction and size of the effects. Since the data collection of the HRS started in 1992, these data cover different retirement cohorts than the ELSA and SHARE, which began data collection in 2002 and 2004, respectively. As a further robustness check, I reduce the HRS data to the same time period of data collection as SHARE and ELSA, meaning that I use only data collected in years 2004, 2006, 2010 and 2012 for all three datasets and run the

regression with this reduced sample. As before, the results suggest a significant positive effect of retirement on physical health, whereas the effect on cognition is insignificant.

I further estimate the regression model separately for men and women and for different educational levels and do not find any changes in the results based on these demographic differences.

2.7 Discussion

This study addresses the research question of how retirement affects an individual's physical and cognitive health and the role of working conditions in this context. I find that overall, retirement has significant positive effects on physical health, as measured by self-reporting and an encompassing health index. In contrast, retirement has a negative effect on cognition, measured by the memory recall score. While the results regarding physical health are confirmed in different robustness checks, the cognitive health measure becomes insignificant in some specifications.

The second research question studies the impact of working conditions in the context of retirement and health. Work quality is measured by the level of control and the balance between effort and reward at work. Our results show that retiring from a job with low work quality has a positive effect on physical health, both objectively and measured by self-reporting, which indicates the positive relief for physical health when retiring from bad working conditions. I do not find significant effects for cognitive health and for those with good working conditions.

Future research should concentrate on the following question: Why does retirement have different effects on physical and cognitive health? This difference could possibly be explained by the post-retirement behavior of the individuals and therefore needs to be analyzed in further studies. Future research of working conditions in this context should take into account the characteristics of the main job by including the type of occupation. Also, whether the characteristics of the final job play a bigger role than the main job should be investigated. Last, it would be helpful to have more harmonized cognition measures to establish more robust results for cognitive health. This depends on the development of the different surveys.

3. Influence of Social Networks on the Effect of Retirement on Cognition

This paper is single-authored. It has been published as MEA Discussion Paper (available at www.mea.mpisoc.mpg.de).[8]

3.1 Introduction

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

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

Börsch-Supan and Schuth (2014) study this relationship using data from the Survey of Health, Ageing

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This paper uses data from SHARE Waves 1, 2, 3 (SHARELIFE), 4, 5 and 6 (DOIs: 10.6103/SHARE.w1.600, 10.6103/SHARE.w2.600, 10.6103/SHARE.w3.600, 10.6103/SHARE.w4.600, 10.6103/SHARE.w5.600, 10.6103/SHARE.w6.600), see Börsch-Supan et al. (2013) for methodological details. (1) 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 Max Planck Society for the Advancement of Science, 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, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

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

The recently published data from wave 6 of the SHARE survey contain an update of the module on social networks, which allows for monitoring the changes in social network size and characteristics on the individual level over time. Following up on the analysis of Börsch-Supan and Schuth (2014), I make use of these panel data to study the relationship between retirement, social networks and cognitive health in a longitudinal setting based on 39,998 observations. More specifically, I first study descriptively how the size and composition of social networks change between wave 4 (2011) and wave 6 (2015) depending on the labor market status. The analytical part of the study takes into account potential endogeneity problems by applying a panel instrumental variable identification strategy. I start the analytical part by examining the effect of retirement on social networks and find that retirement leads to a significant increase in the number of close family members in the social network. No significant effect is found for the change in non-family members such as friends or colleagues. The second part of the analysis focuses on the causal identification of the effect of retirement on cognitive health and the effect of the social network as one possible mechanism. The results suggest that retirement has a negative, but insignificant effect on cognition. An increase in the number of friends or colleagues has potential positive effects on cognition; however, it cannot be concluded that social networks are the mechanism behind the effect of retirement on cognition because the number of friends and colleagues is not significantly influenced by retirement.

3.2 Literature Review

Retirement and cognition

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

Retirement and social networks

Another related strand of literature addresses the question regarding how retirement affects social network size and composition. Ertel et al. (2009) argue that retirement could lead to a decrease in social network size because of a lack of contact opportunities in the workplace. On the other hand, retirees might be able to devote more time to sustaining and developing social contacts and to engaging in social activities. Empirical work by van Tilburg (1992, 2003) compares the social networks of men before and after retirement. The results show that the average size of the networks did not change over time; however, the number of colleagues in the networks decreased. Kalmijn (2012) studies – among other life events – the effect of employment transitions. For men, retirement decreases contact with friends but increases contact with neighbors, indicating a shift to a more local network. Women also increase their contact frequency with neighbors after retirement, but they manage to maintain contact with friends at the same time. Fletcher (2014) uses SHARE data and does not find causal effects of retirement on different social network characteristics by applying an instrumental variable approach. Patacchini and Engelhardt (2016) study the effect of work and retirement on different social network characteristics. The authors exploit panel data from the

American National Social Life, Health and Aging Project and combine a fixed effects estimation strategy with instruments based on public pension claiming ages. They find that retirement reduces the size and density of social networks.

Social networks and cognition

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

Retirement, social networks and cognition

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

The present paper is connected to the work of Börsch-Supan and Schuth (2014) in terms of the

research question addressed and data used. I contribute to the existing literature by using the newly available follow-up data on social networks in wave 6 of SHARE, which allows for the exploitation of the variation in social networks over time and for the application of instrumental variable panel data models as an identification strategy.

3.3 Theory and Hypotheses

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

New analytic strategies and data allow for the recent literature to add more levels of complexity to the basic convoy model and to identify different network types by considering the ratios of the different network circles of a person. The four common network types that have been found in the empirical literature are "diverse", "family-focused", "friend-focused" and "restricted" networks (Litwin and Stoeckel 2013). Different studies show that the network-type patterns vary with cultural context (Antonucci et al. 2014; Fiori et al. 2008). For Europe, there is evidence that family-focused networks are particularly common in Southern European countries, whereas networks in Northern and Western countries are often friend-focused (Litwin and Stoeckel 2013). Similarly to the convoy

model, social network type can change over one's lifetime and respond to specific life events. According to socio-emotional selectivity theory (Carstensen et al. 1999), social interaction is mainly driven by two goals: acquisition of knowledge and regulation of emotions. With increasing age and as a person approaches death, the importance shifts from the long-term goal of knowledge-seeking to the short-term goal of emotional regulation. Consequently, peripheral network members, who formerly acted as information givers, are more likely to be excluded from the social network. Instead, greater attention is given to closer network members with the expectation of greater emotional support. Based on this theory, it is expected that networks change from friend-focused to family-focused networks with increasing age. In contrast, individuals with a family-focused network likely experience more stability in their social network composition. Retirement as a life event in old age might intensify the effect because the withdrawal from the labor force provides a sudden disincentive to invest in relationships that serve the acquisition of knowledge (e.g., co-workers). Based on these reflections, the second hypothesis is as follows: *Social networks become more family-focused and emotionally closer after retirement. This effect is particularly expected in Northern and Western European countries. The prevalent network types in the Southern European countries are family-focused throughout the life course and therefore remain stable after retirement.*

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

To summarize, the analyses of this paper aim to investigate the following hypotheses:

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

3.4 Data

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

In wave 4, SHARE implemented a social network module to gather extensive information on the social interactions of older people. The respondents were asked to name up to seven persons with whom they often discuss important things. By answering several follow-up questions, the specific role (partner, friend, etc.) and gender of the person as well as the emotional closeness, residential proximity and contact frequency were gathered. The resulting pattern is called an ego-network, meaning that the respondents themselves report the immediate social relationships that surround them. In wave 6, the same respondents were again asked the social network questions. Additionally, the social network composition of wave 4 was compared with that of wave 6. If a member of the social network was not named again as an important relationship in wave 6, respondents were asked why this person was not mentioned anymore. Through this strategy, changes in social network patterns can be reconstructed in detail, and it is possible to relate them to different life events (e.g., health shocks, house moving). For my analysis, I use data from wave 4 and wave 6 of SHARE. The newly available panel data on social networks allows for the study of the effect of retirement on different characteristics of social networks (size, satisfaction, etc.) and for the correlation of this change in social networks to a range of cognitive and mental health measures available in SHARE.

3.4.1 Sample

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

3.4.2 Variables

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

The data offer various characteristics of the respondents' social networks (SN). I start by using the change in the **total SN size** as the dependent variable and then amplify the analysis by splitting the social network into different groups: number of **close family members** in SN (partner, parents, siblings, children), number of **distant family members** in SN (e.g., aunt, niece, grandchildren and other relatives), number of **colleagues and friends** in SN, and number of **non-family members** in SN. In addition to the pure size of social networks, I consider other characteristics such as closeness, contact frequency, distance and satisfaction regarding the social network.

For the pooled regressions, I include socio-demographic indicators such as gender, age, whether someone is living together with a partner, number of years of education, whether the household has financial problems and number of activities. I further include a scale measuring quality of life (CASP) and several health indicators such as grip strength, number of limitations in (instrumental) activities of daily living (ADL/IADL), a global activity limitation index (GALI) and whether the respondent is suffering from long-term illness. More details about these variables are presented in the summary statistics in Table 3.2.

The second part of the analysis uses **cognition** as the dependent variable. Cognition is measured by a memory recall test in which respondents should repeat a list of ten words immediately after it is read to them and repeated after approximately 20 minutes. The resulting cognition measure combines the scores from the immediate and delayed recall test and ranges from 0 to 20. Additionally, I construct a variable to account for the learning effect in the memory recall measurement. In general, panel data on cognitive abilities might suffer from the fact that the respondents take the test several times. Although the surveys are separated by two years, it is possible that the respondents anticipate the test and adapt their behavior, particularly for the delayed recall test (Ferrer et al. 2004; Rabbitt et al. 2001). This learning effect would lead to better scores in follow-up waves compared with the results obtained when the test was taken the first time. In the present case, this effect could influence the results because many countries added refreshment samples in wave 4 (Malter and Börsch-Supan 2013). Figure 3.6 in the appendix suggests that the refreshment respondents who participate in SHARE for the first time in wave 4 have higher learning effects than the panel respondents in wave 4; therefore, it is important to control for this effect in the regression model.

3.5 Methodology

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

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

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

The first regression (1) measures the relationship between retirement and social networks, where individual *i* in country *c* has a certain network characteristic *SN* (e.g., size, satisfaction, closeness of social network). *R* is a dummy variable indicating whether someone is working (0) or retired (1). ***X*** contains a set of individual characteristics such as gender, age, living status, education, financial situation, number of activities, quality of life and several health indicators (grip strength, long-term illness, number of ADL/IADL, limitation index). *C* represents the country level fixed effects and *u* the error term. The coefficient of interest is β_2, which measures the marginal effect of retirement on the social network characteristic. In the second regression (2), the dependent variable measures cognitive health COG_{ic}. I am interested in the effects of retirement R_{ic} and social networks SN_{ic} on cognition, controlling for individual characteristics $\boldsymbol{X}_{ic}$ and country level fixed effects. Although controlling for a set of individual observable characteristics, both OLS regressions might not reveal causal relationships for two main reasons: 1) reverse causality and 2) differences in unobservable characteristics.

One can envision that different bidirectional relations in the triangle of retirement, social networks and cognition lead to the problem of reverse causality. For example, it has been shown that retirement affects social networks (Kalmijn 2012; Fletcher 2014); in turn, however, social networks can also influence retirement decisions (Lancee and Radl 2012). Accordingly, there is evidence that retirement accelerates cognitive decline (Börsch-Supan and Schuth 2014), but it is possible that worse cognitive performance affects labor market participation. Furthermore, there could be unobserved components that simultaneously influence retirement, social networks and cognition, such as personality traits, preferences or external circumstances such as moving to another city or

health shocks. These examples show that both the retirement decision and social network characteristics are endogenous, which complicates the identification of causal effects.

3.5.1 Reverse Causality

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

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

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

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

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

3.5.2 Unobserved Heterogeneity

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

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

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

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

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

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

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

Under the premise that the instruments are valid, I expect the IV-FE model in (9) to yield unbiased and consistent two-stage least-squares estimators that reveal the causal effect of retirement on social networks and cognition. The validity of the instruments has been discussed intensively in previous literature (Coe and Zamarro 2011; Bonsang et al. 2012; Mazzonna and Peracchi 2016; Fonseca et al. 2016), indicating that the instruments fulfill the exclusion restriction. In the present case, this finding means that the instruments influence social networks only through the direct effect of retirement. It is unlikely that the claiming eligibility ages of a country are correlated with social network sizes on the individual level. Nevertheless, I apply country level fixed effects to account for any systematic differences in the institutional background. To prove the relevance of the instruments, Table 3.1 shows the first-stage regression demonstrating that the claiming eligibility ages have a significant effect on retirement. Having reached the early retirement age increases the probability of retirement by 3 percentage points, and being over the normal eligibility age increases

the probability of being retired by 10 percentage points. All additional test statistics show that the instruments are strong and valid instruments and that the model is well identified.

Table 3.1: First stage: The effect of reaching the claiming age on retirement probability

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

3.6 Descriptives

3.6.1 Summary Statistics

I restrict the description of the summary statistics to the variables used in the main specification; details on the other variables can be found in Table 3.2. Because of the sample restriction, the age in my sample ranges from 50 to 75, with an average age of 63.5 years. Among those in the sample, 46% are still working and 54% are already retired based on the self-reported employment status and work activity in the last four weeks. On average, 10 out of 20 words can be named in the combined immediate and delayed memory recall test. The total network size contains, on average, 2.7 close confidants.

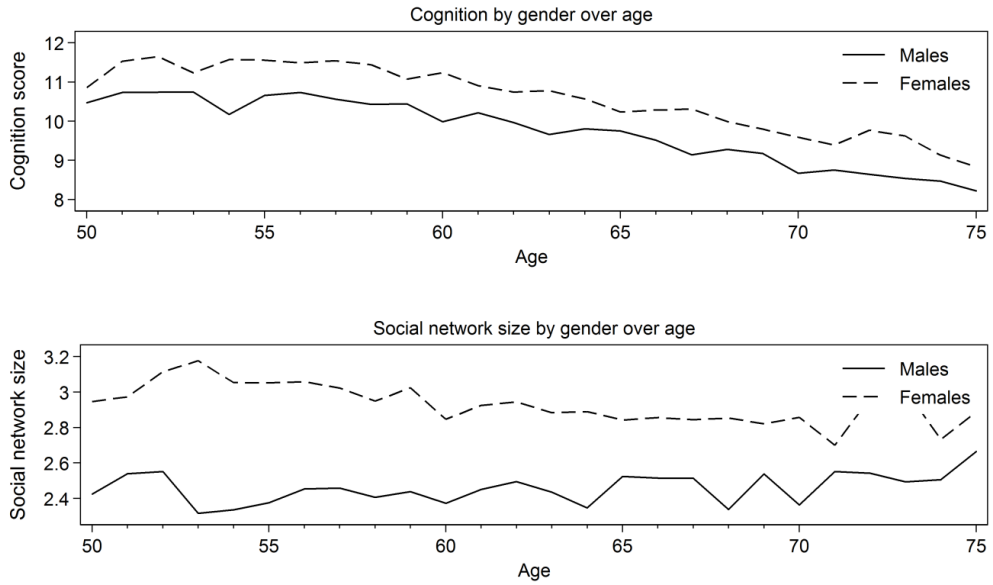
Table 3.2: Summary statistics for pooled sample

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

3.6.2 Descriptive Evidence – Pooled Data

Figure 3.1 describes how cognition and social networks develop with increasing age based on a pooled sample of wave 4 and wave 6.

Figure 3.1: Change in cognition and social networks over age



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

The graph shows a decline in the cognition score, which is parallel for males and females. Females show higher cognition scores at all ages. Females also have larger social networks, the size of which slightly decreases with age. The social networks of males also remain relatively stable at older age. The pattern for both males and females does not indicate a strong relation between age and social network size.

Taking into account retirement as a life-changing event in old age, Table 3.3 compares the means of selected variables for the persons that are retired with the means of the working population. This comparison is based on a pooled sample from wave 4 and wave 6 and reveals that retirees, on average, have a smaller total network size than working persons. Both the number of close family members and the number of non-family contacts including friends or colleagues are lower for retired persons. In contrast, retirees name more distant family members as their confidants. Overall satisfaction with the social network is not significantly different between the two groups. The mean value for emotional closeness is higher for the retirees, supporting socio-emotional selectivity theory. Furthermore, the lower means in geographical distance and contact frequency indicate that the social networks become closer and more local after retirement.

Table 3.3: Comparison of means between working and retired persons

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

3.6.3 Descriptive evidence – panel data

Based on the existing panel data, I can observe how the social networks evolve over time and whether retirement is associated with the change in social networks. For the descriptive analysis, I

form three different groups based on their employment status: working in both waves (always-workers), retired in both waves (always-retirees) and transitioning from working to retirement between wave 4 and wave 6 (transitioners). Figure 3.2 illustrates how different social network characteristics change between the observed waves for the three different groups.

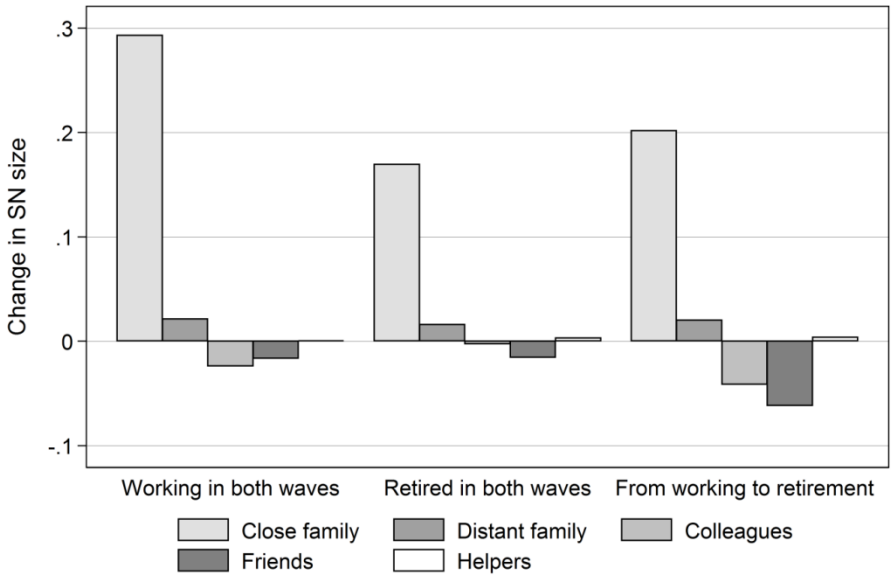
The first panel shows the change in total social network size. Although starting from different levels, I find an increasing network size for all three groups. Both the geographical distance and the contact frequency decrease when transitioning from working to retirement. At the same time, the closeness to the social network members increases. The changes in distance and closeness support the hypothesis that the network becomes more local and more emotionally close after retirement. Overall satisfaction with the social network increases for all three groups between the waves. The always-workers and always-retirees groups show parallel, increasing trends regarding the change in the social network characteristics in all panels. The increasing trend could be influenced by period effects or method effects. The trend could also reflect the fact that social networks gain emotional closeness with age and therefore more persons are named as close confidants in wave 6 according to socio-emotional selectivity theory.

Figure 3.2: Change in social network characteristics between waves

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

Based on the descriptive evidence gathered from the pooled and the panel data, I can conclude that persons who transition from working to retirement have a smaller and geographically closer social network than the control group. While this is an interesting descriptive finding, I cannot claim that retirement has a causal negative effect on social network size because retirement, as the treatment variable, is endogenous.

Figure 3.3: Change in SN subgroups between waves

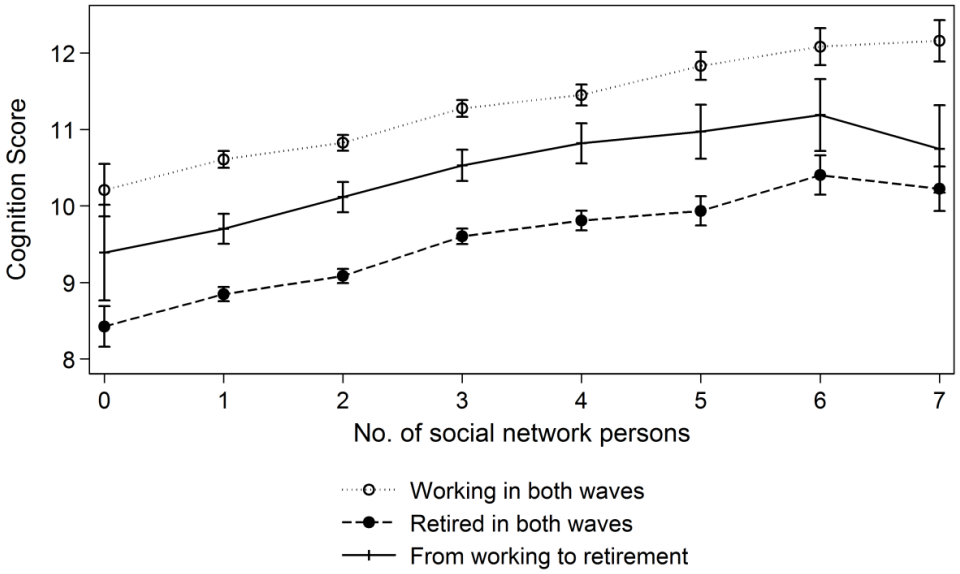


Source: Own calculations based on weighted data from SHARE wave 4 and wave 6.

To descriptively motivate the second hypothesis (social networks become more family-focused and emotionally closer after retirement), I present the change in different subgroups of the social networks between wave 4 and wave 6 in Figure 3.3. Overall, more close family members are added to the social network and surprisingly, the always-workers show the highest increase in the number of close network members. The other subgroups remain quite stable for the always-workers and always-retirees; however, a decline in the number of colleagues and the number of friends is visible for those who transition from working to retirement. This decline descriptively supports my hypothesis that networks become less friend-focused after retirement. Figure 3.4 shows the relationship between the number of social network members and the cognition score for the different groups. Independent of the social network size, the always-workers have the highest predicted cognition score, followed by the transitioners and then the always-retirees. The graph

further shows a positive relationship between the number of social network persons and the cognition score, supporting the hypothesis that a reduced social network leads to cognitive decline.

Figure 3.4: Relationship between social network, cognition and retirement



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

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

3.7 Estimation Results

3.7.1 Effect of Retirement on Social Networks

I start the empirical analysis by examining the effect of retirement on the total size of social networks, presented by different models in Table 3.4. All models include year and country fixed effects (which cancel out for the individual level fixed effects regressions) to control for country-

specific time trends and unobserved cultural or institutional differences that potentially influence retirement age, social networks and cognition.

Table 3.4: Effect of retirement on social networks

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

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

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

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

Table 3.5: Effect on retirement on subgroups of social network

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

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

Table 3.5 presents the effect of retirement on different subgroups of the social networks to investigate the second hypothesis, which postulates a change in social network composition from friend-focused to family-focused. The first column repeats the 2SLS estimator for the effect of retirement on total network size, as already presented in Table 3.54. Column (2) shows that retirement has a significant positive effect on the number of close family members that are named

as confidants in the social network. Similarly to Börsch-Supan and Schuth (2014), who claim that retirement leads to a decrease in the number of friends/colleagues or other non-family members, I find negative coefficients in column (3) and (4), although they are insignificant. In accord with the descriptive part, these results suggest that the social network becomes more family-focused after retirement.

Table 3.6: Heterogeneous effects of retirement on social networks

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

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

To consider possible heterogeneous effects, I run the IV-FE specification separately for male and female respondents and present the related coefficients in Table 3.6. I find that retirement has a significant positive effect on the social network size of male persons, mainly due to a significant increase in the number of close family members in the social network. In contrast, female persons experience a decrease in the total size of the social network after retirement, although this effect is not significant. I further run separate regressions for different geographical regions[9] to investigate

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

whether the trend from friend-focused networks to family-focused networks is found in the Northern European countries in particular, but no clear effect can be found due to insignificance.

3.7.2 Effect of Retirement and Social Networks on Cognition

In the second part of the empirical analysis, I estimate the effect of retirement on cognition, controlling for changes in the size of the social network. Column (1) in Table 3.7 presents the results of an instrumental variable fixed effects estimation with cognition score as the dependent variable and retirement, age, and age squared as basic covariates. Furthermore, a dummy variable controlling for the retesting effect is added. I find a negative but small and insignificant effect of retirement on cognition when controlling for age and age squared. Taking the memory recall test for the first time in wave 4 and being retested again in wave 6 has a significant positive effect on the cognitive score compared with the effect observed for those taking a repeated test in wave 4, indicating a learning effect. In columns (2) to (4), I successively add social network characteristics to the base model, namely, the total size of the social network, the number of close family members and the number of friends or colleagues in the social network. First, adding additional covariates to the model does not change the main effect of retirement on cognition. Concerning the network effects, an increase in the total network size and an increase in the number of friends and colleagues have a significant positive effect on cognition. A greater number of close family members in the social network, however, does not have a significant effect on cognition. Column (5) additionally takes into account changes in other variables that could potentially influence the effect of retirement on cognition. The main effect is not affected by the inclusion of the additional covariates. A change in living status and in financial situation has no significant effect. An increase in the number of activities, however, has a significant positive effect on cognition, indicating that an active lifestyle is associated with higher cognitive performance.

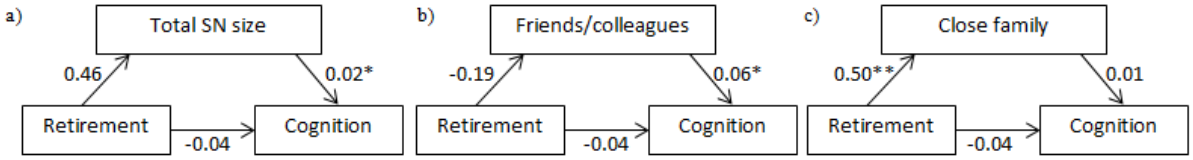
Table 3.7: Effect of retirement and social networks on cognition

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

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

A summary of the results shown in Table 3.5 and Table 3.7 is presented in Figure 3.5. An increase in the total social network size and in the number of friends and colleagues positively influences cognitive performance, as shown in a) and b). However, because retirement does not have a significant effect on total network size or on the number of friends and colleagues, I cannot claim that the interaction with (external) social network members buffers the negative effect of retirement on cognition. Retirement has a significant positive effect on the number of close family members in the social network (c), but this relationship does not affect cognition significantly.

Figure 3.5: Summary of analytical results



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

Table 3.8: Effect on cognition dependent on change in social networks

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

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

Column (1) in Table 3.8 shows that retirement has a significant negative effect on cognition for those with a shrinking social network in terms of friends or colleagues. Thus, the loss of intellectual stimulation through friends or colleagues induced by retirement can lead to faster cognitive decline, as already observed by Börsch-Supan and Schuth (2014). In contrast, if the number of friends or colleagues increases, retirement would have a significant positive effect on cognition, as shown in column (2). This finding supports the hypothesis that an active lifestyle and social interactions with

an extended network can buffer cognitive decline after retirement as well. I do not find significant effects if I reduce the sample to those who experience an increase (3) or decrease (4) in the total size of their social network or in the number of close family members (5 and 6).

3.8 Robustness Checks

As reported by Fonseca et al. (2016), results pertaining to the health effect of retirement depend strongly on model specifications and the definition of retirement. Table 3.9 and Table 3.10 in the appendix present the estimation results based on different retirement concepts. The first alternative specification defines retirement based on self-reported retirement, without taking into account whether someone has performed any other paid work in the last four weeks (2). The next two specifications account for the "honeymoon phase" after retirement by replacing the retirement dummy with dummy variables indicating whether someone has been in retirement for at least one year (3) or two years (4). The last specification (5) considers the time spent in retirement because it has been shown in the literature that the time during which someone has been exposed to retirement conditions can have an important effect. When revising the effects of retirement on social network size for the different specifications, it is shown that the positive effect of retirement on the number of close family members remains stable for the first two alternative specifications. The effect becomes insignificant under the constraint of at least two years in retirement and even negative, but also insignificant, for the time spent in retirement. Therefore, the increase in the number of close family members is rather an immediate response to the new situation after retirement and could be associated with the quest for spousal support after retirement. The results for the effect of retirement and social networks on cognition remain stable across the different retirement definitions and the different estimation strategies.

3.9 Conclusion

Based on the literature and on socio-psychological theories, I formulated three hypotheses to be tested by empirical analysis. The first hypothesis states that retirement leads to a decrease in social network size. Descriptive statistics and graphs support this hypothesis. Additionally, OLS and FE

regressions indicate a significant negative effect or retirement on total social network size. However, after including instruments to account for potential endogeneity problems, I find positive but insignificant effects of retirement on social network size. Therefore, I cannot confirm the first hypothesis based on the empirical results. I further investigated the effect of retirement on different subgroups of the social network. I find that retirement significantly increases the number of close family members mentioned as social network members, particularly for male respondents. I do not find significant differences between European regions. Therefore, I can only confirm the first part of the second hypothesis ("Social networks become more family-focused and emotionally closer after retirement, particularly in Northern and Western countries"). The third hypothesis argues that a reduced social network after retirement intensifies cognitive decline. Although the descriptive statistics suggest a cognitive decline after retirement, I do not find a significant negative effect of retirement on cognition, mainly due to the large standard errors in the IV-FE specification. The results suggest that an increase in total social network size and in the number of friends and colleagues positively influences cognitive performance. However, because retirement does not have a significant effect on total network size or on the number of friends and colleagues, I cannot claim that the interaction with (external) social network members buffers the negative effect of retirement on cognition. Similarly, I cannot conclude that a reduction in the number of friends or colleagues induced by retirement intensifies cognitive decline; therefore, the third hypothesis cannot be confirmed.

The present paper is a follow-up study of the work performed by Börsch-Supan and Schuth (2014), who find that (early) retirement reduces, in particular, the number of non-family members in the social network. They conclude that this reduction could be a possible mechanism that may explain the negative effect of (early) retirement on cognition. This study was based on cross-sectional data from SHARE wave 4. My study extends this previous work by adding the newly available panel data on the social networks in SHARE and by estimating instrumental variable fixed effects regressions to causally identify the effect of retirement and social networks on cognition. The results are not as

straightforward as expected because I do not find a significant reduction in the number of friends or colleagues after entering retirement. Therefore, I cannot claim the change in social networks to be an underlying mechanism for the negative effect of retirement on cognition.

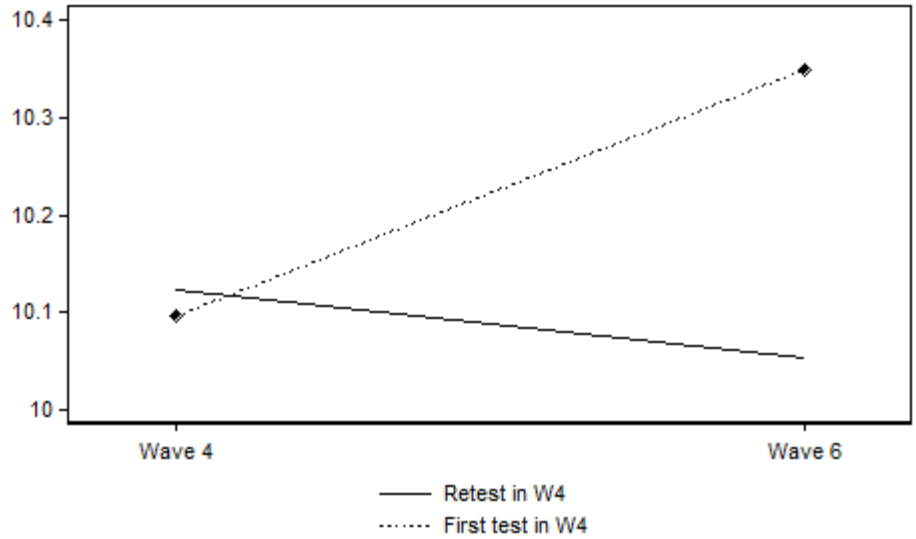
The lack of significant results can, on the one hand, be attributed to the identification strategy because large standard errors are obtained when using an instrumental variable strategy. On the other hand, the method for measuring social networks in SHARE might fail to provide enough variation in the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

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

3.10 Appendix

A. Figures and Tables

Figure 3.6: Learning effect of memory recall test



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

Table 3.9: Robustness checks for effect on social network

		Total SN size IV-FE	Close family IV-FE	Friends/colleagues IV-FE	Non-family IV-FE
Normal specification	Retired (0 1)	0.46	0.50**	-0.19	-0.11
		(0.33)	(0.24)	(0.19)	(0.21)
	F statistic	46.14	76.08	6.804	4.763
	Adj R^2	-0.00	-0.00	-0.00	0.00
	Year FE	YES	YES	YES	YES
One year in retirement	Retired (0 1)	0.23	0.31*	-0.14	-0.09
		(1.14)	(2.00)	(1.13)	(0.68)
	F statistic	46.60	77.02	7.03	4.88
	Adj R^2	-0.99	-0.99	-1.00	-1.00
	Year FE	YES	YES	YES	YES
Two years in retirement	Retired (0 1)	0.11	0.12	-0.06	-0.03
		(0.59)	(0.87)	(0.57)	(0.23)
	F statistic	46.43	76.46	6.76	4.75
	Adj R^2	-0.99	-0.97	-1.00	-1.00
	Year FE	YES	YES	YES	YES
Self-reported retirement	Retired (0 1)	0.22	0.24*	-0.08	-0.04
		(1.39)	(2.01)	(0.88)	(0.41)
	F statistic	46.64	77.12	6.75	4.74
	Adj R^2	-0.99	-0.98	-1.00	-1.00
	Year FE	YES	YES	YES	YES
Time spent in retirement	Retired (0 1)	-0.03	-0.05	0.01	0.01
		(0.68)	(1.34)	(0.37)	(0.26)
	F statistic	46.34	74.56	5.80	4.09
	Adj R^2	-0.98	-0.98	-1.00	-1.00
	Year FE	YES	YES	YES	YES

Table 3.10: Robustness checks for effect on cognition

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

4. Early Determinants of Work Disability in an International Perspective

This chapter has been written in co-authorship with Axel Börsch-Supan and Tabea Bucher-Koenen and has been published as MEA Discussion Paper (available at www.mea.mpisoc.mpg.de).[10]

4.1 Introduction

Work disability is the (partial) inability to engage in gainful employment due to physical or mental illness, resulting in early retirement and/or uptake of disability insurance benefits (Loisel and Anema 2014). Disability insurance (DI) is a substantial part of public social expenditures and an important part of the social safety net of all developed countries (OECD 2003, 2010). The design of work disability insurance systems is a challenging task for policy makers (Havemann and Wolfe 2000; Autor and Duggan 2003, 2006, 2010; de Jong et al. 2011). Like almost all elements of modern social security systems, disability insurance faces a trade-off (Aarts et al. 1996, Diamond and Sheshinski 1995, Banks et al. 2004, Croda and Skinner 2009, Autor et al. 2016). On the one hand, disability insurance is a welcome and necessary part of the social safety net as it prevents income losses for those who lose their ability to work before the normal retirement age. On the other hand, disability insurance may be misused as an early retirement route even if the normal ability to work is not affected at all.

The aim of this study is to shed light on the interrelated roles of health, especially health over the entire life course, and welfare state policies, especially financial incentives of the old-age pension and disability insurance systems, in the decision to take up disability insurance benefits due to work

[10] Acknowledgments:
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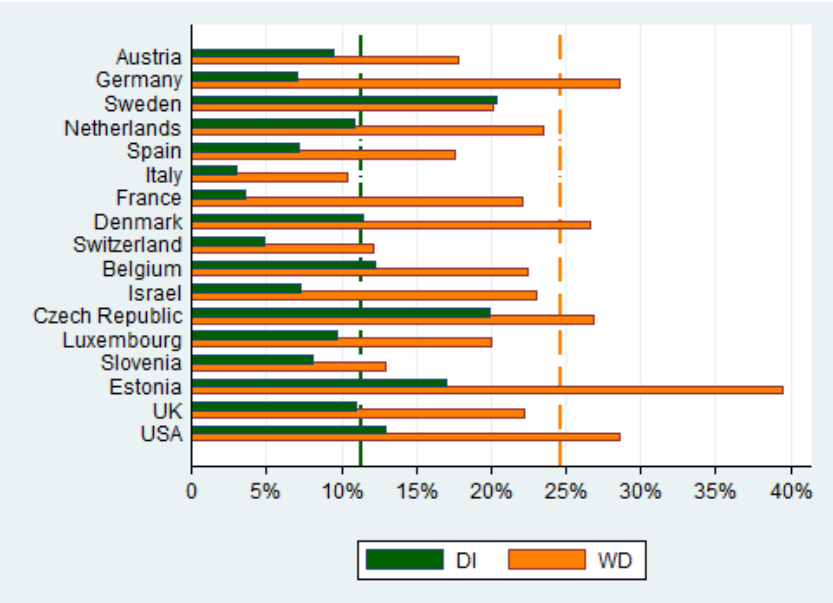
This paper uses data from SHARE Waves 1, 2, 3 (SHARELIFE), 4 and 5 (DOIs: 10.6103/SHARE.w1.500, 10.6103/SHARE.w2.500, 10.6103/SHARE.w3.500, 10.6103/SHARE.w4.500, 10.6103/SHARE.w5.500), see Börsch-Supan et al. (2013) for methodological details. The SHARE data collection has been primarily funded by the European Commission through the 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: °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).

The ELSA data were made available through the UK Data Archive. ELSA was developed by a team of researchers based at the NatCen Social Research, University College London and the Institute for Fiscal Studies. The data were collected by NatCen Social Research. The funding is provided by the National Institute of Aging in the United States, and a consortium of UK government departments co-ordinated by the Office for National Statistics. The developers and funders of ELSA and the Archive do not bear any responsibility for the analyses or interpretations presented here.

The HRS (Health and Retirement Study) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan.

disability. It continues and expands our earlier research on early retirement and disability insurance in Europe (Börsch-Supan and Schnabel 1999, Börsch-Supan et al. 2004, 2007, 2010, 2011, 2012). It makes three new contributions to this string of papers. First, there have been incisive reforms to the DI systems in many of the countries analyzed in our earlier studies, reducing the generosity of DI. This is especially significant for the Netherlands, which used to have the most generous DI system in Europe by far. We show that even after the most striking international differences in DI generosity have been abolished, we still identify a strong reaction of DI uptake to DI regulations. Second, we systematically juxtapose self-reported work disability (WD) with the uptake of DI in order to shed more light on how well DI targets WD. We find systematic international differences in the match quality between WD and DI. Third, we exploit harmonized retrospective data in the US Health and Retirement Study (HRS), the English Longitudinal Study on Ageing (ELSA) and the Survey of Health, Ageing and Retirement in Europe (SHARE) to take life-time health and policy interventions over the life course into account in a systematic way. We find that health problems experienced over the life course even as early as during childhood are important drivers of later life working capacity and the need to rely on DI benefits.

Figure 4.1: Work disability and disability insurance receipt in Europe and the US



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

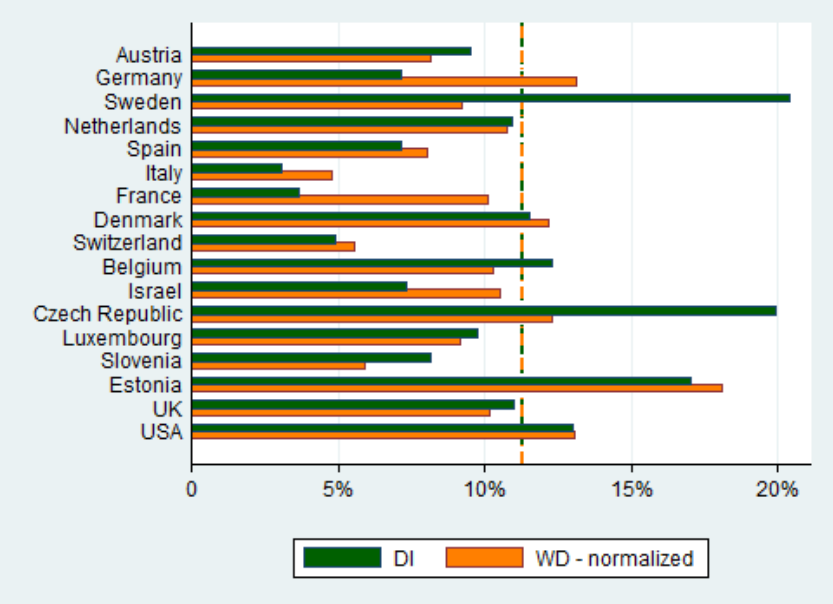
Figure 4.1 shows the extent of work disability (WD) and disability insurance (DI) receipt in 17

different countries in Europe and the US. It is based on internationally comparable measures of WD and DI in SHARE, ELSA and HRS.[11] The data refer to individuals whose age is between 50 years and the age, in which DI benefits are converted to old-age pensions, in most countries at the age of 65 years. In all countries except Sweden the average rate of self-reported WD is higher than the share of persons who receive DI. On average in all countries around 25% self-report that they have a health problem or disability that limits the kind or amount of paid work they can do. The variation between countries is high. The rate ranges from around 11% in Italy to around 40% in Estonia. Compared to that, about 11.5% of these individuals receive DI benefits, again with a substantial variation between countries. The share ranges from around 3-4% in Italy, France and Switzerland up to 20% in Sweden and the Czech Republic. While in almost all countries, there are more individuals reporting WD, there are marked cross-national differences in the relative size of the WD and DI populations. In Sweden, these populations are about equal, while in France, there are about five times as many individuals reporting a WD as receiving DI.

Since self-reported WD and state-regulated DI receipt are two very different concepts, Figure 4.2 normalizes the two underlying scales to have a common average value. Assuming that self-reported WD has the same scale in each country (a strong assumption, cf. Sen 2002, Kapteyn et al. 2007), the result may be interpreted as relative match quality. After the normalization, in many countries the rates of self-reported work disability and DI benefit receipt match each other more or less. There are a couple of exceptions: Sweden and the Czech Republic appear very generous in granting DI benefits. Here DI benefit rates are much higher than the rates of self-reported disability. The opposite is the case for France and Germany, where the fraction of persons with self-reported disabilities is much higher than those receiving DI benefits. Denmark, the Netherlands, the UK and the US get it about right.

[11] Section 4.2 describes our dataset harmonization in more detail.

Figure 4.2: Work disability and disability insurance receipt (normalized)



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

Table 4.1 and Figure 4.3 to Figure 4.5 take a different look at this match quality by basing the comparison between WD and DI on each individual. If all DI systems would work perfectly we should see a perfect match between work disability and disability receipt. I.e. everyone with a limitation should receive benefits and nobody without a limitation should receive benefits (assuming that there are no reporting errors in WD and DI receipt). In our sample of 30,131 individuals in 13 countries,[12] 83% are correctly matched in the sense that they have a WD and receive DI or have no WD and do not receive DI. 4,429 individuals (14.7 %), however, have a self-reported WD but receive no DI benefits. In turn, 640 individuals (2.1 %) receive DI but do not report any WD.

Table 4.1: Work disability and disability insurance receipt

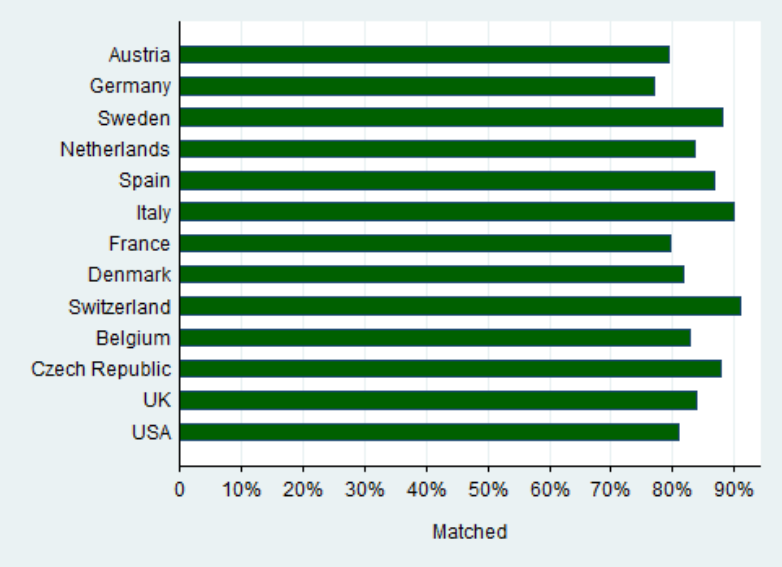
	WD=0	**WD=1**
DI=0	22.450 74.5% ("Matched")	4.429 14.7% ("WD without DI")
DI=1	640 2.1% ("DI without WD")	2.612 8.7% ("Matched")

If there are a lot of individuals who receive benefits without having limitations then the system is either too generous or prone to abuse. If there are many individuals who receive no benefits despite

[12] Our sample is described in more detail in Section 4.2.

a limitation then the system is probably not targeting the persons in need very well. Figure 4.3 shows the frequency of a match which is highest in Switzerland and Italy (around 90%) and lowest in Germany (77%).

Figure 4.3: Match between work disability and disability insurance receipt

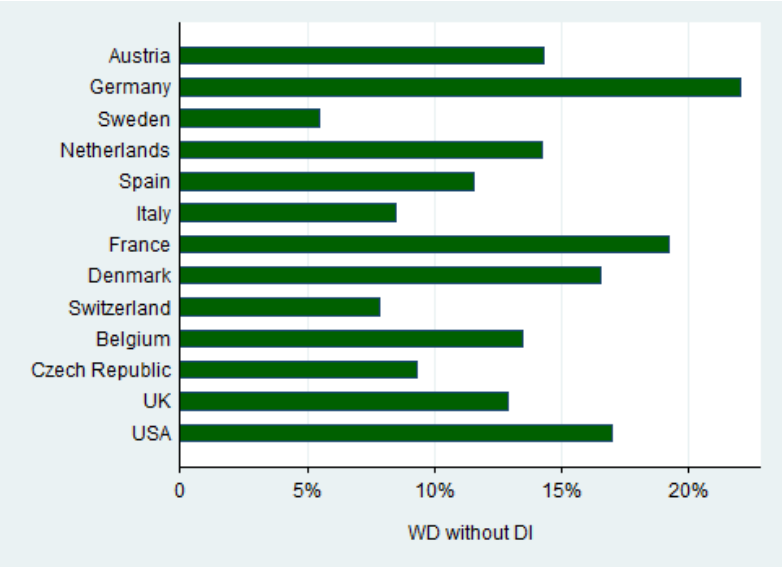


Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

Figure 4.4 displays the fraction of individuals with work limitations that do not receive DI benefits. Germany, France, the US, and Denmark stand out with a fraction of individuals that report WD and do not receive DI benefits which is above 15% of the population. The rate in Germany is particularly high: Almost 22% of the respondents self-report a disability which prevents them from working full-time while they do not receive DI benefits. In contrast to that in Sweden, Switzerland and Italy this first type of mismatch is lowest. In turn, Sweden and Austria give about 6% of all individuals aged between 50 and 65 DI benefits while these respondents do not claim any limitation in their ability to work (Figure 4.5).

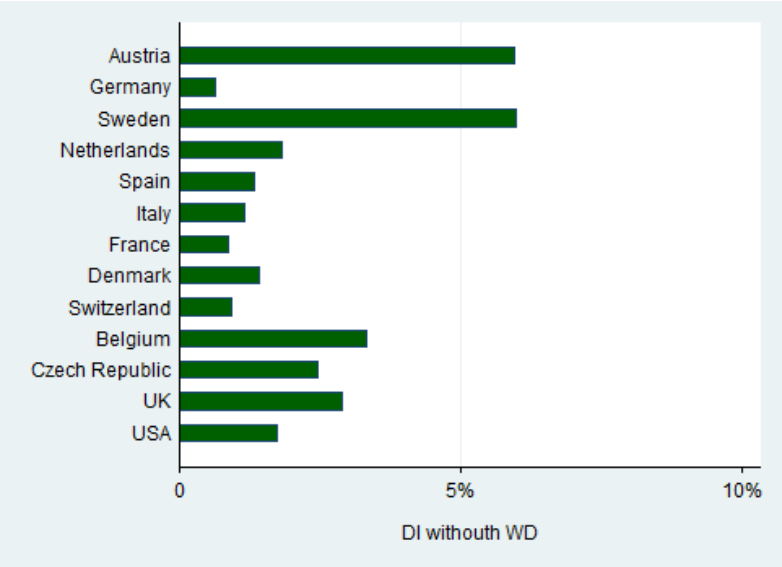
What explains the variation in match quality? Can one country learn from another country to improve match quality? To study this, we try to understand what causes the high variation in the prevalence of WD and which factors can explain why DI is taken up so much more frequently in some countries than in others.

Figure 4.4: Restrictive systems: Work disability but no disability insurance receipt



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

Figure 4.5: Generous systems: Disability insurance receipt but no work disability



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

In order to understand the match quality, it is important to measure the "true need" for DI. Usually, this is understood as a measure of physical and mental health. Health, however, is hard to measure and we will be careful in making causal attributions. The subjective measure of WD underlying the figures in this introduction may not reflect "true need". Self-reported WD may be biased towards worse health outcomes since the respondent may feel urged to justify his or her enrolment in DI in spite of a normal health status (Bound 1991, Kerkhofs and Lindeboom 1995, Dwyer et al. 2003). In

turn, self-reports may also be positively biased due to accommodation (Hill et al. 2016). Moreover, health is subject to measurement error (Butler et al. 1987) and other endogeneity problems (Dwyer and Mitchell 1999, Benitez-Silva et al. 2000). We deal with the justification bias by including more objectively measured health indicators which are included in SHARE, ELSA and HRS in addition to the subjective health measures from the surveys. Objective measures include grip strength for upper body strength, EURO-D for depression and the sum of immediate and delayed word recall for memory abilities. We also include (instrumental) activities of daily living (ADL, IADL) which measure functional health and are between subjective and objective measures of health since they are self-reported but on a well-defined scale. In order to deal with reverse causality problems, we exploit information about life health and use time as an identifying instrument. These variables measure health at childhood as well as episodes of ill health during the entire life course. In this way we pick up health problems that occur well before the onset of work disability and DI receipt.

We consider the four drivers which explain the large variation in reported WD and DI uptake: demographics, current health, policies regulating DI and old-age pensions, and life-course factors.

First, while all European countries are aging, the extent of population aging varies considerably. Hence, a first explanation claims that a country with an older population also has a higher prevalence of disability insurance uptake.

A second potential cause for the cross-national variation is that health, measured more objectively than self-reported WD, differs across the countries depicted in Figure 4.1 and Figure 4.2. Heterogeneity of health in Europe is very large both across and within countries. According to Eurostat, life expectancy at birth of women in the EU varies between 85.5 years in Spain and 78 years in Bulgaria. The gap in life expectancy is even larger for men: it is 80 years in Sweden but only 68.4 years in Lithuania. There is also a large discrepancy between mortality and morbidity. While Swedish and Italian men have about the same life expectancy (79.9 and 79.8 resp.), Swedish men spend seven more years in good health than their Italian counterparts: the gap in healthy life expectancy is 70.6 versus 63.2 years. Moreover, health varies by income and other socio-economic characteristics. Health is more heterogeneous in the US, Germany and the Mediterranean countries than in

Scandinavia (Avendano and Mackenbach 2009).

Third, welfare-state policies, especially the design of the pension and DI systems, have been shown in the country studies edited by Gruber and Wise (1999, 2004) and Wise (2012, 2015) to create strong incentives on individuals' labor market and retirement behavior.

Fourth and finally, this study emphasizes the role of life-course experiences as determining factors for reported WD and the receipt of DI benefits. As already emphasized, episodes of ill health long before WD is reported or DI is received can more easily be interpreted causally than current health. There is now ample evidence that good health in later life emerges from a person's biological make-up, behavior, lifestyle, environmental and occupational conditions, health care interventions, and a multitude of interactions between these factors across the entire life span. An important insight of recent research is that these interactions manifest their effects starting very early in life and then accumulate in positive and negative feedback cycles over the entire life course (Power and Kuh 2006, Heckman and Conti 2013). To this end, this study has constructed an internationally harmonized data set assembled from SHARE, ELSA and HRS in which particular attention has been given to life-time health using the life history data from SHARE and ELSA plus comparable early childhood and life-course data from HRS.

The paper proceeds as follows. In Section 4.2 we present the data and the harmonized variables. In Section 4.3 we describe our empirical methodology. In Section 4.4 and 4.5 we present our results. We first focus on explaining the within-country variation in work disability and disability receipt (Section 4.4). We then use counterfactual simulations to explain the between-country variation (Section 4.5). Section 4.6 concludes and points out directions for future research.

4.2 Data

4.2.1 SHARE, ELSA and HRS

We use harmonized data from three sister studies on aging: The Survey of Health, Ageing and Retirement in Europe (SHARE), the Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA). Harmonization involves extensive data manipulation due to the often subtle differences in variable definitions across the three data sets. These procedures are described briefly

in Subsection 4.2.4.

SHARE is a pan-European data set designed to analyze the process of population aging using cross-national comparisons within Europe and between Europe, America and Asia (Börsch-Supan et al. 2013). The first wave in 2004 included eleven European countries and more than 22,000 individuals aged 50 and older. In the subsequent waves, which are conducted biennially, more countries joined the project so that SHARE currently includes 20 European countries, covering the area from Sweden to Greece and Portugal to Estonia.

SHARE is modelled closely after the US Health and Retirement Study (see Juster & Suzman 1995), which was the first survey of this kind, and the English Longitudinal Study of Ageing (see Marmot et al. 2003) which followed the lead by HRS. The first wave of HRS was initiated in 1992 and the subsequent waves were conducted in a biennial course. The initial sample included 12,652 individuals living in the United States aged between 51 and 61 years and their spouses or partners. Since this sample ages with the time of the survey, new individuals were sampled as a refreshment sample in later waves in order to represent the younger age group. Until today, 11 waves of HRS data are available.

On the basis of the HRS survey, a longitudinal old age survey was implemented in England in 2002. The baseline sample contains 12,099 persons representing the population aged 50 and older in the United Kingdom (UK). Further refreshment samples were added in subsequent waves. Until now, 6 waves of ELSA data are available.

All datasets are multidisciplinary household panel surveys including detailed information on health, socioeconomic status, work history and social networks. Researchers from HRS and ELSA have been participating in the design process of SHARE at all stages. About two-thirds of the variables in SHARE are identical to variables in ELSA and HRS, and most of the remainder is closely comparable. The harmonization of these variables in HRS, ELSA and SHARE enables us to conduct comparative analyses for different regions in Europe, the UK and the US.

We will use internationally comparable life-course data on health and socio-economic circumstances. The main work was to construct a data base of retrospective life histories collected by SHARE and

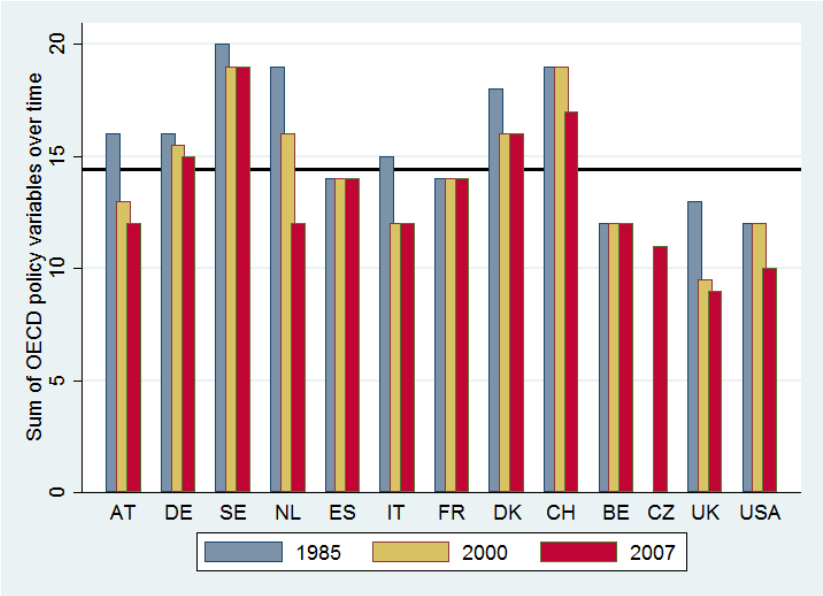
ELSA, and comparable early childhood and life-course data collected by HRS. Life histories are highly structured computer-assisted interviews which collect retrospective data on the most salient health, family, social, work, accommodation, and economic events from childhood to current age (Belli 1998), including markers for genetic predisposition such as parents' health conditions and life spans. They can be interpreted as a short-cut to a life-long cohort study. While retrospective data have some limitations, the value of information obtained from life histories has nevertheless been proven to be great: validation studies have shown that recall data contain very valuable information even if people do not reproduce events from the past perfectly (Rubin 1996, Jürges 2005). In wave 3, the SHARE panel data has been enriched with detailed accounts of the respondents' life histories (SHARELIFE). By integrating this retrospective view, the living conditions in the preceding decades become accessible, thus granting various insights going back as far as into childhood. The SHARE life histories have been modeled in close cooperation with the ELSA life histories. We enrich the data by variables from SHARELIFE and ELSALIFE, especially on socioeconomic status in childhood, on illnesses during childhood and adulthood and on the employment history of the respondents. HRS does not feature such structured life histories yet but the normal questionnaire covers some retrospective variables describing early childhood conditions and salient events in adult life which permit cross-walking between SHARE, ELSA and HRS.

4.2.2 DI Policy and Labor Market Indicators

A cross-national perspective of the data is essential for our analyses because the impact of a policy intervention can only be understood if we observe one policy in contrast to other policies. This is necessary because policy changes over time in one country tend to be confounded with other contemporary changes in that country. The added cross-national variation will support identification. Therefore, we complement the individual level data from the three surveys with some macro-economic indicators. Specifically, we merge data on disability policy indicators provided by the OECD (2003, 2010). These indicators measure the degree of compensation in different DI benefit systems on the basis of the following five characteristics: Coverage (ranging from the total population to employees only); Minimum disability level (lower bound ranging from 0% to 86%); Maximum benefit

level (in terms of replacement rate ranging from RR<50% to RR>=75%), Medical assessment (ranging from treating doctor only to teams of insurance doctors); Vocational assessment (ranging from strict own-occupation assessment to all jobs available). Each indicator is measured according to a predefined scale ranging from zero points (restrictive) to five points (generous). The sum of the indicators is used as covariate in the regression analyses to account for country differences in the generosity of DI benefit systems. The indicators are available for three points in time: around 1985, 2003 and 2007 (see Figure 4.6). We match the year of first DI benefit receipt of our individuals with these three time periods in order to approximate the policy circumstances of the respective time period as well as possible. Since these policy indicators are not available for Estonia, Israel and Slovenia, we exclude these countries from all analyses.

Figure 4.6: Generosity of DI systems over time and by countries



Source: Own calculation based on OECD (2003, 2010)

In Figure 4.6 we show how the level of generosity of the DI systems changed between 1985 and 2007 by plotting the summarized OECD indicators for the different countries. Overall, the sum of the OECD policy indicators decreases over time in almost all countries, meaning that in general the systems have become less generous reflecting the incisive reforms mentioned in the introduction. The exceptions are Spain, France and Belgium, where the overall level of generosity remains stable over time. Sweden, Denmark and Switzerland reveal high OECD policy scores in all points in time reflecting above-average generosity of their DI systems. In contrast, four countries remain below the average

generosity level: Belgium, the UK, the US and the Czech Republic. Some countries started with an above average level of generosity like for example the Netherlands and Austria, but show levels of DI benefit generosity below the average today. In our regression analyses we will include the summary score and alternatively the five sub-scales as explanatory variables.

Maestas et al. (2015) show that labor market conditions play a crucial role when evaluating DI uptake. We therefore include two country level indicators to proxy the labor market environment. First, we use the Job Strain Index created by the OECD by combining information from the European Working Conditions Survey and the Work Orientations modules of the International Social Survey Program.[13] The Job Strain Index represents the quality of the working environment and is based on measures for high levels of job demands (time pressure and physical health risk factors) as well as low levels of job resources (work autonomy and learning opportunities; social support at work). The aggregated variable job strain reflects the percentage of workers in jobs with exceeding job demands and a low number of resources at disposal. The indicator is constructed such that a higher score reflects a higher degree of job strain and ranges between 18.80 for Sweden and 53.88 for Spain (see Table 4.7 in the appendix for details).

Second, in order to take into account the labor market conditions of the respective countries, we include a summary indicator capturing the adaptability of labor markets to economic and structural changes (Boeri et al. 2002). This summary indicator combines four different dimensions of the labor market: Employment protection (PR) against uninsurable risks in terms of labor legislation and the provision of unemployment benefits; Vocational training (TR) provided to the labor force in order to acquire skills and to increase employability; Degree of labor market mobility (MO) measured across labor market states and across regions; Size of the labor market (S) measured by the employment rate of a country.

Employment protection and training are dimensions that in some form depend on government regulations, therefore these dimensions are summed up. Mobility and size are considered as reactions to the provision and training and are therefore included in the overall index such that the

[13] We retrieve the data from OECD.Stat for the year 2005 and the age group 50-64 (OECD 2005).

larger M and S, the larger is the overall adaptability of the labor market. Taking into account these considerations, the adaptability index is created as follows:

$$ADA = S * [(PR + TR) * MO]$$

The ADA index is thus constructed such that a higher score reflects a higher degree of labor market adaptability and ranges from 1.20 for Italy to 11.04 for Denmark (see Table 4.8 in the appendix for details). Denmark has by far the most flexible labor market reflecting the effects of their very radical labor market reforms which have been used as role models for reforms in other countries. The next flexible labor markets are seen in Germany and Sweden.

4.2.3 Sample Selection

We use the current waves of HRS (Wave 11, collected in 2012/13), ELSA (Wave 6, collected in 2012/13) and SHARE (Wave 5, collected in 2013). For some variables, we merge information from previous waves, e.g. for marital status. For the life history variables we add information from SHARE Wave 3 and ELSA Wave 3. Due to the combination of datasets we include thirteen countries in most of our analyses: Austria, Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Switzerland, Belgium, the Czech Republic, the UK, and the US.

We restrict our analysis to individuals in an age range in which disability insurance occurs most frequently. Due to the age focus of all three studies age 50 serves as the lower age bound in our analysis. In most countries disability insurance benefits are automatically converted into old-age pension benefits, thus, our upper age bound is the country specific statutory retirement age. For the definition of the statutory retirement ages we gather information on the national pension systems. We create a binary variable indicating whether someone is above or below the national statutory retirement age. While doing so we take into account transitional arrangements of pension reforms and we also differentiate between special arrangements for men and women and different cohorts (see Table 4.9 in the appendix). We exclude individuals aged above the applicable statutory retirement age so that the sample for the analysis is defined as 50 - age of normal retirement. The upper age bound ranges between 61 years for France and 66 years for the US.

SHARE wave 5 covers 20,428 individuals within this age range. ELSA includes 11,585 and HRS 3,751

individuals. After deleting observations with missing information for the dependent variables or the main health indicators, the remaining sample consists of 30,131 observations. We observe 7,041 individuals (about 23%) who report WD and 3,252 individuals (about 11%) who receive DI benefits.

4.2.4 Variables

Using data from the sister studies SHARE, HRS and ELSA allows for cross-country comparisons in cultures, living conditions and policy approaches between Europe, the UK and the US if the information is sufficiently harmonized (King et al. 2004). The potential of combining these datasets has not fully been exploited so far. Only few empirical studies are based on a harmonized dataset since it is a time-consuming task to construct the corresponding variables based on different survey questions. Ex-ante harmonization with the questionnaire of HRS is an important prerequisite of ELSA and SHARE and great efforts have been made to deliver truly comparable data. However, country-specific deviations in wording, categories or the nonapplicability of questions and modules are unavoidable. Therefore the comparability of items has to be checked thoroughly one by one. All variables taken from HRS, SHARE and ELSA are harmonized carefully.

Dependent variables: For our analysis we use two different dependent variables: self-rated work disability (WD) and the receipt of disability benefits (DI). Both dependent variables used in our analysis are binary. The first dependent variable WD captures the self-assessed work disability based on the question: "Do you have any health problem or disability that limits the kind or amount of paid work you can do?" The second dependent variable DI is defined as receiving disability insurance benefits or not. Disability insurance is defined as all branches of publicly financed insurances providing compensation in case of the loss of the ability to perform gainful employment (see Table 4.10 in the appendix for the country specific details).

In addition to that we use an extensive set of individual level and country level control variables. The following groups of covariates are generated for the analyses:

Demographics: As basic demographics we use gender and the respondents' age at the time of the interview. For ELSA the exact age is given as a variable whereas for SHARE and HRS we calculate the age based on the year of the interview and the year of birth. The current marital status is split into

the categories married, divorced, widowed or single. Since information on the marital status is only given if something changed since the last interview, we need to merge information from all previous waves, even going back to Wave 0 for ELSA, which stems from the predecessor study Health Survey for England (HSE). The same applies for the information on the educational level. We built three categories referring to the ISCED[14] coding (low education (0-2), medium education (3-4), high education (5-6)) and match the educational level of the respondents based on their highest educational qualification.

Health: We use the respondent's self-reported health status rated on a categorical five-point scale from excellent (1) to poor (5). Self-reported health is among the most common measures used in public health surveys; it captures various physical, emotional, social aspects of health and wellbeing and has been found to predict mortality (see, e.g. Idler and Benyamini 1997, Jylhä 2009). Additionally, we include the objectively reported health information on the number of limitations with (instrumental) activities of daily living (ADL and IADL). In order to take a person's mental wellbeing into account, we construct the EURO-D depression index based on the number of depressive symptoms in SHARE. In ELSA and HRS, another depression index called CES-D score is used. SHARE contained the information needed for both the EURO-D and the CES-D score in wave 1. Based on this information we build a prediction rule for EURO-D by means of a linear regression and apply this rule to the HRS and ELSA data to obtain the predicted EURO-D scores. We complement these health measures by information from the physical test measuring the maximal grip strength of a person. Grip strength is our most objective measure of health since the task is performed during the interview. It reflects the overall muscle status of the respondent and has been linked to mortality in previous research (see, e.g., Gale et al. 2007). We impute missing values for maxgrip by setting them to zero implying that the missing values originate from situations where persons are not able to perform the grip strength test due to frailty. We add an additional flag variable to control for these imputed values. Further, we include a cognition measure coming from a verbal learning and a verbal recall test.

[14] International Standard Classification of Education.

Life health: We create the sum of all childhood illnesses the respondents had until they were 16 years old, covering infectious diseases, asthma, respiratory diseases, allergies, headaches, epilepsy, psychological problems, diabetes, heart problems, cancer, fractures and ear problems. The variable adulthood diseases is created accordingly and contains the sum of illnesses since the year of 16 including: back pain, arthritis, osteoporosis, angina heat diseases, diabetes, stroke asthma, respiratory problems, headaches, cancer, psychiatric problems, fatigue, allergies, eyesight problems, and infectious diseases.

Employment history: We use different variables from ELSALIFE and SHARELIFE in order to describe the employment history of a respondent. The number of jobs during the work history is constructed by summing up the employment spells (start and end of job). We also consider the situation between different employment spells and count all times of being sick or disabled as the number of working gaps. We further take into account whether the respondent had periods of ill health or disability that lasted for more than a year. Work quality is measured as the subjective assessment of the physical and psychological demands at work.

Childhood circumstances: The socio-economic status during childhood is measured by the number of books and the number of rooms in the accommodation at the age of ten.

Policy variables: As described earlier, we use the sum score of the OECD indicators for our main regression and also check for the relevance of the five single indicators. We further include the ADA index as a measure for the labor market adaptability.

Table 4.10 in the appendix provides an overview of all the variables used and Table 4.2 presents the summary statistics.

Table 4.2: Summary statistics

	categories	share of total sample	WD=0	WD=1	DI=0	DI=1
DI	Not receiving DI	89.21%	83.52%	16,48%		
	Receiving DI	10.79%	19.68%	80.32%		
WD	No health problem	76.63%			97.23%	2.77%
	Health problem	23.37%			62.90%	37.10%
age	50-55	32.35%	79.06%	20.94%	90.57%	9.43%
	56-60	40.02%	76.93%	23.07%	89.00%	11.00%
	61-66	27.64%	73.37%	26.63%	87.91%	12.09%
gender	Male	46.04%	77.74%	22.26%	89.37%	10.63%
	Female	53.96%	75.69%	24.31%	89.07%	10.93%
education	Low education	25.00%	71.00%	29.00%	84.95%	15.05%
	Medium education	43.29%	75.00%	25.00%	88.59%	11.41%
	High education	29.78%	83.74%	16.26%	93.76%	6.24%
marital	Single	9.26%	69.34%	30.66%	81.32%	18.68%
	Married	72.31%	79.69%	20.31%	91.83%	8.17%
	Divorced	13.65%	68.76%	31.24%	83.03%	16.97%
	Widowed	4.78%	66.97%	33.03%	82.44%	17.56%
numberofjobs	0-2	26.38%	72.24%	27.76%	86.60%	13.40%
	3-4	13.52%	77.81%	22.19%	90.45%	9.55%
	5-6	5.50%	74.15%	25.85%	88.29%	11.71%
	>7	2.63%	77.30%	22.70%	88.78%	11.22%
sphus	excellent	12.33%	96.31%	3.69%	97.50%	2.50%
	very good	26.61%	92.87%	7.13%	96.83%	3.17%
	good	36.04%	81.99%	18.01%	92.72%	7.28%
	fair	18.95%	49.82%	50.18%	77.08%	22.92%
	poor	6.07%	17.43%	82.57%	56.01%	43.99%
iadl_cat	0	90.72%	81.02%	18.98%	91.99%	8.01%
	1	6.12%	42.62%	57.38%	68.98%	31.02%
	2	1.59%	17.92%	82.08%	55.21%	44.79%
	>3	1.56%	15.07%	84.93%	41.61%	58.39%
adl_cat	0	91.25%	81.72%	18.28%	92.04%	7.96%
	1	4.59%	32.51%	67.49%	67.34%	32.66%
	2	1.83%	18.87%	81.13%	56.44%	43.56%
	>3	2.32%	9.43%	90.57%	46.86%	53.14%
maxgrip_cat	0-20	4.24%	52.27%	47.73%	75.74%	24.26%
	20-50	45.83%	78.47%	21.53%	90.15%	9.85%
	40-60	27.23%	82.07%	17.93%	91.90%	8.10%
	>60	2.02%	86.56%	13.44%	94.43%	5.57%
eurod_cat	0	22.65%	91.98%	8.02%	96.45%	3.55%
	1-2	44.84%	82.29%	17.71%	92.35%	7.65%
	3-4	19.43%	65.74%	34.26%	84.08%	15.92%
	5-6	9.20%	50.85%	49.15%	75.41%	24.59%
	>7	3.88%	37.35%	62.65%	69.06%	30.94%
recall_cat	0-5	6.52%	62.16%	37.84%	79.25%	20.75%
	6-10	41.52%	73.34%	26.66%	86.91%	13.09%
	11-15	45.00%	80.57%	19.43%	92.02%	7.98%
	16-20	6.96%	84.40%	15.60%	94.04%	5.96%
illnesses_ch_cat	0	14.19%	79.44%	20.56%	92.47%	7.53%
	1-2	77.49%	77.86%	22.14%	89.65%	10.35%
	3-4	7.45%	62.76%	37.24%	81.38%	18.62%
	>5	0.86%	40.00%	60.00%	63.46%	36.54%
illnesses_adult_cat	0	44.78%	88.96%	11.04%	95.19%	4.81%
	1-2	43.92%	73.30%	26.70%	88.37%	11.63%
	3-4	9.43%	44.83%	55.17%	72.03%	27.97%
	>5	1.86%	19.82%	80.18%	51.96%	48.04%

4.3 Methodology

Our analysis is divided into two parts: first, an analysis of the within-country variation in WD and DI benefit receipt and second an analysis of the between-country variation of WD and DI benefit receipt.

The objective of the first set of analyses is to understand at the individual level whether a person has work disabilities and receives DI benefits and relate this to the different variable groups, namely demographics, health, life health and other life course variables, the individual job characteristics and macro-indicators of the labor market and DI policy regimes. We do this by pooling the data from all countries and performing probit and linear regression analyses. We are particularly interested in the role of life health and life course variables, since they can give some indications of which life time factors contribute to whether people suffer from limitations on their earnings capacity later in life and have to rely on DI receipt. We assess how much of the total variation in WD and DI benefit recipiency rates at the individual level is explained by the different categories of variables.

Second, we try to explain the cross-national variation in WD and DI receipt. Here we present some descriptive statistics on the share of individuals with work disability and disability receipt by country. The overall objective is to understand whether differences in the demographic structure, health or institutions etc. can explain differences in the level of work disability and DI receipts between countries. To do so, we perform counterfactual simulations which hold some of the explanatory variables constant. We equalize the cross-national differences in demographics, health, life course and policy characteristics stepwise and predict how work disability and DI enrolment rates would look like if the variable groups were identical across countries. If the equalized group of variables were the main cause for the international variation, the simulated outcome should produce roughly identical percentages of work disability and DI benefit recipiency rates in each country.

4.4 Within-Country Variation

4.4.1 Descriptive Results

We start our analysis by describing the characteristics of our sample with reference to reporting WD and receiving DI benefits as displayed in Table 4.2. 23.4% of the respondents report suffering from a

disability that limits their working capacity and around 10.8% of the total sample receives DI benefits.[15]

The correlation between the two variables is high: among those with DI more than 80% report a health problem that limits their work capacity and among those not receiving DI benefits only 16.5% report such limitations. On the other hand, among those with a health problem 37% receive DI benefits, while among those without health problems only 3% receive DI benefits.

Figure 4.7: WD and DI over age by gender

Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

With respect to socio-demographics we see the following patterns: WD as well as DI benefits receipt increase with age. Women are somewhat more likely to report a work limitation but the benefit receipt is almost equal among men and women. This relationship is also illustrated in Figure 4.7.

There is a clear education gradient for both variables: Among those with low education more persons report work disability and receive DI (29.0% and 15.0%, respectively) than in the middle (25.0% and 11.4%, respectively) and high education group (16.3% and 6.2%, respectively). The marital status seems to play an important role for the receipt of DI benefits. In the group of married persons only 8.7% receive DI, whereas in the other groups (singles, widowed, divorced) around 17%-19% are enrolled in DI benefits. This can be explained by the fact that in some countries (e.g. Portugal,

[15] These averages are differing slightly from the numbers reported in the introduction. The reason is that in the introduction we included all 17 countries for which the data is available. Here we only report averages for the 13 countries which we include in the remainder of our analyses.

Denmark and Belgium) disability benefits are means-tested and the income of the partner is taken into consideration. Married individuals are also less likely to report WD compared to single, divorced and widowed persons. Here the reasons could be related to selection effects and healthier lifestyles among married individuals.

As expected, all health variables are strongly related to reporting work disability and receiving DI pensions. The worse the health category is, the more persons are restricted and receive an income replacement. The share of persons with work disability and receiving DI is especially high for low categories of self-reported health measures (sphus, adl, iadl). A bad health status according to objective health measures reveals also a higher share of individuals with WD and more DI recipients (maxgrip, recall). Health over the life course matters as well: Among those who report more than five childhood illnesses 60% report WD and 36.5% receive DI at older ages. Among those with more than five adulthood illnesses 80.2% report WD and 48.1% currently receive DI benefits. Multivariate regressions reported in the following subsection will give more insights into those patterns.

4.4.2 Multivariate Analysis

Both dependent variables (WD and DI) are binary and we therefore estimate probit specifications. Table 4.3 presents the results, we report average marginal effects. We include demographic variables and a set of subjective and objective current health indicators, life health, and DI policy indicators. The full models explain 30% and 23% of the total variation for WD and DI receipt, respectively.

Table 4.3: Determinants of WD and DI

		WD	DI
Demographics	age	0.001	0.000
		(0.001)	(0.001)
	female	-0.027	-0.035
		(0.006)**	(0.004)**
	education_high	-0.014	-0.038
		(0.010)	(0.013)**
	education_medium	0.003	-0.014
		(0.010)	(0.010)
	single	0.023	0.053
		(0.006)**	(0.007)**
	divorced	0.037	0.047
		(0.007)**	(0.005)**
	widowed	0.026	0.039
		(0.015)	(0.012)**
Health	sphus	0.109	0.046
		(0.014)**	(0.010)**
	adl	0.067	0.016
		(0.012)**	(0.003)**
	iadl	0.026	0.021
		(0.009)**	(0.002)**
	maxgrip	-0.001	-0.002
		(0.000)**	(0.000)**
	maxgrip_flag	-0.036	-0.046
		(0.019)	(0.013)**
	eurod	0.014	0.005
		(0.001)**	(0.001)**
	recall	0.000	-0.001
		(0.001)	(0.001)
Life health	illnesses_ch	0.019	0.015
		(0.004)**	(0.003)**
	illnesses_adult	0.043	0.023
		(0.004)**	(0.004)**
Policy	oecd_sum	0.010	0.011
		(0.005)*	(0.005)*
	Pseudo R2	0.30	0.23
	N	30,131	30,131

* $p<0.05$; ** $p<0.01$, Standard errors in parentheses, clustered standard errors by country.
Marginal effects of probit specification.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA

Reporting a work disability and receiving DI benefits is not related to age in our sample which is restricted to individuals between age 50 and the statutory retirement age. This could be explained by the following off-setting effects: On the one hand, getting older should increase the vulnerability to work disability. On the other hand, getting older increases the probability of becoming eligible for early retirement benefits and therefore the prevalence of DI benefit recipients should decrease. Conditional on other socio-demographic factors and health women are less likely to self-report work disability and also have a lower probability of receiving DI benefits. This is in line with previous findings (OECD 2003) and can be explained by a lower labor market participation of women in general and the fact that many countries have lower eligibility ages for early retirement for women compared to men. Thus, for them alternative routes to early retirement are available. Education does not matter for determining work disability reports, when controlling for health. However, the higher the education level, the smaller is the probability of receiving DI benefits. This can be explained by the different occupational types. If disability benefits are granted also on the basis of the fact that a specific job can still be done, then those in low skilled but physically demanding situations are more likely to be granted benefits. The fact that less married persons receive DI benefits could be related to the fact that in some countries the benefits are means-tested. Interestingly, our regression results show that not being married does not only significantly increase the probability of receiving DI benefits, but also increases the probability of reporting a health problem that leads to work disability. Explanations for this could be related to selection, i.e. healthier persons select into marriage or on the other hand related to a healthier lifestyle and a better mental and emotional status of married persons.

All individual health variables that measure the current health status are strongly significant and have the expected sign: Worse health leads to a higher probability of reporting work disability and at the same time to a higher probability of receiving DI benefits. In more details: Those with worse subjective health are more likely to report disability and also more likely to receive DI pensions. Restrictions in the (instrumental) activities of daily living influence working capacity and benefit receipt. The more objective health measures like grip strength, and the EURO-D depression scale also

significantly influence the WD and DI likelihood. This is a particularly interesting result since the subjective health measure as well as the ADL, IADL measures are more likely to be plagued by justification bias (Kerkhofs and Lindeboom 1995). This is much less so the case for grip strength and the depression scale as these measures are not self-reported but measured during the interview. We do not find an effect of recall abilities on WD and DI.

Current or very recent health measures, as broadly as they may be measured, may not appropriately capture the full impact of poor health on employability. Work disability may rather be the result of a long lasting process of becoming sick and finally unable to work. This analytical part of our project will take a life-course approach and exploit the life-course variables in SHARE, ELSA and HRS that account for long-run effects. We include lifetime health indicators that describe childhood and adulthood health status in our regression. The life health variables are highly significant determinants of reported WD and the receipt of DI benefits even after controlling for current health. The higher the number of illnesses during childhood or adulthood, the higher the probability of suffering from WD and receiving a DI pension later in life. Thus, health problems experienced over the life course and even as early as childhood are important drivers of later life working capacity and the need to rely on DI benefits. This is an important result for two reasons. First, from a methodological point of view, health indicators measured as early as childhood are much less likely to be endogenous to labor market outcomes due to the time sequence of events. Thus, the measured effects can more convincingly be interpreted causally. Second, from a policy perspective health interventions that target children when young do not only matter for their health at that point in time but have (positive) long-term impacts for health and labor market participation later in life. In addition, we take other life-course features into account such as childhood socio-economic status, quality of the working place and marital status over the whole life course. The analyses will follow in the next subsection, since we have to rely on a smaller sample for those analyses.

Finally, we would like to have a look at the institutional indicators.[16] The OECD score describing the generosity of the disability pension system is an important determinant for WD and DI benefit

[16] Clustered standard errors account for the fact that these variables vary across countries only.

receipt. If the score increases by one point on average the probability of receiving a DI pension increases by around 1%.[17] We also ran a regression where we control for the five individual OECD indicators describing the DI pension systems. Results are reported in Table 4.14 in the appendix. Overall our results for the demographic as well as the health and life health variables remain very similar. The OECD indicators in the regression on benefit receipt are all positive. Meaning the more generous the DI institutions the higher is the likelihood to receive benefits when old. None of the effects are significant. The reason is that the five indicators mostly vary by country and to some small extent over time. Thus, they suffer from high collinearity. Therefore, we refrain from interpreting the individual effects in too much detail.

In a next step we perform a variance decomposition analysis in order to understand the contribution of different variable groups on WD and DI receipt. The decomposition is based on linear regression models presented in Table 4.12 in the appendix. The linear specification gives very similar results as the probit model presented before. Figure 4.8 (left panel) shows the variance decomposition of the individual variation in self-assessed work disability. The explanatory power of the full model is 31%. Most of the variation in WD (29%) can be explained by current health status. The second most important variable group consists of the life health indicators. They can explain 14% of the total variation, indicating that health problems that occur early in life matter a lot for work disabilities later in life. Demographics (3%) have only small explanatory power for individual level work disability. And the DI policy variables do not seem to matter at all, when analyzing individual WD.

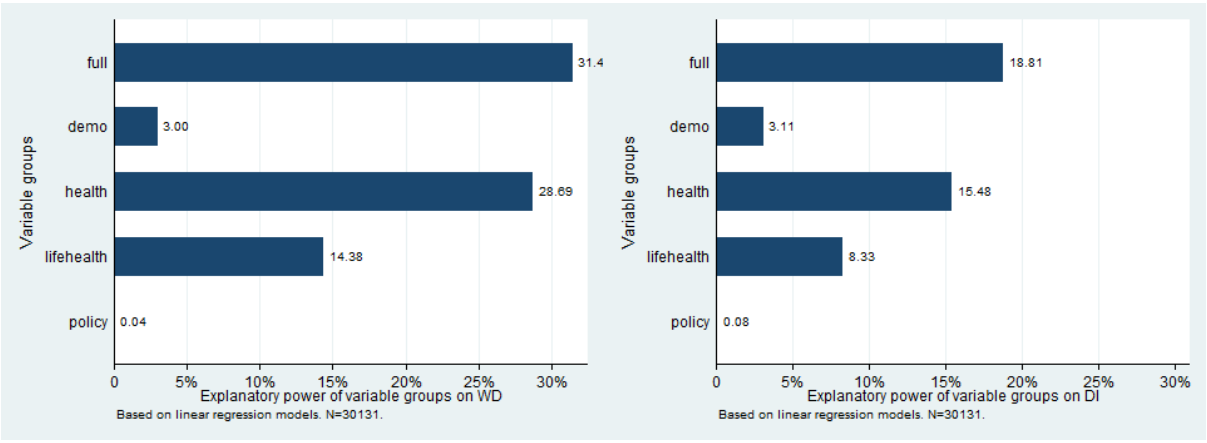
Figure 4.8 (right panel) shows how much of the variation in DI benefit receipt is explained by each variable group. The full model explains 19% of the variation in the data which is less than in the case of self-assessed work disability. However, the overall pattern is rather similar. By far the most important determinant of DI benefit receipt is individual's health: 15% of the variation is explained by the individual health variables. Health over the life course is also important. These variables explain 8% of the total variation in benefit receipt. Basic demographics account for only 3% of the variation.

[17] As a robustness check we run a probit regression with country-fixed effects instead of the OECD variables. As expected, the results for the other variable groups remain stable in size and sign. Results are reported in the appendix.

The policy indicators explain less than 1% of the individual variation in benefit receipt.

Figure 4.8: Variance decomposition for the probability of reporting WD and receiving DI

Work disability (WD) *Receipt of disability insurance (DI)*



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

4.4.3 The Role of Labor Market Conditions

In a next step we would like to understand better how the working environment and the general labor market conditions contribute to the probability of reporting a WD later in life and receive DI benefits. For this purpose we perform several additional regression analyses. Most of the variables used in this subsection are only available for a subset of countries and individuals so that we have to perform the analysis on smaller samples.

First, we are interested in the effect of general labor market conditions on work disability and DI receipt and therefore include the job strain variable as a macro-economic indicator for the quality of the working environment (see Subsection 4.2.2 for detailed description). We find no effect of the job strain indicator on WD but a significant negative effect of job strain on DI benefit receipt (see Table 4.15 in the appendix). This means that in countries classified as having a high degree of job strain fewer people receive DI benefits. This seems counter intuitive at first glance, since we would expect more individuals to receive DI benefits if the job strain is high. Most likely, however, the causal direction is reverse: in countries with restrictive DI systems people have to work even when they are disabled. This leads to a higher job strain for the age group 50-64. This is an interesting finding. In our future work, we will investigate the long term health consequences of working in an environment with a high job strain and no option to receive DI benefits, using policy changes as instruments to

tease out the correct direction of causality.

The ADA index is an indicator for the labor market flexibility (see Subsection 4.2.2 for detailed description). The ADA index is not available for the US, Switzerland and the Czech Republic, therefore our sample is reduced to 18,760 observations in this analysis. In Table 4.16 in the appendix we present probit regressions adding the ADA index as an additional explanatory variable. The ADA index is not significant for DI receipt, indicating that there is no relevant effect of labor market flexibility on DI benefit receipt at the individual level. However, a higher labor market flexibility leads to a significantly higher probability of reporting WD despite controlling for the level of DI system generosity. Looking at the ADA indicator in Table 4.8 in the appendix reveals that the ADA indicator is particularly high in Denmark with a level of 11.04. The countries with the next highest scores are Sweden and Germany. Those countries have relatively flexible labor markets creating many opportunities for the work force. At the same time, demands on the job are relatively high for those who are in worse health. This appears to lead to higher rates of WD among older workers. This effect does not transfer to DI receipt. This means that these persons continue to work despite their health limitations. More work is necessary to understand the precise interactions and causal chains among labor market environment, DI policies and long term health effects.

Besides the assessment of the work quality on a country level, we also include individual level indicators for work quality measured as the subjective assessment of the physical and psychological demands at work of the main job in the work history. These variables are not available for all respondents and we perform the regression analysis only for a small subsample of 3,472 respondents. The results are shown in Table 4.4. Low work quality both in terms of physical and psychological demands has a significantly positive effect on reporting limitations to work, meaning that low work quality in the main job increases the probability of reporting WD. This indicates that, not surprisingly, the working environment has an important effect on whether individuals feel restricted in their capacity to work. If the perceived job strain is high there is a high likelihood to report a work disability. The effect on the uptake of DI benefits is not significant, probably because the individual working environment only plays a minor role in the medical assessment to determine

benefit receipt. A more detailed examination of the interaction between job characteristics and the medical and occupational assessment rules will be desirable for future work.

Table 4.4: Probit specification with individual job characteristics

		WD	DI
Demographics	age	0.001	-0.000
		(0.001)	(0.001)
	female	0.005	-0.014
		(0.021)	(0.006)*
	education_high	-0.022	-0.019
		(0.010)*	(0.009)*
	education_medium	-0.026	-0.016
		(0.009)**	(0.005)**
	single	-0.006	0.017
		(0.023)	(0.005)**
	divorced	0.004	0.002
		(0.012)	(0.007)
	widowed	-0.024	0.012
		(0.022)	(0.015)
Health	sphus	0.069	0.018
		(0.011)**	(0.006)**
	adl	0.063	0.007
		(0.017)**	(0.002)**
	iadl	0.016	0.002
		(0.005)**	(0.004)
	maxgrip	0.000	-0.001
		(0.001)	(0.000)
	maxgrip_flag	0.006	-0.035
		(0.019)	(0.016)*
	eurod	0.009	0.003
		(0.004)*	(0.003)
	recall	0.001	-0.001
		(0.001)	(0.001)
Life health	illnesses_ch	0.018	0.002
		(0.002)**	(0.003)
	illnesses_adult	0.015	0.000
		(0.003)**	(0.002)
Policy	oecd_sum	0.008	0.005
		(0.004)*	(0.002)*
Job quality	job_psycho	0.011	0.000
		(0.003)**	(0.004)
	job_physical	0.018	0.006
		(0.003)**	(0.005)
	Pseudo R2	0.20	0.12
	N	3,472	3,472

* $p<0.05$; ** $p<0.01$
Marginal effects of probit specification.
Standard errors in parentheses, clustered standard errors by country.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA

4.4.4 The Role of Life Course Circumstances

As mentioned in the introduction, work disability may be the result of a long lasting process and therefore demographics and current health measures might not appropriately capture the effect on work ability. We already showed in our previous analysis that health conditions during childhood and adulthood matter a lot for work limitations and disability benefit receipt later in life. However, we would like to add a layer of complexity and therefore include additional life course variables about early childhood conditions and the work history. These variables are only available for SHARE and ELSA and only for respondents having participated in both wave 3 and wave 5/wave 6 of SHARE and ELSA respectively, which leads to a reduction in our sample size to 4,703 observations. The regression results are shown in Table 4.5.

More specifically, in addition to the socio-demographics, the health and the life health indicators, we include the number of gaps in the working history in which a person was sick or disabled. The results are positively significant and as expected: The more working gaps due to sickness someone experienced during their career, the higher the probability of reporting work disability and of receiving DI benefits later in life. We further include a binary variable indicating if someone had suffered from an extended period of poor health, which also has a positive and significant effect on both dependent variables. The number of jobs during the working life in general does not have a significant effect on WD. However, individuals with a particularly low number of jobs have a high likelihood of receiving DI benefits probably because they left the labor market early in their career. The socio-economic status during childhood is measured by the number of books and the number of rooms per person in the accommodation. These early childhood circumstances are not related to work disability or DI receipt. However, we already control for childhood health which might be the more important indicator of the situation in which individuals grew up, that is related to the health and working life situation when old.

Table 4.5: Probit specification with life course variables

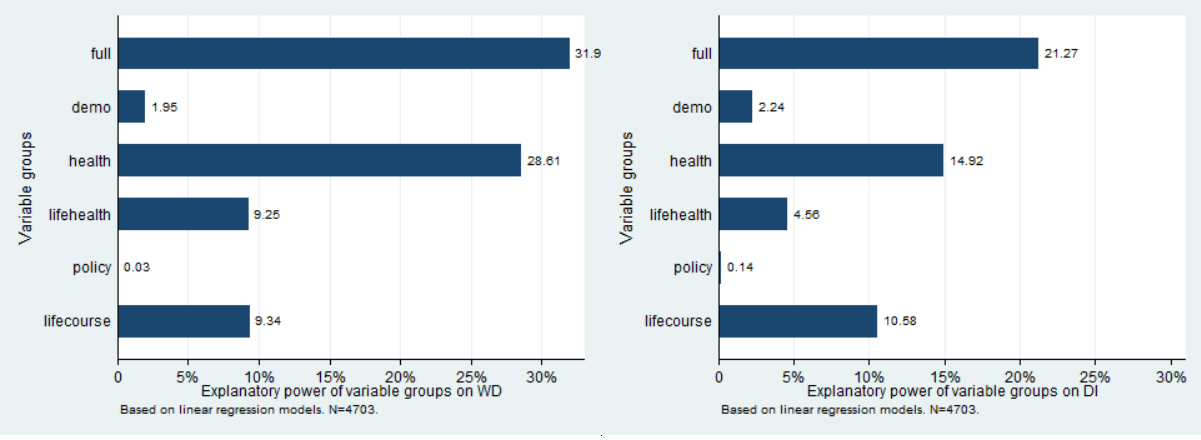
		WD	DI
Demographics	age	0.002	-0.002
		(0.002)	(0.002)
	female	-0.003	-0.046
		(0.017)	(0.015)**
	education_high	-0.017	-0.021
		(0.010)	(0.019)
	education_medium	-0.009	-0.011
		(0.012)	(0.012)
	single	0.017	0.047
		(0.015)	(0.016)**
	divorced	0.018	0.029
		(0.016)	(0.017)
	widowed	-0.058	0.027
		(0.025)*	(0.022)
Health	sphus	0.119	0.047
		(0.009)**	(0.007)**
	adl	0.071	0.013
		(0.011)**	(0.005)**
	iadl	0.045	0.027
		(0.028)	(0.010)*
	maxgrip	-0.001	-0.002
		(0.001)	(0.001)**
	maxgrip_flag	-0.027	-0.038
		(0.026)	(0.021)
	eurod	0.011	0.003
		(0.002)**	(0.003)
	recall	0.001	-0.003
		(0.002)	(0.001)*
Life health	illnesses_ch	0.019	0.002
		(0.003)**	(0.005)
	illnesses_adult	0.028	0.012
		(0.008)**	(0.006)*
Policy	oecd_sum	0.006	0.007
		(0.004)	(0.004)
Life course	working_gaps	0.080	0.066
		(0.026)**	(0.022)**
	poor_health	0.039	0.037
		(0.006)**	(0.004)**
	low_n_jobs	-0.013	-0.036
		(0.012)	(0.012)**
	high_n_jobs	0.014	0.004
		(0.009)	(0.008)
	rooms_ch	-0.001	-0.001
		(0.003)	(0.003)
	books_ch	0.003	0.001
		(0.005)	(0.004)
	Pseudo R2	0.32	0.25
	N	4,703	4,703

* $p<0.05$; ** $p<0.01$
Marginal effects of probit specification.
Standard errors in parentheses, clustered standard errors by country.
Based on ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK

In Figure 4.9 we again present the results of the variance decomposition. The full models including the life course indicators explain 32% (21%) of the total variance in case of WD (DI). As before the variables measuring current health are the most important determinants of work disability and DI benefit receipt. In case of WD life health and other life course indicators are about equally important, both sets of variables explain about 9% of the total variance each. In case of DI benefit receipt the life course indicators are even more important than the life health indicators. They account for 11% of the total variance.

Figure 4.9: Variance decomposition for the probability of reporting WD and receiving DI

Work disability (WD) *Receipt of disability insurance (DI)*



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

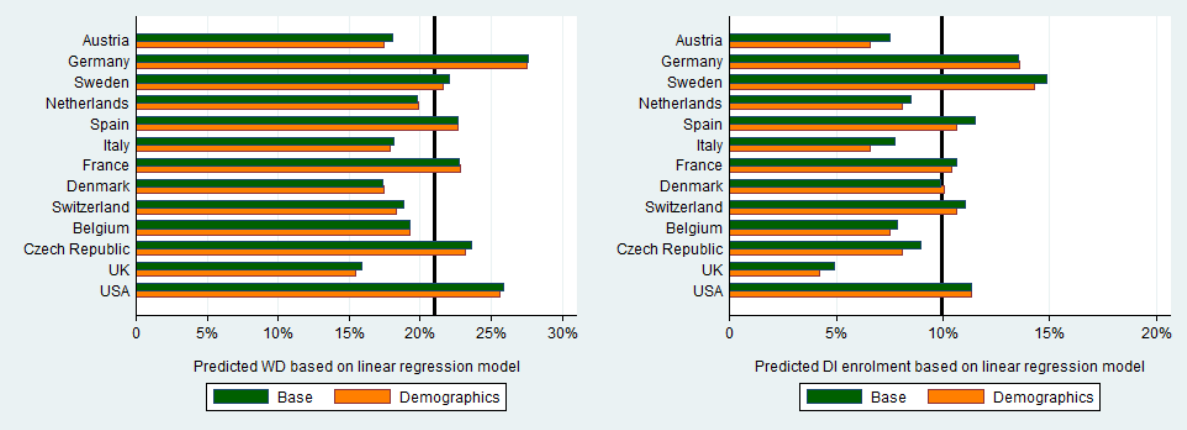
Overall, we find that individual experiences over the life course are important drivers of WD and DI benefit receipt later in life. This means that individual health, working conditions and the institutional environment that influences health and working conditions early in life, matter for health and working capacity later in life. Individuals who were sick during childhood and adulthood, who experience stressful working environments, and who have interrupted working careers due to health problems are very likely to report a reduced working capacity later in life and have to rely on DI benefits.

4.5 Between-Country Variation

Why are there so large differences in WD and DI enrolment rates between countries? While health explains a great deal of the within-country variation in early retirement at any point in time, there is

hardly any relationship between disability benefit receipt and average population health in a cross-national perspective (Börsch-Supan 2005). Moreover, there is hardly any time series correlation between old-age labor force participation and objective measures of population health such as mortality rates (Börsch-Supan and Jürges 2012). In this section we analyze the between-country variation in WD and DI enrolment rates. Our first step is to normalize self-reported work disability and DI enrolment with respect to demographic differences across countries. Italy, for instance, has an older population than the European average, while Denmark has a younger population. We take out demographic differences by first establishing the influence of age, gender, marital status and education on work disability and DI take up. We then predict which share of our sample would report a WD and take up DI benefits if all countries had the same demographic distribution as the average of all countries. The results for DI and WD are shown in Figure 4.10, comparing the counterfactual simulation results to the baseline results.

Figure 4.10: Counterfactual simulation for demographics



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

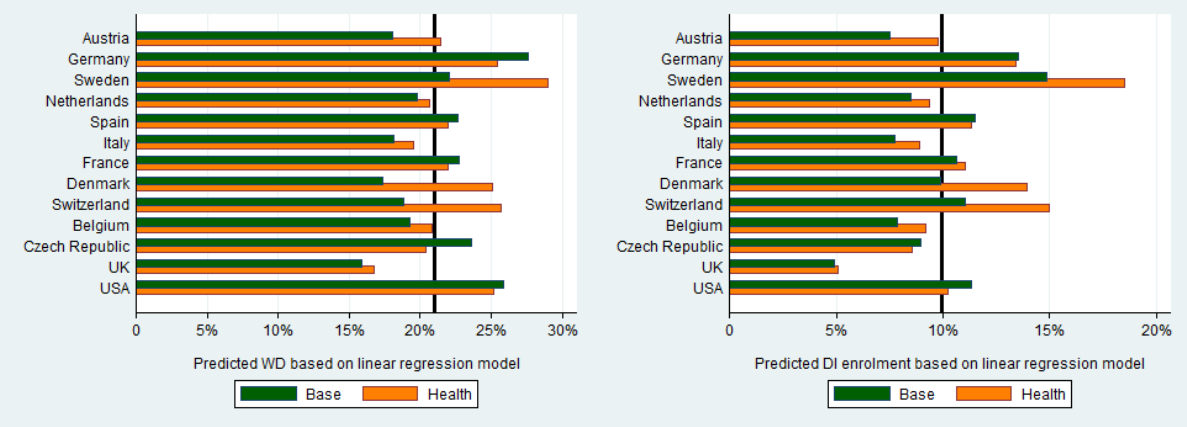
Taking account of demographic differences does not make a substantive difference neither in the DI enrolment rates nor in the self-assessment of WD. Therefore, demographic differences across Europe and the US can be ruled out as the main cause of the between-country variation.

Our second step is to account for differences in the health status of the population by first establishing the influence of health on work disability and disability insurance take up, and then predict which share of our sample individuals would report being disabled or would take up disability insurance if the health status measured along the different dimensions would be identical to the

average of our countries. The results are shown in Figure 4.11.

Equalizing all current health measures generates more changes in the variation of WD and DI receipt than equalizing demographics. In countries with a good average population health, such as Sweden, Denmark and Switzerland, both WD rates and DI enrolment rates would be much higher if they had the same average health status. Countries with worse population health like the US reveal lower rates of DI uptake when simulating a relatively better health status. If health would be the main determinant for the variation of DI enrolment rates, the predicted counterfactual rates would be equal around the average DI rate of 9%. As we can see, the counterfactual DI rates do not approach the mean DI rate, meaning that differences in health cannot be the explanation behind the between-country variation of WD and DI benefit receipt.

Figure 4.11: Counterfactual simulation for health

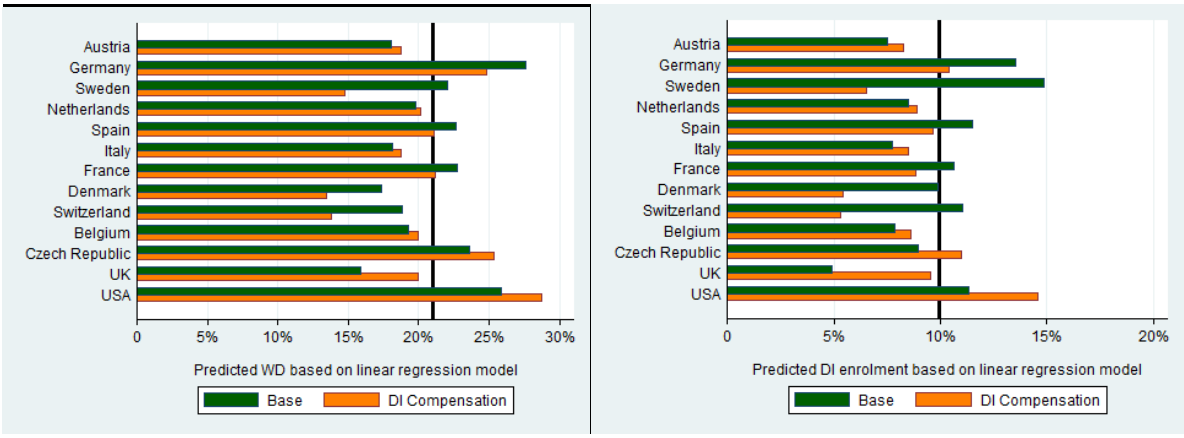


Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

The last counterfactual simulation is based on equalizing DI institutions across countries, i.e. we level the OECD policy summary indicator for all countries and then predict WD and the DI enrolment rates.[18] Thus, the institutional environment in countries like the UK and the US is assumed to become more generous, while countries like Sweden or Denmark become less generous when granting DI benefits. Figure 4.12 shows the predicted rates if the system characteristics were identical to the average in all countries of our cross-national sample.

[18] We also did the same exercise using the five subscales of the OECD policy indicator and the results are the same.

Figure 4.12: Counterfactual simulation for OECD policy indicators



Source: Own calculations based on weighted data from SHARE Wave 5, ELSA Wave 6, HRS Wave 11.

The pattern of DI uptake rates changes strikingly when equalizing the policy variables. In most countries, the counterfactual simulation leads to DI enrolment rates that approach the overall average DI rate. Exceptions are the most generous and at the same time the healthiest countries like Sweden, Switzerland and Denmark, where the simulated DI enrolment rates decrease far below the average DI rate of 9%. The contrary holds for the US which has one of the most restrictive DI regulations and on average an unhealthy population. In this case applying the average degree of generosity would increase the incentives to enroll in DI benefits and the simulated DI uptake rates grow up to 15%. Similar, but less pronounced effects can be found for the variation in self-reported work disability.

4.6 Conclusions and Outlook

The objective of disability insurance (DI) is to provide basic protection for those who suffer from work disabilities (WD). This protection has two dimensions: protection from poverty by income support and protection from deteriorating health by permitting individuals to retire early. This study has evaluated both of the objectives of DI using harmonized data from SHARE, ELSA and HRS.

At the individual level within each of the 13 countries in this study, we found strong and equi-directional effects of current health and socio-demographic circumstances on reporting WD and receiving DI benefits.

Moreover, health experienced early in life matters a great deal for reported WD and DI receipt later

in life. The life health variables are statistically highly significant and have large effect sizes. They are the second most important group of variables explaining WD and DI after current health indicators. Thus, health problems experienced over the life course are important drivers of later life working capacity and the need to rely on DI benefits. Even illnesses experienced in childhood have long term consequences. Social expenditures on health of children are therefore well spent since they do not only improve health but also have very long-term benefits for the onset of work disabilities and ultimately the reliance of DI benefit receipt.

Already on an individual level, we find that DI institutions matter for DI receipt. More generous systems increase the likelihood of getting DI pensions holding health and socio-demographic indicators constant. However, on the individual level the variables measuring DI generosity are much less important in explaining reported WD and DI uptake compared to the variables measuring individual health as our variance decompositions show.

The individual job situation matters for reporting a work limitation both at the individual and the macro level. However, there is no effect on the benefit receipt.

At the country level, the picture is dominated by factors describing the generosity of the DI systems while country differences in demographic characteristics such as population aging and health differences contribute very little in explaining the international variation in DI benefit receipt. In our counterfactual simulation exercises, DI enrolment rates approach the average DI rate when the policy variables are equalized. Exceptions are the healthiest and most generous countries such as Sweden, Switzerland and Denmark on the one hand, and the least healthy and most restrictive country, the US, on the other hand.

The large country differences may not be due to DI policies alone. More work is necessary to understand the precise interactions and causal chains among labor market environment, DI policies and long term health effects, as well as the interactions between job characteristics and the medical and occupational assessment rules.

Given the large differences in the generosity and the prevalence of DI, and given the large costs of DI, the obvious next question is then whether the added expenses are well spent. Does a generous DI

system improve individuals' wellbeing and health? Will this permit re-integration into the labor market? Further research is also needed to better understand which countries are successful by providing special employment programs or flexible work schemes following up on DI benefit receipt.

4.7 Appendix

A. Contextual Information

Table 4.6: DI system indicators per country

1985	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Benefit_system_coverage	5	3	5	3	2	3	4	1	5	5	n.a.	3	3
Minimum_disability_benefit	5	2	3	2	3	2	5	4	4	3	n.a.	1	1
Disability_benefit_generosity	1	1	4	3	2	3	5	4	5	4	n.a.	1	3
Medical_assessment_rules	3	2	4	2	4	2	1	0	4	5	n.a.	3	4
Vocational_assessment_rules	2	4	2	4	5	5	4	5	2	2	n.a.	5	1
SUM	16	12	18	14	16	15	19	14	20	19	n.a.	13	12

OECD (2003)

2000	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Benefit_system_coverage	2	3	5	3	2	3	4	3	5	5	n.a.	3	3
Minimum_disability_benefit	3	2	3	2	5	2	5	4	5	4	n.a.	1	1
Disability_benefit_generosity	2	1	4	3	2	3	5	4	5	4	n.a.	1	3
Medical_assessment_rules	1	2	3	2	3	1	1	0	3	4	n.a.	3	4
Vocational_assessment_rules	5	4	1	4	3,5	3	1	3	1	2	n.a.	1,5	1
SUM	13	12	16	14	15,5	12	16	14	19	19	n.a.	9,5	12

OECD (2003)

2007	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Benefit_system_coverage	2	3	5	3	3	3	4	3	5	5	1	3	3
Minimum_disability_benefit	3	2	2	2	5	2	4	4	5	4	4	1	0
Disability_benefit_generosity	2	1	3	3	2	3	3	4	5	3	3	1	3
Medical_assessment_rules	1	2	4	2	3	1	1	0	3	3	2	3	4
Vocational_assessment_rules	4	4	2	4	2	3	0	3	1	2	1	1	0
SUM	12	12	16	14	15	12	12	14	19	17	11	9	10

OECD (2010)

Table 4.7: Job Strain Index for age group 50-64 in percentage

	Job Strain	Job Strain					
		High level of job demands	High level of job demands		Low level of job resources	Low level of job resources	
			Time pressure	Physical health risk factors		Work autonomy and learning opportunities	Social support at work
Austria	38.55	26.94	63.23	34.17	40.36	33.15	51.60
Belgium	40.42	22.47	52.66	33.21	44.62	31.35	34.96
Czech Republic	43.80	17.07	53.51	22.56	57.04	26.99	23.61
Denmark	25.03	13.45	51.69	19.58	29.14	38.52	53.42
France	42.66	16.17	28.56	46.04	62.49	24.74	21.07
Germany	53.88	22.18	64.30	29.94	64.05	17.85	25.85
Italy	48.23	12.92	42.89	26.34	79.07	16.63	6.41
Netherlands	20.73	9.66	39.61	18.07	44.91	26.80	42.89
Spain	53.88	22.94	51.15	40.44	63.72	12.27	30.87
Sweden	18.80	16.50	43.35	23.69	23.63	58.78	38.26
Switzerland	30.61	17.27	59.02	20.15	35.56	44.61	42.64
United Kingdom	36.44	17.86	51.31	27.95	44.18	29.38	47.01
United States	28.88	20.43	53.49*	35.57	28.71	33.77	41.81*

Source: OECD (2005) with calculations from European Working Conditions Surveys (EWCSs) and International Social Survey Programme (ISSP).

**not available for age group 50-64, replaced by value for total population*

Table 4.8: ADA index per country

	PR INDEX	**TR INDEX**	**MOB INDEX**	**(PR+TR)*MO**	**S**	**ADA INDEX S*[(PR*TR)*MO] SCALED**
Austria	5.2	2.0	7.17	51.7	67.9	3.96
Belgium	5.8	2.9	5.35	46.5	61.5	3.22
Denmark	7.6	5.6	9.73	128.0	76.5	11.04
France	5.2	2.7	6.65	52.7	62.4	3.70
Germany	6.8	7.7	6.40	92.4	65.5	6.82
Italy	3.4	0.9	4.56	19.6	54.5	1.20
Netherlands	6.5	3.2	6.92	67.2	74.1	5.62
Spain	3.4	4.2	5.17	39.0	56.6	2.49
Sweden	6.9	9.7	5.27	87.7	72.2	7.14
United Kingdom	3.6	2.7	7.83	49.6	71.6	4.00

Source: Boeri et al. (2002)

Table 4.9: Definition of statutory retirement ages per country

	Women	**Men**
Austria	60	65
Belgium	60 if year of birth <1936 61 if year of birth >=1936 & <1938 62 if year of birth >=1938 & <1940 63 if year of birth >=1940 & <1942 64 if year of birth >=1942 & <1944 65 if year of birth >=1942 & <1944 65 if year of birth >=1944	65
Czech Republic	57 if year of birth <1941 58 if year of birth >=1941 & <1944 59 if year of birth >=1944 & <1947 60 if year of birth >=1947 & <1950 61 if year of birth >=1950 & <1953 62 if year of birth >=1953 & <1956 63 if year of birth >=1956	60 if year of birth <1941 61 if year of birth >=1941 & <1947 62 if year of birth >=1947 & <1953 63 if year of birth >=1953 & <1959 64 if year of birth >=1959 & <1965 65 if year of birth >=1965 & <1971 66 if year of birth >=1971 & <1977 67 if year of birth >=1977
Denmark	65 67 if year of birth <=1939	65 67 if year of birth <=1939
France	65 if year of birth <=1919 60 if year of birth >=1951	65 if year of birth <=1919 60 if year of birth >=1951
Germany	65 if year of birth<1958	65 if year of birth<1958
Italy	55 if year of birth <1939 56 if year of birth =1939 57 if year of birth =1939 58 if year of birth =1940 59 if year of birth =1940 60 if year of birth >=1941	60 if year of birth <1934 61 if year of birth =1934 62 if year of birth =1934 63 if year of birth =1935 64 if year of birth =1935 65 if year of birth >=1936
Netherlands	65	65
Spain	65	65
Sweden	65	65
Switzerland	62 63 if year of birth >=1956	65
United Kingdom	60 if year of birth<1951 61 if year of birth<1952	65
United States	65 if year of birth <=1937 66 if year of birth >=1937 & <1943 67 if year of birth >=1943	65 if year of birth <=1937 66 if year of birth >=1937 & <1943 67 if year of birth >=1943

Source: Own elaboration based on country-specific legal regulations

Table 4.10: Definition of disability benefits

Austria	Staatliche Invaliditäts- bzw. Berufsunfähigkeitspension, Versehrtenrente oder Krankengeld (aus der Haupt- und Nebenbeschäftigung)
Belgium	Wettelijke/ Aanvullende uitkering bij ziekte of invaliditeit of wettelijke uitkering bij beroepsziekte of arbeidsongeval; Une allocation/pension maladie/invalidité/incapacité légale, Une deuxième assurance maladie/invalidité/incapacité légale
Czech Republic	Státní invalidní důchod, nemocenské dávky
Switzerland	Rente de l''assurance invalidité (AI); Rente der Invalidenversicherung (IV); Rendita invalidità AI
Germany	Erwerbsminderungsrente bzw. Beamtenpension wegen Dienstunfähigkeit, oder Krankengeld
Denmark	Førtidspension, herunder sygedagpenge
Spain	Pensión pública de invalidez/incapacidad o prestación pública por enfermedad, Segunda pensión pública de invalidez/incapacidad o segunda prestación pública por enfermedad; Pensió pública d''invalidesa / incapacitat o prestació pública per malaltia, Segona pensió pública d''invalidesa / incapacitat o segona prestació pública per malaltia
France	Une pension d'invalidité publique (y c. rente d'accident du travail et allocation supplémentaire d'invalidité)
Italy	Indennità pubblica di disabilità; pensione di invalidità, incapacità (incluso assegno di accompagnamento)
Netherlands	WAO, Waz, WIA, of ander invaliditeitspensioen
Sweden	Sjukersättning (förtidspension) eller sjukpenning
England	Incapacity benefits (previously invalidity benefits), Employment and Support Allowance, Severe Disablement Allowance SDA, Statutory sick pay SSP, Attendance Allowance, Disability Living Allowance, Industrial Injuries Disablement benefits
United States	SSDI and SSI disability pension

Source: Country-specific SHARE questionnaires

Table 4.11: Overview of variable groups used in regression analyses

Group	Variable	Description	Range	Categories	Available in SHARE	Available in ELSA	Available in HRS
Demographics	age	Age at time of interview	20-89	20-89	yes	yes	yes
	female	Gender	0-1	0. Male 1. Female	yes	yes	yes
	Education_low	Education category	0-1	0. Not in low education category 1. In low education category (ISCED 0-2)	yes	yes	yes
	education_medium	Education category	0-1	0. Not in medium education category 1. In medium education category (ISCED 3-4)	yes	yes	yes
	education_high	Education category	0-1	0. Not in high education category 1. In high education category (ISCED 5-6)	yes	yes	yes
	single	Currently not married, divorced or widowed	0-1	0. Not single 1. Single	yes	yes	yes
	married	Currently married	0-1	0. Not married 1. Married	yes	yes	yes
	divorced	Currently divorced	0-1	0. Not divorced 1. Divorced	yes	yes	yes
	widowed	Currently widowed	0-1	0. Not widowed 1. Widowed	yes	yes	yes
Health	sphus	Self-reported health	1-5	1. Excellent 2. Very good 3. Good 4. Fair 5. Poor	yes	yes	yes
	iadl	IADL: number of limitations with instrumental activities of daily living	0-6	Difficulties with: Using a map, preparing a hot meal, shopping for groceries, making telephone calls, taking medications and managing money	yes	yes	yes
	adl	ADL: number of limitations with activities of daily living	0-6	Difficulties with: Dressing, eating, using the toilet, bathing and showering, getting in and out of bed, walking across a room	yes	yes	yes
	recall	Ten words list learning – sum first and delayed recall	0-10	0-10	Yes	yes	yes
	maxgrip	Maximal Grip Strength (Kg)	0.5 - 90	0.5 – 90	yes	yes	yes
	maxgrip_flag	Flag variable if missing value was imputed	0-1	0. No value was imputed 1. Missing value was replaced by zero	yes	yes	yes
	eurod	Depression scale	0-11	0-11	yes	from cesd	from cesd
	lim_work	Health problem that limits paid work	0-1	0. No 1. Yes	yes	yes	yes
Life health	illnesses_ch	Childhood Illnesses	0-9	0-9	yes	yes	Yes
	illnesses_adult	Adulthood Illnesses	0-9	0-9	yes	yes	yes
Lifecourse others	working_gaps	Working gaps due to sickness	0-2	0-2	yes	yes	no

Group	Variable	Description	Range	Categories	Available in SHARE	Available in ELSA	Available in HRS
	poor_health	Number of period of very poor health	0-5	0. None 1. One 2. Two 3. Three 4. More than three 5. Have been ill or with disabilities for all or most of my life	yes	yes	no
	rooms_ch	Number of rooms when ten years old	0-50	0-50	yes	yes	No
	books_ch	Number of books when ten years old	1-5	1. None or very few (0-10 books) 2. Enough to fill one shelf (11-25 books) 3. Enough to fill one bookcase (26-100 books) 4. Enough to fill two bookcases (101-200 books) 5. Enough to fill two or more bookcases (more than 200 books)	yes	yes	No
	job_physical	Physical Demand of Work	0-1	0. No physical demand at work 1. Physical demand at work	yes	yes	Yes
	job_psycho	Psychological Demand of Work	0-1	0. No psychological demand at work 1. Psychological demand at work	yes	yes	yes
	low_n_jobs	Number of jobs over lifetime	0-1	0. Not having had a low number of jobs 1. Having had a low number of jobs (0-2)	yes	yes	yes
	medium_n_jobs	Number of jobs over lifetime	0-1	0. Not having had a medium number of jobs 1. Having had a medium number of jobs (3-4)	yes	yes	yes
	high_n_jobs	Number of jobs over lifetime	0-1	0. Not having had a high number of jobs 1. Having had a high number of jobs (>5)	yes	yes	yes
Policy	oecd_coverage	Benefit system coverage	0-5	0. Employees 1. Labour force 2. Labour force with voluntary self-insurance 3. Labour force plus means-tested non-contr. scheme 4. Some of those out of the labour force (e.g. congenital) 5. Total population (residents)	Not for Estonia, Israel, Slovenia	yes	Yes
	oecd_minimum	Minimum disability benefit	0-5	0. 86-100% 1. 71-85% 2. 56-70% 3. 41-55% 4. 26-40% 5. 0-25%	Not for Estonia, Israel, Slovenia	yes	Yes
	oecd_di_generosity	Disability benefit generosity	0-5	0. RR < 50%, minimum not specified 1. RR < 50%, reasonable minimum 2. 75 > RR > = 50%,	Not for Estonia, Israel, Slovenia	yes	Yes

Group	Variable	Description	Range	Categories	Available in SHARE	Available in ELSA	Available in HRS
				minimum not specified 3. 75 > RR > = 50%, reasonable minimum 4. RR > = 75%, minimum not specified 5. RR > = 75%, reasonable minimum			
	oecd_medical	Medical assessment rules	0-5	0. Insurance team and two-step procedure 1. Team of experts in the insurance 2. Insurance doctor exclusively 3. Insurance doctor predominantly 4. Treating doctor predominantly 5. Treating doctor exclusively	Not for Estonia, Israel, Slovenia	yes	Yes
	oecd_vocational	Vocational assessment rules	0-5	0. All jobs available taken into account, strictly applied 1. All jobs available taken into account, leniently applied 2. Current labour market conditions are taken into account 3. Own-occupation assessment for partial benefits 4. Reference is made to one's previous earnings 5. Strict own or usual occupation assessment	Not for Estonia, Israel, Slovenia	yes	Yes
	oecd_sum	Sum of five OECD indicators	9-20	9-20	Not for Estonia, Israel, Slovenia	yes	Yes
Macro	job_strain	Share of persons per country in high strain jobs	18.8-53.88	18.8-53.88	Yes	yes	yes
	ada_index	Degree of labor market flexibility per country	1.2-11.04	1.2-11.04	Not for Switzerland and Czech Republic	yes	No

B. Figures and Tables

Table 4.12: Determinants of WD and DI - linear specification

	WD	DI
age	0.001	-0.000
	(0.002)	(0.001)
female	-0.037	-0.042
	(0.007)**	(0.005)**
education_high	-0.015	-0.034
	(0.011)	(0.014)*
education_medium	-0.000	-0.020
	(0.011)	(0.013)
single	0.026	0.061
	(0.007)**	(0.009)**
divorced	0.043	0.055
	(0.008)**	(0.006)**
widowed	0.025	0.043
	(0.017)	(0.016)*
sphus	0.115	0.043
	(0.013)**	(0.011)**
adl	0.085	0.047
	(0.006)**	(0.005)**
iadl	0.036	0.054
	(0.007)**	(0.006)**
maxgrip	-0.002	-0.002
	(0.000)**	(0.000)**
maxgrip_flag	-0.049	-0.056
	(0.021)*	(0.015)**
eurod	0.022	0.008
	(0.002)**	(0.002)**
recall	0.000	-0.001
	(0.001)	(0.001)
illnesses_ch	0.021	0.019
	(0.005)**	(0.003)**
illnesses_adult	0.056	0.034
	(0.004)**	(0.004)**
oecd_sum	0.011	0.013
	(0.005)*	(0.006)*
_cons	-0.374	-0.159
	(0.107)**	(0.114)
Adjusted R2	0.31	0.19
N	30,131	30,131

* $p<0.05$; ** $p<0.01$
Based on linear regression specification.
Standard errors in parentheses, clustered standard errors by country.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA
Reference categories: Male, low education, married, medium number of jobs, no period of poor health

Table 4.13: Probit specification with country-fixed effects

	WD	DI
age	0.001	-0.000
	(0.002)	(0.001)
female	-0.035	-0.037
	(0.008)**	(0.007)**
education_high	-0.033	-0.040
	(0.009)**	(0.008)**
education_medium	-0.008	-0.011
	(0.009)	(0.004)**
single	0.020	0.051
	(0.005)**	(0.008)**
divorced	0.032	0.040
	(0.005)**	(0.006)**
widowed	0.022	0.038
	(0.015)	(0.010)**
sphus	0.108	0.046
	(0.014)**	(0.008)**
adl	0.065	0.015
	(0.011)**	(0.002)**
iadl	0.025	0.019
	(0.008)**	(0.002)**
maxgrip	-0.002	-0.002
	(0.000)**	(0.000)**
maxgrip_flag	-0.052	-0.059
	(0.009)**	(0.008)**
eurod	0.015	0.005
	(0.002)**	(0.001)**
recall	-0.001	-0.002
	(0.000)**	(0.001)**
illnesses_ch	0.014	0.011
	(0.003)**	(0.001)**
illnesses_adult	0.044	0.024
	(0.005)**	(0.002)**
AT	0.017	0.043
	(0.007)*	(0.002)**
DE	0.063	-0.006
	(0.009)**	(0.004)
SE	0.072	0.140
	(0.004)**	(0.003)**
NL	0.070	0.060
	(0.009)**	(0.002)**
ES	-0.032	-0.015
	(0.013)*	(0.002)**
IT	-0.102	-0.068
	(0.011)**	(0.003)**
FR	0.033	-0.045
	(0.011)**	(0.002)**
DK	0.160	0.089
	(0.004)**	(0.003)**
CH	0.002	0.013
	(0.005)	(0.003)**
BE	0.043	0.060
	(0.007)**	(0.002)**
CZ	0.034	0.084
	(0.016)*	(0.004)**
UK	0.036	0.044
	(0.007)**	(0.003)**
Pseudo R2	0.31	0.26
N	30,131	30,131

* $p<0.05$; ** $p<0.01$
Marginal effects of probit specification.
Standard errors in parentheses, clustered standard errors by country.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA
Reference category: USA

Table 4.14: Probit specification with five single OECD indicators

	WD	DI
age	0.001	0.001
	(0.002)	(0.001)
female	-0.030	-0.035
	(0.007)**	(0.005)**
education_high	-0.029	-0.044
	(0.007)**	(0.011)**
education_medium	-0.012	-0.022
	(0.009)	(0.006)**
single	0.020	0.052
	(0.006)**	(0.008)**
divorced	0.033	0.045
	(0.007)**	(0.004)**
widowed	0.023	0.036
	(0.015)	(0.012)**
sphus	0.109	0.045
	(0.016)**	(0.010)**
adl	0.066	0.016
	(0.011)**	(0.002)**
iadl	0.025	0.021
	(0.008)**	(0.002)**
maxgrip	-0.002	-0.002
	(0.000)**	(0.000)**
maxgrip_flag	-0.052	-0.052
	(0.011)**	(0.012)**
eurod	0.014	0.005
	(0.001)**	(0.001)**
recall	-0.001	-0.001
	(0.000)*	(0.001)
illnesses_ch	0.016	0.015
	(0.003)**	(0.003)**
illnesses_adult	0.042	0.021
	(0.005)**	(0.005)**
oecd_coverage	0.018	0.001
	(0.016)	(0.015)
oecd_minimum	0.016	0.016
	(0.007)*	(0.014)
oecd_di_generosity	-0.010	0.013
	(0.007)	(0.017)
oecd_medical	0.027	0.025
	(0.013)*	(0.016)
oecd_vocational	0.007	0.013
	(0.010)	(0.013)
Pseudo R2	0.31	0.24
N	30,131	30,131

* $p<0.05$; ** $p<0.01$
Marginal effects of probit specification.
Standard errors in parentheses, clustered standard errors by country.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA

Table 4.15: Probit specification including Job Strain Index

	WD	DI
age	0.001	-0.000
	(0.002)	(0.001)
female	-0.029	-0.038
	(0.006)**	(0.007)**
education_high	-0.019	-0.044
	(0.010)	(0.010)**
education_medium	0.000	-0.018
	(0.009)	(0.006)**
single	0.019	0.047
	(0.005)**	(0.008)**
divorced	0.033	0.042
	(0.006)**	(0.005)**
widowed	0.024	0.036
	(0.014)	(0.011)**
sphus	0.111	0.049
	(0.016)**	(0.011)**
adl	0.067	0.016
	(0.011)**	(0.003)**
iadl	0.024	0.019
	(0.009)**	(0.002)**
maxgrip	-0.002	-0.002
	(0.000)**	(0.000)**
maxgrip_flag	-0.049	-0.064
	(0.014)**	(0.013)**
eurod	0.014	0.005
	(0.001)**	(0.001)**
recall	-0.000	-0.002
	(0.001)	(0.001)*
illnesses_ch	0.017	0.013
	(0.003)**	(0.002)**
illnesses_adult	0.041	0.020
	(0.005)**	(0.003)**
oecd_sum	0.010	0.010
	(0.005)	(0.004)*
job_strain	-0.002	-0.002
	(0.001)	(0.001)**
Pseudo R2	0.30	0.24
N	30,131	30,131

* $p<0.05$; ** $p<0.01$
Marginal effects of probit specification.
Standard errors in parentheses, clustered standard errors by country.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA

Table 4.16: Probit specification including ADA index

	WD	DI
age	-0.001	0.001
	(0.001)	(0.001)
female	-0.044	-0.042
	(0.011)**	(0.006)**
education_high	-0.036	-0.032
	(0.005)**	(0.009)**
education_medium	-0.015	-0.015
	(0.004)**	(0.010)
single	0.017	0.045
	(0.008)*	(0.009)**
divorced	0.039	0.042
	(0.009)**	(0.006)**
widowed	-0.003	0.019
	(0.013)	(0.009)*
sphus	0.126	0.047
	(0.002)**	(0.008)**
adl	0.052	0.015
	(0.013)**	(0.006)**
iadl	0.018	0.022
	(0.014)	(0.005)**
maxgrip	-0.002	-0.002
	(0.000)**	(0.000)**
maxgrip_flag	-0.034	-0.039
	(0.016)*	(0.010)**
eurod	0.015	0.005
	(0.002)**	(0.002)**
recall	-0.000	0.000
	(0.001)	(0.001)
illnesses_ch	0.015	0.017
	(0.005)**	(0.004)**
illnesses_adult	0.033	0.017
	(0.003)**	(0.004)**
oecd_sum	-0.003	0.008
	(0.002)	(0.007)
ada_index	0.023	0.006
	(0.002)**	(0.004)
Pseudo R2	0.30	0.21
N	18,760	18,760

* $p<0.05$; ** $p<0.01$
Marginal effects of probit specification.
Standard errors in parentheses, clustered standard errors by country.
Based on HRS, ELSA and SHARE including the following countries:
AT, DE, SE, NL, ES, IT, FR, DK, CH, BE, CZ, UK, USA

5. Does Disability Insurance Improve Health and Well-being?

This chapter has been written in co-authorship with Axel Börsch-Supan and Tabea Bucher-Koenen.[19]

5.1 Introduction

The purpose of disability insurance (DI) is to protect people who develop functional impairments that limit their ability to work (referred to as "work disability"). The protection is twofold. First, DI provides compensation payments for the forgone earnings if work disabled individuals cannot participate in the labor market to the full extent. These payments ensure income security by providing the affected individuals with basic financial means to cover the living costs. Second, in many countries DI protects work disabled individuals from being excluded from economic and social life. These integrational measures aim at encouraging and supporting work disabled persons to participate in social activities and, arguably even more important, to find adequate occupations in the labor market. DI programs form a substantial part of the social expenditures in most industrialized countries. It is therefore of special policy relevance to evaluate the effectiveness of DI benefit programs in delivering protection for those people who develop functional impairments that limit their ability to work. This paper takes advantage of internationally harmonized panel data and the differences across DI programs in Europe and the United States as well as their changes over time to estimate the effect of receiving DI benefits on health and well-being.

Since the mid-1990s, there have been incisive reforms to reduce the generosity of the DI systems in

[19] Acknowledgments:

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This paper uses data from SHARE Waves 1, 2, 3 (SHARELIFE), 4, 5 and 6 (DOIs: 10.6103/SHARE.w1.600, 10.6103/SHARE.w2.600, 10.6103/SHARE.w3.600, 10.6103/SHARE.w4.600, 10.6103/SHARE.w5.600, 10.6103/SHARE.w6.600), 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 Max Planck Society for the Advancement of Science, 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, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

The ELSA data were made available through the UK Data Archive. ELSA was developed by a team of researchers based at the NatCen Social Research, University College London and the Institute for Fiscal Studies. The data were collected by NatCen Social Research. The funding is provided by the National Institute of Aging in the United States, and a consortium of UK government departments co-ordinated by the Office for National Statistics. The developers and funders of ELSA and the Archive do not bear any responsibility for the analyses or interpretations presented here.

The HRS (Health and Retirement Study) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan.

many countries. They mainly lowered DI generosity along two dimensions: Stronger screening mechanisms with stricter eligibility rules aiming at reducing the number of DI claimants and lower replacement rates aiming at decreasing the amount of DI payments. A key question is whether these generosity reductions have an impact on health and well-being.

Relatively little research has been devoted to this issue. García-Gomez and Gielen (2014) investigate a Dutch reform of the DI system and find that stricter eligibility rules lead to greater rates of hospitalization and mortality. Gelber et al. (2017) look at the effect of DI payments by exploiting a discontinuity in the benefit formula in the US. They find that higher DI payments reduce the mortality rates. These studies show that the design of a DI system can have far-reaching impact on the life circumstances of disabled persons and therefore reflects the importance to study the effect of DI payments on health and well-being on an individual level.

More work has been done regarding the health effects of labor force withdrawal in relation to retirement – which for some countries includes the path via DI. Such exits from the labor market are regarded as incisive life events since they do not only affect the daily routines, but can have severe impact on the financial situation and the physical health and mental well-being of a person (Rohwedder and Willis 2010, Coe and Zamarro 2011, Bonsang et al. 2012, Mazzonna and Peracchi 2012). Some of these studies show a negative impact of labor force withdrawal on cognition, others a positive effect on physical health. They do not, however, address the specific effects of labor force withdrawal that is induced by work disability and ensuing DI benefit receipt. Especially given the high prevalence of DI benefit receipt in many countries, surprisingly little is known about the impact of disability benefits on the personal circumstances of the claimants. This project aims at filling this research gap by analyzing the effect of labor market inactivity in conjunction with work disability and DI program participation. More specifically, we evaluate people's health and well-being after the take-up of DI benefits in comparison to work disabled persons who do not receive DI benefits.

We add to the existing literature by evaluating the effect of DI benefits on different measures of health and well-being based on extensive individual level panel data for different European countries, and the US. For this purpose we harmonize data from three different surveys: The Survey

of Health Ageing and Retirement in Europe (SHARE), The English Longitudinal Study of Ageing (ELSA) and the US Health and Retirement Study (HRS). Further, we are able to illustrate the effect on health for those who report a work disability but do not receive DI benefits. This helps in reflecting the possible consequences of stricter eligibility rules on the health of denied DI claimants. Our main research interest is: How does health and well-being develop after someone becomes work disabled? How does DI benefits receipt influence this development? Do the compensation payments provide enough support to improve or at least stabilize the medical conditions? On the country level, we are interested in the interplay between the generosity level of a country and the impact of DI benefits on health. Does a generous DI system improve individuals' health and well-being more or less? We will also evaluate the integration policies in the different countries and analyze to which extent disabled persons can be re-integrated into the labor market.

The estimation of the causal effect of DI benefit receipt on physical and mental health as well as for psychological and financial well-being is challenging because of two underlying econometric problems. First, there is reverse causality due to the fact that DI benefits may not only change health and well-being but DI benefit uptake is also determined by health status. Second, even with modern microdata at hand, there are unobserved variables that influence both DI uptake and health. This creates a selectivity problem since the initial health status of those who receive DI benefits and of those who do not may not be observed. This problem is related to self-selection into the DI application process. Depending on the parameters of this process, individuals decide whether it is worth to apply for DI benefits or not. An endogeneity problem arises if the decision to apply for DI benefits is influenced by a variable that is also correlated with the outcome of interest, such as health. For example, health literacy and knowledge of the health care and DI systems are hard to measure. Knowledgeable individuals have a higher probability to successfully apply for DI benefits. At the same time, knowledgeable individuals might also be more likely to experience a fast recovery from a work disability.

More formally, the aim of this paper is to estimate the causal effect of DI receipt (DI) on a measure of

health[20] (Y). Consider an individual i who receives DI benefits at time t (in the language of experiments: "is a member of the treatment group"). The effect of the treatment DI is defined as the difference between the potential health outcome Y_{it}^1 when individual i is receiving DI benefits and the potential outcome Y_{it}^0 when individual i is not receiving DI benefits (in the language of experiments: "is a member of the control group"). It is not possible to observe both outcomes on the same individual at the same time; therefore, we cannot directly estimate the individual level causal effect $Y_{it}^1 - Y_{it}^0$. If DI benefits were randomly assigned, we could estimate the average treatment effect $E(Y_{it}^1 - Y_{it}^0)$ as the differences in average health between the treatment and the control group. Due to reverse causality and self-selection, however, this will lead to biased results.

We use two approaches to obtain unbiased estimates of the treatment effect. The first approach instruments the treatment variable DI. We exploit the variation in the share of DI recipients over country, time, age, and gender as instrumental variable. The intuition is that the share of DI recipients reflects the current policy situation and the generosity of a DI system. The temporal variation in the instrument captures the effect of reforms and changes in the DI policies. Previous work has shown that the variation in DI uptake rates across countries is to a large extent explained by institutional factors rather than differences in population health (Börsch-Supan and Schnabel 1999, Börsch-Supan et al. 2004, 2007, 2010, 2011, 2012, 2017a).

As an alternative, our second econometric approach uses fixed effects to purge DI from unobserved variables that create reverse causality and self-selection. The intuition underlying this second approach is that the individual fixed effect captures the initial health status as well as all other unobservable characteristics of the individual that may determine both health and DI status, such as health literacy and knowledge about the health care and DI systems. Assuming that these characteristics are time-invariant, the fixed effect captures the two main sources of endogeneity and can be removed by differencing over time.

The two strategies have their advantages and disadvantages. The instrumental variable approach

[20] For reasons of readability, we explain the methodology part exemplary with health as the dependent variable. We also present estimates for psychological well-being and the financial status in the results chapter.

identifies the level effect of DI benefits on health and the other outcome variables, i.e., the absolute difference in the outcome variables between the treatment and the control group. The precision of this estimate, however, crucially depends on the cross-national and intertemporal variation of the instrument, namely the share of DI recipients, which is limited as we will see. One may also argue that the share of DI recipients is not a valid instrument because its cross-national and temporal variation is at least partially determined by population health which may be influenced by the DI system.

The fixed effects estimator can only identify the changes of the effect of DI benefits on health and the other outcome variables over time, not its level. This, however, permits analyses of timing effects, such as a distinction between short and long run effects of DI benefit receipt. The weakness of the approach is its reliance on the assumption that the unobservable characteristics responsible for reverse causation and self-selection are time invariant. As we will see, the fixed effects approach yields stronger and richer results than the instrumental variable approach.

Both econometric approaches require international panel data. The cross-national variation is essential for identification since this is where most policy variation takes place. The additional policy variation across time – some countries have experienced major reforms in their DI systems – is helpful but limited since many countries have adapted their DI systems only gradually. The panel dimension is essential in identifying the temporal pattern of the effects of DI benefits on health and well-being. Our analysis exploits the harmonized merger of data from SHARE, HRS and ELSA. This combined data set uses all currently available waves from 2004 through 2015 and covers more than 90,000 individuals from age 50 to 65 with a total of almost 270,000 observations in 23 countries. Our main study sample includes all individuals who either self-report a work disability or receive DI benefits in at least one of the six waves. These are around 33,000 individuals with a total of about 110,000 observations.

We find that self-reported health stabilizes after DI benefit receipt. Mental health improves more for DI benefit recipients than non-recipients relative to their health at the beginning of DI benefit receipt. The effects on objective health measures are positive but largely insignificant. The

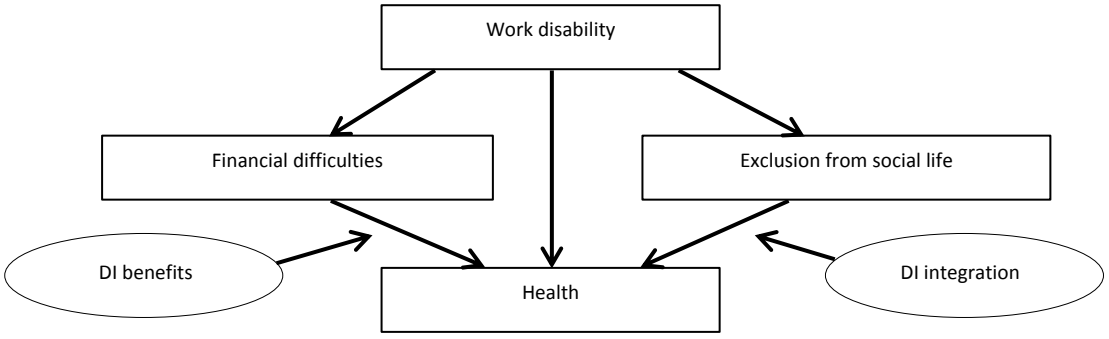
stabilization or even improvement of different health measures can be observed at least in the short run. The effects are slightly stronger in countries with more generous DI systems where generosity refers to the benefit generosity.

The paper proceeds as follows. In Section 5.2, we present the related literature and derive different hypotheses regarding the effects of work disability and DI benefit receipt on health. Section 5.3 describes the data and the key variables used for the analysis. Section 5.4 provides a description of the characteristics of DI benefit recipients, their health status and their re-employment rates. Section 5.5 reports the results from a basic regression model, Section 5.6 from the instrumental variable estimator and Section 5.7 from the fixed effects regressions. Section 5.8 provides a discussion of the results and concludes.

5.2 Literature and Hypotheses

In this section we derive our main hypotheses based on the existing literature. We structure this section by the main mechanisms through which the receipt of DI benefits affects the health and well-being of an individual who has become work disabled (Figure 5.1). Such work disability can have a direct effect on health and indirect effects via financial difficulties and the exclusion from economic and social life.

Figure 5.1: Graphical illustration of interrelationships



Work disability may directly affect health after someone becomes disabled. E.g., if a work disability forces a person into a wheel chair, this limits this individual's possibilities to be physically active which in turn has negative effects on physical health. A work disability may also cause depression and generally worsen emotional well-being. There are also indirect effects of work disability on health.

Figure 5.1 depicts two channels. First, work disability may precipitate financial difficulties due to restrictions on the extent and the type of work that a disabled individual can perform. Second, work disability may cause exclusion from economic and social life. One reason for this is the anchoring of economic and social life at the work place where the disabled person appears less often or not at all. Another reason is limited mobility. DI protects people with work disability from financial difficulties by providing basic financial means to cover the living costs. This attenuates the first indirect channel but may also directly improve health via better access to health care. The integrational measures which accompany DI in many countries aim at encouraging and supporting disabled persons to participate in social activities and to find adequate occupations in the labor market.

The effectiveness of the integrational measures with regard to the labor force participation has been studied with mixed evidence by looking at the cross-country variation of disability policies (Böheim and Leoni 2015) or by evaluating specific reforms leading to stricter eligibility rules for DI programs of specific countries (Chen and van der Klaauw 2008, Karlström et al. 2008, Staubli 2011). The effectiveness of the DI programs with regard to benefit payments and especially with regard to the superior goal of protection from health deterioration has, to the best of our knowledge, not been studied on the individual level.

Direct effect of work disability on health

The initial health status of an individual, starting from earliest childhood, is an important determinant of work disability at older ages (García-Gómez et al. 2011, Börsch-Supan et al. 2017a). However, only few studies have investigated how health evolves after someone becomes functionally disabled to perform the accustomed type and amount of work. Work disability might be restricted to a special body region, but it can have direct effects on the emotional well-being or on physical health due to functional limitations. Among patients with psoriatic arthritis, Wallenius et al. (2009) compare those with and without work disability. They find that work-disabled patients had a worse health status than non-work-disabled patients. Freedman et al. (2012) investigate the link between disability and subjective well-being and find that married adults with disability report worse subjective well-being than those without. Flores et al. (2015) complement this research by finding a strong negative

relationship between old-age disability and experienced utility corresponding to low levels of emotional well-being. Longitudinal studies, in contrast, find that the negative effects of work disability are rather short-run and that work-disabled persons adapt to the new situation so that only small differences in self-reported life satisfaction and well-being are found in the long-run (Lucas 2007, Oswald and Powdthavee 2008, Pagan-Rodriguez 2010). Based on this literature, we derive the first hypothesis:

H1: Work disability per se has a negative effect on later health and well-being. This holds for members of both the control group (work-disabled individuals not receiving DI benefits) and the treatment group (individuals receiving DI benefits).

Indirect effect of work disability on health via financial difficulties

Besides the direct effect of work disability on health, work disability impacts health through its effects on the financial situation due to forgone earnings. The primary goal of DI benefits is to provide income security for those with limited or non-existent labor market capability. Not directly related to disability benefits but to social security benefits in general, Ayyagari (2015) using US data finds that higher benefits improve health outcomes, especially in functional limitations and cognitive functioning. Additionally, the financial resources offered by DI benefits can lead to improved health outcomes because more time and more money can be invested in health care. Michalopoulos et al. (2012) find in the RAND Health Insurance Experiment that among new Social Security Disability Insurance (SSDI) beneficiaries health care benefits can increase health care use and health outcomes. As mentioned before, Gelber et al. (2017) based on data from the US Social Security Administration (SSA) find that higher DI payments reduce mortality rates. Based on these findings, we derive the second hypothesis:

H2: Work disability has a negative effect on health and well-being through financial difficulties for those work-disabled individuals who do not receive DI benefits (members of the control group). DI benefit payments buffer this effect and lead to a stabilization or even improvement of health and well-being for those individuals who receive DI (members of the treatment group).

Indirect effect of work disability on health via work exclusion

Empirical evidence shows that work disability is strongly connected to inactivity in the labor market. Employment rates of working-age disabled persons are rather low, especially for people over age 50 (OECD 2003). Leaving the labor market can have severe impacts on the physical and mental well-being of a person. These effects have been studied widely in the literature especially for the transition from working to retirement. While some studies find positive effects of retirement on health (Coe and Zamarro 2011), most studies suggest negative effects, mostly on cognition (Bonsang et al. 2012, Mazzonna and Peracchi 2012). Especially earlier retirement tends to be associated with poorer health outcomes. This is shown for overall well-being (Börsch-Supan and Jürges 2009) as well as for cognition (Rohwedder and Willis 2010, Börsch-Supan and Schuth 2014). In addition, Mazzonna and Peracchi (2017) study the effect heterogeneity across occupational groups and find a positive immediate effect of retirement for people with physically demanding jobs. For these people, the relief effect from the arduous work exceeds the negative effect induced by the lack of cognitive and physical stimulation, at least in the short run. We apply this reasoning to form the third hypothesis:

H3: Exclusion from the labor market induced by work disability has positive effects in the short run for those individuals who do not receive DI benefits (control group) due to the instantaneous relief effect. However, the negative effects of labor market inactivity, as shown in the retirement literature, might predominate in the long run. To prevent these negative effects, the integrational measures of the DI programs aim at encouraging and supporting disabled persons to participate in labor market activities. Such integrational measures can buffer these negative effects of work inactivity on health. Hence, we expect a positive effect of DI benefits on health both in the short run (relief effect) and in the long run (inclusion effect) for individuals who receive DI benefits (treatment group).

Differences in DI systems

The organization of DI systems and the degree of generosity differ for various European countries and the US. A number of studies (Börsch-Supan 2005, Börsch-Supan 2010, Börsch-Supan and Jürges 2012, Jürges et al. 2014, Börsch-Supan et al. 2017a) suggest that the level of generosity and the

related financial incentives lead to a large cross-country variation in disability program enrollment rates. Many countries are in a transformation process towards disability schemes that actively support the labor market participation of disabled persons to prevent social and economic exclusion. We expect that the size of the DI benefit payments and the extent of integration measures offered in a country influence the magnitude of the effect on health. Our fourth hypothesis is thus the following:

H4: In countries with less generous DI systems, where the minimum health impairments to obtain benefits are more severe, we expect DI participation to result in better or at least stabilized health due to the relief effect. In countries with more generous DI systems, where people with less severe health impairments can still enroll, we expect the labor market inactivity to have a more ambiguous effect on participant health, possibly reflecting some of the negative effects shown in studies of early retirement more generally.

Table 5.1 summarizes the hypotheses on the different effects on health for work disabled individuals who receive DI benefits and those who do not. In total, we expect that work disabled persons experience a health improvement in the short run, but health deterioration in the long run. The benefit and integration measures of DI programs aim to prevent these negative effects; therefore we expect a health stabilization or improvement for DI recipients in the short and in the long run.

Table 5.1: Summary of hypotheses H1-H3 (effects on health)

	Work disabled	**DI recipients**
H1: Direct effect	Negative effect **-**	Negative effect **-**
H2: Indirect effect (financial situation)	Negative effect due to financial stress **-**	Compensation payments buffer financial stress and promote health-preserving behavior, therefore we expect stabilization or improvement of health **+**
H3: Indirect effect (labor market inactivity)	Short-term: Positive effect due to instantaneous relief effect **+** Long-term: Negative effects due to lacking physical and mental stimulation according to the retirement literature **-**	Short-term: Positive effect due to instantaneous relief effect **+** Long-term: Integration measures buffer negative inactivity effects and lead to stabilization or improvement **+**
Total expected effect	Positive effect in the short run and negative effect in the long run **+/-**	Positive effect both in the short run and in the long run thanks to DI program **+**

5.3 Data

5.3.1 SHARE, ELSA and HRS – Longitudinal Harmonization

We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE, see Börsch-Supan et al. 2013), the U.S. Health and Retirement Study (HRS, see Juster and Suzman 1995) and the English Longitudinal Study of Ageing (ELSA, see Marmot et al. 2003). SHARE is a pan-European data set designed to analyze the process of population aging using cross-national comparisons within Europe and between Europe, America, and Asia. Until Wave 6, SHARE included 20 European countries plus Israel and Switzerland; from Wave 7 on SHARE includes all 26 countries of the European Union. SHARE is modelled closely after the HRS and ELSA. All three surveys cover the interplay between economic, health, and social factors in shaping living conditions of individuals aged 50 and older.

The current project benefits from the harmonization of SHARE, ELSA and HRS data which has already been conducted in an earlier project ("Early determinants of work disability in an international perspective"). The previously harmonized dataset was cross-sectional and contained the most recent available waves (SHARE Wave 5, ELSA Wave 6, and HRS Wave 11). It further included internationally comparable life-course data on health and socio-economic circumstances and has been augmented by data on country-specific health and social policy interventions. Since the aim of this project is to compare the circumstances before and after the DI uptake, we need to construct a panel data set including information on health, finances and psychological well-being over time. We have therefore augmented the harmonized dataset by additional available waves so that all studies cover the same time span, starting from 2004 with the first wave of SHARE and ending in 2015 with SHARE Wave 6, ELSA Wave 7, and HRS Wave 12.

5.3.2 Sample Selection

Our initial sample consists of more than 165,000 individuals and 467,000 person-year-observations. In a first step, we restrict the sample to the age group that is relevant for our research question regarding work disability and the receipt of DI benefits.[21] We therefore keep only individuals that are

[21] See Subsection 5.3.3 for precise definitions of work disability and DI benefit receipt.

aged between 50 and 65 at their first time being interviewed. Our resulting sample consists of 92,984 individuals and 266,968 person-year-observations which are distributed across 23 countries as displayed in Table 5.2.

Table 5.2: Sample sizes per country and share of DI recipients

Country	Individuals	Percent of total sample	Work disabled in at least one wave	First DI receipt	Main study Sample (Work disabled or first DI receipt in at least one wave)
Austria	3,415	3.7	25.2%	10.8%	958
Germany	5,168	5.6	35.9%	8.9%	1,694
Sweden	3,464	3.7	30.6%	30.4%	1,372
Netherlands	4,055	4.4	28.2%	14.3%	1,187
Spain	4,411	4.7	30.7%	10.6%	1,351
Italy	4,880	5.3	21.5%	6.6%	1,056
France	4,787	5.2	31.8%	6.5%	1,478
Denmark	3,578	3.9	36.7%	14.8%	1,330
Greece	3,662	3.9	10.9%	4.0%	443
Switzerland	2,591	2.8	20.5%	7.6%	550
Belgium	5,930	6.4	32.1%	14.7%	1,994
Israel	2,211	2.4	34.4%	14.9%	756
Czech Republic	4,832	5.2	37.8%	18.1%	1,917
Poland	1,973	2.1	50.7%	21.5%	1,039
Ireland	697	0.8	19.2%	13.9%	138
Luxembourg	1,233	1.3	23.4%	12.1%	332
Hungary	1,756	1.9	42.3%	20.1%	789
Portugal	1,199	1.3	37.0%	11.7%	468
Slovenia	2,848	3.1	21.4%	12.9%	752
Estonia	4,054	4.4	45.3%	27.8%	1,980
UK	9,716	10.5	39.3%	24.1%	4,353
Croatia	1,398	1.5	21.9%	11.0%	366
US	15,126	16.3	45.2%	18.1%	7,080
Total	92,984	100.0	34.1%	15.5%	33,383

Since the countries have very different sample sizes, all descriptive results are weighted both by the individual weights provided by each survey and the country weights displayed in the third column of Table 5.2. Across all countries, around 34% of individuals self-report a work disability in at least one of the six waves. The exact measurement of work disability and DI benefits receipt will be explained in subsection 5.3.3. The share of work-disabled individuals ranges from 10.9% in Greece to 50.7% in

Poland. Around 15.5% of our sample receives DI benefits in at least one of the six waves. The share of DI recipients in a country varies between 4.0% in Greece and 30.4% in Sweden.

Our main study sample is conditioned on work disability and the timing of DI benefit receipt. It includes all individuals who either self-report a work disability in at least one of the six waves or receive DI benefits for the first time during the observation period 2004 to 2015. We exclude individuals who received DI benefits before 2004 already. This information is known to us from the event histories in the three surveys. However, we lack the matching covariates if the first time of DI benefit receipt is before 2004. Thus our sample consists of 33,383 individuals with a total of 110,028 observations. We use the main study sample for pooled analyses, but for some parts we restrict the sample to countries and individuals that have repeatedly participated in the survey depending on the question we aim to answer in the specific chapters (e.g., to individuals who have participated in least three waves). Therefore, the number of observations and also the countries might differ in certain analyses from the list displayed in Table 5.2.

Table 5.3 tabulates work disability against the receipt of DI benefits. It refers to the full sample of 33,383 individuals minus 546 observations for which we observe the DI benefit receipt but cannot ascertain the corresponding work disability status, plus 55,602 who neither report work disability nor receive DI benefits. These individuals are included in Table 5.3 for completeness sake but are dropped from the following analyses.

Table 5.3: Work disability (*WD*) and DI benefit receipt (*DI*)

	no DI during observation time	**first DI benefit receipt**	**TOTAL**
no WD during observation time	**55,602** *95%* *75%*	**2,640** *5%* *19%*	**58,242** *100%* *66%*
WD at least once	**19,018** *63%* *25%*	**11,179** *37%* *81%*	**30,197** *100%* *34%*
TOTAL	**74,620** *84%* *100%*	**13,819** *16%* *100%*	**88,439** *100%* *100%*

Of those individuals who reported a work disability in at least one wave 63% do not receive DI benefits during our observation period, in turn 37% report their first DI benefit receipt between 2004 and 2015. The majority of individuals who receive DI benefits for the first time during our observation period report being work disabled in at least one period (81%). However, 19% of the individuals who receive DI benefits do not report a work disability during our observation window. This might on the one hand be due to miss-reporting; on the other hand it might be related to the use of the DI system as early retirement route.

5.3.3 Variables

DI receipt: The main policy variable of interest in our study is a binary variable indicating whether someone is receiving DI benefits in any of the waves (*DI*). Disability insurance is defined as all branches of publicly financed insurances providing compensation in case of the loss of the ability to perform gainful employment. In many countries this also covers sick pay (see Table 5.14 in the appendix for the country specific details). The questions on the receipt of DI benefits from the different studies are displayed in Table 5.4.

Table 5.4: Questions for DI benefit receipt in different surveys*

Study	Question	Categories
SHARE	EP671: Have you received income from any of these sources in the last year?	4. Main public sickness benefits 5. Main public disability insurance pension
ELSA	IahdN: Which of these health or disability benefits are you receiving at the moment?	1. Incapacity Benefit (previously Invalidity Benefit) 2. Severe Disablement Allowance (SDA) 3. Statutory sick pay (SSP) 4. Attendance Allowance 5. Disability Living Allowance 6. Industrial Injuries Disablement Benefit 7. War Disablement Pension or War Widows Pension 8. Invalid Care Allowance 9. Disabled persons tax credit (formerly Disability Working Allowance) 95 Some other benefit for people with disabilities (SPECIFY)
HRS	M030: Which program was this: the Social Security Disability or the Supplemental Security Income program, or both?	1. Social security Disability Insurance (SSDI) 2. Supplemental Security Income (SSI) 3. Both

**Examples from last available wave, question wording can slightly deviate between waves and depending on person-specific routing.*

Work disability: We are interested in the effect that the receipt of DI benefits has on the life circumstances of individuals who suffer from a functional limitation regarding the type and extent of work that they can do. We define our control group as those individuals who have a work disability but who do not receive any DI benefits, see Section 5.5. We use the self-rated work disability question (shown in Table 5.5) to create a binary variable indicating whether someone is work disabled in at least one of the six waves (*WD*).

Table 5.5: Questions for self-rated work disability in different surveys*

Study	Question	Categories
SHARE	PH061: Do you have any health problem or disability that limits the kind or amount of paid work you can do?	1. Yes 5. No
ELSA	HELWK: Do you have any health problem or disability that limits the kind or amount of paid work you could do, should you want to?	1. Yes 2. No
HRS	M002: Do you have any impairment or health problem that limits the kind or amount of paid work you can do?	1. Yes 2. No

**Examples from last available wave, question wording can slightly deviate between waves and depending on person-specific routing.*

Labor market status: In Section 5.4, we evaluate the success rates of reintegration in the labor market after the incidence of work disability and compare this across countries. We use the self-reported employment status that is ex-ante harmonized across surveys and that contains the following groups: 1) Retired 2) Employed/Self-employed 3) Unemployed 4) Sick or disabled 5) Homemaker/Other. We validate and extend these self-reported employment situations by information on labor income or pension income.

Health: A key outcome measure of our analysis is health. We use several dimensions. First, we employ the respondent's self-reported health status (*sphus*) rated on a categorical five-point scale from poor (1) to excellent (5). Self-reported health is among the most common measures used in public health surveys; it captures various physical, emotional, and social aspects of health and has been found to predict mortality (e.g. Idler and Benyamini 1997, Jylhä 2009). Since self-reported health may suffer from justification bias (Bound 1991, Sen 2002), we also include more objective health information. A second health variable is therefore the number of limitations to perform

(instrumental) activities of daily living (*ADL* and *IADL*). Third, in order to take a person's mental health into account, we construct the *EURO-D* depression index based on the number of depressive symptoms in SHARE. In ELSA and HRS, another depression index called CES-D score is used. SHARE contained the information needed for both the EURO-D and the CES-D score in wave 1. Based on this information we build a prediction rule for EURO-D by means of a linear regression and apply this rule to the HRS and ELSA data to obtain the predicted EURO-D scores. As a fourth health measure, we include the result from a physical performance test measuring the maximal grip strength of a person (*maxgrip*). Grip strength is our most objective measure of health since the task is performed during the interview. It reflects the overall muscle status of the respondent and has been linked to mortality in previous research (e.g. Gale et al. 2007).

Well-Being: Besides health measures, we also study the effect of DI benefits on psychological well-being. Well-being is strongly related to health. It is also affected by material conditions, social and family relationships or social roles and activities (Steptoe et al. 2015). We use the question about the life satisfaction of an individual to measure the evaluative well-being. The questions differ across surveys and also across waves for ELSA and HRS. Thus, we have to group the response options according to Table 5.6 in order to create the harmonized variable (*life_sat*).

Table 5.6: Harmonization of life satisfaction variable

SHARE	**ELSA**		**HRS**		**Harmonized**
	Wave 2, 3, 4, 5	**Wave 6, 7**	**Wave 7, 8**	**Wave 9, 10, 11, 12**	
ac012: On a scale from 0 to 10, how satisfied are you with your life?	sclifec: I am satisfied with my life	scovsa: Overall, how satisfied are you with your life nowadays?	klb003c: I am satisfied with my life.	nlb003c: I am satisfied with my life.	**life_sat**
0 Completely dissatisfied	7 Strongly disagree	0 Not at all	1. Strongly disagree	1. Strongly disagree	1 very dissatisfied
1		1			
2		2			
3	6 Disagree	3	2. Somewhat disagree	2. Somewhat disagree	2 dissatisfied
4	5 Slightly disagree	4	3. Slightly disagree	3. Slightly disagree	
5	4 Neither agree nor disagree	5	4. Slightly agree	4. Neither agree or disagree	3 satisfied
6	3 Slightly agree	6		5. Slightly agree	
7		7			
8	2 Agree	8	5. Somewhat agree	6. Somewhat agree	4 very satisfied
9	1 Strongly agree	9	6. Strongly agree	7. Strongly agree	
10 Completely satisfied		10 very much			

Finances: A third outcome dimension besides health and well-being is financial status indicating whether an individual suffers from financial difficulties and whether DI benefits can compensate for this. We use the questions on the self-rated financial situation provided by the three surveys. These questions differ between surveys and have to be harmonized also in respect to the response options. Table 5.7 shows how we built the harmonized binary variable indicating whether a household has financial problems or not (*fin_prob*).

Table 5.7: Harmonization of variable measuring financial difficulties*

SHARE	HRS	ELSA	Harmonized
CO007: Thinking of your household's total monthly income, would you say that your household is able to make ends meet ...	Q415: Have you always had enough money to buy the food you need?	IAFCON: Which of the phrases on the card best describes how you and husband/wife/partner are getting along financially these days?	fin_prob
2. With some difficulty 3. Fairly easily 4. Easily	1. Yes	1 manage very well 2 manage quite well 3 get by alright 4 don't manage very well 5 have some financial difficulties	0. No
1. With great difficulty	5. No	6 have severe financial difficulties	1. Yes

**Examples from last available wave, question wording can deviate slightly between waves and depending on person-specific routing.*

Demographics: As basic demographics, we use *gender* and the respondents' *age* at the time of the interview. For ELSA, the exact age is given as a variable whereas for SHARE and HRS we calculate the age based on the year of the interview and the year of birth. We further include the number of *children* and the current marital status, which is split into the categories *married*, *divorced*, *widowed* or *single*. Since information on the marital status is only given if something changed since the last interview, we need to merge information from all previous waves, even going back to Wave 0 for ELSA, which stems from the predecessor study Health Survey for England (HSE). The same applies for the information on the educational level. We built three categories referring to the ISCED[22] coding (*low education* (0-2), *medium education* (3-4), *high education* (5-6)) and match the educational level of the respondents based on their highest educational qualification.

[22] International Standard Classification of Education

Summary statistics (mean and standard deviation) of these variables in our main study sample are shown in Table 5.8. The table is based on person-year observations. All values are weighted by the individual weights provided by the three surveys and the country shares as reported in Table 5.2. While more than half of the person-years show a work disability only 16.4% of those are covered by DI benefit receipt.

Table 5.8: Summary statistics

	TOTAL		SHARE		HRS		ELSA	
VARIABLES	mean	sd	mean	sd	mean	sd	mean	sd
female	0.531	0.499	0.530	0.499	0.559	0.497	0.518	0.500
age	60.75	5.684	60.58	5.691	62.08	5.595	61.53	5.458
married	0.697	0.459	0.695	0.460	0.668	0.471	0.749	0.434
divorced	0.133	0.339	0.132	0.338	0.169	0.376	0.106	0.308
widowed	0.0918	0.289	0.0936	0.291	0.0896	0.286	0.0723	0.259
children	2.288	1.604	2.256	1.556	2.957	2.026	1.863	1.243
education_low	0.381	0.486	0.406	0.491	0.154	0.362	0.298	0.458
education_high	0.186	0.389	0.189	0.391	0.271	0.445	0.0648	0.246
education_medium	0.404	0.491	0.377	0.485	0.574	0.495	0.568	0.496
DI	0.164	0.370	0.165	0.371	0.108	0.310	0.207	0.406
fin_prob	0.232	0.422	0.156	0.363	0.109	0.312	0.015	0.121
iadl	0.229	0.745	0.212	0.729	0.383	0.874	0.252	0.750
WD	0.513	0.500	0.526	0.499	0.515	0.500	0.398	0.490
maxgrip	35.12	12.39	35.33	12.43	33.32	11.33	32.43	11.99
eurod	2.775	2.237	2.787	2.336	2.825	1.699	2.604	1.615

DI policy indicators: In Sections 5.4 and 5.7, we stratify our results by generosity of the DI system using the disability policy indicators provided by the OECD (2003, 2010). These indicators measure the degree of *benefit generosity* in different DI benefit systems on the basis of the following characteristics: coverage (ranging from employees only to the total population); minimum disability level (lower bound ranging from 86% to 0%); disability level for full benefit (ranging from 100% to <50%); benefit generosity (in terms of replacement rate ranging from RR<50% to RR>=75%), permanence of payments (from temporary to strictly permanent); medical assessment (ranging teams of insurance doctors to treating doctor only); vocational assessment (ranging from all jobs available to strict own-occupation assessment), sickness benefit generosity (in terms of replacement rate ranging from RR<50% to RR=100%); sickness benefit duration (from <6 months to >12 months); sickness benefit monitoring (from strict follow-up controls to lenient requirements). Each indicator is

measured according to a predefined scale ranging from zero points (restrictive) to five points (generous). The sum of the compensation indicators is used to account for country differences in the benefit generosity of DI systems.

The generosity of a DI system in terms of *integration* is measured by the following indicators: access to employment programs (ranging from strict eligibility restrictions to full accessibility); agency responsibility (different agencies vs. same agency for all programs); employer responsibility (no obligations to major obligations); supported employment program (from not existent to strong program); subsidized employment program (from not existent to strong program); sheltered employment program (from not existent to strong program); vocational rehabilitation program (from voluntary rehabilitation to compulsory rehabilitation); vocational rehabilitation timing (only for DI recipients vs. any time); benefit suspension rules (none vs. two years or more); work incentives rules (some additional income allowed vs. permanent in-work benefit).

The sum of the integration indicators is used for the descriptive results in connection with the analysis of the re-employment situation after the DI benefit receipt. All indicators are available for two relevant points in time: around 2000 and 2007 (see Table 5.15 and Table 5.16 in the appendix).

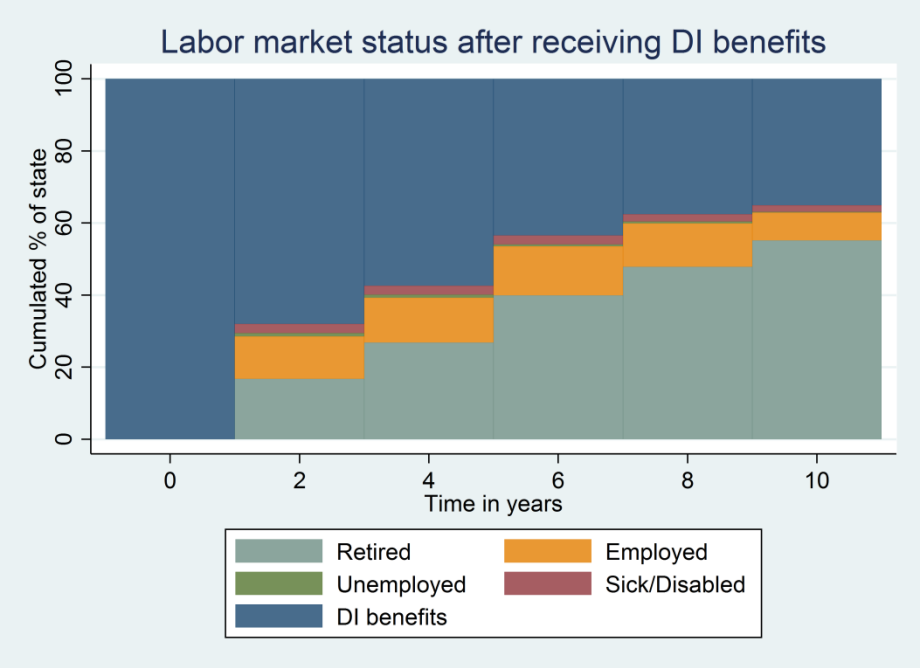
5.4 Descriptive Results

Before estimating the causal effect of DI benefits on health, we present some descriptive results in order to better understand the data and the characteristics of DI benefit receipt. These descriptive statistics can only deliver correlations. They do not permit causal interpretations and policy conclusions from these results have to be drawn with caution. The results in this section are based on sequence analysis; i.e., we define a sequence of states for each individual in the panel. We distinguish five states: “Receiving DI benefits”, “Employed (and not receiving DI benefits)”, “Unemployed (and not receiving DI benefits)”, “Sick/Disabled (and not receiving DI benefits)” and “Retired (with benefits from a non-DI program)”. In other words, if someone receives DI benefits and is employed at the same time, we would count them as DI benefit recipient. An example for a typical

sequence is “EDDR” which indicates that an individual who was observed for 4 waves was employed in the first wave, then received DI benefits for two waves and retired in wave 4.

When deriving our hypotheses, we assumed that being work disabled and receiving DI benefits is strongly connected to labor market inactivity. We verify this assumption on the basis of our data by performing a sequence analysis for the labor market situation after the first year of DI benefit receipt. Figure 5.2 graphically displays the results from an unbalanced panel sample with 32,482 person-years-observations. The graph shows that only a small fraction of individuals who have received DI benefits manages to start working again. For example, after two years about 12% of the individuals report being employed. Most individuals stay in DI benefits for a long time or they transit into retirement. We will analyze the long-term and short-term recipients of DI benefits further below.

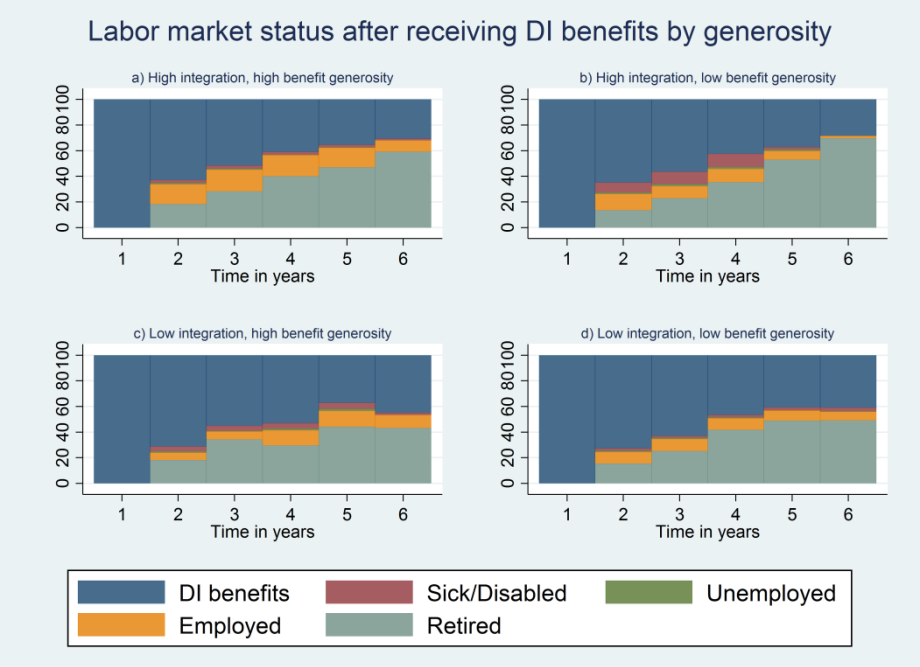
Figure 5.2: Sequence analysis for the labor market situation after DI receipt



Source: Own calculations based on SHARE, ELSA, HRS data

Many countries have implemented special measures for the re-integration of disabled persons into the labor market. Figure 5.3 shows whether these increased efforts are reflected in the re-employment rates of our sequence analysis. For this purpose we split our sample into the four possible combinations of high and low integration and benefit generosity measures according to the OECD policy indicators from around 2007.

Figure 5.3: Sequence analysis by generosity level[23]



Source: Own calculations based on SHARE, ELSA, HRS data

Indeed, the upper two panels a) and b) defined by high integration efforts reveal higher rates of re-employment; therefore, these integration measures seem to be effective. Panel a) indicates that even higher re-employment rates are achieved by a combination of these measures with generous DI benefits also in monetary terms. In a situation with high integration and low benefit generosity, panel b), the share of "sick/disabled" is also relatively high compared to the other systems. This might be the downside of strict eligibility rules. If unhealthy individuals fail to be reintegrated into the labor market, they might end up being sick without receiving any support. The lower panels c) and d) display the situation for countries with low integration measures. Here, most individuals stay in the DI program or transit into early retirement, especially in countries with a low generosity level of DI benefits. It is difficult to draw conclusions from these graphs because there are only few countries with opposite generosity levels in the benefit and integration dimensions. The results might therefore be driven by regulations of specific countries (e.g. waiting time, employer responsibilities etc.). However, we can conclude that even in the best case scenario with high integration and high compensation measures, the re-employment rate after the uptake of DI benefits is rather low. This

[23] High integration, high benefit generosity: Austria, Germany, Sweden, Netherlands, Denmark, Switzerland, Luxembourg, Hungary, UK (N=14,588)
High integration, low benefit generosity: France, Greece, Belgium (N=2,338)
Low integration, high benefit generosity: Spain, Italy, Poland, Portugal (N=1,998)
Low integration, low benefit generosity: Israel, Czech Republic, Slovenia, Estonia, Croatia, US (N=13,558).

conclusion is in line with the result of the OECD (2010) report, stating that despite the increased efforts in the integration measures, the employment levels of people with disability have not improved, especially for those aged over 50. In summary, work disability and the uptake of DI benefits are unfortunately still closely correlated with labor market inactivity.

We also use sequence analysis to explore the differences in health status between short-term and long-term DI recipients. For this purpose, we keep only individuals in our sample who we observe three consecutive waves after their first receipt of DI benefits. This leads to a sample reduction to 2,366 individuals and 9,464 person-years-observations. For these individuals, we evaluate the specific sequences and create three groups depending on the success of an individual in leaving the state of DI receipt (details are shown in Table 5.20 in the appendix). The first group is called "Never got out of DI benefits" and includes all individuals who stay in DI for all three subsequent periods or who directly transit from DI benefits into retirement or unemployment. "Long-term out of DI" refers to individuals who succeed transiting back into the labor market and not falling back into DI benefit receipt. "Short-term out of DI" are individuals who succeed to work at least one period after DI benefit receipt but then fall back into DI benefits receipt for at least one period. Table 5.9 shows that most of the individuals that we observe for three consecutive waves after the first report of DI benefits, never leave the state of DI benefits receipt (76%).

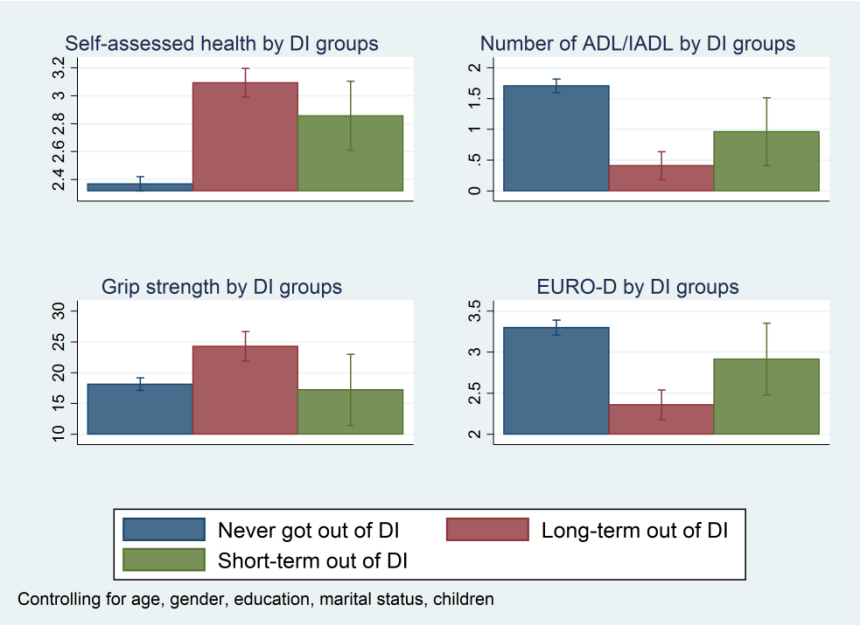
Table 5.9: Categorization of DI recipients

	Frequency	**Percent**
Never got out of DI	1,808	76.42
Long-term out of DI	478	20.20
Short-term out of DI	80	3.38
Total	2,366	100.00

In a next step, we examine the differences in health for these three groups controlling for age, gender, education, marital status, and the number of children. Despite the low number of observations, Figure 5.4 shows the expected pattern: Those individuals who never get out of DI benefits have the worst health status. More specifically, we find that self-assessed health is worst for

those who never got out of DI and best for those who succeed to leave disability benefits permanently. Grip strength is also highest for those who are long-term out of DI benefits. It is much lower and about equal for the two other groups. For the number of ADL/IADL and the EURO-D depression scores, we have to consider that higher values represent worse health. Keeping this in mind, we find again that these two health measures are worst for those who never get of out DI benefits.

Figure 5.4: Differences in health by duration of DI receipt



Source: Own calculations based on SHARE, ELSA, HRS data

Overall, these results reveal the expected pattern: DI benefit receipt is highly correlated with a bad health status. This correlation, however, cannot be interpreted as causation. Since our sample is highly selective, this correlation may only indicate the health status before the DI application process and therefore does not represent a causal effect of the duration of DI payments on health. This will be addressed in the following sections.

5.5 Ordinary Least Squares Analysis

The aim of this paper is to estimate the causal effect of disability insurance receipt (DI_{it}) on a measure of health (y_{it}). However, different selection processes lead to the problem that the treatment and the control group might not be the same based on observed or unobserved factors. This leads to endogeneity problems and to the need for identification strategies which we will

address in turn. The first step in modelling the different selection processes is to control for those observable variables that jointly influence the treatment variable and the outcome variable. These variables include the demographic background, education and the initial health status of an individual. To control for the confounding initial health, we include the lagged health status y_{it-1} from the previous period and the number of childhood conditions C_i in the regression, which have been shown to have a predictive effect on the probability of becoming work disabled and receiving DI benefits (Börsch-Supan et al. 2017a). The specification can then be described as:

$$y_{it} = \beta_0 + \beta_1 DI_{it} + \beta_2 \boldsymbol{X}_{it} + \beta_3 y_{it-1} + u_{it} \quad (1)$$

where y_{it} denotes the outcome variable such as the health status, DI_{it} is a binary treatment variable, X_{it} contains a set of individual characteristics such as gender, age, education, marital status, financial situation, and the number of childhood conditions, and y_{it-1} represents the outcome variable from the previous period. The results are presented in Table 5.10.

They show that DI benefits receipt is associated with worse self-reported health, more limitations in daily life, more depressive symptoms, less life satisfaction, and with a higher likelihood of financial problems. In contrast, there is a positive relation between DI benefits and the maximal grip strength. The other covariates show the expected sign of correlation and the lagged dependent variable is a highly significant control variable for all measures of health and well-being.

Although controlling for these variables improves our model specification, we still cannot claim a causal relationship for the effect of DI benefits on health due to the remaining unobserved confounding factors in u_{it}. The estimates of the treatment effect β_1 are not consistent but biased if treatment DI_{it} is correlated with the unobserved confounding factors in the error term u_{it} which render the treatment variable as endogenous. Reverse causality and the selection processes mentioned in the introduction affect both the treatment and the control group and lead to endogeneity problems and biased parameter estimates of the treatment effect.

Table 5.10: OLS Regression

VARIABLES	(1) sphus OLS	(2) adl_iadl OLS	(3) maxgrip OLS	(4) eurod OLS	(5) life_sat OLS	(6) fin_prob OLS
DI benefits	-0.14***	0.30***	0.65**	0.19***	-0.07***	0.02***
	(0.015)	(0.024)	(0.266)	(0.025)	(0.014)	(0.004)
Male or female	0.00	0.08***	-4.49***	0.45***	-0.02*	0.01**
	(0.013)	(0.021)	(0.310)	(0.025)	(0.012)	(0.004)
Age	-0.01***	0.02***	-0.26***	0.00	0.00	-0.00***
	(0.001)	(0.002)	(0.018)	(0.002)	(0.001)	(0.000)
Single (0 1)	-0.08***	0.19***	-0.73	0.22***	-0.18***	0.03***
	(0.027)	(0.043)	(0.489)	(0.049)	(0.030)	(0.009)
Divorced (0 1)	-0.08***	0.10***	-1.39***	0.22***	-0.13***	0.04***
	(0.020)	(0.033)	(0.347)	(0.036)	(0.021)	(0.006)
Widowed (0 1)	-0.03*	0.09**	-0.85***	0.29***	-0.16***	0.02***
	(0.021)	(0.038)	(0.319)	(0.039)	(0.022)	(0.006)
Low education (0 1)	-0.24***	0.15***	2.60***	0.27***	-0.04**	0.05***
	(0.018)	(0.028)	(0.337)	(0.033)	(0.016)	(0.005)
Medium education (0 1)	-0.11***	0.04*	-0.20	0.13***	-0.08***	0.01***
	(0.017)	(0.025)	(0.329)	(0.029)	(0.016)	(0.004)
Childhood illnesses	-0.02**	0.05***	0.54***	0.09***	-0.01*	0.00
	(0.007)	(0.012)	(0.130)	(0.012)	(0.007)	(0.002)
Lagged dependent	0.62***	0.29***	0.64***	0.53***	0.76***	0.34***
	(0.007)	(0.010)	(0.011)	(0.008)	(0.010)	(0.007)
Constant	1.66***	-1.55***	16.49***	-0.37***	0.60***	0.10***
	(0.072)	(0.111)	(1.401)	(0.125)	(0.073)	(0.020)
Observations	36,642	35,853	33,459	35,821	20,829	32,911
R-squared	0.33	0.25	0.30	0.35	0.29	0.28

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

First, there is reverse causality. Most countries require strict medical examinations for the justification of DI payments. Hence, the treatment is not assigned randomly between groups, but it is conditional on health. While we have included lagged health and childhood health, this may not fully describe the health status that was determining a successful application process. Means-tested DI benefit programs add to this problem if the level of income is related to the health outcome.

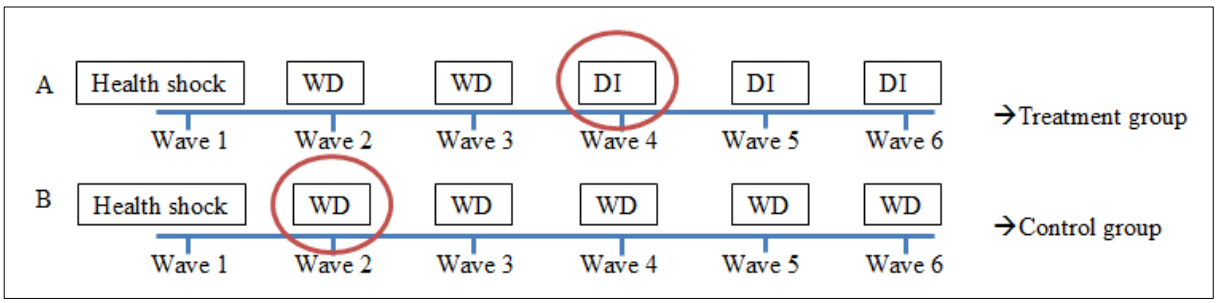
Second, there is self-selection into the treatment group. Depending on the application process for DI benefits payments of a country, individuals decide whether it is worth to apply for DI benefits or, in other words, they self-select into a DI program. An endogeneity problem arises if the decision to apply for DI benefits is influenced by a variable that is also correlated with the outcome variable y_{it}. Health literacy and health care system literacy, for example, could lead to a positive selection if highly educated individuals have more knowledge about the rights to claim benefits and about the

administrative process. If this leads to higher DI admission rates and if health literacy at the same time positively influences the recovery process and the health outcome, we will obtain biased results. In contrast, a negative selection might remain in the treatment group if a high level of wealth decreases the need for benefit payments and therefore the probability of applying for DI benefits. Again, the results will be biased if at the same time a high wealth level enables special rehabilitation measures and therefore positively influences the health outcome. We can control for some of these confounding factors as we did in Table 5.10, but education may not fully capture health literacy and health care system literacy, and wealth tends to be measured with considerable error and relatively low item response rates.

Third, the assignment to the control group is likely to be selective. The control group consists of individuals that report a work disability at least once during the observed time period but who never received DI benefits. The work disability status, however, is self-reported and may suffer from justification bias. To illustrate an extreme case: a perfectly healthy individual becomes unemployed and reports to have a work disability to justify the inactivity in the labor market. This individual may not be eligible for DI benefits but enters our control group. In this case, non-treatment would not be random and the control group would exhibit a better average health status than the treatment group due to the healthy individuals who over report work disability for justification reasons.

Finally, left and right truncation threatens the comparability of the control with the treatment group. Even with six waves of panel data and the event histories in the three surveys, we do not observe the entire sequence of work disability and DI benefit receipt status. Consider for example individual A and individual B as illustrated in Figure 5.5.

Figure 5.5: Observation windows in treatment and control group



Individual A experiences a health shock in the first wave and reports having a work disability in wave 2 and in wave 3. In wave 4, individual A reports the receipt of DI benefits for the first time and based on this information individual A is assigned to the treatment group. Note that we do not have left truncation for the DI variable because we delete individuals who had their first DI benefit receipt before 2004 due to missing covariates as mentioned in Subsection 5.3.2. Individual B also experiences a health shock in the first wave and reports a work disability in the subsequent waves. Since this individual never reports receiving DI benefits during our observation time, individual B is assigned to the control group. The decision over treatment and control group is therefore dependent on the length of the observation time which is truncated both at the left and at the right. The window of observation is at most six waves, often less, and we do not know whether an individual in the treatment group has been work disabled for several years before receiving DI benefits due to a long application phase, waiting time etc. The same holds for an individual in the control group if work disability has already occurred before 2004. We also do not know whether individual B will receive DI benefits after wave 6. Hence, the duration of work disability may be different between individuals A and B. The time since the onset of a work disability, however, is likely to affect the health status after receiving DI benefits. Moreover, if the duration of work disability is correlated with the receipt of DI benefits, e.g., via waiting time, then it adds to the list of unobserved variables in u_{it} which bias the OLS parameter estimates because it is correlated with the treatment variable *DI*.

5.6 Instrumental Variable Approach

As a first identification strategy we will introduce an instrumental variable approach in this section. The strength of the instrumental variable approach is that we estimate the average treatment effect for those who respond to our instrument which reflects the incentive and admission structure of a DI system. The reference group in these regressions consists of the work disabled persons who do not receive DI benefits; hence, we can directly evaluate the effectiveness of DI benefits in comparison to the control group by comparing the levels of the outcome variables between the treatment and the control group. The instrumental variable approach has its own weaknesses which will be discussed

further below. As a second identification strategy we therefore apply an individual level fixed effects estimator in Section 5.7.

5.6.1 Methodology

The instrumental variable approach replaces the treatment variable DI_{it} in the regression equation (1) by a predicted variable $\widehat{DI}_{it}$ which is uncorrelated with the error term u_{it}. In a first stage, equation (2), this prediction relies on the instrument Z_{it}, which needs to be uncorrelated with the unobserved variables in u_{it} but at the same time affects the outcome variable y_{it} and generates exogenous variation in the treatment variable DI_{it}. In the second stage, equation (3), we then obtain the local average treatment effect β_1 without bias.

$$DI_{it} = \gamma_0 + \gamma_1 Z_{it} + \gamma_2 \boldsymbol{X}_{it} + \gamma_3 y_{it-1} + v_{it} \quad \text{(First stage)} \quad (2)$$

$$y_{it} = \beta_0 + \beta_1 \widehat{DI}_{it} + \beta_2 \boldsymbol{X}_{it} + \beta_3 y_{it-1} + u_{it} \quad \text{(Second stage)} \quad (3)$$

In our context, we need to find a predictor for the uptake of DI benefits that is uncorrelated with the individual health status and all unobserved determinants of health and DI benefits receipt, thus the error term. We estimate the age- and gender-specific probabilities of receiving DI benefits for each country and wave and use these probabilities – estimated by their sample shares – as instrumental variable. The intuition behind this approach is that the share of DI recipients reflects the current policy situation and the generosity of a DI system. It has been shown in previous work that the variation in DI recipient rates between the countries is better explained by institutional factors rather than population health (Börsch-Supan and Schnabel 1999, Börsch-Supan et al. 2004, 2007, 2010, 2011, 2012, 2017a). These institutional factors reflect different degrees of requirements and means-tests creating variation both in the incentives to apply for DI benefits and in the admission rate at a specific point in time. The more generous a DI system is, the higher the expected share of DI recipients. The cross-time variation in the instrument implicitly captures the effect of reforms and changes in the DI policies. Additionally, we allow the instrument to vary over age and gender to account for age- and gender-specific regulations. To ensure that the share of DI recipients is representative for a respective country, we generate the instrumental variable based on the

complete sample (e.g. including healthy and retired individuals) adjusted by calibrated cross-sectional weights.

The instrument solves all four endogeneity problems mentioned at the end of the previous section since it breaks the correlation between the treatment variable and the unobserved variables in the error term that cause the endogeneity problems in the first place. The key identifying assumption is that the *population* shares of DI receipt are not correlated with the *individual* health status. Figure 5.8 in the appendix shows the variation in the share of DI recipient rates over age by gender and across countries. This variation is correlated with the individual DI status (see first stage regression in Table 5.11), but exogenous with respect to the health of the individual and therefore suited as an instrument. It could be argued that countries with generous DI programs might also have more comprehensive health care systems or even special DI prevention programs that might impact the individual health status. In addition, other factors besides the generosity of the DI system might influence the number of DI recipients in a country, such as the labor market flexibility or the availability of early retirement schemes. To account for such systematic differences between the countries, we add country level fixed effects in some of the regressions.

5.6.2 Results

The results of the first stage, equation (2), are presented in Table 5.11.[24] They show the relevance of our instrumental variable: The higher the share of DI recipients in a specific country, age cohort, gender and wave, the higher the individual likelihood of receiving DI benefits.

The coefficient of the instrumental variable and the F-test are highly significant, supporting the predictive power of our instrumental variable.[25]

[24] This first stage regression includes self-reported health (*sphus*) as lagged dependent variable. Other first stage regressions use other lagged outcome variables (see Table 5.21 in appendix). They deliver very similar results.

[25] As robustness check we calculated instruments based on three dimensions only (e.g. country, age, gender). Results are available upon request.

Table 5.11: First-stage regression

VARIABLES	(1) DI benefits	(2) DI benefits
Share of DI recipients	1.59***	0.68***
	(0.051)	(0.053)
Female	-0.06***	-0.06***
	(0.010)	(0.010)
Age	-0.01***	-0.01***
	(0.001)	(0.001)
Single (0 1)	0.13***	0.12***
	(0.021)	(0.020)
Divorced (0 1)	0.10***	0.10***
	(0.015)	(0.015)
Widowed (0 1)	0.03**	0.04***
	(0.015)	(0.014)
Low education (0 1)	0.11***	0.11***
	(0.014)	(0.014)
Medium education (0 1)	0.05***	0.04***
	(0.013)	(0.012)
Childhood illnesses	0.01	-0.00
	(0.005)	(0.005)
Lagged sphus	-0.02***	-0.04***
	(0.006)	(0.006)
Constant	0.75***	1.14***
	(0.054)	(0.056)
Observations	36,611	36,611
Partial R^2	0.063	0.008
Country FE		YES
Instrument validity		
Kleibergen-Paap rk LM statistic	708.07	163.81
	(0.000)	(0.000)
Kleibergen-Paap rk Wald F statistic	971.79	168.94
	(0.000)	(0.000)

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

The results of the second stage, equation (3), are presented in Table 5.12 for three measures of physical health as dependent variables and in Table 5.13 for mental health, well-being and financial status as dependent variables. The self-reported health status is significantly better when receiving DI benefits. Compared to the result of the OLS estimation, the sign of the coefficient switches from negative to positive when including the instrument. This indicates the underlying endogeneity problem and stresses the importance of an identification strategy. However, this effect turns insignificant when we control for country fixed effects. By including country fixed effects we only use

the within country variation in DI benefit receipt and therefore lose an important source of variation in our instrumental variable.

Table 5.12: IV regressions for DI effect on physical health

VARIABLES	(1) sphus IV	(2) sphus IV	(3) adl_iadl IV	(4) adl_iadl IV	(5) maxgrip IV	(6) maxgrip IV
DI benefits	0.11**	-0.02	0.09	0.26	0.98**	-0.21
	(0.047)	(0.130)	(0.063)	(0.182)	(0.445)	(1.114)
Female	0.02	0.01	0.06***	0.07***	-10.59***	-10.76***
	(0.014)	(0.016)	(0.022)	(0.025)	(0.228)	(0.248)
Age	-0.01***	-0.01***	0.02***	0.02***	-0.28***	-0.30***
	(0.001)	(0.002)	(0.002)	(0.003)	(0.012)	(0.020)
Single (0 1)	-0.11***	-0.10***	0.21***	0.19***	-1.32***	-1.31***
	(0.028)	(0.031)	(0.044)	(0.048)	(0.282)	(0.298)
Divorced (0 1)	-0.10***	-0.09***	0.12***	0.10***	-0.22	-0.32
	(0.021)	(0.024)	(0.034)	(0.037)	(0.193)	(0.207)
Widowed (0 1)	-0.04*	-0.04*	0.10***	0.08**	0.03	-0.08
	(0.021)	(0.021)	(0.038)	(0.038)	(0.210)	(0.211)
Low education (0 1)	-0.27***	-0.25***	0.17***	0.18***	-1.31***	-0.58***
	(0.019)	(0.024)	(0.029)	(0.038)	(0.179)	(0.199)
Medium education (0 1)	-0.13***	-0.12***	0.06**	0.04	-0.10	-0.06
	(0.017)	(0.018)	(0.026)	(0.027)	(0.162)	(0.163)
Childhood illnesses	-0.02***	-0.03***	0.05***	0.06***	-0.06	-0.14**
	(0.008)	(0.008)	(0.012)	(0.013)	(0.072)	(0.071)
Lagged health	0.62***	0.60***	0.29***	0.28***	0.47***	0.46***
	(0.008)	(0.010)	(0.010)	(0.011)	(0.010)	(0.011)
Constant	1.33***	1.60***	-1.29***	-1.45***	38.31***	41.41***
	(0.094)	(0.193)	(0.132)	(0.237)	(1.091)	(1.730)
Observations	36,611	36,611	35,822	35,822	23,309	23,309
R-squared	0.32	0.33	0.25	0.26	0.70	0.71
IV F-Test	971.8	168.9	1075	196.6	937.2	166.4
Country FE		YES		YES		YES

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

The same pattern holds for the grip strength variables while the number of limitations in (instrumental) activities of daily living is insignificant in both specifications. Table 5.13 relates to mental health, well-being and financial status. The number of depressive symptoms is significantly lower for recipients of DI benefits. Similarly, life satisfaction indicates an improvement of well-being. Including country fixed effects, however, increases the standard errors dramatically and only EURO-D remains weakly significant. The coefficient for the financial well-being is insignificant.

Table 5.13: IV regressions for DI effect on mental health, well-being and financial status

VARIABLES	(1) eurod IV	(2) eurod IV	(3) life_sat IV	(4) life_sat IV	(5) fin_prob IV	(6) fin_prob IV
DI benefits	-0.17*	-0.50*	-0.11***	0.07	0.00	0.06
	(0.091)	(0.259)	(0.040)	(0.117)	(0.014)	(0.041)
Female	0.42***	0.39***	-0.02*	-0.00	0.01**	0.01**
	(0.026)	(0.031)	(0.013)	(0.014)	(0.004)	(0.004)
Age	-0.00*	-0.01**	0.00	0.01***	-0.00***	-0.00**
	(0.002)	(0.004)	(0.001)	(0.002)	(0.000)	(0.001)
Single (0 1)	0.26***	0.28***	-0.18***	-0.20***	0.03***	0.03***
	(0.050)	(0.057)	(0.030)	(0.031)	(0.009)	(0.010)
Divorced (0 1)	0.25***	0.25***	-0.13***	-0.14***	0.04***	0.04***
	(0.037)	(0.044)	(0.021)	(0.021)	(0.007)	(0.007)
Widowed (0 1)	0.29***	0.27***	-0.16***	-0.15***	0.02***	0.02***
	(0.040)	(0.041)	(0.022)	(0.022)	(0.006)	(0.006)
Low education (0 1)	0.31***	0.43***	-0.03*	-0.07***	0.05***	0.04***
	(0.034)	(0.046)	(0.016)	(0.021)	(0.006)	(0.007)
Medium education (0 1)	0.15***	0.14***	-0.08***	-0.04***	0.01***	0.01**
	(0.030)	(0.033)	(0.016)	(0.016)	(0.004)	(0.005)
Childhood illnesses	0.09***	0.09***	-0.01*	-0.01	0.00	0.00*
	(0.012)	(0.013)	(0.007)	(0.007)	(0.002)	(0.002)
Lagged dependent	0.53***	0.54***	0.76***	0.76***	0.34***	0.33***
	(0.008)	(0.009)	(0.010)	(0.011)	(0.007)	(0.007)
Constant	0.07	0.69**	0.67***	0.08	0.11***	0.05
	(0.166)	(0.322)	(0.095)	(0.199)	(0.027)	(0.053)
Observations	35,791	35,791	20,822	20,822	32,881	32,881
R-squared	0.34	0.33	0.29	0.31	0.28	0.28
IV F-Test	957.2	162.1	712.3	91.45	818.7	131.4
Country FE		YES		YES		YES

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

As a robustness check we estimate the level effect between the treatment and the control group at the time of the trigger event. As shown in Table 5.22 in the appendix, the combination of the small sample size at the time of the trigger event and loss of variation in the instrument when controlling for country-fixed effects lead to insignificance in the effects of DI benefits on all dependent variables except for life satisfaction. Here the results show that the group of DI recipients has a lower level of life satisfaction than the control group at the time of first benefit receipt.

The result that we lose significance when including country fixed effects is certainly disappointing and creates a dilemma. On the one hand, exploiting all the variation in DI benefit receipt seems important. On the other hand, country fixed effects are important in order to prevent that systematic

differences between the countries bias our results. An example for such differences is the variety of national health care systems which directly affect health outcomes.

We have experimented with other instruments such as the OECD policy indicators described at the end of Section 5.3. Unfortunately, they provide similarly weak instruments which are highly correlated with the country dummies and therefore deliver insignificant results.

5.7 Individual Level Fixed Effects

The weakness of our instrumental variable strategy is the weakness of the instrument itself, i.e., the little remaining variation in the population shares of DI receipt once we include country-specific fixed effects. Therefore, we introduce individual level fixed effects estimation as a second estimation strategy.

5.7.1 Methodology

Individual level fixed effects models address the endogeneity problem by eliminating all variables that are constant over time. In our case, these variables include the initial health status before an individual developed a work disability or receives disability benefits as well as all variables that are a function of this initial health status. Consider a standard model in which y_{it} represents the health status of individual *i* at time *t*, $\boldsymbol{X}_{it}$ contains individual time-varying characteristics, α_i captures the individual time-fixed effects and u_{it} is the remaining error term:

$$y_{it} = \beta \boldsymbol{X}_{it} + \alpha_i + u_{it} \tag{4}$$

We define t_0 as the point in time at which a person in the control group reports a work disability and a person in the treatment group reports the uptake of DI benefits for the first time in the observed time span between the years 2004 and 2015. We refer to this point in time as the time of the trigger event. The individual time-fixed effect α_i can then be split into three components:

$$\alpha_i = y_{t0} + DI_{t0}(y_{t0}) + \alpha'_i \tag{5}$$

The first component y_{t0} represents the health status at the time of the trigger event. The second component $DI_{t0}(y_{t0})$ is the DI status at the time of the trigger event. This status is a function of the

health status at that time which creates the selection effect. The third component includes all other time-invariant characteristics of the individual. They include observed variables such as gender, age at trigger event, education, childhood health etc. as well as unobserved variables such as health literacy and knowledge about the DI system at the time of the trigger event. The first two components capture the two main sources of endogeneity – the health status at the time of the trigger event influences whether someone is included in our estimation sample and it influences whether someone is receiving DI benefits and assigned to the treatment group. The key assumption is that these sources of endogeneity are time-invariant and thus disappear in the fixed effect. This assumption is not completely innocent. If health and DI status at the time of the trigger event affect the probability of recovery, the estimates will be biased. This could for example be the case if DI benefits are granted conditional on the expected probability of recovery.

Under the assumption that the health status at the time of the trigger event is fixed across time within an individual, this source of endogeneity cancels out when applying individual level fixed effects. The following steps demonstrate this formally:

$$y_{it} = \beta X_{it} + y_{t0} + DI_{t0}(y_{t0}) + \alpha'_i + u_{it} \tag{6}$$

$$y_{it} - \bar{y}_i = \beta(X_{it} - \bar{X}_i) + (y_{t0} - \bar{y}_{t0}) + (DI_{t0} - \overline{DI}_{t0}) + (\alpha'_i - \bar{\alpha}'_i) + (u_{it} - \bar{u}_i) \tag{7}$$

$$y_{it} - \bar{y}_i = \beta(X_{it} - \bar{X}_i) + (u_{it} - \bar{u}_i) \tag{8}$$

since $y_{t0} = \bar{y}_{t0}$, $DI_{t0} = \overline{DI}_{t0}$, $\alpha'_i = \bar{\alpha}'_i$ due to the time invariance of these components.

Taking care of the endogeneity problems by individual level fixed effects has the great advantage of more flexibility in the specification of the treatment variable. In principle, a richer specification could also be included in the instrumental variable approach but each variable which describes the treatment requires a separate instrument. As we have seen in Section 5.6, the dearth of available instruments prevents such a strategy.

Specifically, we are interested in the timing of the effects generated by DI receipt. As stated in Section 5.2, there are different mechanisms through which DI benefits might influence the health status of a work-disabled individual. While the direct effect of DI benefits on health might cause

instantaneous relief, it might take some time until the indirect effects through financial support or rehabilitation measures have generated a noticeable impact on health. Also, self-reported health status might improve more quickly due to the relief effect whereas the impact on objective health measures might take longer. It is therefore important to evaluate the effect of DI benefits on health over time. This suggests measuring the treatment effect at different times after the trigger event.

We therefore apply the following specification:

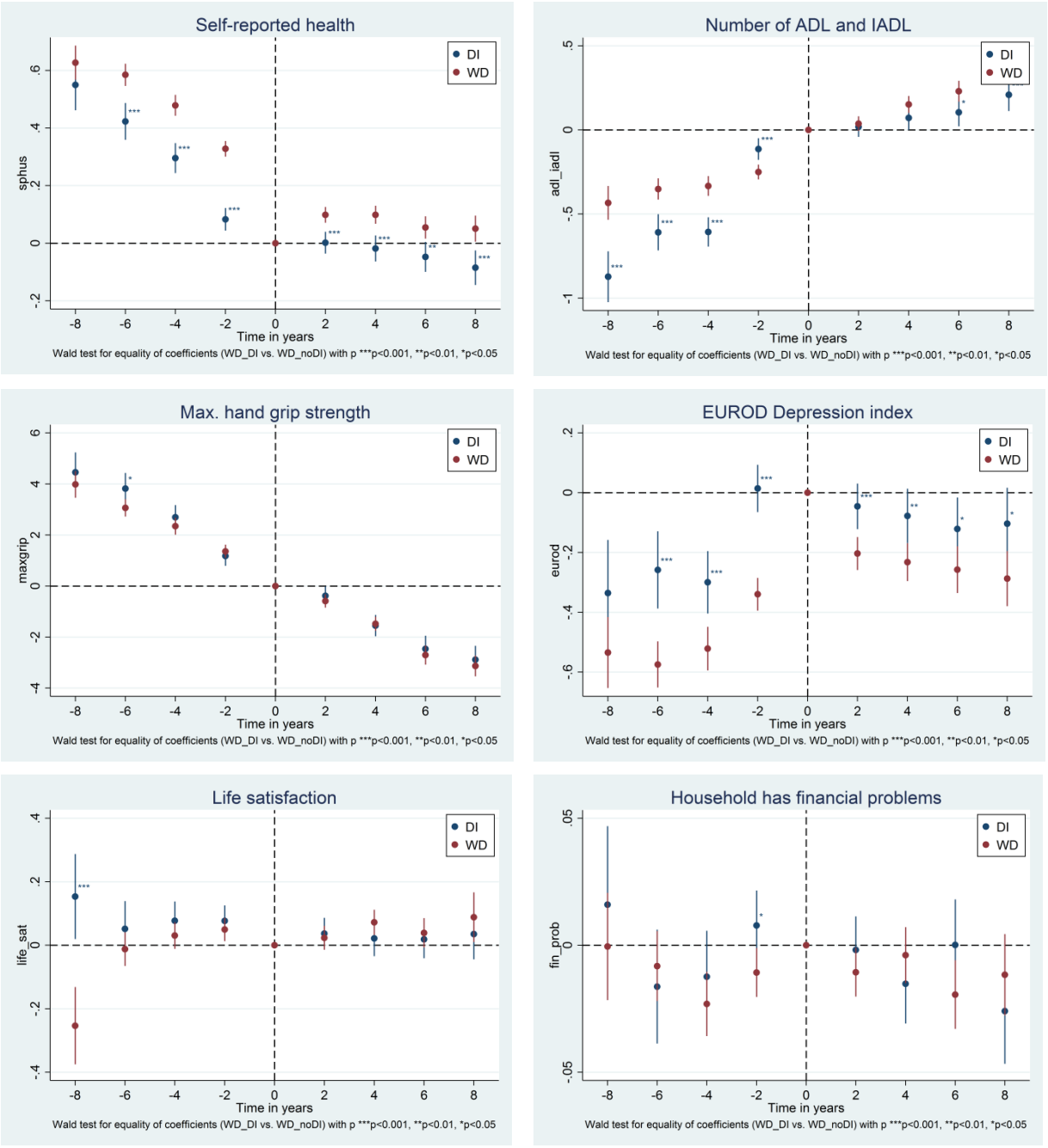
$$y_{it} = \sum_{j=1\ldots4} \beta_j^{1,A} \left(Time_j^A * DI_{i,to}^1\right) + \sum_{j=1\ldots4} \beta_j^{0,A} \left(Time_j^A * DI_{i,to}^0\right) + \sum_{j=1\ldots4} \beta_j^{1,B} \left(Time_j^B * DI_{i,to}^1\right) + \sum_{j=1\ldots4} \beta_j^{0,B} \left(Time_j^B * DI_{i,to}^0\right) + \alpha_i + u_{it} \quad (9)$$

The superscripts 1 and 0 indicate the treatment and the control group, while the superscripts A and B refer to the time after and before the trigger event. We go at most four waves forwards and at most four waves backwards in time relative to t_0, the time of the trigger event. $Time_j^A$ is a dummy variable indicating the time *j* waves after the trigger event, $Time_j^B$ the time *j* waves before the trigger event, and DI_{to}^1 and DI_{to}^0 are dummy variables indicating whether individual *i* received DI benefits at time t_0 or not. The coefficients $\beta_j^{1,A}$ therefore measure the differences of the outcome variable *j* waves after the trigger event for those individuals who receive DI benefits at time t_0, relative to the outcome variable at t_0, the time of the trigger event. Similarly, $\beta_j^{0,B}$ refers to individuals who did not receive DI benefits and the waves before the trigger event, etc. This way we can measure the group-specific time effects which allow us to compare the health development after the time of the trigger event between the treatment and the control group.

5.8 Results

We present the results for the group-specific time effects graphically in Figure 5.6 for the different health measures. The regression results in detail are included in Table 5.23 in the appendix.

Figure 5.6: Group-specific time effect of DI on health and well-being



We first concentrate on the upper left panel for the self-reported health measure. The blue coefficients represent the results for the treatment group, thus individuals who reported receiving DI benefits for the first time while being surveyed. The red coefficients correspond to the control group, thus individuals who at least once reported having a work disability but never received DI benefits while being surveyed. The time measure on the x axis represents the distance to the time of the trigger event, i.e., either the first time that a member of the treatment group reports the DI receipt or the first time that a member of the control group reports having a work disability during our

observation window. The health status at the time of the trigger event is fixed for an individual and disappears in the individual fixed effects regression. The health at the time of the trigger event is therefore the reference outcome. The other coefficients represent the health development relative to this reference outcome. For example, the downward development in the second quadrant indicates that the self-reported health status was better before the time of the trigger event for both groups, but it was continuously decreasing when approaching the time of the trigger event. This is indicated by smaller differences between the health at time t and the health at time zero, expressed formally $(y_{-4} - y_0) > (y_{-2} - y_0)$ for both the treatment and the control group. It is important to note that we cannot compare the health status between the treatment and the control group at a specific point in time. We can only compare whether there is a difference in the health development between the groups relative to the reference outcome. This difference is indicated by the asterisks in the graph representing the significance of a Wald test for equality of the coefficients between the treatment and the control group for each point in time.

The interesting finding in this graph about the self-reported health is that this negative health trend stabilizes after the time of the trigger event for both groups. We interpret this as the relief effect from stopping to work for both groups. Our hypothesis suggested that the financial aspects of the DI benefits add to this work relief effect and therefore we expected the recovery effect to be more distinct for the treatment group, but this cannot be confirmed for self-reported health. In contrast, we see a stronger recovery effect for the treatment group with DI benefits when it comes to the number of limitation in performing (independent) activities of daily life. For the control group, we see a more or less steady increase in the number of limitations, both before and after the time of the trigger event. For the treatment group, we see that there is a jump in the number of limitations between two years before the time of the trigger event. This could reflect a health shock that increases the number of limitations and which could cause the receipt of DI benefits two years later. The interesting development is, however, that the number of limitations stays relatively stable after the trigger event and especially more stable than for the control group.

The pattern for the grip strength measure is rather unclear due to large error bounds; therefore, we cannot identify the recovery effect for the grip strength. In contrast, the development for the depression index does not only reveal a stabilizing effect after the time of the trigger event, but even a health improving effect since the number of depressive symptoms decrease again after the time of the trigger event for both groups. Similarly to the number of limitations, we can see a jump in the number of depressive symptoms for the group of DI recipients in the period before the trigger event. Life satisfaction remains relatively stable before and after the time of the trigger event. Also, there are no significant differences in the development of life satisfaction between the two groups. The development of the financial situation is unclear due to large error bounds for both groups. Our binary variable might not be a strong indicator for the financial situation because we lose a lot of information due to the rough harmonization of the different response options.[26]

5.9 Effect Heterogeneity

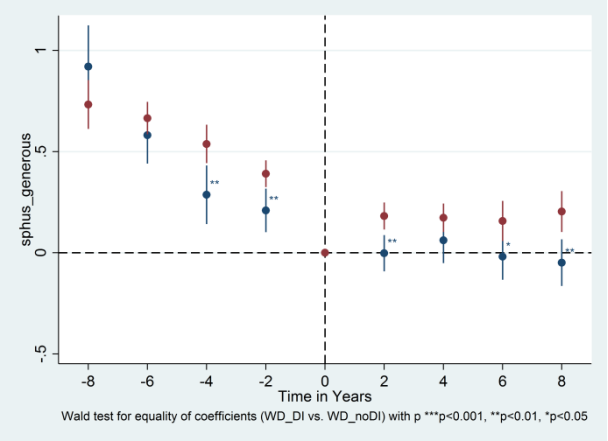
We finally examine the effect heterogeneity, i.e., how the effects measured in the previous section differ by demographic characteristics (e.g. gender, education[27]) and other life circumstances, in particular the generosity of the DI systems in the different countries. For the latter, we use the sum of the benefit generosity measures of the OECD policy indicators of 2007 in order to split the countries into generous DI systems (Germany, Sweden, Spain, Italy, Demark, Switzerland) and less generous DI systems (Austria, Netherlands, France, Belgium, Czech Republic, UK, US). Figure 5.7 shows that the stabilizing effect for self-reported health and for ADL/IADL is more distinct for countries with a generous DI system in terms of benefit payments.

[26] For future research it might be worth the time-intensive effort of harmonizing the household income between the different surveys.

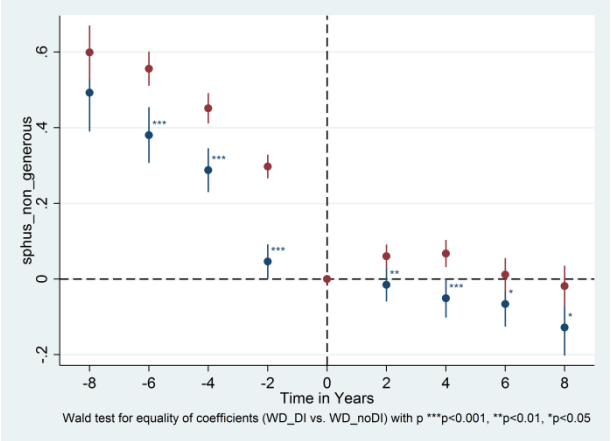
[27] There is very little effect heterogeneity by gender and education. Corresponding graphs are therefore relegated to the appendix.

Figure 5.7: Effect heterogeneity for generosity of DI system

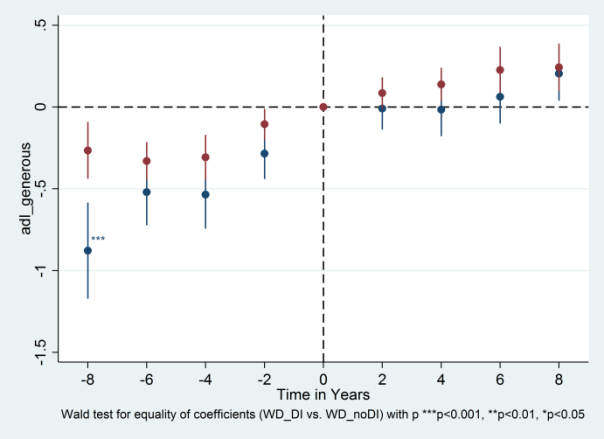
Generous DI system: self-reported health



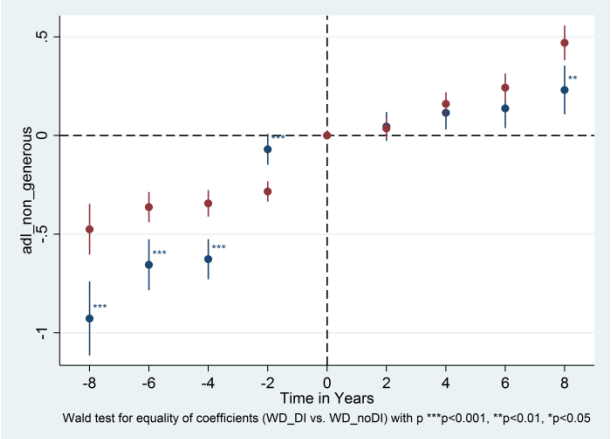
Less generous DI system: self-reported health



Generous DI system: ADL/IADL



Less generous DI system: ADL/IADL



5.10 Discussion and Conclusion

The objective of disability insurance is to provide basic protection for those who suffer from work disabilities. This protection has two dimensions: protection from poverty by income support and protection from deteriorating health by permitting individuals to retire from the career they are not able to follow any more and instead by integrating them adequately into an alternative work life. This study has evaluated both objectives using harmonized data from SHARE, ELSA and HRS. The extensive panel data allowed studying the effect of DI programs on health over time compared to persons who become work disabled but do not receive any DI payments.

The results from the linear regression model demonstrated differences between the treatment and the control group in the sense that DI benefit recipients have a worse health status than the work

disabled persons. These results stress the need for identification strategies to overcome the endogeneity problem.

First, we estimated different instrumental variable models based on pooled data. The results showed that DI benefit receipt has a significant positive impact on self-reported health, grip strength, depression and life satisfaction However, after including country level fixed effects only the DI effect on depression remains significant. This weakness of the instrumental variable strategy lies in the weakness of the instrument itself, i.e., the little remaining variation in the population shares of DI receipt once we include country-specific fixed effects.

We therefore pursued a second strategy to overcome the endogeneity problem and performed individual level fixed effects estimations. This has the added advantage of evaluating the differential health development over time for those who receive DI benefits and those who do not. Overall, we find that health stabilizes or even improves compared to the time of the trigger event for both the work disabled persons and the DI benefits recipients.

The two identification strategies complement each other. The instrumental variable approach identifies the level effect of DI benefits while employing individual level fixed effects identifies the timing effect of DI benefits.

Regarding the hypotheses that were developed at the outset of this study, we expected that work disabled persons experience a health improvement in the short run, but health deterioration in the long run. We can confirm the health improvement in the short run, but we do not find a negative trend for the long run. The reason might be that the number of observations declines with the number of years after the time of the trigger event, either because the individuals reported the work disability in later waves or because individuals with severe health problems drop out of the survey and a positive selection effect might drive the results for the longer durations.

We further hypothesized that the monetary benefit and integration measures of DI programs buffer the negative effects of a detachment from the labor force, leading to a stabilization or improvement

of health for DI recipients in the short and in the long run. We can confirm this hypothesis in the sense that we find a recovery effect for the DI benefit recipients for the whole observed period after the time of the trigger event. However, we cannot clearly identify the buffering effect of DI programs since the health development is similar for the group of DI recipients and work disabled persons and since the level effect at the time of the trigger event is significant only for depression after controlling for country level fixed effects.

Concerning the effect heterogeneity, we find that in countries with generous DI systems, the recovery effect for self-reported health and the number of limitations in performing (independent) activities of daily life is more distinct than in countries with less generous systems. This finding contradicts our hypothesis. However, we observe the higher recovery effect in countries with generous DI systems also for the work disabled persons who do not receive DI payments. This might be due to other country-specific influences (e.g. healthcare system) that might be captured by this analysis.

Summing up, we find that labor market withdrawal induced by work disability is a relief for the individuals indicated by a stabilization of the health measures at least in the short run. DI benefit programs add to this positive relief effect by providing income security and integration measures.

There is ample potential and need for future research. Following up on the last point, the interrelationship between the generosity of a DI system and the effect of work disability and DI receipt on health is unclear and needs more detailed investigation. Related to this, it would be interesting to disentangle the effect of the different dimensions of DI policies to understand the effect of work disability on health via the indirect effect of financial scarcity and work exclusion to a better extent. For this purpose, we would need to take into account whether individuals are successfully integrated in the labor market or other social activities after the occurrence of a work disability. In addition, it would be helpful to differentiate between the different levels of severity of disability. Improvements in the methodological part should also be contemplated. First, the instrumental variable approach would gain from more variation over time, maybe considering

specific reforms or policy regulations. Second, the composition of the control group could be sharpened by taking into account the severity level of disability by using objective health measures in conjunction with the self-reported work disability question. Further, it would be interesting to directly relate the results to the extensive literature on the health effects of retirement by comparing the health development of (early retirees) as additional group in the same graph as the work disabled persons and the DI benefit recipients. This would also help to disentangle the duration of the relief effect and the expected negative trend in the long run. Further research is also needed to examine the effect heterogeneity with respect to the generosity of the DI systems in order to draw tighter policy conclusions.

5.11 Appendix

A. Contextual Information

Table 5.14: Definition of disability benefits

Austria	Staatliche Invaliditäts- bzw. Berufsunfähigkeitspension, Versehrtenrente oder Krankengeld (aus der Haupt- und Nebenbeschäftigung)
Belgium	Wettelijke/ Aanvullende uitkering bij ziekte of invaliditeit of wettelijke uitkering bij beroepsziekte of arbeidsongeval; Une allocation/pension maladie/invalidité/incapacité légale, Une deuxième assurance maladie/invalidité/incapacité légale
Czech Republic	Státní invalidní důchod, nemocenské dávky
Switzerland	Rente de l''assurance invalidité (AI); Rente der Invalidenversicherung (IV); Rendita invalidità AI
Germany	Erwerbsminderungsrente bzw. Beamtenpension wegen Dienstunfähigkeit, oder Krankengeld
Denmark	Førtidspension, herunder sygedagpenge
Spain	Pensión pública de invalidez/incapacidad o prestación pública por enfermedad, Segunda pensión pública de invalidez/incapacidad o segunda prestación pública por enfermedad; Pensió pública d''invalidesa / incapacitat o prestació pública per malaltia, Segona pensió pública d''invalidesa / incapacitat o segona prestació pública per malaltia
France	Une pension d'invalidité publique (y c. rente d'accident du travail et allocation supplémentaire d'invalidité)
Italy	Indennità pubblica di disabilità; pensione di invalidità, incapacità (incluso assegno di accompagnamento)
Netherlands	WAO, Waz, WIA, of ander invaliditeitspensioen
Sweden	Sjukersättning (förtidspension) eller sjukpenning
England	Incapacity benefits (previously invalidity benefits), Employment and Support Allowance, Severe Disablement Allowance SDA, Statutory sick pay SSP, Attendance Allowance, Disability Living Allowance, Industrial Injuries Disablement benefits
United States	SSDI and SSI disability pension

Source: Country-specific SHARE questionnaires

Table 5.15: DI system indicators per country – benefit generosity

2000	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Coverage	2	3	5	3	2	3	4	3	5	5	n.a.	3	3
Minimum disability level	3	2	3	2	5	2	5	4	5	4	n.a.	1	1
Disability level for full benefit	4	3	1	1	3	0	2	1	1	3	n.a.	2	2
Benefit generosity	2	1	4	3	2	3	5	4	5	4	n.a.	1	3
Permanence of payments	1	4	4	1	1	1	3	5	3	4	n.a.	2	4
Medical assessment	1	2	3	2	3	1	1	0	3	4	n.a.	3	4
Vocational assessment	5	4	1	4	3.5	3	1	3	1	2	n.a.	1.5	1
Sickness benefit generosity	3	3	2	2	4	3	3	2	4	4	n.a.	1	2
Sickness benefit duration	2	2	2	5	4	3	3	4	4	2	n.a.	2	0
Sickness benefit monitoring	2	2	2	2	2	3	2	4	3	1	n.a.	4	1
SUM	25	26	27	25	29.5	22	29	30	34	33	n.a.	20.5	21

Source: OECD (2003)

2007	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Coverage	2	3	5	3	3	3	4	3	5	5	1	3	3
Minimum disability level	3	2	2	2	5	2	4	4	5	4	4	1	0
Disability level for full benefit	4	3	1	1	3	0	2	1	1	3	3	2	1
Benefit generosity	2	1	3	3	2	3	3	4	5	3	3	1	3
Permanence of payments	1	4	4	1	1	1	2	5	4	4	0	2	2
Medical assessment	1	2	4	2	3	1	1	0	3	3	2	3	4
Vocational assessment	4	4	2	4	2	3	0	3	1	2	1	1	0
Sickness benefit generosity	3	2	4	2	4	3	4	2	4	3	0	1	3
Sickness benefit duration	2	2	3	5	4	5	4	4	4	4	5	2	0
Sickness benefit monitoring	2	2	0	2	5	5	0	1	5	1	5	5	1
SUM	24	25	28	25	32	26	24	27	37	32	24	21	17

Source: OECD (2010)

Table 5.16: DI system indicators per country – integration

2000	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Access to employment programs	2	3	2	5	4	4	4	4	3	4	n.a.	2	0
Agency responsibility	3	3	5	2	0	2	2	3	3	3	n.a.	2	0
Employer responsibility	1	2	2	2	3	4	3	3	5	1	n.a.	4	4
Supported employment program	4	1	5	2	5	1	2	1	2	1	n.a.	3	5
Subsidized employment program	4	5	5	5	4	1	1	3	4	1	n.a.	1	1
Sheltered employment program	2	2	2	2	3	2	5	3	2	3	n.a.	2	2
Vocational rehabilitation program	5	2	5	1	5	0	2	4	5	5	n.a.	1	1
Vocational rehabilitation timing	4	3	5	2	5	2	2	4	4	3	n.a.	3	1
Benefit suspension rules	0	2	3	0	3	0	5	0	5	0	n.a.	4	5
Work incentives rules	3	0	5	3	3	2	4	2	0	2	n.a.	5	4
SUM	28	23	39	24	35	18	30	27	33	23	n.a.	27	23

Source: OECD (2003)

2007	AT	BE	DK	FR	DE	IT	NL	ES	SE	CH	CZ	UK	USA
Access to employment programs	2	3	4	3	4	4	4	4	3	4	3	4	0
Agency responsibility	3	3	4	2	0	2	4	3	4	4	1	4	0
Employer responsibility	3	3	2	3	4	4	4	3	5	2	4	4	3
Supported employment program	4	1	3	3	5	1	2	1	2	1	1	3	4
Subsidized employment program	4	5	5	5	4	1	2	2	4	1	1	1	1
Sheltered employment program	2	2	2	4	3	2	4	3	3	3	3	2	2
Vocational rehabilitation program	5	2	5	1	5	0	4	2	3	5	1	1	1
Vocational rehabilitation timing	4	3	4	2	5	2	4	2	3	4	4	3	1
Benefit suspension rules	0	2	5	0	3	0	2	0	5	0	0	5	5
Work incentives rules	3	0	3	3	2	2	5	2	0	3	3	5	4
SUM	30	24	37	26	35	18	35	22	32	27	21	32	21

Source: OECD (2010)

B. Data Background

Table 5.17: Overview of variable groups used in analyses

Group	Variable	Description	Range	Categories	Available in SHARE	Available in ELSA	Available in HRS
Demographics	age	Age at time of interview	50-81	50-81	yes	yes	yes
	gender	Male or female	0-1	0. Female 1. Male	yes	yes	yes
	education_low	Education category	0-1	0. Not in low education category 1. In low education category (ISCED 0-2)	yes	yes	yes
	education_medium	Education category	0-1	0. Not in medium education category 1. In medium education category (ISCED 3-4)	yes	yes	yes
	education_high	Education category	0-1	0. Not in high education category 1. In high education category (ISCED 5-6)	yes	yes	yes
	single	Currently not married, divorced or widowed	0-1	0. Not single 1. Single	yes	yes	yes
	married	Currently married	0-1	0. Not married 1. Married	yes	yes	yes
	divorced	Currently divorced	0-1	0. Not divorced 1. Divorced	yes	yes	yes
	widowed	Currently widowed	0-1	0. Not widowed 1. Widowed	yes	yes	yes
Health	sphus	Self-reported health	1-5	1. Excellent 2. Very good 3. Good 4. Fair 5. Poor	yes	yes	yes
	iadl	IADL: number of limitations with instrumental activities of daily living	0-6	Difficulties with: Using a map, preparing a hot meal, shopping for groceries, making telephone calls, taking medications and managing money	yes	yes	yes
	adl	ADL: number of limitations with activities of daily living	0-6	Difficulties with: Dressing, eating, using the toilet, bathing and showering, getting in and out of bed, walking across a room	yes	yes	yes
	maxgrip	Maximal Hand Grip Strength (Kg)	0.5 - 99	0.5 – 99	yes	yes	yes
	eurod	Depression scale	0-12	0-12	yes	from cesd	from cesd
	lim_work	Health problem that limits paid work	0-1	0. No 1. Yes	yes	yes	yes

Work	ep005_	Current job situation	1-6	1: Retired 2: Employed or self-employed (including working for family business 3: Unemployed 4: Permanently sick or disabled 5: Homemaker 6: Other	yes	yes	yes
	fin_prob	Household has financial problems	0-1	0: no 1: yes	yes	yes	yes
Well-being	life_sat	how satisfied are you with your life?	1-4	1: very dissatisfied 2: dissatisfied 3: satisfied 4: very satisfied	yes	yes	yes

Table 5.18: Harmonization of waves

Wave SHARE	1	2	3*	4	5	6
Wave ELSA	2	3	4	5	6	7
Wave HRS	7	8	9	10	11	12
Harmonized wave	**1**	**2**	**3**	**4**	**5**	**6**
Year	**2004/2005**	**2006/2007**	**2008/2009**	**2010/2011**	**2012/2013**	**2014/2015**

**Wave 3 of SHARE contains mainly retrospective life history data. Some information (like current labor market status) can be inferred from the information given in the retrospective employment module.*

Table 5.19: Detailed list of harmonized variables

Variable	Description	SHARE						ELSA						HRS					
		W1	W2	W3	W4	W5	W6	W1	W2	W3	W4	W5	W6	W1	W2	W3	W4	W5	W6
Work disability and disability benefits																			
DI	disability benefits	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WD	Health problem that limits paid work	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Identifiers (merging…)																			
mergeid	Identifier in SHARE	X	X	X	X	X	X												
idauniq	Identifier in ELSA							X	X	X	X	X	X						
hhidpn	Identifier in HRS													X	X	X	X	X	X
study	study identifier	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
wave	Harmonized wave identifier 1-6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
int_year	Interview year	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
int_month	Interview month	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Demographic																			
country	Country identifier	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
yrbirth	Year of birth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
mobirth	Month of birth	X	X	X	X	X	X							X	X	X	X	X	X
age	Age	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
gender	Gender	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
married	Is respondent married?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ever_married	Has respondent ever been married?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
divorced	Is respondent divorced?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ever_divorced	Has respondent ever been divorced?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
widowed	Is respondent widowed?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ever_widowed	Has respondent ever been widowed?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
children	Number of children	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
grandchildren	Has grandchildren or great-grandchildren	X	X		X	X	X	X	X	X	X	X	X						
Education																			
education	education category (low medium high)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Job																			
empl_status	Current job situation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ret_year	Retirement year	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
numberjobs	number of jobs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
working_gaps	number of working gaps	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
job_title	Name or title of job		X		X	X	X							X	X	X	X	X	X
job_industry	Job industry		X		X	X	X							X	X	X	X	X	X
fin_prob	Household has financial problems	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
co007_	Is household able to make ends meet?	X	X		X	X	X	X	X	X	X	X	X						
Biomarker																			
maxgrip	Max. of grip strength measure	X	X		X	X	X	X		X		X		X	X	X	X	X	X

Variable	Description	SHARE						ELSA						HRS					
General Health																			
ph006d1	Doctor told you had: heart attack	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d2	Doctor told you had: high blood pressure or hypertension	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d3	Doctor told you had: high blood cholesterol	X	X		X	X	X	X	X	X	X	X	X						
ph006d4	Doctor told you had: stroke	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d5	Doctor told you had: diabetes or high blood sugar	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d6	Doctor told you had: chronic lung disease	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d10	Doctor told you had: cancer	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d12	Doctor told you had: Parkinson disease	X	X		X	X	X	X	X	X	X	X	X						
ph006d13	Doctor told you had: cataracts	X	X		X	X	X	X	X	X	X	X	X						
ph006d14	Doctor told you had: hip fracture or femoral fracture	X	X		X	X	X	X	X	X	X	X	X						
ph006d16	Doctor told you had: alzheimer's disease, dementia, senility		X		X	X	X	X	X	X	X	X	X						
ph006d18	Doctor told you had: other affective/emotional disorders					X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d19	Doctor told you had: rheumatoid arthritis					X	X	X	X	X	X	X	X	X	X	X	X	X	X
ph006d20	Doctor told you had: osteoarthritis/other rheumatism					X	X	X	X	X	X	X	X						
sphus	Self-reported health	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
dis_cause	Disability caused by work	X	X		X									X	X	X	X	X	X
hc114_	Could not see doctor because of cost					X	X											X	X
ph004_	Long-term illness	X	X		X	X	X	X	X	X	X	X	X						
Mental Health																			
eurod	Depression scale EURO-D - high is depressed	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
life_sat	How satisfied with life - grouped		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X
Limitations in activities of daily living																			
iadl	Number of limitations with instrumental activities of daily living	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
adl	Number of limitations with activities of daily living	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Life course history																			
illnesses_ch	sum childhood illnesses	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
illnesses_adult_ever	Sum ever had illness (Adult)		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Activities																			
ac035d1	Activities in last year: done voluntary or charity work				X	X		X	X	X	X	X	X	X	X	X	X	X	X
ac035d4	Activities in last year: attended an educational or training course				X	X		X	X	X	X	X	X		X	X	X	X	X
ac035d5	Activities in last year: gone to a sport, social or other kind of club				X	X		X	X	X	X	X	X					X	X
ac035d6	Activities in last year: taken part in activities of a religious organization				X	X		X	X	X	X	X	X						
ac035d7	Activities in last year: taken part in a political or community-related organization				X	X		X	X	X	X	X	X					X	X
ac035d8	Activities in last year: read books, magazines or newspapers				X	X												X	X
ac035d10	Activities in last year: played cards or games such as chess				X	X												X	X
ac035dno	Activities in last year: none of these				X	X													

C. Figures and Tables

Table 5.20: Sequences of labor market situations after DI benefits receipt

Percent	state1	state2	state3	state4	group_dummy
39.46	DI benefits	DI benefits	DI benefits	DI benefits	Never got out of DI
13.02	DI benefits	DI benefits	DI benefits	Retired	Never got out of DI
11.07	DI benefits	DI benefits	Retired	Retired	Never got out of DI
10.26	DI benefits	Retired	Retired	Retired	Never got out of DI
6.42	DI benefits	Employed	Employed	Employed	Long-term transition out of DI
3.26	DI benefits	DI benefits	Employed	Employed	Long-term transition out of DI
2.48	DI benefits	DI benefits	Retired	DI benefits	Never got out of DI
2.34	DI benefits	Employed	Retired	Retired	Long-term transition out of DI
1.95	DI benefits	DI benefits	DI benefits	Employed	Long-term transition out of DI
1.67	DI benefits	Retired	DI benefits	DI benefits	Never got out of DI
1.24	DI benefits	Retired	Retired	DI benefits	Never got out of DI
1.10	DI benefits	Retired	DI benefits	Retired	Never got out of DI
0.92	DI benefits	DI benefits	Employed	Retired	Long-term transition out of DI
0.75	DI benefits	DI benefits	Employed	DI benefits	Short-term transition out of DI
0.67	DI benefits	Employed	DI benefits	DI benefits	Short-term transition out of DI
0.64	DI benefits	Employed	Employed	DI benefits	Short-term transition out of DI
0.50	DI benefits	Employed	Retired	Employed	Long-term transition out of DI
0.46	DI benefits	DI benefits	Retired	Employed	Long-term transition out of DI
0.43	DI benefits	Employed	DI benefits	Retired	Short-term transition out of DI
0.35	DI benefits	Employed	DI benefits	Employed	Long-term transition out of DI
0.25	DI benefits	Retired	Retired	Employed	Long-term transition out of DI
0.21	DI benefits	DI benefits	DI benefits	Unemployed	Never got out of DI
0.18	DI benefits	DI benefits	Retired	Sick/Disabled	Never got out of DI
0.14	DI benefits	Employed	Unemployed	Employed	Long-term transition out of DI
0.11	DI benefits	Retired	Employed	DI benefits	Short-term transition out of DI
0.07	DI benefits	DI benefits	Unemployed	Retired	Never got out of DI
0.04	DI benefits	Retired	Sick/Disabled	Employed	Long-term transition out of DI

Figure 5.8: Share of DI recipients by age, gender, and country

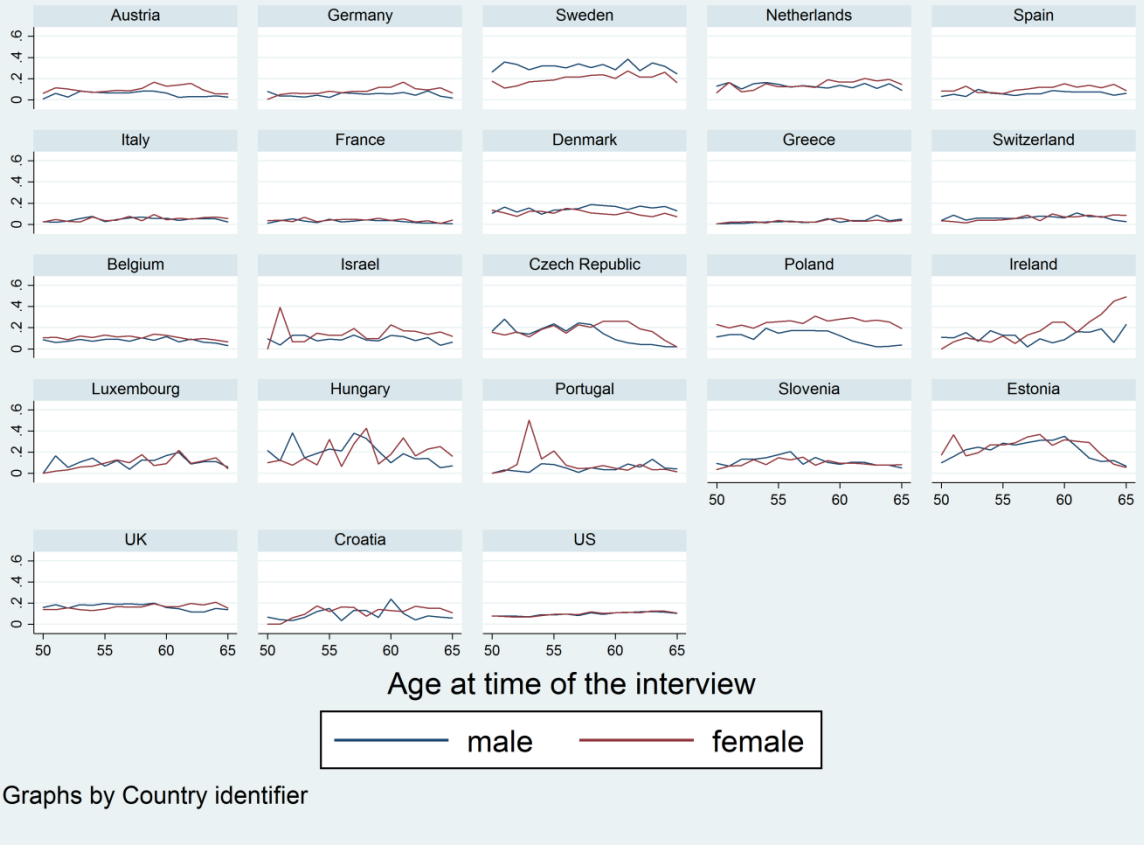


Table 5.21: First-stage regressions for different specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	DI benefits	DI benefits	DI benefits	DI benefits	DI benefits	DI benefits	DI benefits	DI benefits	DI benefits	DI benefits
Share of DI recipients	1.63***	0.73***	1.57***	0.71***	1.60***	0.68***	1.62***	0.64***	1.62***	0.66***
	(0.050)	(0.052)	(0.051)	(0.055)	(0.052)	(0.053)	(0.061)	(0.067)	(0.055)	(0.058)
Female	-0.06***	-0.06***	-0.09***	-0.09***	-0.07***	-0.07***	-0.05***	-0.05***	-0.05***	-0.05***
	(0.010)	(0.010)	(0.013)	(0.013)	(0.010)	(0.010)	(0.012)	(0.011)	(0.011)	(0.011)
Age	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Single (0 1)	0.13***	0.12***	0.11***	0.10***	0.11***	0.11***	0.10***	0.09***	0.11***	0.11***
	(0.021)	(0.020)	(0.022)	(0.022)	(0.021)	(0.020)	(0.023)	(0.023)	(0.021)	(0.021)
Divorced (0 1)	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.06***	0.06***	0.08***	0.08***
	(0.015)	(0.015)	(0.016)	(0.016)	(0.015)	(0.015)	(0.017)	(0.017)	(0.015)	(0.015)
Widowed (0 1)	0.03**	0.04***	0.03**	0.04**	0.03**	0.03**	0.01	0.01	0.03*	0.03*
	(0.014)	(0.014)	(0.016)	(0.015)	(0.015)	(0.015)	(0.017)	(0.017)	(0.015)	(0.015)
Low education (0 1)	0.11***	0.11***	0.06***	0.07***	0.11***	0.12***	0.10***	0.11***	0.13***	0.13***
	(0.013)	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)	(0.015)	(0.016)	(0.014)	(0.015)
Medium education (0 1)	0.05***	0.05***	0.03**	0.03**	0.05***	0.05***	0.05***	0.05***	0.06***	0.05***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.013)	(0.013)
Childhood illnesses	0.00	-0.00	0.01	-0.00	0.00	-0.00	0.00	-0.01*	-0.00	-0.00
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
Lagged iadl_adl	0.02***	0.02***								
	(0.002)	(0.002)								
Lagged maxgrip			-0.00***	-0.00***						
			(0.001)	(0.001)						
Lagged eurod					0.01***	0.02***				
					(0.002)	(0.003)				
Lagged life_sat							-0.03***	-0.04***		
							(0.009)	(0.009)		
Lagged fin_prob									0.02	0.06***
									(0.012)	(0.012)
Constant	0.65***	0.93***	0.76***	1.08***	0.63***	0.90***	0.86***	1.25***	1.05***	0.92***
	(0.050)	(0.051)	(0.063)	(0.061)	(0.053)	(0.053)	(0.071)	(0.073)	(0.071)	(0.055)
Observations	35,822	35,822	23,309	23,309	35,791	35,791	20,822	20,822	32,881	32,881
Partial R	0.066	0.009	0.076	0.011	0.064	0.008	0.070	0.007	0.052	0.007
Country FE		YES		YES		YES		YES		YES

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

Table 5.22: Level effect at the time of the trigger event

VARIABLES	(1) sphus IV	(2) adl_iadl IV	(3) maxgrip IV	(4) eurod IV	(5) life_sat IV	(6) fin_prob IV
DI benefits	0.17	0.08	-0.19	-0.12	-0.27*	-0.03
	(0.112)	(0.191)	(1.001)	(0.275)	(0.146)	(0.045)
Male or female	0.05**	0.00	-7.78***	0.37***	0.01	0.00
	(0.023)	(0.039)	(0.558)	(0.051)	(0.030)	(0.008)
Age	0.00	0.01	-0.17***	-0.02***	0.01	-0.00***
	(0.003)	(0.005)	(0.032)	(0.006)	(0.004)	(0.001)
Single (0 1)	-0.11**	0.05	-1.26**	0.10	-0.25***	0.05***
	(0.045)	(0.078)	(0.523)	(0.098)	(0.061)	(0.019)
Divorced (0 1)	-0.06*	0.10*	-0.22	0.15**	-0.30***	0.09***
	(0.034)	(0.058)	(0.366)	(0.073)	(0.053)	(0.014)
Widowed (0 1)	-0.05	-0.01	-0.78*	0.22***	-0.19***	0.06***
	(0.036)	(0.064)	(0.412)	(0.081)	(0.059)	(0.016)
Low edu (0 1)	-0.21***	0.11*	-0.84**	0.29***	-0.08*	0.07***
	(0.034)	(0.059)	(0.336)	(0.071)	(0.045)	(0.013)
Medium edu (0 1)	-0.09***	-0.03	-0.16	0.14**	-0.03	0.03***
	(0.028)	(0.045)	(0.323)	(0.056)	(0.039)	(0.009)
Childhood illnesses	-0.01	0.06***	-0.14	0.09***	0.01	0.01**
	(0.011)	(0.021)	(0.150)	(0.023)	(0.018)	(0.005)
Lagged dependent	0.46***	0.60***	0.54***	0.49***	0.40***	0.36***
	(0.014)	(0.031)	(0.025)	(0.015)	(0.027)	(0.021)
Constant	1.39***	0.03	31.89***	2.51***	2.06***	0.28***
	(0.226)	(0.349)	(2.914)	(0.446)	(0.344)	(0.077)
Observations	6,323	6,059	2,518	6,094	2,293	5,472
R-squared	0.32	0.28	0.75	0.30	0.21	0.22
Country FE	YES	YES	YES	YES	YES	YES
IV F-Test	277.9	285.9	189.4	259.1	105.8	248.3

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5.23: Regression results individual-fixed effects model

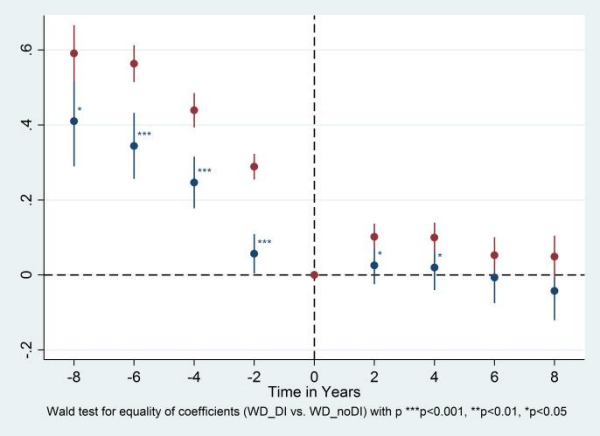
	(1) sphus		(2) adl/iadl		(3) maxgrip		(4) eurod		(5) financial problems		(6) life satisfaction	
	b	se	b	se	b	se	b	se	b	se	b	se
Dp1	0.550***	(0.045)	-0.873***	(0.077)	4.456***	(0.397)	-0.336***	(0.091)	0.016	(0.016)	0.153*	(0.068)
Dp2	0.423***	(0.033)	-0.609***	(0.055)	3.819***	(0.312)	-0.259***	(0.066)	-0.016	(0.011)	0.052	(0.045)
Dp3	0.296***	(0.026)	-0.607***	(0.045)	2.694***	(0.244)	-0.300***	(0.053)	-0.012	(0.009)	0.077*	(0.031)
Dp4	0.083***	(0.020)	-0.114***	(0.033)	1.175***	(0.196)	0.014	(0.040)	0.008	(0.007)	0.077**	(0.025)
Dp5	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
Dp6	0.002	(0.019)	0.018	(0.031)	-0.382*	(0.189)	-0.046	(0.039)	-0.002	(0.007)	0.037	(0.025)
Dp7	-0.018	(0.023)	0.072	(0.037)	-1.551***	(0.213)	-0.078	(0.046)	-0.015	(0.008)	0.021	(0.028)
Dp8	-0.048	(0.027)	0.105*	(0.043)	-2.463***	(0.263)	-0.121*	(0.054)	0.000	(0.009)	0.019	(0.030)
Dp9	-0.085**	(0.031)	0.209***	(0.049)	-2.885***	(0.276)	-0.104	(0.061)	-0.026*	(0.011)	0.035	(0.041)
noDp1	0.627***	(0.030)	-0.434***	(0.051)	3.982***	(0.266)	-0.535***	(0.061)	-0.001	(0.011)	-0.254***	(0.062)
noDp2	0.585***	(0.020)	-0.352***	(0.032)	3.061***	(0.174)	-0.575***	(0.039)	-0.008	(0.007)	-0.012	(0.027)
noDp3	0.479***	(0.018)	-0.334***	(0.030)	2.345***	(0.170)	-0.522***	(0.037)	-0.023***	(0.006)	0.031	(0.021)
noDp4	0.328***	(0.014)	-0.250***	(0.022)	1.360***	(0.133)	-0.340***	(0.028)	-0.011*	(0.005)	0.050**	(0.019)
noDp5	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)	0.000	(.)
noDp6	0.098***	(0.014)	0.037	(0.022)	-0.587***	(0.133)	-0.204***	(0.028)	-0.011*	(0.005)	0.023	(0.019)
noDp7	0.099***	(0.016)	0.152***	(0.025)	-1.480***	(0.142)	-0.233***	(0.032)	-0.004	(0.006)	0.072***	(0.020)
noDp8	0.055**	(0.020)	0.230***	(0.032)	-2.707***	(0.193)	-0.258***	(0.040)	-0.019**	(0.007)	0.039	(0.024)
noDp9	0.050*	(0.023)	0.412***	(0.037)	-3.134***	(0.209)	-0.288***	(0.047)	-0.012	(0.008)	0.088*	(0.040)
Constant	2.589***	(0.007)	0.729***	(0.012)	33.398***	(0.066)	2.997***	(0.015)	0.110***	(0.003)	3.333***	(0.008)
R-squared	-0.210		-0.255		-0.350		-0.286		-0.310		-0.602	
N	40267		39460		24928		38953		36376		23073	

Robust standard errors in parentheses

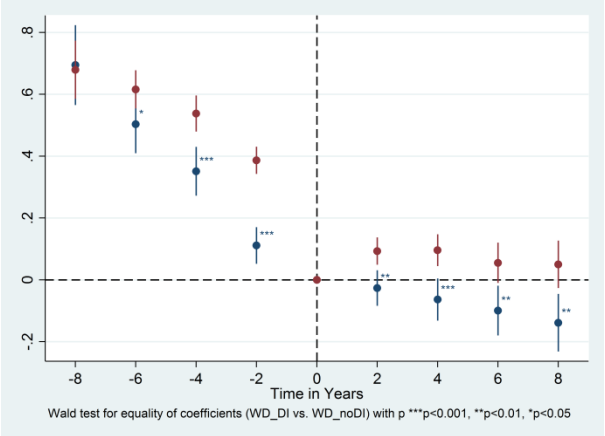
*** p<0.01, ** p<0.05, * p<0.1

Figure 5.9: Effect heterogeneity by gender

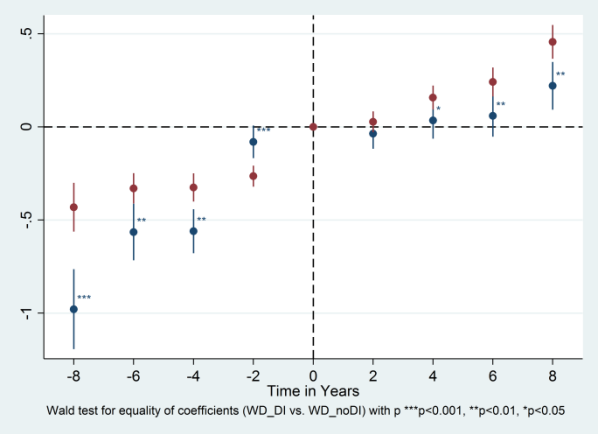
Male: self-reported health



Female: self-reported health



Male: ADL/IADL



Female: ADL/IADL

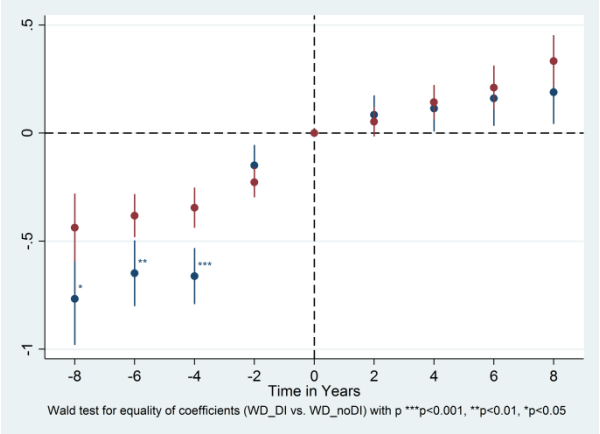
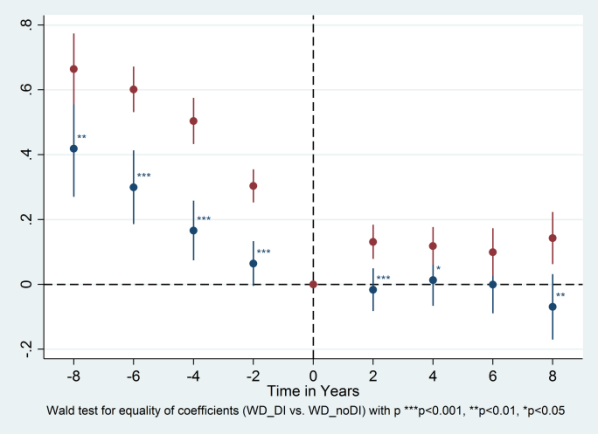
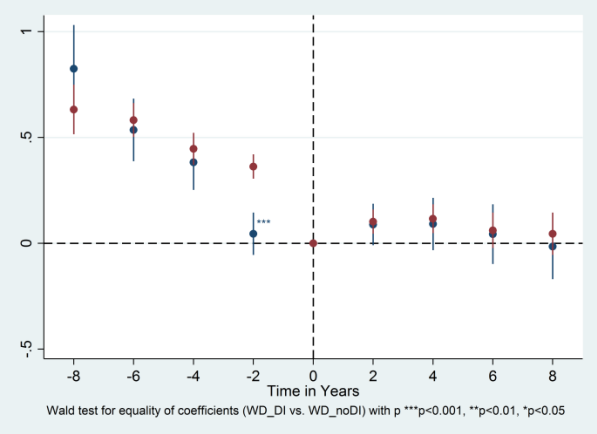


Figure 5.10: Effect heterogeneity by education

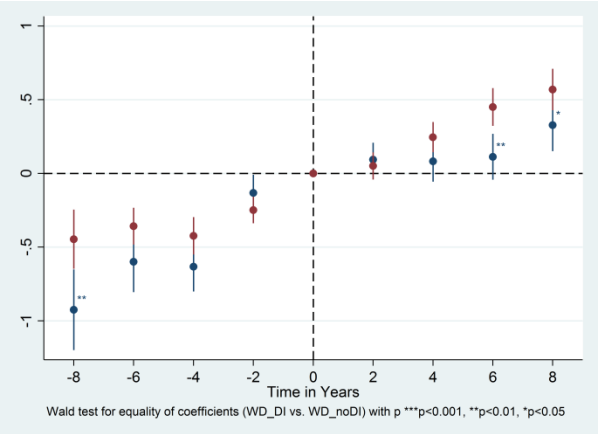
Low education: self-reported health



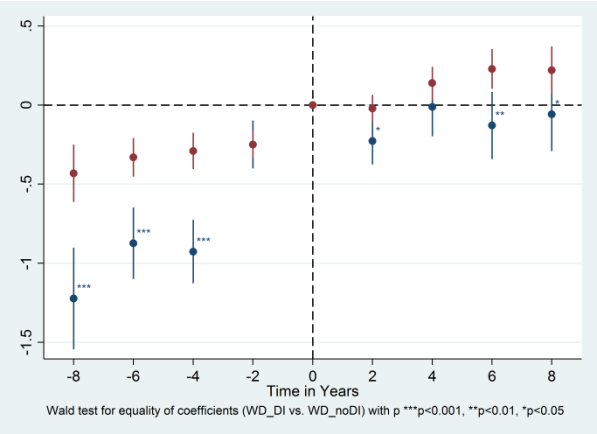
High education: self-reported health



Low education: ADL/IADL



High education: ADL/IADL



Bibliography

Aarts, L. J. M., Burkhauser, R. V. and P. R. de Jong (eds) (1996): Curing the Dutch disease. An international perspective on disability policy reform. Aldershot, Avebury.

Antonucci, T. C. and H. Akiyama (1987): Social networks in adult life and a preliminary examination of the convoy model. *Journal of Gerontology*. 42(5), 519-27.

Antonucci, T. C., Ajrouch, K. J. and K. S. Birditt (2014): The Convoy Model: Explaining Social Relations From a Multidisciplinary Perspective. *The Gerontologist*, 54(1), 82-92.

Autor, D. H. and M. G. Duggan (2003): The Rise in the Disability Rolls and the Decline in Unemployment. *Quarterly Journal of Economics*, 118(1), 157–205.

Autor, D. H. and M. G. Duggan (2006): The Growth in the Social Security Disability Rolls: A Fiscal Crisis Unfolding. *Journal of Economic Perspectives*, 20(3), 71-96.

Autor, D. H. and M. G. Duggan (2010): Supporting Work: A Proposal for Modernizing the U.S. Disability Insurance System. Center for American Progress and the Hamilton Project.

Autor, D. H., Duggan, M. G., Greenberg, K. and D. S. Lyle (2016): The Impact of Disability Benefits on Labor Supply: Evidence from the VA's Disability Compensation Program. *American Economic Journal: Economic Policy*, 8(3), 31-68.

Avendano, M., Glymour, M., Banks, J. and J. P. Mackenbach. (2009): Health Disadvantage in US Adults Aged 50 to 74 Years: A Comparison of the Health of Rich and Poor Americans With That of Europeans. *American Journal of Public Health*, 99, 541-548.

Ayyagari, P. (2015): Evaluating the impact of social security benefits on health outcomes among the elderly. *Center for Retirement Research at Boston College*, CRR WP 2015-25.

Banks, J., Kapteyn, A., Smith, J. P. and A. van Soest (2004): International Comparisons of Work Disability. *RAND Working Paper*, WR-155.

Barnes, L. L., Mendes de Leon, C. F., Wilson, R. S., Bienias, J. L. and D. A. Evans (2004): Social resources and cognitive decline in a population of older African Americans and whites. *Neurology*. 63(12), 2322-6.

Béland, F., Zunzunegui, M. V., Alvarado, B., Otero, A. and T. Del Ser (2005): Trajectories of cognitive decline and social relations. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 60(6), 320-330.

Belli, R. F. (1998): The Structure of Autobiographical Memory and the Event History Calendar: Potential Improvements in the Quality of Retrospective Reports in Surveys. *Psychology Press Ltd*, 6 (4), 383-406.

Benitez-Silva, H., Buchinsky, M., Chan, H., Sheidvasser, S. and J. Rust (2000): How Large is the Bias in Self-Reported Disability? *NBER Working Paper #7526*. Cambridge, MA: National Bureau of Economic Research.

Boeri, T., Garibaldi, P., Macis, M. and M. Maggioni (2002): Adaptability of Labour Markets: a Tentative Definition and a Synthetic Indicator. Policy Report.

Böheim, R. and T. Leoni (2015): Disability policies across Europe: Reforms and employment outcomes for workers aged 50+. *NBER Disability Research Center*.

Bonsang, E., Adam, S. and S. Perelman (2012): Does retirement affect cognitive functioning? *Journal of health economics*, 31(3), 490-501.

Börsch-Supan, A. and R. Schnabel (1999): Social Security and Retirement in Germany. Ch. 4 in: Gruber, J. and D. Wise (eds.): Social Security and Retirement around the World. University of Chicago Press.

Börsch-Supan, A., Schnabel, R., Kohnz, S., and G. Mastrobuoni (2004): Micro-Modeling of Retirement Decisions in Germany. Ch. 5 in: Gruber, J. and D. Wise (eds.): Social Security Programs and Retirement around the World: Micro-Estimation. University of Chicago Press.

Börsch-Supan, A. (2005): Work Disability and Health. In A. Börsch-Supan, A. Brugiavini, H. Jürges, J. Mackenbach, J. Siegrist and G. Weber, *Health, Ageing and Retirement in Europe* (pp. 253-258). Mannheim.

Börsch-Supan, A., Kohnz, S. and R. Schnabel (2007): The Budget Impact of Reduced Early Retirement Incentives on the German Public Pension System. Ch. 5 in: Gruber, J. and D. Wise (eds.): Social Security Programs and Retirement around the World: Fiscal Implications of Reform. University of Chicago Press.

Börsch-Supan, A. and H. Jürges (2009): Early retirement, social security, and well-being in Germany. In D. Wise, *Developments in the economics of aging* (pp. 173-202). Chicago: University of Chicago Press.

Börsch-Supan, A., Brugiavini, A. and E. Croda (2010): The Role of Institutions and Health in European Patterns of Work and Retirement. *Journal of European Social Policy*, 19(4), 341-358.

Börsch-Supan, A. (2010): Work Disability: The Effects of Demography, Health, and Disability Insurance. In D. Wise, *Research Findings in the Economics of Aging* (pp. 37-58). Chicago: University of Chicago Press.

Börsch-Supan, A. and H. Roth (2011): Work Disability and Health over the Life Course. In: Börsch-Supan, A. et al. (eds.): The Individual and the Welfare State: Life Histories in Europe. Springer.

Börsch-Supan, A. (2011): Health and Disability Insurance. *Zeitschrift für Arbeitsmarktforschung*, 44 (4), 349-362.

Börsch-Supan, A. H. and H. Jürges (2012): Disability, Pension Reform, and Early Retirement in Germany. Ch. 7 in Wise, D. (ed.): Social Security Programs and Retirement around the World: Historical Trends in Mortality and Health, Employment, and Disability Insurance Participation and Reforms. University of Chicago Press.

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S. and S. Zuber (2013): Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE). *International Journal of Epidemiology 42(4)*: 1-10.

Börsch-Supan, A. and M. Schuth (2014): Early Retirement, Mental Health, and Social Networks. In D. Wise, *Discoveries in the Economics of Aging* (pp. 225-254). Chicago: The University of Chicago Press.

Börsch-Supan, A., Bucher-Koenen, T., Kluth, S., Hanemann, F., Goll, N. (2015): *Erwerbsbeteiligung und Erwerbsintensität Älterer in Deutschland vor und nach dem Renteneintritt*, MEA Discussion Paper 04-2015.

Börsch-Supan, A., Bucher-Koenen, T., and F. Hanemann (2017a): Early determinants of work disability in an international perspective. *MEA Discussion Papers*.

Börsch-Supan, A. (2017b): Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 1. Release version: 6.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w1.600.

Börsch-Supan, A. (2017c): Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 2. Release version: 6.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w2.600.

Börsch-Supan, A. (2017d): Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 3 – SHARELIFE. Release version: 6.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w3.600.

Börsch-Supan, A. (2017e): Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 4. Release version: 6.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w4.600.

Börsch-Supan, A. (2017f): Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 5. Release version: 6.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w5.600.

Börsch-Supan, A. (2017g): Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 6. Release version: 6.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w6.600.

Bosma, H., Peter. R., Siegrist, J. and M. Marmot (1998): Two alternative job stress models and the risk of coronary heart disease. Am J Public Health 88:68-74.

Bound, J. (1991): Self-Reported Versus Objective Measures of Health in Retirement Models. *Journal of Human Resources,* 26, 106-138.

Bound, J., Schoenbaum, M., Stinebrickner, T. R. and T. Waidmann (1999): The dynamic effects of health on the labor force transitions of older workers*. Labour Economics,* 6, 179-202.

Butler, J. S., Burkhauser, R.V, Mitchell, J. M. and T. P. Pincus (1987): Measurement Error in Self-reported health Variables. *Review of Economics and Statistics*, 644-650.

Carstensen, L. L., Isaacowitz, D. M. and S. T. Charles (1999): Taking time seriously: A theory of socioemotional selectivity. *American Psychologist*, 54(3), 165–181.

Celidoni, M. and V. Rebba (2016): Healthier lifestyles after retirement in Europe? Evidence from SHARE. *The European Journal of Health Economics*, 1-26.

Chen, S. and W. van der Klaauw (2008): The work disincentive effects of the disability insurance program in the 1990s. *Journal of Econometrics*, 142, 757–784.

Coe, N.B. and G. Zamarro (2011): Retirement effects on health in Europe. *Journal of Health Economics*, 30, 77-86.

Coe, N. B., von Gaudecker, H. M., Lindeboom, M. and J. Maurer (2012): The effect of retirement on cognitive functioning. *Health Economics*, 21, 913-927.

Crimmins, E. M., Kim, J.K. and A. Sole-Auro (2011): Gender differences in health: results from SHARE, ELSA and HRS. *European Journal of Public Health*, 21, 81-91.

Croda, E. and J. Skinner (2009): Disability Insurance and Health in Europe and the US. Paper prepared for the SHARE User Conference, October 2009, Mainz, Germany.

Dal Bianco, C., Trevisan, E. and G. Weber (2014): "I want to break free". The role of working conditions on retirement expectations and decisions. *European Journal of Ageing*, 12, 17-28.

de Jong, P., Lindeboom, M. and B. van der Klaauw (2011): Screening disability insurance applications. *Journal of the European Economic Association*, 9, 106–129.

Diamond, P. and E. Sheshinski (1995): Economic aspects of optimal disability benefits. *Journal of Public Economics,* 57(1), 1–23.

Dwyer, D. S. and O. S. Mitchell (1999): Health Problems as Determinants of Retirement: Are Self-Rated Measures Endogenous?. *Journal of Health Economics* 18, 173-193.

Dwyer, D., Jianting, H., Vaughan, D.R. and B. Wixon (2003). Counting the disabled: Using survey self-reports to estimate medical eligibility for social security's disability programs, *Journal of Economic and Social Measurement,* 28(3), 109-42.

Ertel, K. A., Glymour, M. M. and L. F. Berkman (2008): Effects of social integration on preserving memory function in a nationally representative US elderly population. *American Journal of Public Health*, 98(7), 1215-20.

Ertel, K. A., Glymour, M. M. and L.F. Berkman (2009): Social networks and health: A life course perspective integrating observational and experimental evidence. *Journal of Social and Personal Relationships,* 26, 73-92.

Ferrer, E., Salthouse, T. A., Stewart, W. F. and B. S. Schwartz (2004): Modeling age and retest processes in longitudinal studies of cognitive abilities. *Psychology and Aging*, 19(2), 243-259.

Fiori, K. L., Antonucci T. C. and H. Akiyama (2008): Profiles of social relations among older adults: a cross-cultural approach. *Ageing & Society,* 28, 203-231.

Fletcher, J. M. (2014): Late life transitions and social networks: The case of retirement. *Economics Letters,* 125, 459-462.

Flores, G., Ingenhaag, M. and J. Maurer (2015): An anatomy of old-age disability: Time use, affect and experienced utility. *Journal of Health Economics,* 44, 150–160.

Fonseca, R., Kapteyn, A., Lee, J., Zamarro, G. and K. Feeney (2014): A longitudinal study of well-being of older europeans: does retirement matter? *Journal of Population Ageing*, 7, 21-41.

Fonseca, R., Kapteyn, A. and G. Zamarro (2016): Retirement and Cognitive Functioning: International Evidence. *Working Paper 16-10*.

Fratiglioni, L., Paillard-Borg, S., and B. Winblad (2004): An active and socially integrated lifestyle in late life might protect against dementia. *Lancet Neurology*, 3(6), 343-53.

Freedman, V. A., Stafford, F., Schwarz, N., Conrad, F. and J. C. Cornman (2012): Disability, participation, and subjective wellbeing among older couples. *Social Science & Medicine*, 74, 588-596.

Gale, C. R., Martyn, C. N., Cooper, C. and A. A. Sayer (2007): Grip strength, body composition, and mortality. *International Journal of Epidemiology*, 36(1), 228-235.

García-Gómez. P., von Gaudecker, H.-M. and M. Lindeboom (2011): Health, disability and work: patterns for the working age population. *International Tax and Public Finance*, 18, 146–165.

García-Gómez, P. and A. Gielen (2014): Health Effects of Containing Moral Hazard: Evidence from Disability Insurance Reform. *IZA Discussion Paper No. 8386*.

Gelber, A., Moore, T. and A. Strand (2017): Disability Insurance Income Saves Lives. *Working Paper*.

Glei, D. A., Landau, D. A., Goldman, N., Chuang, Y. L., Rodríguez, G. and M. Weinstein (2005): Participating in social activities helps preserve cognitive function: an analysis of a longitudinal, population-based study of the elderly. *International Journal of Epidemiology*, 4, 864-71.

Grossman, M. (1972): On the concept of health capital and the demand for health, *The Journal of Political Economy*, 80(2): 223–255.

Gruber, J. D. and D. A. Wise (1999): Social Security and Retirement around the World. The University of Chicago Press: Chicago.

Gruber, J. D. and D. A. Wise (eds.) (2004): Social Security and Retirement Around the World: Micro Estimation of Early Retirement Incentives. University of Chicago Press.

Haveman, R. and B. L. Wolfe (2000): The economics of disability and disability policy. In: Culyer, A. J. and J. P. Newhouse (eds.): Handbook of Health Economics, Vol. 1, (p. 995-1051). Amsterdam: Elsevier Science.

Heckman, J. J. and G. Conti (2013): The Developmental Approach to Child and Adult Health. *Pediatrics*, 131, 133-141.

Hill, M. J., Maestas N. and K. J. Mullen (2016): Employer accommodation and labor supply of disabled workers. *Labour Economics*, 41, 291-303.

Idler, E. L. and Y. Benyamini (1997): Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies. *Journal of Health and Social Behavior, 38*(1), 21-37.

Insler, M. (2014): The health consequences of retirement. *Journal of Human Resources*, 49, 195-233.

Jahoda, M. (1982): Employment and unemployment: A social-psychological analysis. Cambridge: Cambridge University Press.

Jürges, H. (2005): Retrospective error in SOEP calendar data: the case of unemployment. *Journal of Applied Social Science Studies (Schmollers Jahrbuch),* 125(1), 157-165.

Jürges, H. (2007): True health vs response styles: exploring cross-country differences in self-reported health. *Health Economics*, 16, 163-178.

Jürges, H., Thiel, L., Bucher-Koenen, T., Rausch, J., Schuth, M. and A. Börsch-Supan (2014): Health, Financial Incentives, and Early Retirement: Micro-Simulation Evidence for Germany. *NBER Working Paper w19889*.

Juster, F. T. and R. Suzman (1995): An overview of the Health and Retirement Study. *Journal of Human Resources* 30 (Special Issue), 7-56.

Jylhä, M. (2009): What is self-rated health and why does it predict mortality? Towards a unified conceptual model. *Social Science & Medicine,* 69(3), 307-316.

Kahn, R. L and T. C. Antonucci (1981): Convoys of social support: A life-course approach. In S. B. Kiesler, J. N. Morgan, & V. K. Oppenheimer (Eds.), Aging: Social change (pp. 383-405). New York: Academic Press.

Kalmijn, M. (2012): Longitudinal analyses of the effects of age, marriage, and parenthood on social contacts and support. *Advances in Life Course Research*, 17, 177-190.

Kalwij, A. and F. Vermeulen (2008): Health and labour force participation of older people in Europe: what do objective health indicators add to the analysis? *Health Economics*, 17, 619-638.

Kapteyn, A., Smith, J. P. and A. van Soest (2007): Self-reported Work Disability in the US and The Netherlands. *The American Economic Review*, 461-473.

Karasek, R. and T. Theorell (1991) Healthy work: stress, productivity, and the reconstruction of working life. Basic Books, New York.

Karasek, R., Brisson, C., Kawakami, N., Houtman, I., Bongers, P. and B. Amick (1998): The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *Journal of Occupational Health Psychology*, 3, 322-55.

Karlström, A., Palme, M. and I. Svensson (2008): The Employment Effect of Stricter Rules for Eligibility for DI: Evidence from a Natural Experiment in Sweden. *Journal of Public Economics*, 92(10-11), 2071-82.

Kerkhofs, M. and M. Lindeboom (1995): Subjective health measures and state dependent reporting errors. *Health Economics*, 4, 221–235.

King, G., Murray, C., Salomon, J. and A. Tandon (2004): Enhancing the validity and cross-cultural comparability of measurement in survey research. *American Political Science Review,* 98(1), 567-583.

Lancee, B. and J. Radl (2012): Social connectedness and the transition from work to retirement. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 67(4), 481-90.

Lindeboom, M. and E. van Doorslaer (2004): Cut-point shift and index shift in self-reported health. *Journal of Health Economics*, 23, 1083-1099.

Litwin, H. and K. J. Stoeckel (2012): Social networks and subjective wellbeing among older Europeans: does age make a difference? *Aging and Society,* 33, 1263-81.

Litwin, H. and K. J. Stoeckel (2013): Confidant Network Types and Well-Being Among Older Europeans. *The Gerontologist,* 54(5), 762-772.

Loisel, P. and J. Anema (Eds., 2014): Handbook of Work Disability: Prevention and Management, Springer.

Lucas, R. E. (2007): Long-Term Disability Is Associated With Lasting Changes in Subjective Well-Being: Evidence From Two Nationally Representative Longitudinal Studies. *Journal of Personality and Social Psychology*, 92(4), 717–730.

Maestas, N., Mullen, J. M. and A. Strand (2015): Disability Insurance and the Great Recession. *American Economic Review,* 105(5), 177-82.

Malter, F. and A. Börsch-Supan (2013): SHARE Wave 4: Innovations & Methodology. Munich: MEA, Max Planck Institute for Social Law and Social Policy.

Marmot, M., Banks, J., Blundell, R., Lessof, C. and J. Nazroo (2003): Health, Wealth and Lifestyles of the Older Population in England: The 2002 English Longitudinal Study of Ageing. London: The Institute for Fiscal Studies.

Mazzonna, F. and F. Peracchi (2012): Ageing, cognitive abilities and retirement. *European Economic Review*, 56(4), 691-710.

Mazzonna, F. and F. Peracchi (2016): Unhealthy retirement? Evidence of occupation heterogeneity. *Journal of Human Resources*, 52, 128-151.

Michalopoulos, C., Wittenburg, D., Israel, D. R. A. and A. Warren (2012): The Effects of Health Care Benefits on Health Care Use and Health - A Randomized Trial for Disability Insurance Beneficiaries. *Medical Care*, 50(9), 764-771.

OECD (2003): Transforming Disability into Ability: Policies to Promote Work and Income Security for Disabled People. OECD Publishing, Paris.

OECD (2005): OECD Health Data, Paris. [last access on 15 Sep 2016 http://stats.oecd.org/]

OECD (2010): Sickness, Disability and Work: Breaking the Barriers: A Synthesis of Findings across OECD Countries, OECD Publishing, Paris.

Ostry, A. S., Kelly, S., Demers, P. A., Mustard, C. and C. Hertzman (2003): A comparison between the effort-reward imbalance and demand control models. *BMC Public Health,* 3, 10-27.

Oswald, A. J. and N. Powdthavee (2008): Does happiness adapt? A longitudinal study of disability with implications for economists and judges. *Journal of Public Economics*, 92, 1061–77.

Pagan-Rodriguez, R. (2010): Onset of disability and life satisfaction: evidence from the German Socio-Economic Panel. *European Journal of Health Economics*, 11, 471–485.

Patacchini, E. and G. V. Engelhardt (2016): Work, Retirement and Social Networks at older Ages. *Working Paper.*

Pikhart, H., Bobak, M., Pajak, A., Malyutina, S., Kubinova, R., Topor, R., Sebakova, H., Nikitin, Y. and M. Marmot (2004): Psychosocial factors at work and depression in three countries of Central and Eastern Europe. *Social Science & Medicine*, 58, 1475-82.

Poterba, J.M., Venti, S.F. and D.A. Wise (2010): The asset cost of poor health, National Bureau of Economic Reasearch Working Paper No. 16389. National Bureau of Economic Research, Cambridge, MA.

Power, C. and D. Kuh (2006): Life course development of unequal health. In: Siegrist, J. and M. Marmot (eds.): Socioeconomic position and health: new explanations and their policy implications (p. 77-115). London: Oxford University Press.

Rabbitt, P., Diggle, D., Smith, D., Holland, F. and L. McInnes (2001): Identifying and Separating the Effects of Practice and of Cognitive Ageing During a Large Longitudinal Study of Elderly Community Residents, *Neuropsychologia*, 39(5), 532–543.

Rafnsson, S. B., Shankar, A. and A. Steptoe (2015): Longitudinal Influences of Social Network Characteristics on Subjective Well-Being of Older Adults: Findings From the ELSA Study. *Journal of Aging and Health*, 27, 919–934.

Rohwedder, S. and R. J. Willis (2010): Mental retirement. *Journal of Economic Perspectives*, 24, 119-138.

Rubin, D. C. (1996): Remembering Our Past. Studies in Autobiographical Memory. Cambridge: Cambridge University Press.

Salthouse, T. A. (2006): Mental Exercise and Mental Aging. *Perspectives on Psychological Science,* 1(1), 68-87.

Scarmeas, N. and Y. Stern (2003): Cognitive Reserve and Lifestyle. *Journal of clinical and experimental neuropsychology*. 25(5), 625-633.

Sen, A. (2002): Health perception versus observation. *British Medical Journal 324*, 860-861.

Siegrist, J. (1996) Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology,* 1, 27-41.

Siegrist, J. and M. Wahrendorf (2011): Quality of work, health and early retirement: European comparisons. In: Börsch-Supan A, Brandt M, Hank K, Schröder M (eds) The individual and the welfare state: life histories in Europe. Springer, Heidelberg, 169-177.

Siegrist, J., Lunau, T., Wahrendorf, M. and N. Dragano (2012): Depressive symptoms and psychosocial stress at work among older employees in three continents. *Globalization and Health*, 8(27).

Smart, E. L., Gow, A. J. and I. J. Deary (2014): Occupational complexity and lifetime cognitive abilities. *Neurology,* 83(24), 2285–91.

Sörman, D. E., Rönnlund, M., Sundström, A., Norberg, M. and L.-G. Nilsson (2016): Social Network Size and Cognitive Functioning in Middle-Aged Adults: Cross-Sectional and Longitudinal Associations, *Journal of Adult Development*, 1-12.

Staubli, S. (2011): The impact of stricter criteria for disability insurance on labor force participation. *Journal of Public Economics*, 95(9), 1223-35.

Steptoe, A., Deaton A. and A. Stone (2015): Psychological wellbeing, health and ageing. *Lancet*, 385(9968), 640–648.

van der Noordt, M., IJzelenberg, H., Droomers, M., Proper K. I. (2014): Health effects of employment: a systematic review of prospective studies, *Occupational and Environmental Medicine, 0, 1-7.*

van Domelen, D. R., Koster, A., Caserotti, P., Brychta, R. J., Chen, K. Y., McClain, J. J., Troiano, R. P., Berrigan, D. and T. B. Harris (2011): Employment and physical activity in the U.S. *American Journal of Preventive Medicine*, 41, 136-45.

van Tilburg, T. (1992): Support Networks Before and After Retirement. *Journal of Social and Personal Relationships,* 9, 433–445.

van Tilburg, T. (2003): Consequences of Men's Retirement for the Continuation of Work-Related Personal Relationships. *Ageing International,* 28, 345-358.

Vries, R., Blane, D. and G. Netuveli (2014): Long-term exposure to income inequality: implications for physical functioning at older ages. *European Journal of Ageing*, 11, 19-29.

Wallenius, M., Skomsvoll, J. F., Koldingsnes, K., Rødevand, E., Mikkelsen, K., Kaufmann, C., and T. K. Kvien (2009): Work disability and health-related quality of life in males and females with psoriatic arthritis. *Ann Rheum Dis*, 68, 685–689.

Wanberg, C. R. (2012): The Individual Experience of Unemployment. *Annual Review of Psychology,* 63, 369-396.

Wise, D. (eds) (2012): Social Security Programs and Retirement around the World: Historical Trends in Health, Employment and Disability Insurance and Reforms. University of Chicago Press.

Wise, D. (eds) (2015): Social Security Programs and Retirement around the World: Disability insurance programs and retirement. University of Chicago Press.

Wooldridge, J. (2002): Econometric Analysis of Cross Section and Panel Data, MIT Press.

Ybarra, O., Burnstein, E., Winkielman, P., Keller, M. C., Manis, M., Chan, E. and J. Rodriguez (2007): Mental Exercising Through Simple Socializing: Social Interaction Promotes General Cognitive Functioning. *Personality and Social Psychology Bulletin*, 34(2), 248-259.

Zantinge, E. M., van den Berg, M., Smit, H. A. and H. S. J. Picavet (2014): Retirement and a healthy lifestyle: opportunity or pitfall? A narrative review of the literature, *The European Journal of Public Health,* 24(3), 433-439.