# Does Disability Insurance Improve Health and Well-being?

**Axel Börsch-Supan[abcd], Tabea Bucher-Koenen[ad] and Felizia Hanemann[ab]**

a: Munich Center for the Economics of Aging (MEA) at the Max Planck Institute for Social Law and Social Policy, Munich, Germany.

b: Department of Economics and Business, Technical University of Munich (TUM), Munich, Germany.

c: National Bureau of Economic Research (NBER), Cambridge, Mass.

d: Network for Studies on Pensions, Aging and Retirement (Netspar), Tilburg, Netherlands.

**Abstract:** The purpose of disability insurance (DI) is to protect people with health problems that limit their ability to work. We evaluate the effectiveness of DI benefit programs in delivering this protection by following people's health and financial well-being after the take-up of DI benefits. 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. We use several econometric approaches to account for the potential endogeneity of DI enrollment and sample selectivity. We find that self-reported health stabilizes after DI benefit receipt. Mental health improves more for DI benefit recipients than 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.

**Zusammenfassung:** Das Ziel von Erwerbsminderungsrenten ist es, Menschen abzusichern, deren Erwerbsfähigkeit aufgrund von Krankheiten oder Behinderungen eingeschränkt ist. Wir evaluieren diesen Schutzmechanismus von Erwerbsminderungsrenten, indem wir die Gesundheit und die finanzielle Lage nach dem Erhalt von Rentenzahlungen beobachten. Mit Hilfe von international harmonisierten Paneldaten können wir sowohl Unterschiede zwischen Ländern Europas und den USA, als auch Veränderungen über die Zeit betrachten. In verschiedenen ökonometrischen Ansätzen berücksichtigen wir Endogenitäts- und Selektivitätsprobleme. Unsere Ergebnisse zeigen, dass sich die selbst eingeschätzte Gesundheit nach dem Erhalt von Erwerbsminderungsrenten stabilisiert und nicht weiter verschlechtert. Die mentale Gesundheit verbessert sich im Vergleich zum Zeitpunkt des ersten Rentenbezugs mehr für die Bezieher von Renten als für diejenigen, die zwar in ihrer Erwerbsfähigkeit eingeschränkt sind, aber keine Renten erhalten. Dieser Effekt ist stärker in Ländern mit großzügigeren Rentenleistungen im Falle von Erwerbsunfähigkeit. In Bezug auf die objektive Gesundheit sind die Ergebnisse positiv, aber nicht signifikant.

**Keywords:** Work disability; disability insurance; health; international comparisons (H55, J21, J26)

**Acknowledgments:** This research was supported by the U.S. Social Security Administration through grant #1 DRC12000002-05 to the National Bureau of Economic Research as part of

the SSA Disability Research Consortium. The findings and conclusions expressed are solely those of the author(s) and do not represent the views of SSA, any agency of the Federal Government, or the NBER.
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.

We would like to thank Carina Rein and Caroline Knebel for their research assistance. We are grateful to Rob Alessie and Helmut Farbmacher as well as participants in the MEA seminar for their helpful comments.

**Address:**
MEA at the Max Planck Institute
for Social Law and Social Policy
Amalienstrasse 33
D-80799 Muenchen, Germany
Email: axel@boersch-supan.de

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## 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 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[1] (*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, 2017).

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

[1] 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.

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 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 2, we present the related literature and derive different hypotheses regarding the effects of work disability and DI benefit receipt on health. Section 3 describes the data and the key variables used for the analysis. Section 4 provides a description of the characteristics of DI benefit recipients, their health status and their re-employment rates. Section 5 reports the results from a basic regression model, Section 6 from the instrumental variable estimator and Section 7 from the fixed-effects regressions. Section 8 provides a discussion of the results and concludes.

## 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 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.

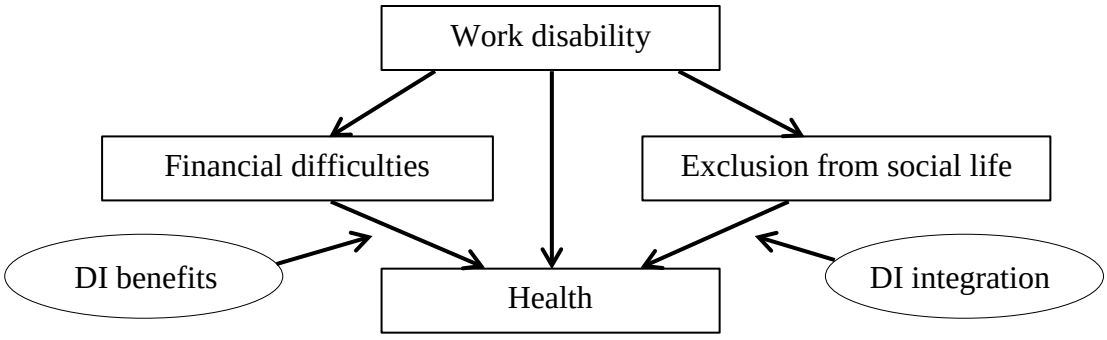



**Figure 1: Graphical illustration of interrelationships**

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 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. 2017). 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 and the treatment group.**

*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. 2017) 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 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 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 | + | 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 | - | 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 | + |

## 3. Data

### 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 a previously funded SSA 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. Detailed information on the harmonized dataset can be found in the Technical Appendix B.

### 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.[2] We therefore keep only individuals that are 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 2. 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 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 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.

[2] See Subsection 3.3 for precise definitions of work disability and DI benefit receipt.

**Table 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 |

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 2.

Table 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 3 for completeness sake but are dropped from the following analyses.

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.

**Table 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**<br>*95%*<br>*75%* | **2,640**<br>*5%*<br>*19%* | **58,242**<br>*100%*<br>*66%* |
| **WD at least once** | **19,018**<br>*63%*<br>*25%* | **11,179**<br>*37%*<br>*81%* | **30,197**<br>*100%*<br>*34%* |
| **TOTAL** | **74,620**<br>*84%*<br>*100%* | **13,819**<br>*16%*<br>*100%* | **88,439**<br>*100%*<br>*100%* |

### 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 B.3 in the appendix for the country specific details). The questions on the receipt of DI benefits from the different studies are displayed in Table 4.

**Table 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<br>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)<br>2. Severe Disablement Allowance (SDA)<br>3. Statutory sick pay (SSP)<br>4. Attendance Allowance<br>5. Disability Living Allowance<br>6. Industrial Injuries Disablement Benefit<br>7. War Disablement Pension or War Widows Pension<br>8. Invalid Care Allowance<br>9. Disabled persons tax credit (formerly Disability Working Allowance)<br>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)<br>2. Supplemental Security Income (SSI)<br>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. We use the self-rated work disability question (shown in Table 5) to create a binary variable indicating whether someone is work disabled in at least one of the six waves (*WD*).

**Table 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<br>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<br>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<br>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 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 6 in order to create the harmonized variable (*life_sat*).

**Table 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 7 shows how we built the harmonized binary variable indicating whether a household has financial problems or not (*fin_prob*).

**Table 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<br>3. Fairly easily<br>4. Easily | 1. Yes | 1 manage very well<br>2 manage quite well<br>3 get by alright<br>4 don't manage very well<br>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[3] 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.

Summary statistics (mean and standard deviation) of these variables in our main study sample are shown in Table 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 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 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 4 and 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

[3] International Standard Classification of Education

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 B.1 and B.2 in the appendix).

## 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 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.

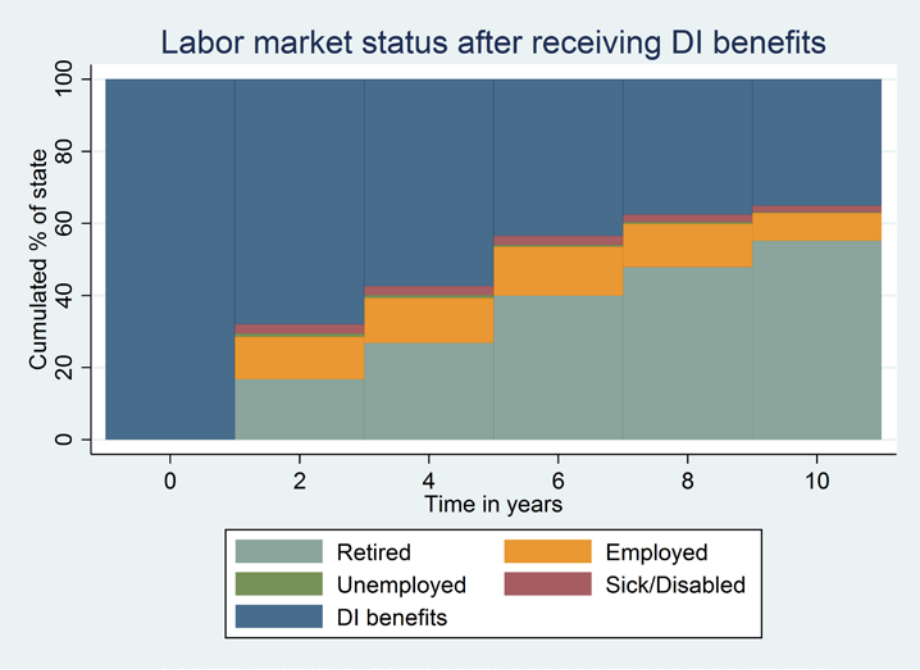



**Figure 2: Sequence analysis for the labor market situation after DI receipt**

Many countries have implemented special measures for the re-integration of disabled persons into the labor market. Figure 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.

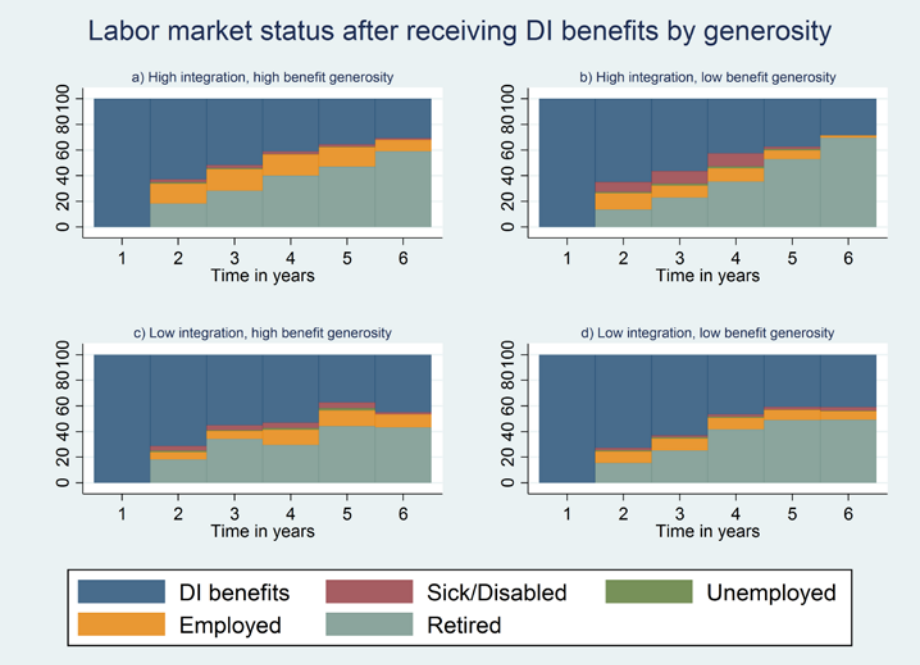



**Figure 3: Sequence analysis by generosity level**[4]

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

4 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)

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 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 A.1 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 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 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 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.

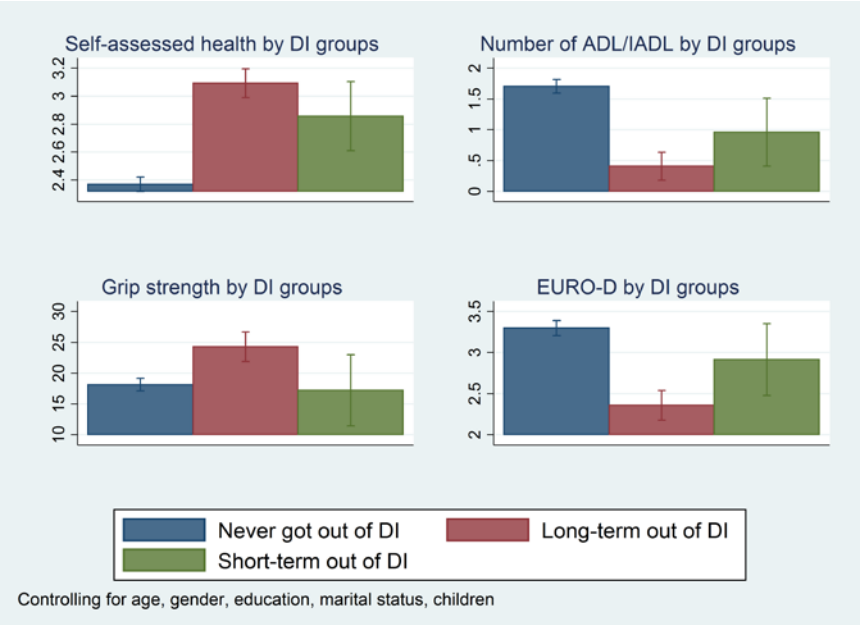



**Figure 4: Differences in health by duration of DI receipt**

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. 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. 2016). 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 10.

**Table 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 |

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

They show that DI benefits receipt is associated with worse self-reported health, more limitations in daily life, more depressive symptom, 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 $\beta_1$ 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.

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 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.

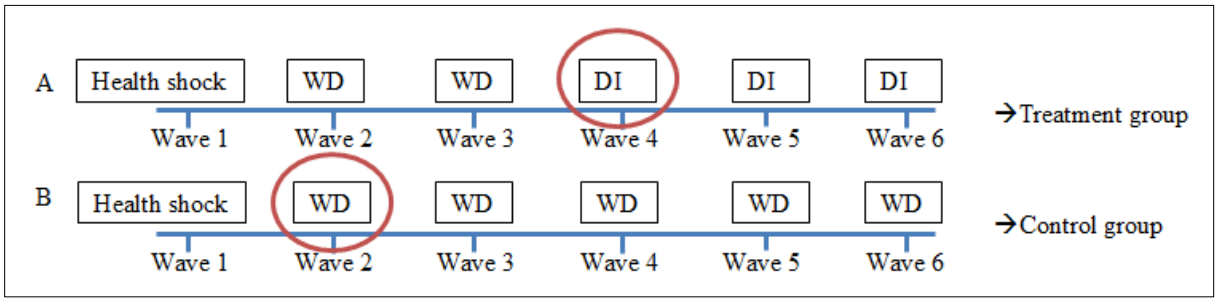



**Figure 5: Observation windows in treatment and control group**

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 section 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*.

## 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 7.

### 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 $\beta_1$ without bias.

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

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

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, 2017). 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 A.1 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 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.

### 6.2 Results

The results of the first stage, equation (2), are presented in Table 11.[5] 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.

**Table 11: First-stage regression**

| VARIABLES | (1)<br>DI benefits | (2)<br>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

[5] This first stage regression includes self-reported health (*sphus*) as lagged dependent variable. Other first stage regressions use other lagged outcome variables (see appendix in A.2). They deliver very similar results.

The coefficient of the instrumental variable and the F-test are highly significant, supporting the predictive power of our instrumental variable.[6]

The results of the second stage, equation (3), are presented in Table 12 for three measures of physical health as dependent variables and in Table 13 for mental health, well-being and financial status as dependent variables.

**Table 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 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

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

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. 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 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 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 A.3 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 3. Unfortunately, they provide similarly weak instruments which are highly correlated with the country dummies and therefore deliver insignificant results.

## 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.

### 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, $\alpha_i$ captures the individual time-fixed effects and $u_{it}$ is the remaining error term:

$$y_{it} = \beta \boldsymbol{X}_{it} + \alpha_i + u_{it} \quad (4)$$

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 $\alpha_i$ can then be split into three components:

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

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:

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

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

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

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 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 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:

$$y_{it} = \sum_{j=1\dots4} \beta_j^{1,A} \left(Time_j^A * DI_{i,to}^1\right) + \sum_{j=1\dots4} \beta_j^{0,A} \left(Time_j^A * DI_{i,to}^0\right) + \sum_{j=1\dots4} \beta_j^{1,B} \left(Time_j^B * DI_{i,to}^1\right) + \sum_{j=1\dots4} \beta_j^{0,B} \left(Time_j^B * DI_{i,to}^0\right) + \alpha_i + u_{it} \quad (9)$$

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.

## 7.2 Results

We present the results for the group-specific time effects graphically in Figure 6 for the different health measures. The regression results in detail are included in Table A.4.

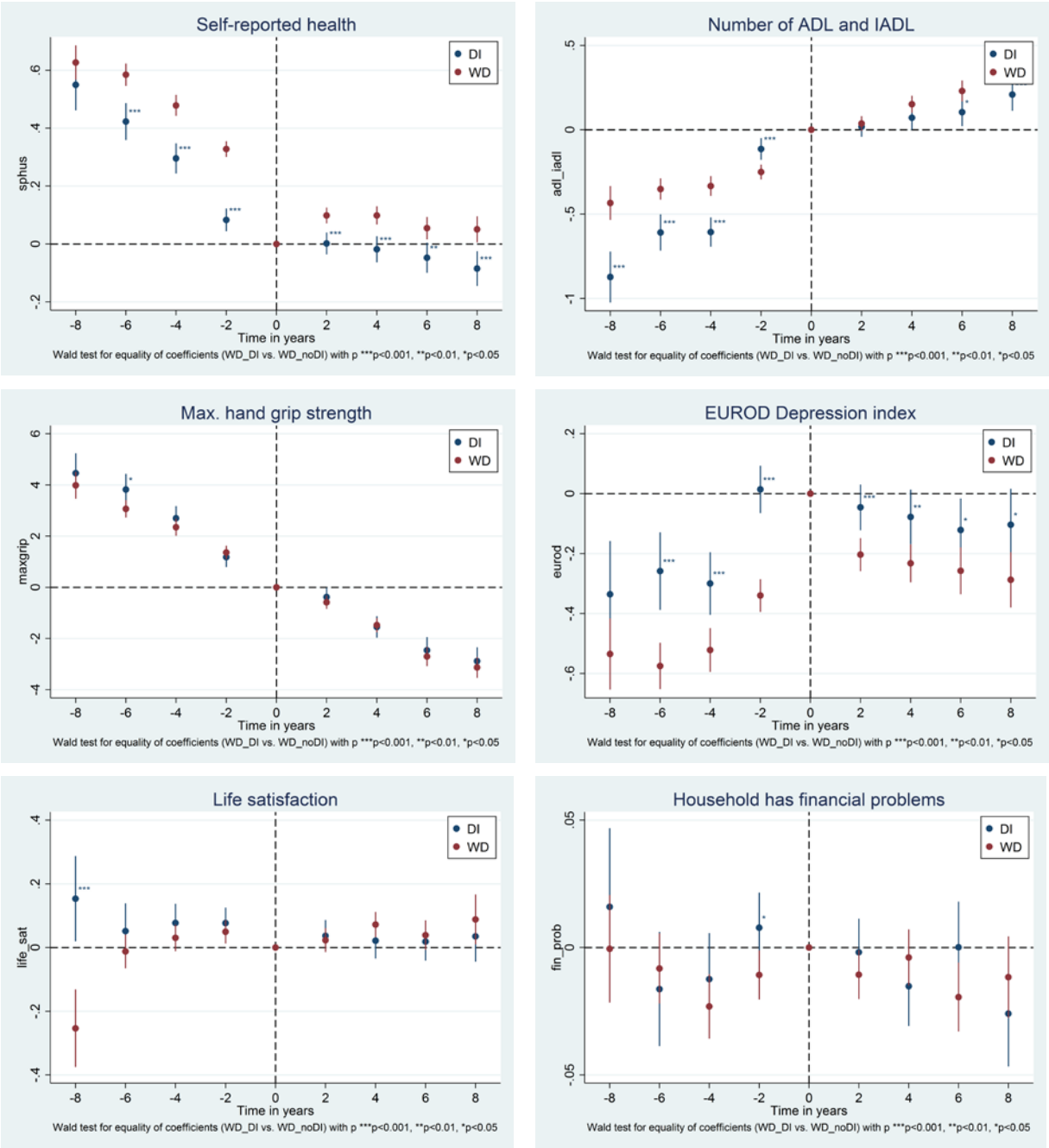



**Figure 6: Group-specific time effect of DI on health and well-being**

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.[7]

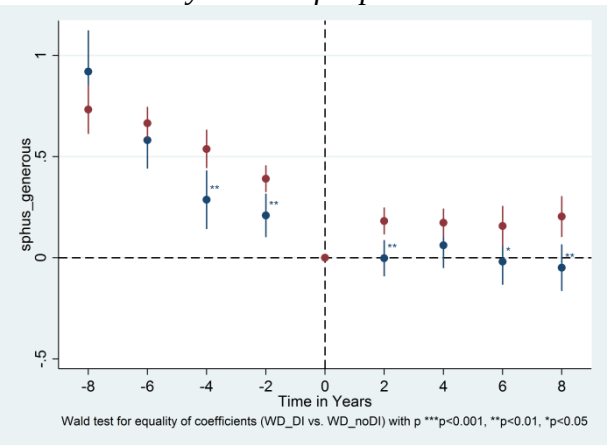
### 7.3 Effect heterogeneity

We finally examine the effect heterogeneity, i.e., how the effects measured in the previous subsection differ by demographic characteristics (e.g. gender, education) 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 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.[8]

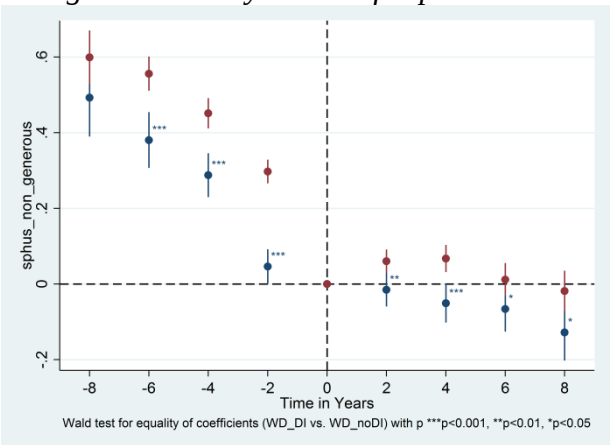
[7] For future research it might be worth the time-intensive effort of harmonizing the household income between the different surveys.

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

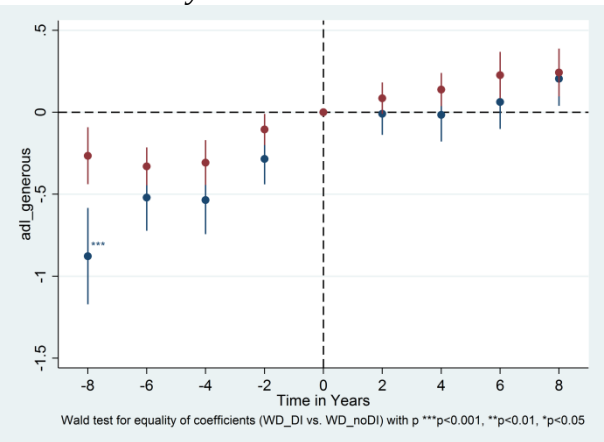
*Generous DI system: self-reported health*




*Less generous DI system: self-reported health*




*Generous DI system: ADL/IADL*




*Less generous DI system: ADL/IADL*

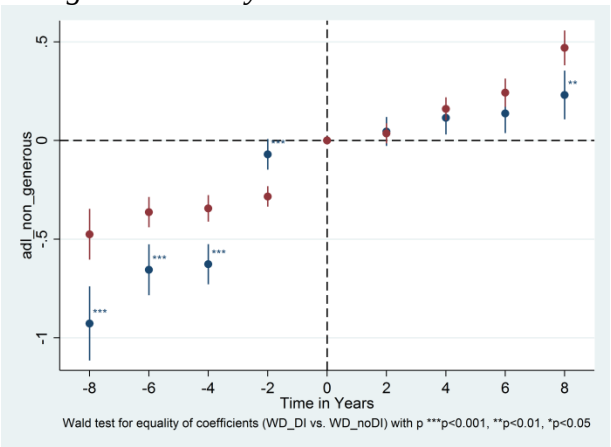



**Figure 7: Effect heterogeneity for generosity of DI system**

## 8. 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 allowing to evaluate 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.

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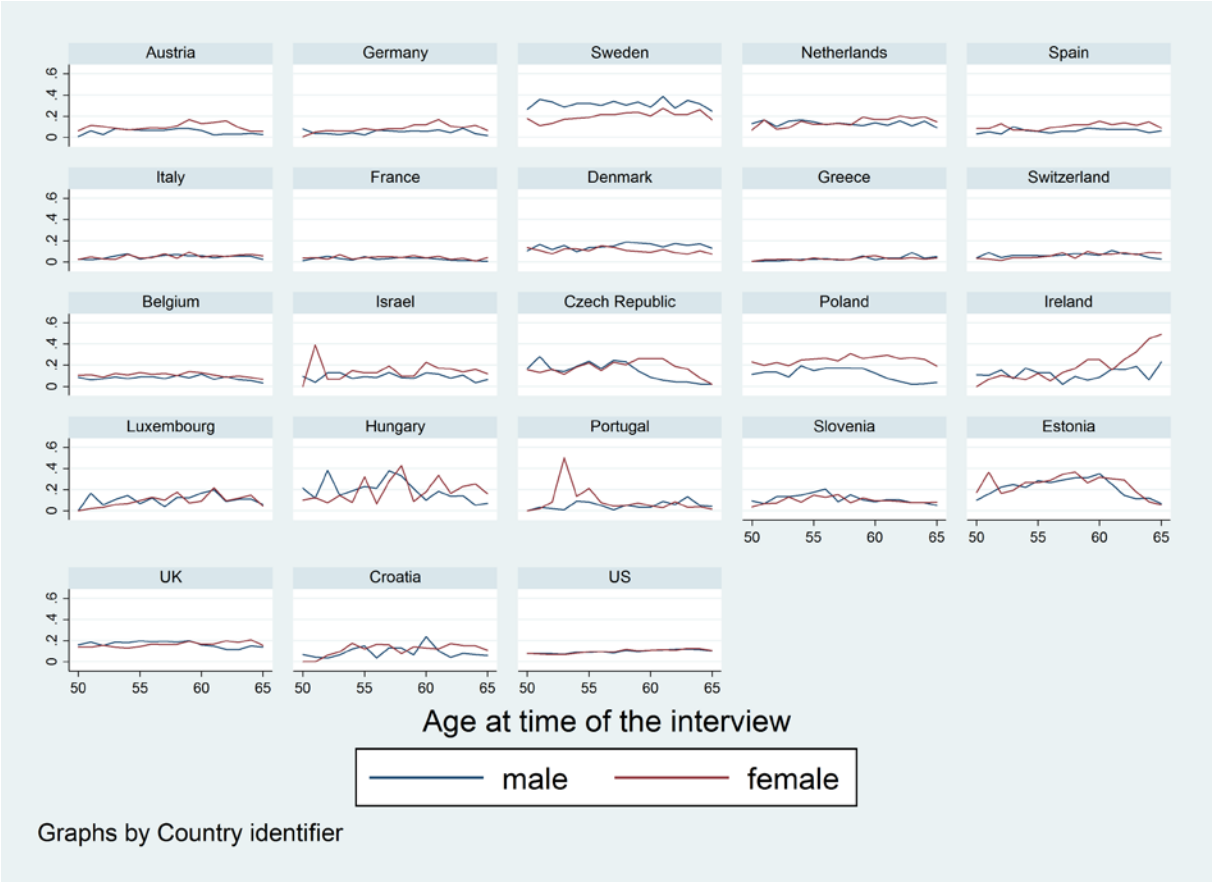
# A. Appendix

### Table A.1: 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 A.1: Share of DI recipients by age, gender, and country



## Table A.2: First-stage regressions for different specifications

| VARIABLES | (1) DI benefits | (2) DI benefits | (3) DI benefits | (4) DI benefits | (5) DI benefits | (6) DI benefits | (7) DI benefits | (8) DI benefits | (9) DI benefits | (10) 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 A.3: 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

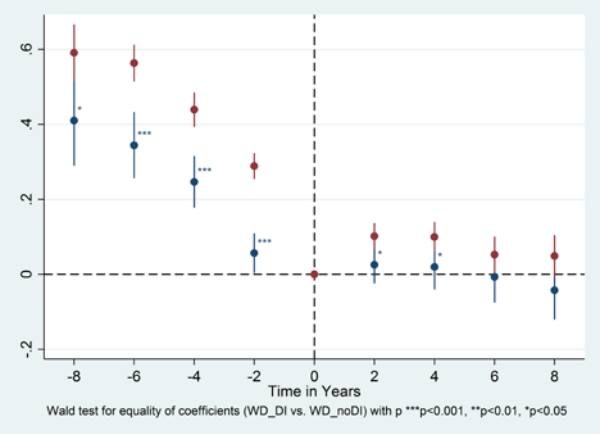
**Table A.4: Regression results individual-fixed effects model**

| | (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 | |

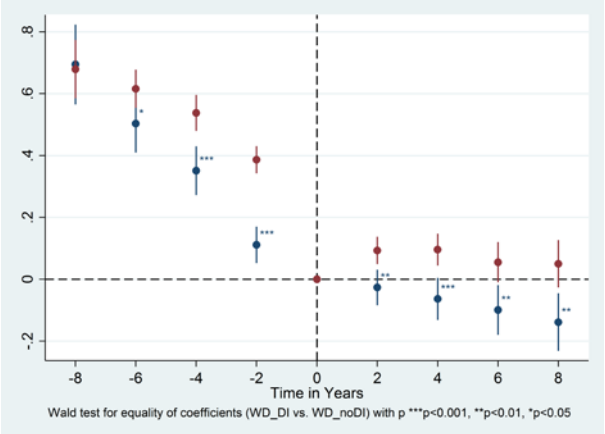
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## Figure A.2: Effect heterogeneity by gender

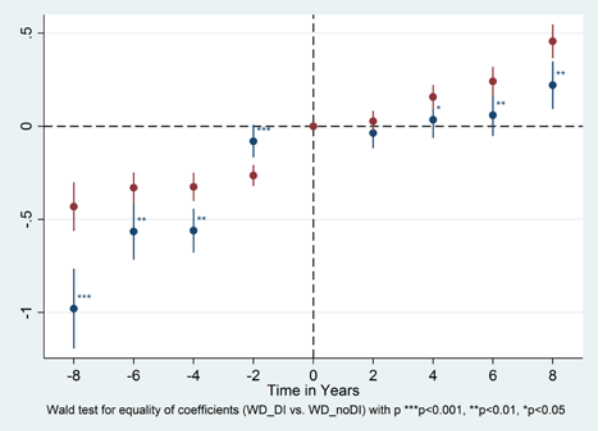
*Male: self-reported health*



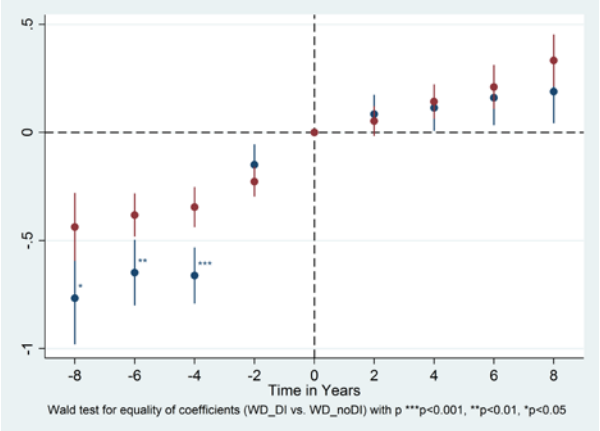

*Female: self-reported health*




*Male: ADL/IADL*

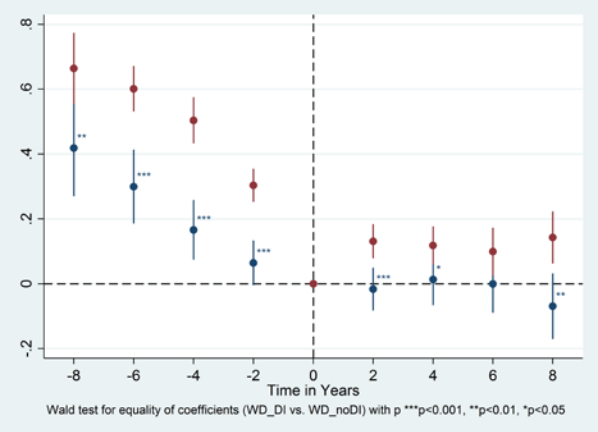



*Female: ADL/IADL*

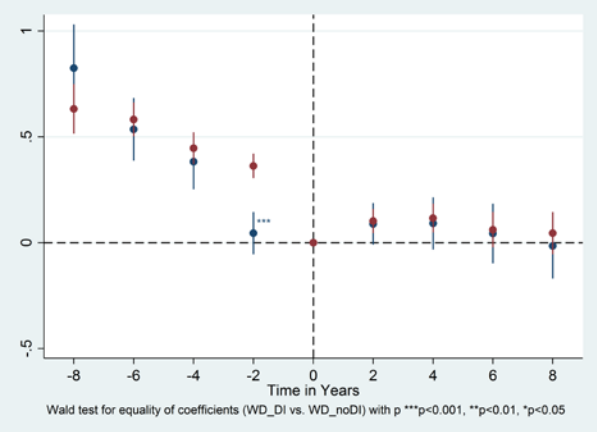


## Figure A.3: Effect heterogeneity by education

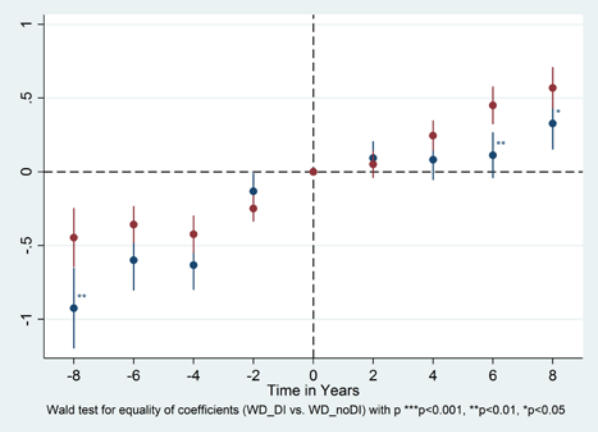
*Low education: self-reported health*



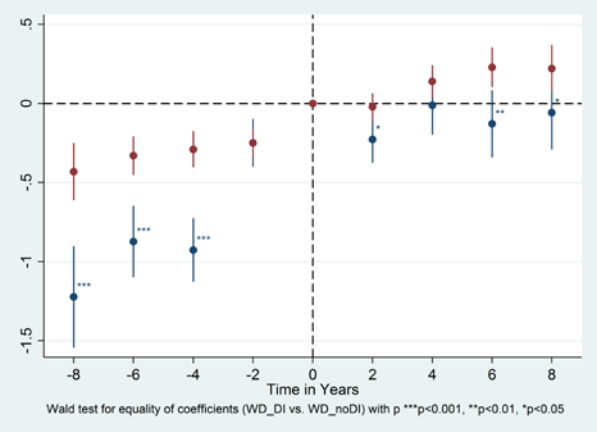

*High education: self-reported health*




*Low education: ADL/IADL*




*High education: ADL/IADL*



## B. Technical Appendix

### Table B. 1: 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 B. 2: 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)

**Table B. 3: 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 |

## Table B. 4: 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<br>1. Male | yes | yes | yes |
| | education_low | Education category | 0-1 | 0. Not in low education category<br>1. In low education category (ISCED 0-2) | yes | yes | yes |
| | education_medium | Education category | 0-1 | 0. Not in medium education category<br>1. In medium education category (ISCED 3-4) | yes | yes | yes |
| | education_high | Education category | 0-1 | 0. Not in high education category<br>1. In high education category (ISCED 5-6) | yes | yes | yes |
| | single | Currently not married, divorced or widowed | 0-1 | 0. Not single<br>1. Single | yes | yes | yes |
| | married | Currently married | 0-1 | 0. Not married<br>1. Married | yes | yes | yes |
| | divorced | Currently divorced | 0-1 | 0. Not divorced<br>1. Divorced | yes | yes | yes |
| | widowed | Currently widowed | 0-1 | 0. Not widowed<br>1. Widowed | yes | yes | yes |
| Health | sphus | Self-reported health | 1-5 | 1. Excellent<br>2. Very good<br>3. Good<br>4. Fair<br>5. Poor | yes | yes | yes |
| | iadl | IADL: number of limitations with instrumental activities of daily living | 0-6 | Difficulties with:<br>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:<br>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<br>1. Yes | yes | yes | yes |

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

### Table B.5: 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** |
| **Time** | **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 B.6: 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 |
| | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | | | | | | | | | |
| Weights | | | | | | | | | | | | | | | | | | | |
| SHARE_weight | Cross-sectional SHARE weights, wave specific | X | X | X | X | X | X | | | | | | | | | | | | |
| ELSA_weight | Cross-sectional ELSA weights, wave specific | | | | | | | X | X | X | X | X | X | | | | | | |
| HRS_weight | Cross-sectional HRS weights, wave specific | | | | | | | | | | | | | X | X | X | X | X | X |