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ABSTRACT

Disability and Labor Market Performance*

This paper analyzes the individual-level effects of disability onset on labor market outcomes using novel administrative data from Germany. Combining propensity score matching techniques with an event-study design, we find lasting negative impacts on employment and wages. One important mechanism is transitions to nonemployment after disability onset: newly disabled individuals' probability of becoming nonemployed increases by 10 percentage points after one year and by 15 percentage points after five years relative to that of the control group. For those who stay in employment, working part-time and switching to less physically or psychosocially demanding jobs are important adjustment paths. The negative labor market effects of disability onset are more pronounced for severely disabled, older and low-skilled individuals.

JEL Classification: I10, J14, J21, J71

Keywords: disability, labor market outcomes, propensity score matching, event study

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1 Introduction

Disability is a widespread issue affecting the lives of millions of individuals. In 2019, one in seven working-age adults in OECD countries was identified as having a disability (OECD, 2022). As aging is often accompanied by age-related chronic illnesses, this number is likely to grow in the future. Disabilities, such as physical impairments, hamper the opportunities of individuals in many domains, including the labor market.[1] Due to the sheer number of affected individuals and its implications for economic growth and societal welfare, many developed and developing countries have disability laws and acts aimed at abolishing discrimination against individuals with disabilities and eliminating barriers to their inclusion in society (United Nations, 2022). These acts often include policy or institutional measures such as return-to-work programs, special protections against dismissal, disability pensions and employment quotas. Against this backdrop, an understanding of the labor market effects of becoming disabled is key, as it can support the design of effective disability policies to improve the recruitment, retention and development of disabled workers.

This paper quantifies the labor market effects of the onset of disability (defined, in our context, as the recognition of a severe disability status) and analyzes their underlying mechanisms for the first time based on administrative data. We focus on Germany, a country that is strongly affected by demographic change and where approximately 8 million individuals (9.5 percent of the population) are classified as having a permanent physical, mental or psychological health restriction involving severe disability. Specifically, we use the Employment Statistics of Severely Disabled People (BsbM), which include annual information on the employment status of disabled workers in firms since 2003. In Germany, at least five percent of the workforce of firms with 20 or more employees must be disabled workers. These firms must declare annually which of their employees are disabled. Based on this information, we identify severely disabled individuals in the social security data of the Federal Employment Agency. Firms not meeting the quota are penalized. Thus, firms have an incentive to correctly declare their employees' disability status. Additionally, employees have an incentive to apply for disability status, as the status is associated with benefits such as additional leave days and social security benefits.[2] These are great data to track employees closely attached to the labor market who become disabled over the course of their working lives. In order to identify a severe

[1] According to OECD (2022), people with disabilities are 40 percent less likely to be in employment than people without disabilities.

[2] We describe the institutional system in detail in the next section.

and sudden health shock, we restrict our sample to individuals who are employed five years before disability onset.

We use the combined data set, which covers individuals reporting the onset of a severe disability between 2005 and 2013, to validate the survey evidence on the impact of disability onset on labor market outcomes. Furthermore, the data allows us to study effect heterogeneities by individual and establishment characteristics and to investigate the potential mechanisms underlying the adverse labor market effects of disability onset. While much of the literature focuses on changes in working time, receipt of unemployment benefits or receipt of other replacement benefits (see, e.g., Charles, 2003; Lechner and Vazquez-Alvarez, 2011; Polidano and Vu, 2015), little is known about other underlying mechanisms. In our paper, we attempt to fill this gap by exploiting information on deaths as a reason for being out of the labor force and information on employer or occupational switches. These analyses allow us to draw conclusions about which groups of disabled individuals are more likely to succeed in reintegration into the labor market and what changes in the employment relationship, for instance, with regard to working hours, the tasks performed and employer characteristics, are associated with this.

Moreover, the contribution of this paper lies in the fact that our administrative data set can be used to overcome challenges – such as selection into disability status, measurement of disability and sample size – that are poorly addressed by other empirical studies based on survey data. First, we have a considerably larger sample than the samples in previous works, with approximately 150,000 treated and more than 9 million potential control individuals for whom we have employment and wage information at daily frequency over a long time horizon. Longitudinal data from surveys, in contrast, typically enable the analysis of only 200–2,500 disability events (see, e.g., Charles, 2003; Lechner and Vazquez-Alvarez, 2011).

Second, to address biases through selection, such as the fact that individuals who are more likely to become disabled systematically differ in their labor market trajectories from nondisabled coworkers, we combine propensity score matching with an event-study approach. The process of registering for disability status takes time and can happen only after the actual onset of disability. Therefore, we match disabled individuals to nondisabled coworkers two years before the measured date of disability onset based on a broad array of observable characteristics, including detailed information on past labor market performance. We also take unobserved heterogeneity into account by conditioning on AKM-style measures for individual and establishment fixed effects.

Third, administrative data sources are less prone to measurement error, sample

selection and panel attrition than comparable survey data sources. Disability status is a sensitive characteristic that might be misreported in surveys. Economic and psychological incentives, coupled with potential difficulties in interpreting the survey questions, are reasons for unreliable self-reports of disability status (e.g., Myers, 1982; Bowe, 1993; Hale, 2001). Moreover, some studies document that individuals who find themselves out of the labor force tend to systematically overreport disability (see, e.g., Kreider, 1999; Kreider and Pepper, 2007; Lindeboom and Kerkhofs, 2009), which could be explained by a so-called justification bias: People justify their labor market failures by using ill health as an excuse. In addition to the data on the treatment variable, information on wages and employment states might suffer from misreporting and selectivity issues (Pedace and Bates, 2000). In surveys, short unemployment spells tend to be underreported, and unemployed persons tend to not respond to surveys at all (see, e.g., Van Den Berg et al., 2006; Pyy-Martikainen and Rendtel, 2009; Lafuente, 2020).

Based on our administrative data source, we document the following key results. Days in employment decrease and days in nonemployment increase for the disabled, even two years before our measured date of disability onset. One year after onset, nonemployment days increase by 36 days per year and the probability of being nonemployed increases by 10 percentage points in comparison to those of the control group. After five years, the effects amount to 15 percentage points and 55 days, respectively. Transitions to unemployment after disability onset, in contrast, do not seem to play an important role. Receipt of replacement benefits from health insurance and the end of the employment relationship are reasons listed for permanently leaving the labor force. Disabled workers remaining in the labor force experience a significant drop in daily wages: the difference from the wages of the control group amounts to 7 percentage points five years after the onset of disability. A significant share of disabled workers reduce their working time, and a rather small fraction change employers. We observe horizontal occupational switches toward less physically or psychosocially demanding jobs as well as vertical occupational switches toward jobs with a lower job requirement level. The negative labor market effects of disability onset are more pronounced for severely disabled, older and low-skilled individuals. Overall, disability onset is thus accompanied by a variety of adverse labor market outcomes.

In addition to our analyses using administrative records, we use survey data from the Panel Study Labour Market and Social Security (PASS) to provide descriptive evidence on the representativeness of our estimation sample and the types of disabilities that individuals usually face. Based on both the administrative and

survey data sources, we document that the sample restrictions applied in our main analysis do not seem to strongly increase the selectivity of our sample. Moreover, the type of disability does not seem to depend on the degree of labor market attachment: approximately 90 percent of disabled individuals report physical disabilities and approximately 30 percent report psychological impairments.

Our paper represents an important contribution to the literature on the labor market integration of disabled individuals. It connects closely to studies focusing on the employment and income effects of disability onset by using comparable empirical identification strategies but relying on survey panel data and thus on assessments of the respondents. Lechner and Vazquez-Alvarez (2011) show for Germany based on the German Socio-Economic Panel (GSOEP) that becoming disabled reduces an individual's employment probability by 9 to 13 percentage points, depending on the degree of disability. The authors do not find a statistically significant relationship between the event of becoming disabled and a reduction in earnings or an increase in unemployment. Polidano and Vu (2015) also find negative impacts on employment rates, especially for full-time employment, using Australian panel data. The effects are particularly pronounced for younger individuals and individuals without post-school qualifications. The latter group has higher chances of being out of work and on income support than individuals with qualifications up to four years after disability onset. Charles (2003) concentrates on the impact of becoming disabled on the earnings of American men. The results indicate that disabled men experience sharp drops in earnings around the year of disability onset. Their earnings recover rapidly in the first two post-onset years, but a modest downward trend follows, which results in significant long-term losses of approximately 12 percent per year. Moreover, the author documents heterogeneous effects: being older at onset, nonwhite, more chronically disabled, and less educated come along with larger losses from disability and a smaller recovery. A large portion of these differences across groups appear to derive from industry affiliation after onset.

Other longitudinal studies on the impact of disability onset or health shocks confirm the negative effects on labor market participation and earnings.[3] Besides a significant and long-lasting decline in the probability of employment, Jones et al. (2018) document a decrease in life satisfaction and Meyer and Mok (2019) poorer

[3]See, e.g., Jenkins and Rigg (2004), Gannon (2005), Oguzoglu (2010), Jones and McVicar (2020) and Jolly and Wagner (2023) on the impacts of disability onset. Riphahn (1999), Garcia-Gomez (2011) and Lenhart (2019) study the effects of a deterioration of self-reported health status. Garcia-Gomez et al. (2013), Lundborg et al. (2015) and Dobkin et al. (2018) analyze the effects of acute hospitalization, while Moller Dano (2005), Crichton et al. (2011), Halla and Zweimüller (2013) and Parro and Pohl (2021) look at the impact of accidents and injuries. Moran et al. (2011), Heinesen and Kolodziejczyk (2013) and Jeon (2016) investigate the effects of surviving cancer.

economic conditions, as reflected by a decrease in earnings, net income, consumption and wealth at disability onset. The negative consequences are particularly pronounced for individuals with a chronic and severe disability condition.

Our paper also relates to analyses investigating the regulatory features of the German legislation as stipulated by the People with Severe Disabilities Act. The act was reformed in 2001, involving, among others, a substantial reduction in the generosity of the public disability insurance system. In a recent paper, Fischer et al. (2022) show that the reform significantly reduced the inflow of new benefit recipients but do not observe compensation through the private insurance market.[4] In addition, under the 2001 reform, the threshold for the applicability of the legislation for employers was increased, and the quota of positions to be filled with disabled workers was reduced. Studies evaluating the impact of this policy reform suggest that the reform was not successful in increasing the employment chances of severely disabled workers (see Verick, 2004; Braakmann, 2008).[5] Analyses of the disability quota threshold on firm dynamics and firm outcomes have come to different results. While Wagner et al. (2001) and Koller et al. (2007) document zero or small threshold effects on firm dynamics, Hiesinger (2022) finds significant effects on the number of employed disabled workers, firm growth, employment structure and wages.[6]

This paper is structured as follows. Section 2 elaborates on the German institutional context with respect to acquiring disability status and receiving social benefits after a health shock. Section 3 describes the data source, sample selection and empirical identification strategy. Section 4 presents the results of the empirical analysis, and Section 5 concludes.

[4]The impact of the generosity of the public disability insurance system on take-up rates, labor supply and the probability of returning to work outside of Germany has been studied, for instance, by French and Song (2014), Kostøl and Mogstad (2014), Autor et al. (2019) and Krekó et al. (2022).

[5]Supply and demand effects of labor market disability policies such as employment quotas or wage subsidies for disabled workers have also been studied, e.g., by Barnay et al. (2019) for France, Szerman (2022) for Brazil, Baert (2016) for Belgium or Lalive et al. (2013) for Austria.

[6]One possible explanation for these differences is the different data sets used in the respective studies: both Wagner et al. (2001) and Koller et al. (2007) use establishment-level survey data and hence rely on a small number of observations. In contrast, the study by Hiesinger (2022) uses an administrative data set that contains information on all German firms subject to the employment obligation.

2 The German Institutional Background

2.1 Acquiring Disability Status

In Germany, disability is defined as a physical, mental or psychological disorder that is not typical for the age of the patient and that has permanent consequences for the individual's health status. This disorder must impair the ability of the patient to participate in social life. An individual who wants to acquire a disability must go through a formal procedure carried out by an independent institution, the *Versorgungsamt* (§159 SGB IX). For this procedure, all medical documents related to the relevant health impairment(s) covering the preceding two years, for example, from treating physicians, must be submitted to the *Versorgungsamt*. This institution evaluates the degree of disability on a scale ranging from 20 to 100, graduated in steps of ten. An individual is defined to be "severely disabled" if his or her degree of disability is equal to or larger than 50.[7] Individuals with a degree of disability between 30 and 50 can be treated as severely disabled in the labor market if the disability restricts the possibilities of finding and holding a job.[8] As acquiring a disability status is a formal procedure involving several parties (e.g., the disabled individual, physicians, public authorities), the acquisition process takes time. Thus, there is probably a (considerable) time gap between the date of disability onset and the date of approval of disability status.[9] Once approved, the disability status is normally valid for five years.[10] Individuals are obliged to disclose their disability status to their employers only if the status affects the occupational activity in such a way that others or the individuals themselves would be at risk. Otherwise, acquiring disability status and communicating it to one's employer are voluntary. However, there are incentives for the individual worker to do so, as will be described in the following paragraphs.

The legal framework to promote the integration of people with disabilities in the labor market in Germany is laid down in part 3 of Book IX of the Social Code "Integration and Rehabilitation of Disabled People (SGB IX, 2001)", also called the Disabled Worker Law (*Schwerbehindertenrecht*). Enacted in 2001, it built upon the People with Severe Disabilities Act, which was originally implemented in 1974. In

[7] An example of a degree of 50 is voicelessness or stunted growth of 120 to 130 cm.

[8] Note that according to Lechner and Vazquez-Alvarez (2011), it is rare that individuals with an assigned degree of disability between 30 and 50 are *not* treated as severely disabled in the labor market.

[9] Note that "disability onset" itself is often not a sudden change in status but a slow process (Jenkins and Rigg, 2004).

[10] Disability status is granted infinitely only if the severity of the disability is unchangeable or worsens over time.

2018, the so-called *Bundesteilhabegesetz* replaced the former law. One key element of the disability law is the *employment obligation* whereby public and private employers with at least 20 employees must fill at least five percent of their employment positions with severely disabled workers.[11] Many other OECD countries, such as Austria, France, Italy and Spain, use similar quota systems to mandate the employment of workers with severe disabilities (OECD, 2003, 2010). The aim of this obligation is to create an incentive for employers to retain and/or hire disabled workers. Firms that do not comply with this obligation have to pay a graduated noncompliance fine (*Ausgleichsabgabe*).[12]

From workers' perspective, employees with a recognized severe disability are institutionally better protected than those with an unrecognized disability in two ways. First, they are subject to special dismissal protection. If the disabled employee has been working longer than six months in a firm, the employer needs to obtain permission for dismissal from the local integration office.[13] Second, a severely disabled worker receives more vacation days, i.e., an additional five days per year. Moreover, a recognized disability status may help an employee obtain special workplace equipment or financial assistance for occupational rehabilitation. Apart from better institutional protection in the labor market, individuals with a recognized severe disability status may receive further disadvantage compensations, e.g., in the form of reduced public transportation costs or museum admission. Thus, even though the acquisition of disability status is voluntary, the institutional framework in Germany offers many incentives to formally acquire such a status.

According to figures from the Federal Statistical Office (2022), 7.8 million individuals in Germany were considered severely disabled in 2021. Disabilities occur mainly in older people: Over one-third (34 percent) of the severely disabled individuals were 75 years and older, 45 percent were between 55 and less than 75 years

[11]Note that there are threshold rules with regard to the employment obligation for small firms: Firms with 20 to fewer than 40 employees must fill at least one position with a severely disabled individual per year, whereas firms with 40 to fewer than 60 employees must fill at least two positions with severely disabled individuals. Firms with 60 or more employees must meet the five percent quota. In general, one severely disabled individual is credited to one position. However, in the case of a very severe impairment due to the disability, a disabled individual may also be credited for more than one position (multiple crediting).

[12]The fine is based on the number of unfilled positions and is graduated according to the extent of noncompliance. The current fines are 140, 245 and 360 EUR per month and unfilled position. As in almost all countries with a quota system, the employment quota is generally not met in Germany. In 2021, approximately 61 percent of employers with 20 or more employees did not meet their employment obligation and thus had to pay the noncompliance fine.

[13]In practice, the integration offices approve dismissals in most cases. For example, in 2019, 79 percent of dismissals were approved (Bundesarbeitsgemeinschaft der Integrationsämter und Hauptfürsorgestellen, 2020). Nevertheless, many firms perceive the regulation as a hurdle to dismissing individuals with severe disabilities (Hiesinger and Kubis, 2022).

old, and only 3 percent were younger than 18 years. Among the working-age group (individuals between 15 and 65 years old), 3.1 million individuals were considered severely disabled, representing approximately 6 percent of the total population in this age group. Illness is the main cause of the vast majority of disabilities (almost 90 percent). Hence, only a small share of disabilities are congenital or due to war damage, accidents or other causes. Further, physical causes, in particular organ disorders, account for the majority of disabilities (58 percent). While 14 percent of the severely disabled had mental or emotional disabilities, 9 percent suffered from cerebral disorders. For the remaining fraction (19 percent), the type of the most severe disability is not indicated. With respect to the degree of disability, 22 percent of severely disabled individuals had the highest degree of disability (100), while 34 percent had a degree of disability of 50.

2.2 Social Benefits after Health Shocks

In addition to returning to employment, there are alternative ways for individuals with health impairments to receive income. In the following, we will discuss the four most relevant statutory regulations on the receipt of social benefits in Germany: sick pay, transitional benefits, unemployment benefits, and reduced earnings capacity pensions.

During the first six weeks of an illness episode, employees are entitled to short-term sick pay, which must be covered by the employer.[14] The replacement ratio amounts to 100 percent of individuals' earnings.[15] After six weeks of sickness with the same disease diagnosis, employees are entitled to long-term sick pay from the statutory health insurance fund.[16] The latter is mandatory for all employees subject to social security contributions and whose earnings fall short of the contribution limit of the statutory health insurance scheme. Thus, it covers the majority (approximately 90 percent) of the German population. The maximum duration of long-term sick pay for the same disease is 78 weeks within a period of three years, and the replacement level amounts to 70 percent of gross earnings.

After the expiration of long-term sick pay, employees who are still incapable of

[14]The mandatory maximum duration of sick pay may also be reached if the employee accumulates several shorter illness periods within the preceding year provided that they are due to the same disease diagnosis.

[15]According to the German Continued Remuneration Act (*Entgeltfortzahlungsgesetz*), an employee who falls sick needs to hand in a medical certificate no later than the fourth day of absence. However, the law permits employers to require a medical certificate starting from the first day of illness.

[16]If an accident at work or an occupational disease caused the health impairment, the *Berufsgenossenschaften* pay an injury benefit during the period of medical rehabilitation.

working can receive transitional benefits (*Übergangsgeld*). In general, this requires that former employees have contributed to the statutory pension insurance scheme and intend to participate in medical rehabilitation or vocational training measures. The statutory pension insurance takes over the transitional benefits for all rehabilitation measures that are intended to preserve the employability of individuals. The statutory accident insurance applies to individuals who have become ill as a result of an occupational accident or occupational disease. The Federal Employment Agency pays for vocational training measures that enable people with disabilities to participate in working life. Although responsibilities are not always entirely clear, recent figures show that the statutory pension insurance is most often involved: in 2020, approximately one million completed measures were documented, while the Federal Employment Agency took over the transitional benefits for approximately 7 thousand individuals (Federal Employment Agency, 2022; German Pension Insurance, 2022*b*). Transitional benefits for insured persons without children amount to 68 percent of the last net salary (75 percent for insured persons with children).

Individuals are entitled to receive insurance-based unemployment benefits (*Arbeitslosengeld I*) amounting to 60 percent (67 percent for claimants with children) of their previous net salary if they fulfill certain requirements. Specifically, they must have been employed and making social security contributions for at least 12 months within a certain time frame prior to becoming unemployed, and they must register as unemployed and as seeking employment at the Federal Employment Agency. Unemployed persons can receive unemployment benefits for a maximum duration of one year; for older individuals, longer periods of benefit receipt are also possible.[17] Persons whose qualifying period has ended but who are (still) unable to work, for instance, due to illness or disability, are also entitled to insurance-based unemployment benefits. After the expiration of insurance-based benefits, individuals can receive permanent means-tested welfare benefits (*Arbeitslosengeld II*).

In general, sick pay and transitional and unemployment benefits in Germany pursue the overall aim of sustaining the long-term employability of individuals who are still in the labor force. The nonpermanent character of these schemes is first reflected in the limited entitlement duration. Furthermore, individuals who experienced a long-term illness episode are generally entitled to conclude a reintegration agreement with their employer with the general objective of a (possibly stepwise) reintegration into their former job.[18] Individuals who are registered as unemployed

[17]Since 2008, a maximum period of two years has been granted to individuals who are 58 years of age or older and have been employed for at least 48 months in the last five years.

[18]Individuals receiving long-term sick pay may also be monitored by the health insurance program's auditing system to prevent potential abuse of the sick pay system.

should be willing to find a job, for instance, by applying to vacancies or participating in integration measures or training courses.

Finally, we discuss statutory schemes that enable individuals to permanently withdraw from the labor market. The possibilities of receiving an old-age pension before retirement age due to unemployment or severe disability have become increasingly restricted or have been abolished altogether since the beginning of 2000. However, individuals with a degree of disability of 50 or more can apply for an old-age pension for severely disabled people before they reach the standard retirement age if they fulfill a minimum insurance period of 35 years.[19] Apart from this, individuals who fulfil a minimum insurance period of five years and made compulsory contributions during the last three years and who are unable to work for at least three hours per day can apply for a full reduced earnings capacity pension (*Erwerbsminderungsrente*) covered by the statutory pension insurance.[20] Individuals who are able to work for more than three hours but are unable to work for more than six hours per day are entitled to a partial pension. For severely disabled persons, reduced earning capacity pensions are not automatically granted. Doctors and physicians commissioned by the statutory pension insurance scheme draw up an expert opinion on the claimant's earning capacity based on submitted medical reports and, if necessary, on their own examinations. Of course, the documents and files play a decisive role both in the application for a severely disabled person's disability status certificate and for the prospect of obtaining a reduced earning capacity pension. Then, it is first examined whether the individual's earning capacity can be restored or at least improved through medical and/or occupational rehabilitation measures. If neither is possible, the reduced earnings capacity pension is usually granted for a maximum of three years and is converted to a permanent pension, at the latest, after nine years. The amount of the pension is based on the pension contributions of insured individuals and on their projected earnings until retirement age. When the individual reaches the statutory pension age, the reduced earnings capacity pension is converted to an old-age pension. Recent figures show that this institution is very relevant in Germany: in 2021, 88 thousand individuals received a partial reduced earnings capacity pension, and 1.7 million individuals received a full reduced earnings capacity pension. The average age of entry is slightly above

[19] A severe disability generally allows an individual to retire before age 63. With a deduction of up to 11 percent, retirement is even possible at just over 60 years of age.

[20] The reduced earnings capacity pension is not associated with the occupation previously performed. Statutory occupational disability insurance was abolished in 2001. However, people of working age are increasingly taking out private insurance policies (according to the German Insurance Association (GDV), there were just under 17 million insurance policies covering occupational disability in 2017 (Deutsche Aktuarvereinigung e.V., 2018)).

50. Almost 90 percent of new pensioners with reduced earnings capacity are under 60 years of age when they retire (German Pension Insurance, 2022*a*,*b*).

3 Data, Sample and Empirical Strategy

3.1 Data

Our empirical analysis is based on three administrative data sets from the German Federal Employment Agency. The *Employment Statistics of Severely Disabled People* (BsbM) offer annual statistics available since 2003 on the employment of disabled workers in firms. As spelled out in Section 2.1, firms with 20 or more employees must fill a certain share of their employment positions with workers with disabilities. Thus, firms of this size must declare annually how many employees they have and which of their employees are severely disabled.[21]

The information from the BsbM data can be merged with severely disabled workers' employment histories from the *Integrated Employment Biographies* (IEB) until 2013 (for detailed information on a subsample of this data set, see, e.g., Frodermann et al., 2021).[22] The IEB include detailed information on individual characteristics (such as gender, age, nationality), different labor market states (such as periods of employment and registered unemployment) and employment information (such as occupation or daily wages) of individuals in Germany with at least one entry in their social security records (starting from 1975 onward in West Germany and from 1992 onward in East Germany). Thus, periods of self-employment, civil service, and military service are not included in the data set. Further, the data also include an establishment identifier that allows us to merge further information from the establishment data of the Federal Employment Agency, namely, the *Establishment History Panel* (BHP) (Schmucker et al., 2018).[23] The BHP provides detailed annual information on establishments' workforce such as their skill, employment or wage structure on the reference date of June 30.

[21]Severely disabled means that an individual has a degree of disability of at least 50. As spelled out in Section 2.1, individuals with a degree of disability between 30 and 50 can be treated as severely disabled in the labor market if the disability restricts their possibilities of finding and holding a job. These individuals are included and account for 14.7 percent of the disabled workers in the BsbM data.

[22]The records were linked based on personal identifiers and birth dates from the Data Infrastructure Management (DIM) department of the Institute of Employment Research (IAB). 86 percent of these severely disabled individuals could be linked to the IEB. Due to data restrictions, the records can be linked only up to 2013.

[23]Note that the BsbM is a firm data set while the BHP contains information on establishments. Thus, in the case of multiestablishment firms, the establishment information of the *Establishment History Panel* refers only to the main establishment.

3.2 Sample and Variables

We restrict our sample of disabled workers to individuals for whom we observe a change in status from nondisabled to disabled during their employment in the reporting establishment.[24] Further, we exclude individuals for whom we observe more than one change from nondisabled to disabled in our observation period to ensure that the event of disability onset is not influenced by previous onset events.[25]

In addition to the sample of disabled workers, we draw a control sample of nondisabled workers employed in the same establishments and occupations[26] as the disabled workers. Specifically, our control sample includes individuals not identified as disabled who ever worked in one of the reporting establishments between 2005 and 2013. To ensure comparability between individuals, we restrict our control group to individuals working in the firms and occupations in which at least one disabled worker is employed. Since our focus is on the impact of disability on labor market outcomes, we restrict our sample to individuals closely attached to the labor market. In our main specification, we therefore include in the sample only individuals who have been participating in the labor force for at least five years (i.e., in t-5, t-4, t-3, t-2 and t-1) prior to potential disability onset.[27] Furthermore, we aim to rule out that establishments purposely hire individuals with a (developing) severe disability. Thus, we restrict our sample to individuals with a sufficiently long tenure in an establishment and occupation, i.e., individuals who have been employed in the reporting establishment for at least three years prior to disability onset.[28] We also restrict on individuals being in the same occupational segment one year before matching and in the year of matching. Last, as disability onset is particularly

[24] As spelled out in the first paragraph of this section, the information on whether an individual is disabled stems from reports by the employer. Thus, we do not have a fixed date of "disability status acquisition" for an individual but rely on the annual report of his or her employing firm. Our sample consequently contains disabled individuals who were not reported as being disabled for at least one year in an establishment that later reported him or her as such. "Reporting" establishments are thus establishments that (1) are subject to the employment obligation (and thus employ 20 or more employees) and (2) report at least one disabled worker during the observation period.

[25] This exclusion affects 14.9 percent of the individuals in the original sample.

[26] The 2-digit aggregate of the German Classification of Occupations 2010 (KldB 2010) contains 14 occupational segments that are summarized based on the tasks characterizing a job (Matthes et al., 2015).

[27] Note that many studies that analyze the effects of health shocks on labor market outcomes condition on employment prior to the shock (see, e.g., Lundborg et al., 2015 or Jeon, 2016).

[28] For this, we make sure that an individual has an employment spell in the same establishment as of the reference date, June 30th, in the years t-1, t-2 and t-3. Thus, we allow for variation in employment days during the year. Nevertheless, to ensure that we consider only individuals closely attached to the reporting establishment in the sample, we further exclude individuals with fewer than 365 employment days in the reporting establishment within the two years before potential disability onset.

relevant at an advanced age, we exclude individuals under the age of 30 (at the time of matching). Moreover, disabled employees aged 58 years or older are not subject to the special dismissal regulations. Thus, we include only individuals younger than 56 years (at the time of matching).[29] By definition, we do not observe a disability onset event for our control individuals.

Creating a balanced panel, we observe individuals five years before and five years after potential disability onset. This leads to a sample of 148,660 disabled and a pool of 9,231,050 nondisabled observations. Table 1 on page 16 and 17 presents individual and establishment characteristics separately for treated and control individuals (columns (1) and (2)). The table suggests that 57 percent of the individuals experiencing disability onset are male, 45 percent are between 50 and 55 years old and 80 percent have a vocational training degree (are medium skilled). Compared to the control group, the group experiencing disability onset includes more older and low- or medium-skilled individuals. Moreover, treated individuals work in smaller establishments, have a longer employment duration and earn lower wages. Interestingly, disability onset does not seem to be concentrated in specific occupations or industries.

We focus on two aspects of labor market outcomes: employment and labor earnings. For employment, we analyze the effect of disability on (1) being employed on the reference date (June 30th) and (2) the number of days in employment per calendar year. The employment status helps us compare the effect that we identify with the effects found in the literature, as this measure is widely used as an outcome variable in disability studies (see, e.g., Polidano and Vu, 2015 or Lechner and Vazquez-Alvarez, 2011). In addition to employment status, the annual number of days in employment provides a more precise measure of labor market participation after disability onset. For labor earnings, we focus on (1) annual labor earnings (in EUR and deflated to 2015 prices, measured as the inverse hyperbolic sine (IHS) transformation to account for zeros in annual labor earnings), which can be interpreted as a measure of economic welfare, and (2) log daily wages (in EUR and deflated to 2015 prices) as an indicator of productivity (Charles, 2003).[30]

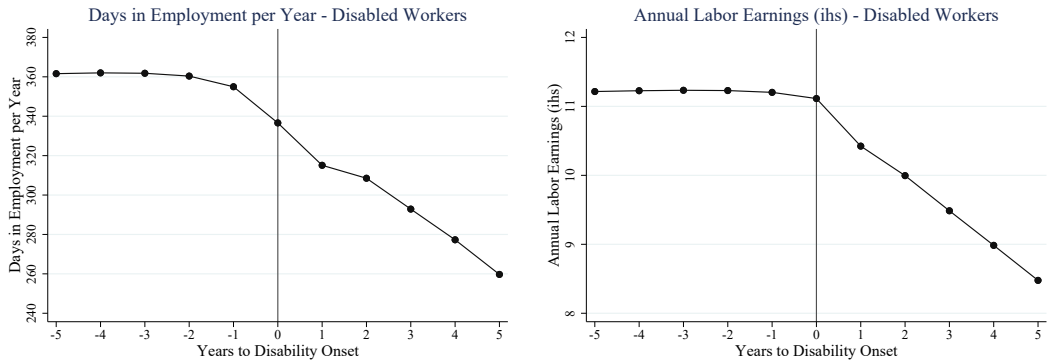
To give a first impression of the outcome variables, Figure 1 shows the trend for employment days and annual earnings for disabled workers. Both outcome variables

[29]This restriction is also in line with common practice in the literature, as many studies focus on individuals aged between 30 and the late 50s (e.g., Lundborg et al. (2015), Heinesen and Kolodziejczyk (2013) and Moran et al. (2011)).

[30]Note that gross daily wages are right censored in the IEB due to the upper limit on social security contributions. However, we assume that this censoring should, if anything, result in attenuation bias, as observations in the control group should be more likely to report censored wages, which would lead to an underestimation of the magnitude of the effects of disability.

show constant development until two years before disability onset. In t-2, in particular, the number of days in employment begins to decline, indicating that disability is already relevant before the official acquisition of disability status.[31]

Figure 1: Descriptives: Employment Days and Annual Earnings



Notes: The figure shows the trends for employment days and (IHS-transformed) annual earnings for the sample of disabled workers five years before and after disability onset. Earnings are deflated to 2015 prices.
Source: BsbM and IEB, years of disability onset: 2005–2013, n=148,660, own calculations.

3.3 Empirical Strategy

The onset of disability is, in many cases, not a random event but depends, for instance, on occupational tasks and health history. To address potentially nonrandom self-selection into treatment, we apply a matching strategy, more specifically, 5-nearest-neighbor propensity score matching combined with exact matching. As discussed in the previous paragraph and shown by the descriptive trends of the outcome variables, the process of registering for disability status takes time and can only happen after the actual onset of disability. Thus, we split the sample by future disability status two years prior to the appearance of disability status in our data to identify the treatment and control groups.[32] Our control sample consists of individuals with a hypothetical disability onset event two years later. One nondisabled individual can therefore be used as control several times (in several calendar years and multiple times as nearest neighbor).[33]

[31] As spelled out in Section 2.1, this is not surprising since the acquisition of disability status takes time.

[32] Note that matching on observables two years before the measured date of disability onset is also in line with common practice in the literature (Polidano and Vu, 2015).

[33] Of our sample of 624,439 control observations, 566,069 are unique individuals. In Section 4.4, we show that our results are robust in estimations applying 1-nearest-neighbor propensity score matching without replacement.

For the matching procedure, we use a rich set of individual, establishment and predisability characteristics, i.e., variables that cannot be affected by the treatment. We match exactly on gender, age categories and calendar year. To estimate the propensity score, we match on nationality, qualification, occupation and job requirement level as individual characteristics. Among establishment characteristics, we use establishment size, industry as well as median wage and location of the establishment (East vs. West Germany) as matching variables. Last, to match on the individual employment history, we include the cumulative duration (in months) of previous employment, tenure and nonemployment and the cumulative number of nonemployment spells as well as employment and nonemployment days (in categories) in the preceding years of disability onset (i.e., in t-5, t-4, t-3 and t-2).[34] Furthermore, we match on the logarithm of daily wages in the predisability years and on dummy variables indicating whether an individual was in a different establishment than the reporting establishment in t-5 and t-4. Table 1 describes the matching quality.

The last columns report the standardized differences in covariate means (Δ_X) between treated and (matched) control observations as a scale-free measure of balancing (see, e.g., Austin, 2011; Guo and Fraser, 2014).[35] Since there is no universally agreed criterion for how small the standardized difference must be to provide balance, we lean on the general rule of $\Delta_X < |0.1|$ suggested by Austin (2011). The standardized differences between treated and control observations reported are substantially reduced after matching, resulting in differences that are very close to zero and fulfill the criterion. Thus, we conclude that the matching procedure is successful in identifying a suitable control group.

In the next step, we use the generated matching weights in an event study analysis similarly to Kleven et al. (2019). We compare individuals who eventually become disabled (the treatment condition) to individuals who never experience disability (the control group). We then depict the results over time from five years prior to the onset of disability to five years afterward. This strategy allows us first to assess whether the treatment and control groups are truly comparable in their trajectories by investigating the trajectories in labor market outcomes prior to the

[34]Note that we cannot match on individual sickness history because we cannot clearly identify illness periods in our data. However, nonemployment spells include periods of long-term sickness. Thus, we can assume that we approximately control for individual sickness history by including the number and duration of nonemployment spells.

[35]The standardized difference is defined as $\Delta_X = \left(\bar{X}_1 - \bar{X}_0\right) / \left((S_1^2 + S_0^2)/2\right)^{0.5}$, where $\bar{X}_w$ is the sample mean of treated ($w = 1$) or control ($w = 0$) observations and S_w^2 are the respective sample variances (Austin, 2011). The advantage of Δ_X over the usual t statistic is that it does not mechanically increase with the sample size and therefore avoids exaggerating small imbalances that would still appear significant in a t test.

Table 1: Balancing of Covariates

	Treated	Control Unmatched	Control Matched	Standardized Differences	
	(1)	(2)	(3)	(1)-(2)	(1)-(3)
Male	0.570	0.609	0.570	-0.078	0.000
Age Categories					
30–34 Years	0.038	0.069	0.038	-0.140	0.000
35–39 Years	0.088	0.206	0.088	-0.337	0.000
40–44 Years	0.169	0.268	0.169	-0.241	0.000
45–49 Years	0.258	0.241	0.258	0.041	0.000
50–55 Years	0.447	0.217	0.447	0.504	0.000
Foreign	0.080	0.078	0.082	0.007	-0.008
Qualification					
Low-Skilled	0.086	0.067	0.087	0.069	-0.003
Medium-Skilled	0.801	0.745	0.800	0.135	0.003
High-Skilled	0.113	0.188	0.113	-0.211	0.000
Occupation					
Agriculture, Forestry, Horticulture	0.007	0.002	0.007	0.066	-0.002
Manufacturing	0.131	0.121	0.133	0.029	-0.005
Production Technology	0.158	0.213	0.155	-0.143	0.008
Building and Interior Construction	0.039	0.021	0.041	0.107	-0.009
Food, Gastronomy, Tourism	0.025	0.013	0.026	0.092	-0.004
Medical and Nonmedical Healthcare	0.078	0.130	0.080	-0.171	-0.008
Social Sector and Cultural Work	0.058	0.047	0.060	0.048	-0.008
Commerce and Trade	0.043	0.021	0.044	0.123	-0.008
Business Management and Organization	0.202	0.179	0.196	0.057	0.015
Business-Related Services	0.072	0.105	0.072	-0.114	0.001
IT Sector and Natural Sciences	0.046	0.062	0.045	-0.067	0.006
Safety and Security	0.018	0.008	0.018	0.093	0.005
Traffic and Logistics	0.100	0.066	0.101	0.122	-0.005
Cleaning Services	0.023	0.012	0.023	0.085	0.001
Job Requirement Level					
Unskilled/Semiskilled	0.059	0.039	0.060	0.096	-0.001
Specialist	0.750	0.726	0.753	0.057	-0.006
Complex Specialist	0.094	0.096	0.090	-0.009	0.012
Highly Complex	0.097	0.139	0.097	-0.133	-0.001
Establishment Characteristics					
Industry					
Agrarian, Fishery	0.003	0.001	0.003	0.057	-0.001
Energy, Mining	0.023	0.020	0.023	0.024	0.000
Manufacturing	0.385	0.430	0.380	-0.091	0.012
Construction	0.029	0.011	0.030	0.131	-0.004
Wholesale	0.082	0.039	0.082	0.179	0.000
Traffic, Communication	0.048	0.046	0.051	0.011	-0.011
Banking, Insurance	0.058	0.103	0.060	-0.168	-0.011
Other Services	0.075	0.057	0.076	0.075	-0.003
Public Administration (PA)	0.265	0.268	0.264	-0.007	0.003
Public Sector (w/o PA)	0.031	0.026	0.032	0.034	-0.003
Location: East Germany	0.138	0.125	0.138	0.041	0.002
Number of Employees in Firm					
20–49 Employees	0.104	0.010	0.106	0.414	-0.008
50–99 Employees	0.119	0.023	0.118	0.383	0.002
100–199 Employees	0.137	0.050	0.136	0.302	0.002
200–499 Employees	0.196	0.144	0.194	0.138	0.005
500–999 Employees	0.142	0.173	0.140	-0.085	0.005
1000+ Employees	0.303	0.600	0.306	-0.626	-0.006
Median Wages in Establishment	102.447	113.564	102.381	-0.395	0.002
Number of Observations	148,660	9,231,050	624,439		

Notes: Gender and age categories are matched exactly. In addition to the covariates shown, our matching procedure uses years (exact matching). All listed covariates are measured at t-2 (two years before (hypothetical) disability onset). We impute the education variable following Fitzenberger et al. (2006). Categories of education: (1) low-skilled: no vocational training; (2) medium-skilled: vocational training; (3) high-skilled: university or university of applied sciences. The summary statistics of the matched control observations (column (3)) are weighted by the matching weights described in Section 3.3.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Table 1: Balancing of Covariates *(continued)*

	Treated	Control Unmatched	Control Matched	Standardized Differences	
	(1)	(2)	(3)	(1)-(2)	(1)-(3)
Individual Employment History					
Cum. Employment Duration	263.853	233.895	263.482	0.342	0.004
Cum. Nonemployment Duration	27.053	26.549	27.149	0.012	-0.002
Tenure	162.295	161.523	162.352	0.008	-0.001
Number of Nonemployment Spells	2.881	2.180	2.908	0.261	-0.009
Days in Employment in t-5	361.603	363.191	361.470	-0.092	0.007
Days in Employment in t-4	362.013	363.891	361.907	-0.127	0.006
Days in Employment in t-3	361.808	364.116	361.734	-0.160	0.004
Days in Employment in t-2	360.383	364.237	360.545	-0.230	-0.008
Days in Nonemployment in t-5	2.480	1.328	2.603	0.086	-0.008
Days in Nonemployment in t-4	2.532	0.919	2.595	0.128	-0.004
Days in Nonemployment in t-3	3.061	0.891	3.085	0.161	-0.001
Days in Nonemployment in t-2	4.688	0.942	4.497	0.230	0.009
(ln) Daily Wages in t-5	4.458	4.557	4.451	-0.205	0.014
(ln) Daily Wages in t-4	4.486	4.590	4.479	-0.225	0.015
(ln) Daily Wages in t-3	4.512	4.621	4.505	-0.243	0.016
(ln) Daily Wages in t-2	4.528	4.646	4.521	-0.262	0.016
Different Establishment in t-5	0.090	0.078	0.090	0.043	0.000
Different Establishment in t-4	0.045	0.038	0.045	0.036	-0.001
Number of Observations	148,660	9,231,050	624,439		

Notes: Cumulative durations and tenure are measured in months. For our matching procedure, we use 3 (in t-3 and t-2) and 5 (in t-5 and t-4) categories of employment and nonemployment days. We classify the categories at the median/quartiles and generate a separate category for 365/366 employment days and zero nonemployment days. The summary statistics of the matched control observations (column (3)) are weighted by the matching weights described in Section 3.3.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

onset of disability, which should not diverge. Second, we can observe the treatment effect and dynamics in this effect over time by investigating the trajectories after the onset of disability.

Specifically, we estimate the following equation:

$$Y_{it} = \alpha + \beta disabled_i + \sum_{\substack{k=-5,\\ k\neq -2}}^{5} \delta_k disabled_i \times I(t=k) + \sum_{\substack{k=-5,\\ k\neq -2}}^{5} \gamma_k\, I(t=k) + \omega X_{it} + \epsilon_{it}, \quad (1)$$

where Y_{it} is the outcome of interest (e.g., employment status or daily wage) of individual i in period $t = \{-5, \ldots, +5\}$ before or after disability onset. $disabled_i$ is an individual-constant group indicator for ever becoming disabled, $I(t = k)$ indicates the periods around the year of disability onset and X_{it} is a set of covariates including age, gender and year dummies. ϵ_{it} is the idiosyncratic error term. Considering the matching procedure performed previously, we assign $I(t = k)$ to individuals who never become disabled based on the timing of the onset of disability of the individuals to whom they are matched. α is a regression constant, and β accounts for the level difference between disabled and nondisabled individuals in the reference period, i.e., at t-2. γ_k measures the impact of time period k relative to the reference period for the control group. δ_k is the coefficient of interest, which provides the difference

between the outcomes of individuals who become disabled and those of their control group in period k and thus the treatment effect. As nondisabled individuals can be used as controls several times (in several calendar years and multiple times as nearest neighbors), we display standard errors adjusted for clustering at the individual level.

4 Results

4.1 Baseline Results

To shed more light on the dynamics over the entire 10-year observation period, we use a graphical representation of our estimation results. Specifically, we plot the coefficients of the interaction between the years to disability onset and the treatment dummy with reference year t-2.[36] Figure 2 shows the event-study results for the employment indicators. As we restrict our sample to employed individuals in the years prior to potential disability onset, the pretrends for employment status are set to zero by construction. The results imply that the probability of being employed drops by 10.3 percentage points one year after disability onset relative to that of the control group. Thereafter, the effect remains at this level for one year, possibly because some individuals return to employment after the expiration of sick pay or transitional or unemployment benefits (see Section 2.2). In year three after disability onset, the employment rate decreases again, resulting in an effect of -16.3 percentage points after five years. Our findings are comparable to the effect of -9 percentage points in the year of disability onset identified by Polidano and Vu (2015). Lechner and Vazquez-Alvarez (2011) identify an effect of -9.3 percentage points in the second year after disability onset, which is also quite close to our estimated effect in t+2 (-10.4 percentage points).[37]

Furthermore, the results for employment days show that the days in employment do not diverge between the treatment and control groups until two years before our measured date of disability onset. Within the two years before disability onset, the number of days in employment decreases substantially by 25 days per year relative to t-2. Days in employment continue to fall after disability onset; then, we again

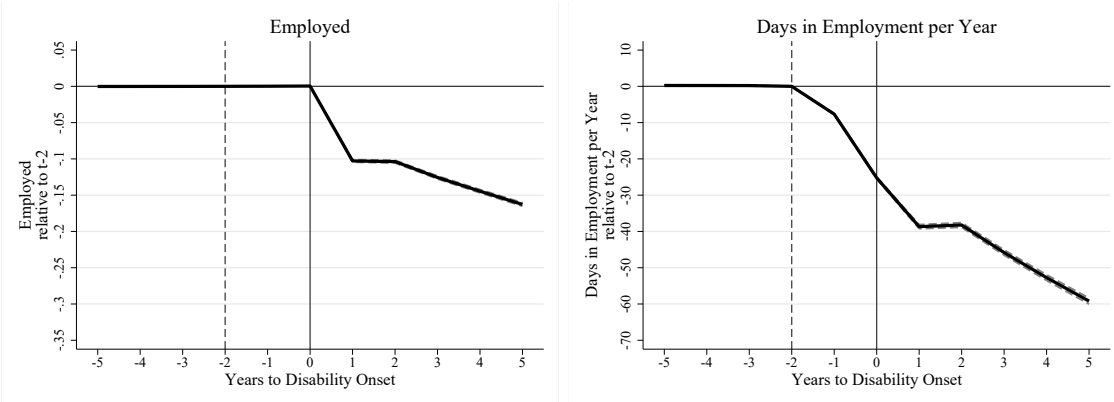
[36] The development of the outcome variables of the treatment and control groups can be found in Figure A.1 in the appendix.

[37] Note that our sample selection differs somewhat from that in the studies of Polidano and Vu (2015) and Lechner and Vazquez-Alvarez (2011). Specifically, we condition on employment five years prior to onset and observe only individuals employed at the time of (acquisition of) disability status (t). Thus, the individuals in our sample are probably more closely attached to the labor market. However, as discussed in Section 4.4, the sample restrictions tied to employment do not seem to strongly affect the selectivity of our sample.

observe a plateau between t+1 and t+2 up to a total decline of 59 days per year in t+5.

Figure 3 illustrates the event-study results for the earning variables. Again, the pretrends do not diverge between control and treated individuals. Annual labor earnings decrease slightly until disability onset before decreasing substantially until five years after onset. In the fifth year after disability onset, disabled workers experience an overall reduction in ihs-transformed annual labor earnings of -1.710 (approximately -41 percentage points in annual earnings)[38] relative to those of the control group. Note that for the estimation of this outcome variable, both individuals who stay in the labor market and those who leave the labor market are included. Furthermore, disabled workers who stay in the labor force are found to experience drops in daily wages that predate the date of disability onset. Daily wages recover one year after disability onset before they decrease again, resulting in an effect of -0.072 log-points (approximately -7 percentage points, see footnote [38]) in t+5. The decrease in earnings and wages is in line with the findings of the study by Charles (2003) of substantial long-term earnings losses among disabled men and stands in contrast to those of the study by Lechner and Vazquez-Alvarez (2011), who find only a small, if any, reduction in earnings among those who remain employed after disability onset.

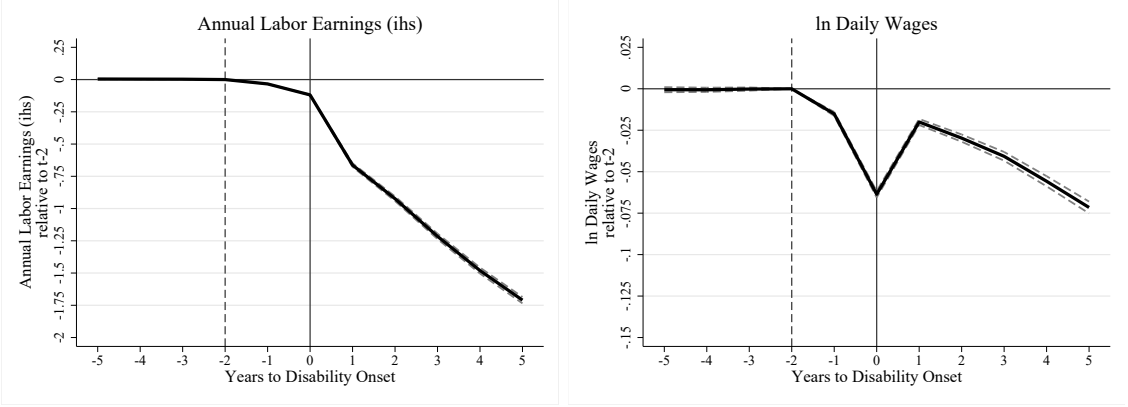
Figure 2: Main Effects: Employment



Notes: The figure shows the effects of disability on employment (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. Number of treated (matched control) observations in t-2: 148,660 (624,439). The employment indicator is measured at the reference date June 30th.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

[38]The estimated effect on annual earnings is calculated as: $(exp(\delta_5 + \gamma_5) - 1) * 100 - (exp(\gamma_5) - 1) * 100$ with δ_5, γ_5 from equation (1).

Figure 3: Main Effects: Earnings



Notes: The figure shows the effects of disability on earnings (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. Number of treated (matched control) observations in t-2: 148,660 (624,439). Annual labor earnings are defined as the product of employment days and daily wages and are measured by an inverse hyperbolic sine transformation. Earnings and wages are deflated to 2015 prices.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

4.2 Channels

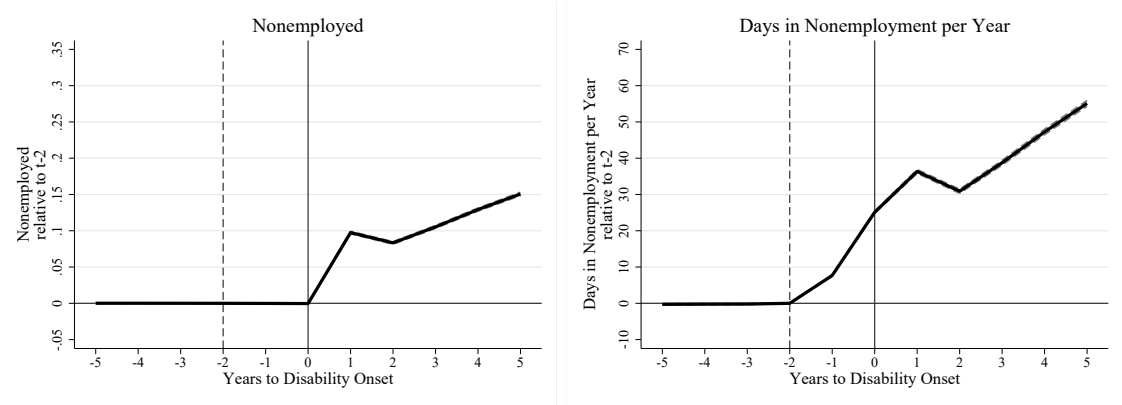
Channels for Employment Outcomes

In what follows, we aim to dig deeper into potential mechanisms that can explain our main results. To explore the mechanisms for the employment outcomes, we first focus on nonemployment status and the yearly number of nonemployment days.[39] The results shown in Figure 4 illustrate that nonemployment is an important driver of the decline in employment: one year after disability onset, the probability of being nonemployed increases by 10 percentage points and the days in nonemployment by 36 days per year in comparison to those of the control group. The effect decreases slightly in t+2 for both the nonemployment rate and the days in nonemployment per year. This suggests that the expiration of temporary social benefits and the regaining of earning capacity favors a return to employment. However, this may be only temporary, as individuals may become ill again or transition after some time to early retirement. After five years, the effects on nonemployment amount to 15 percentage points and 55 days, respectively. In contrast, the effect on unemployment status is quite small. Compared to the outcome for the control group, days in unemployment increase slightly after the onset of disability but fall again in t+5 (see Figure A.3 in the appendix). Although the individuals in our sample should be

[39]We define an individual to be unemployed as soon as he or she receives any kind of benefit receipt. We define an individual as nonemployed when there is no entry in the social security record. This means that we fill in gaps between administrative entries and periods after permanent exit from the labor market with nonemployment days.

entitled to unemployment benefits, Section 2.2 suggests that the lower replacement rate, the limited replacement duration and the job search requirements make receipt of unemployment benefits less attractive than receipt of social benefits under other schemes in Germany. The small effect of disability onset on unemployment has also been documented by other studies (see, e.g., Lechner and Vazquez-Alvarez, 2011).

Figure 4: Channel: Nonemployment



Notes: The figure shows the effects of disability on nonemployment (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. Number of treated (matched control) observations in t-2: 148,660 (624,439). The nonemployment indicator is measured at the reference date June 30th.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

In the next step, we dig deeper into the transitions into nonemployment by exploiting the information on individuals' reasons for being out of the labor force. In the employment notifications, employers deregister employees when they leave the labor force and indicate a reason for the deregistration (*Abmeldegrund*). The main reasons for permanently leaving the labor force in our sample include the end of employment, receipt of replacement benefits and death.[40] The reason "end of employment" describes the regular end of an employment relationship (e.g., due to the expiration of a fixed-term contract, dismissal by the employer or employment termination by the employee).[41] A deregistration with the listed reason of "receipt

[40]Note that we use the information on deregistration only when an individual permanently leaves the labor force. Specifically, we create a dummy for each of the three reasons that take *1* only when the reason is indicated in the last observable employment spell. For individuals who do not leave the labor force permanently (i.e., for whom we observe subsequent employment or unemployment spells) and for individuals for whom the reason is not indicated, the dummy takes *0*. Thus, the reason for (subsequent) nonemployment can already be reported in the spell containing t. The share of disabled individuals who permanently leave the labor force after disability onset is 6.2 percent in our sample.

[41]A worker who switches to a full reduced earnings capacity pension or an old-age pension (see Section 2.2) would also probably be deregistered with this reason listed (or with the reason "other".)

of replacement benefit" means that an employee is now entitled to compensation by the statutory health insurance provider. In Germany, the statutory health insurance scheme provides compensation for (1) maternity leave (at least six weeks before and eight weeks after childbirth) and (2) long-term illness (see Section 2.2).[42] Finally, a deregistration with the reason "death" describes the death of an employee.

Figure 5 shows the event-study results for the three main reasons listed for permanent nonemployment. All three reasons play a significant role after the onset of disability and serve to explain the mechanisms behind the increase in permanent nonemployment. In the fifth year after disability onset, the probability of deregistration with the reason "receipt of replacement benefits" increases by 1.1 percentage points, with the reason "end of employment" by 0.7 percentage points and with the reason "death" by 0.3 percentage points relative to that of the control group. Concerning magnitudes, replacement benefits seem to play the largest role (especially in the year directly after disability onset), whereas death is a comparably minor reason.

Channels for Earnings Outcomes

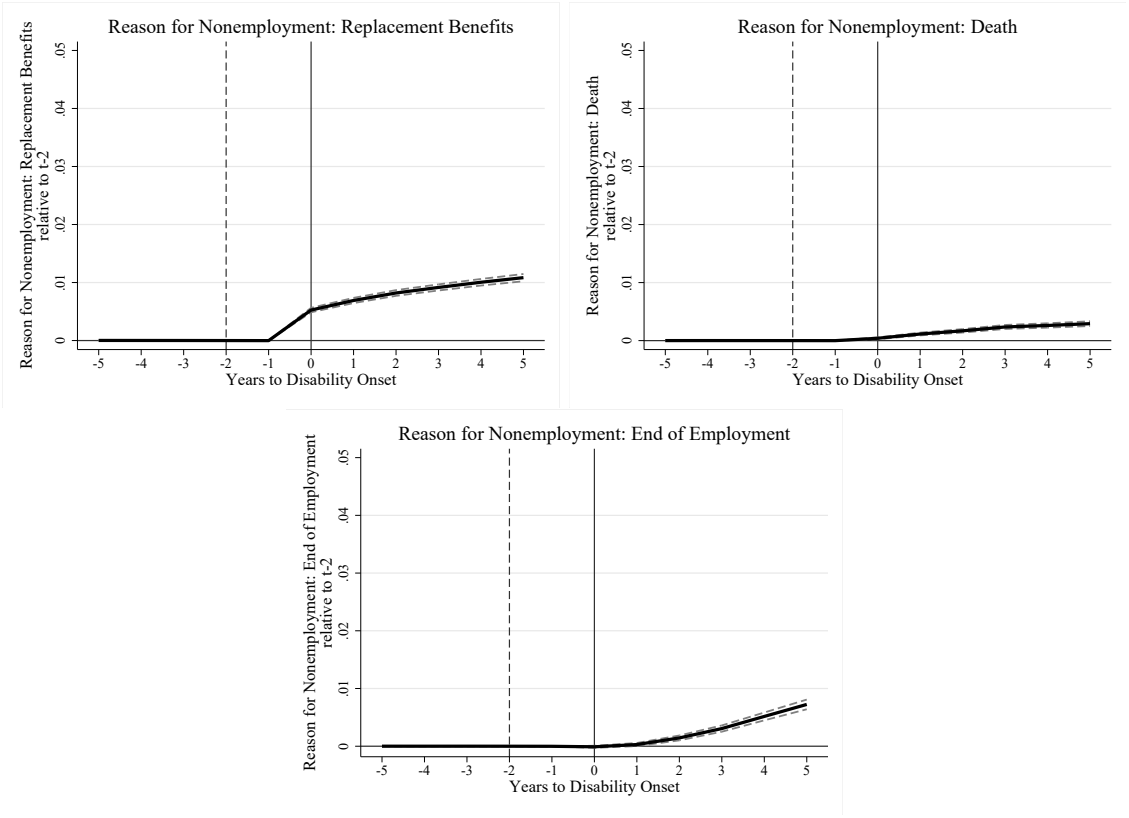
As shown in the right graph of Figure 3, workers experience drops in daily wages that predate the measured date of disability onset. However, daily wages seem to rapidly recover within the first year after onset. One possible explanation for this kink could be positive selection since we observe daily wages only for individuals who stay in the labor market after disability onset. In fact, the results from a logit regression show that among disabled workers, mainly younger, well-educated and high-earning men in larger and better-paying firms remain in the workforce (see Table A.2 in the appendix). However, when we restrict the sample to individuals employed in t+1 and perform the matching procedure for this sample, the kink is still present (although somewhat less pronounced; see Figure A.2 in the appendix), indicating that compositional differences alone cannot explain the pattern of daily wages.

Another explanation could be the dynamics of working time around the onset of disability. As pointed out by Charles (2003), the drop in annual earnings for disabled men is caused mainly by a reduction in working hours. Further, the regulations relating to the partial reduction in earnings capacity pension (see Section 2.2) may

In principle, the "end of employment" reason for deregistration could also include transitions to self-employment. At an older age, however, efforts to become self-employed typically decrease (Wasserman, 2012), which should especially be the case in the group of severely disabled persons.

[42]Note that this reason for deregistration only includes replacement benefits provided by the statutory health insurance provider (Müller et al., 2022). Transitional benefits by the pension insurance scheme (see Section 2.2) presumably correspond to the category "other deregistration reason".

Figure 5: Channel: Reasons for Nonemployment



Notes: The figure shows the effects of disability on reasons for deregistration (permanent nonemployment) (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. Number of treated (matched control) observations in t-2: 148,660 (624,439).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

provide an incentive to work part-time after disability onset. Thus, to explore the mechanisms for the earnings outcomes, we first analyze whether disability affects part-time employment.[43] The upper left graph in Figure 6 shows that for those who stay in employment after disability onset, part-time work plays an important role: in year two after disability onset, the probability of working part-time increases by 2.5 percentage points in comparison to that of the control group. The effect amounts to 4.7 percentage points in year five, which corresponds to an increase in part-time work of 27 percent of the sample mean.[44] This result is also in line with the findings by Polidano and Vu (2015) of a high prevalence of part-time employment after disability onset. Unfortunately, the administrative records do not include information on hours worked. Instead, we can only differentiate between part-time and full-time employment as described above. This restriction prevents us from examining in detail the dynamics of working time around the onset of disability. However, as supported by the findings of Charles (2003), dynamics in working hours seem to play an important role in both the initial decline and the subsequent recovery of earnings.

A further reason for the drop in earnings may be establishment or occupational changes. Individuals who experience a severe health shock may not be able to work in their former occupation and/or establishment. Some jobs, for example, those with physically demanding tasks, may be difficult for individuals to return to after disability onset. Some employers may not be willing or able to provide workplaces equipped to meet the special needs of disabled workers. The loss of occupation- and/or firm-specific human capital may explain the drop in daily wages. The upper right graph in Figure 6 shows that an individual's probability of changing employers does not change significantly up to two years after disability onset but increases by 1.4 percentage points after five years in comparison to that of the control group. The establishments to which individuals move are, on average, less productive than the initial establishments in which they become disabled (see Table A.3 in the appendix).

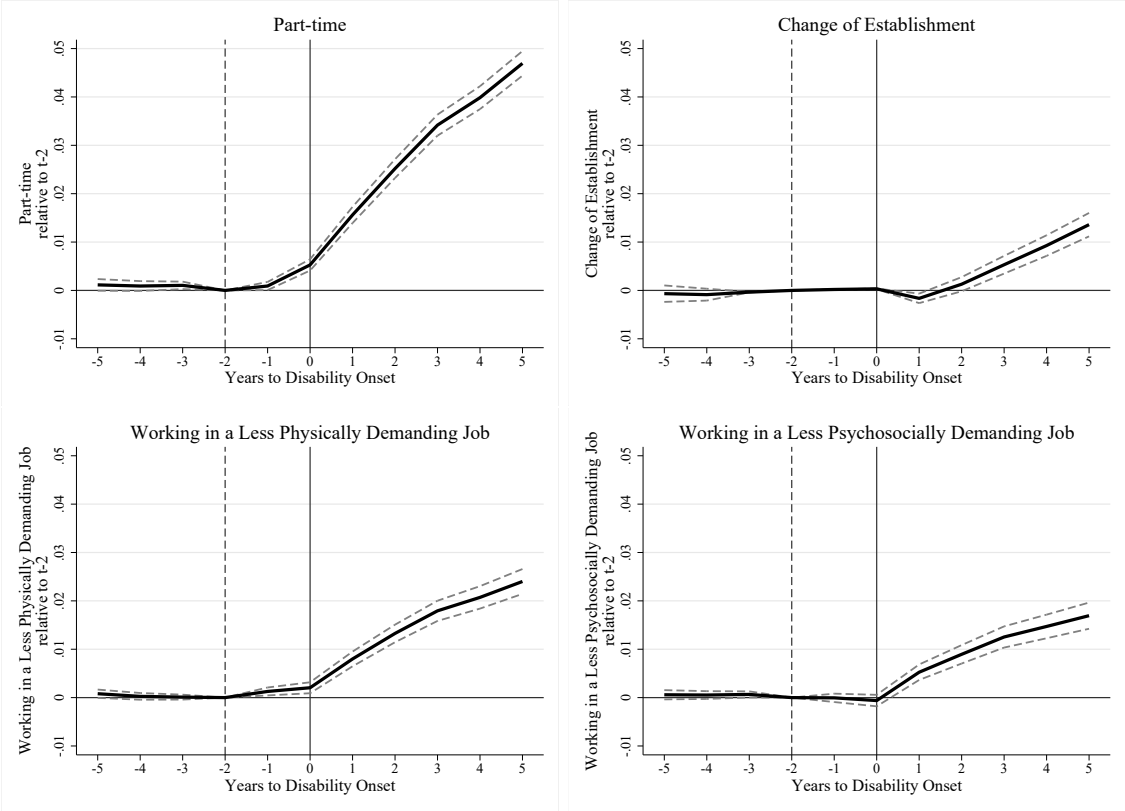
Furthermore, we analyze whether workers have a higher propensity to work in less demanding jobs after disability onset. For this, we use an index of physical and psychosocial job demands that can be merged with the occupations in our data (Kroll, 2011).[45] The index describes the extent of the demandingness of each occupation on a scale ranging from 1 (less demanding) to 10 (highly demanding). The basis for the index is a representative survey of employees, namely, the BIBB/BAuA Employment

[43] In the data, "part-time" indicates that the contractual working hours are less than the usual working hours in the establishment.

[44] The share of part-time employment in t-2 in the whole sample is 17.3 percent.

[45] For the merge, we use the 3-digit level of the German Classification of Occupations 2010.

Figure 6: Channel: Part-time, Establishment and Occupational Changes



Notes: The figure shows the effects of disability on part-time employment, establishment changes and changes to a less physically or psychosocially demanding job (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. Number of treated (matched control) observations in t-2: 148,660 (624,439). For switches to a less physically (psychosocially) demanding job, we use the Kroll index, which provides information on the extent of physical (psychosocial) demands in an occupation (Kroll, 2011).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Survey, which asks about a broad range of work-related demands. Physical demands include, for example, frequent carrying of heavy loads, working in forced postures or working with noise. Psychosocial demands include, for example, high time pressure, frequent interruptions, working overtime or having no support from colleagues. The lower left (right) graph in Figure 6 shows the effects of disability on the probability of working in a less physically (psychosocially) demanding job.[46] It illustrates that horizontal occupational switches toward less physically (psychosocially) demanding occupations play some role directly after disability onset and become more frequent over time. Five years after disability onset, the probability of switching to a less physically (psychosocially) demanding job increases by 2.4 (1.7) percentage points relative to the probability in the control group.[47] We also find some evidence for vertical occupational switches.[48] While for job "upgrading" no relevant effects emerge, we find some evidence for job "downgrading": In the fifth year after disability onset, the probability of switching to a job with a lower requirement level increases by 1.6 percentage points in comparison to that of the control group (see Figure A.4 in the appendix).[49]

In sum, our channel analysis shows that dynamics in working time – although insufficiently observable and approximated here by a part-time indicator – seem to play an important role in explaining the wage pattern after disability onset. We also observe switches toward less demanding jobs, both in terms of physical and psychosocial dimensions and in terms of formal requirement levels, while establishment switches play only a minor role.

4.3 Effect Heterogeneity

In this section, we analyze heterogeneity in the effects. To do so, we differentiate between age and skill groups and between two levels of disability (i.e., individuals with a degree of disability between 30 and less than 50 and severely disabled individuals with a degree of disability of at least 50).

[46] We define a transition to a less physically (psychosocially) demanding job with a dummy indicating that the index of physical (psychosocial) work demands in the new occupation is lower than the index in the occupation in t-2.

[47] Note that switching to less physically and less psychosocially demanding jobs is highly correlated: 67.7% of individuals in our sample switching to a less physically demanding job until t+5 are also switching to a less psychosocially demanding job.

[48] We define a vertical occupational change as an upward or downward change at the 5-digit level of the German Classification of Occupations 2010. The fifth digit of this level describes the job requirement level of an occupation with categories unskilled/semiskilled, specialist, complex specialist and highly complex (Paulus and Matthes, 2013).

[49] Vertical and horizontal job switches are also strongly correlated: 24.5% (23.5%) of those who "downgrade" until t+5 also switch to a less physically (psychosocially) demanding job.

Severely Disabled Individuals

As shown in the upper right graph of Figure A.5 in the appendix, the effect on employment days is particularly pronounced for individuals with a degree of disability of at least 50. Five years after disability onset, those with a degree of disability of at least 50 work, on average, 65 fewer employment days per year than control individuals. In contrast, those with a degree of disability between 30 and less than 50 work only 35 fewer employment days.[50] The same pattern arises for the effect on annual labor earnings (see Figure A.6 in the appendix). This finding is in line with previous studies that document larger effects on employment and earnings among individuals with more severe or chronic disabilities (see, e.g., Charles, 2003; Jones et al., 2018; Lechner and Vazquez-Alvarez, 2011).

Older Individuals

The lower left graphs of Figures A.5 and A.6 in the appendix suggest that the employment and earning effects are also more pronounced among those in the oldest age cohort, i.e., individuals aged 50–55 at the time of matching. This finding is in line with that of the study by Charles (2003) but stands in contrast to the results of Jenkins and Rigg (2004) and Polidano and Vu (2015), who find the employment impacts of disability to be most pronounced during prime age. Jenkins and Rigg (2004) and Polidano and Vu (2015) argue that disability in advanced age may be due more to a slow deterioration in health rather than to a sharp health shock. Thus, when disability onset occurs at the end of a slow deterioration in health, many labor market adjustments, such as plans for early retirement, may already be made prior to onset. In our study, we restrict our sample to individuals closely attached to the labor market prior to onset, i.e., those employed five years before disability onset. As a consequence, we probably observe sharper health shocks, as individuals experiencing a slow deterioration in health and prior labor market adjustments are not in our sample. Thus, being older at onset and suffering a sharp and probably unforeseen health shock cause larger losses from disability.

Low-Skilled Individuals

Last, as shown in the lower right graphs of Figures A.5 and A.6 in the appendix, low-skilled workers who become disabled experience larger employment and earning effects than the effects found for the baseline sample. Low-skilled workers show 69 fewer employment days per year five years after disability onset than the workers in the control group. Among the high-skilled, this decline amounts to only 50 days.[51] Again, this finding is in line with the results from previous studies that

[50] The results are not shown but are available on request.

[51] The results are not shown but are available on request.

consistently document larger effects among the low-skilled after a health shock (see, e.g., Charles, 2003; Heinesen and Kolodziejczyk, 2013; Polidano and Vu, 2015; Jones and McVicar, 2020). Low-skilled workers may have a higher risk of working in physically demanding jobs. As most disabilities are due to physical illness, it may be harder for the low skilled to return to these physically demanding jobs.[52] Further, as spelled out by Polidano and Vu (2015), for individuals with no vocational training who leave or lose their jobs, a lack of credentials can make it more difficult to find suitable alternative employment.[53]

Further Heterogeneities

In terms of gender, we do not identify any substantial differences between men and women (see Figures A.7 and A.8 in the appendix), consistent with the findings of Jenkins and Rigg (2004) and Polidano and Vu (2015). Women seem to have a slightly more pronounced decline in employment days from t-2 to t+1, but the overall decline of 59 employment days per year until t+5 is the same as for men. Moreover, the importance of part-time employment as a channel for earnings loss seems to be somewhat more pronounced for women.[54]

Last, we analyze whether it makes a difference whether individuals are employed in firms that (do not) meet the employment quota for disabled workers. On the one hand, firms that do not meet the quota at t-2 may be more inclined to retain a worker who becomes severely disabled because he or she contributes to meeting the quota. On the other hand, firms that do not meet the quota may have less employee-friendly (and, in particular, less disability-friendly) structures, which may lead to disabled workers being more likely to leave these firms. However, we do not find heterogeneity in the effects with regard to this aspect. If anything, the effects on employment and earnings are slightly more pronounced among individuals working

[52]To check this channel, we analyze whether the employment and earnings effects are more pronounced for individuals working in physically demanding jobs. To do so, we again use the physical work exposure index from Kroll (2011) to identify physically demanding jobs. Although the effects are somewhat more pronounced among workers in these jobs, the differences are not substantial (the results are not shown but are available on request).

[53]To analyze this mechanism, we test whether establishment changes are less relevant for the low skilled. In fact, we cannot identify significant change-of-establishment effects among the low skilled (the results are not shown but are available on request). Note, however, that due to the relatively small sample of individuals with no vocational training, the confidence intervals are quite large. The point estimates do not differ substantially from those estimated for the whole sample (see the second graph in Figure 6).

[54]Please note that the true effect heterogeneities by gender may be masked by the fact that the approximation of an individual's past sickness history by nonemployment spells (see Section 3.3) may be insufficient for women, since their nonemployment histories also often include maternity and child-rearing periods.

in firms that do not meet the quota.[55]

4.4 Testing for Robustness and Selectivity

Using AKM Effects

To check the robustness of our results and the selectivity of our sample of disabled individuals, we make use of AKM effects. AKM person and establishment fixed effects stem from a wage decomposition pioneered by Abowd et al. (1999) and can serve as a proxy for establishment and employee productivity (Bellmann et al., 2020).[56] First, we perform a robustness check by including the pre-disability onset AKM effects for the 1998–2004 period as matching variables instead of the median establishment wage in t-2 and the individual daily wages in t-3, t-4 and t-5. The results are very similar to our baseline results, as shown in Figure A.9 in the appendix.[57]

Second, we compare the AKM effects in samples with different restrictions: the raw sample (i.e., only individuals for whom we observe a disability onset), a sample not restricted to employment in t-5 and t-4 and the AKM-matched treated and control sample described above. We use this analysis to obtain an understanding of potential selectivity in the groups. The results displayed in Table 2 show that the differences in productivity between the samples are not pronounced (the standardized differences are below 0.1). These findings suggest that our sample restrictions tied to employment do not seem to lead to relevant positive selection. In Section 4.5, we discuss the issue of selectivity again using survey data.

Table 2: Productivity: Raw Sample, Unrestricted Sample, Treated, Control

	Raw Sample	Treated Unrest.	Treated	Control	Stand. Differences		
	(1)	(2)	(3)	(4)	(3)-(4)	(3)-(2)	(3)-(1)
Person fixed effect	4.469	4.474	4.486	4.483	0.010	0.039	0.052
# of observations	404,672	158,606	128,994	542,906			

Notes: The table displays productivity indicators measured by person AKM fixed effects (1998–2004) for four samples: "Raw Sample" is the raw sample (including only individuals experiencing disability onset and excluding individuals with multiple changes from nondisabled to disabled); "Treated Unrest." is the prepared sample of disabled individuals without the 5-year pre-employment restriction (but with, e.g., restrictions on age or valid values for relevant variables). "Treated" ("Control") is the sample of disabled (nondisabled) observations from robustness check R2 (see Tables A.4 and A.5), which uses AKM individual fixed and establishment fixed effects (1998–2004) and daily wages in t-2 as matching variables. In (3) and (4), the sample is restricted to individuals employed in t-5, t-4, t-3, t-2 and t-1.
Source: BsbM and IEB, own calculations.

Further Sensitivity Checks

To further check whether our results are sensitive to the choice of matching algo-

[55]The results are not shown but are available on request.

[56]The construction of the AKM effects is explained in Table A.1 in the appendix.

[57]Note that the preonset AKM effects are not available for all individuals in our baseline sample. Thus, the sample is reduced to 128,994 disabled individuals. The effects for all four main outcomes are also shown in the second row (R1) in Tables A.4 and A.5.

rithm, the choice of control variables included in the propensity score function or the sample restrictions, we perform several robustness checks, the results of which are displayed in Tables A.4 and A.5 in the appendix. First, we use a 1-nearest-neighbor matching algorithm. The point estimates are almost identical to those from the main specification with a 5-nearest-neighbor matching algorithm. Second, to reduce the impact of extreme outliers in our matching procedure, we drop the top one percent of matching weights. Third, we do not include pre-event wages (i.e., ln daily wages in t-2, t-3, t-4 and t-5) as control variables in the propensity score function. Fourth, in contrast to how we construct our baseline sample, which is restricted to individuals permanently employed five years before disability onset, we restrict the sample to individuals employed only three years before onset (i.e., in t-3, t-2 and t-1). Fifth, we exclude the years 2005, 2008 and 2009 to ensure that our results are not driven by economic crises.[58] In sum, the results of all the robustness checks are very similar to those of the baseline model.

Finally, we randomly assign 100,000 of the observations in our control group to a placebo treatment group by randomly selecting one spell of the control observations and treating them as if disability onset happened during this spell. We then use this setup to repeat our matching procedure and estimate the coefficient δ_k of event-study equation (1). The results of the placebo estimations consistently show zero effects for all outcomes (see Figure A.10 in the appendix).

4.5 Descriptive Insights from the PASS-Survey

Thus far, our results have shown that disability is accompanied by a severe and persistent deterioration of labor market outcomes over time. However, the administrative data tell us little about the selectivity of our sample restrictions with regards to the sample of eventually disabled individuals that we use in the analysis, the types of disabilities that people experience or the actual relationship between disability onset and health deterioration.

To examine these issues, we use survey data from the Panel Study Labour Market and Social Security (PASS) administered by the IAB. The PASS is a yearly panel study that has been collected since 2006. In our analysis, we use wave 15, which covers interviews up until 2021.[59] The sample consists of a sample of long-term unemployment benefit recipients and a general population survey and contains information on approximately 10,000 households per year. The PASS has been

[58]The year 2005 saw very high unemployment rates in Germany. In addition, a substantial labor market reform (the Hartz reform) was introduced. In 2008 and 2009, the global financial crisis prevailed.

[59]See doi: 10.5164/IAB.PASS-SUF0621.de.en.v1

widely used in social science research with a special focus on topics related to health (Trappmann et al., 2019). It contains information on self-reported disability status and types of disability. Thus, it is well suited for the analysis. However, it is important to consider that the definitions of disability differ slightly from those in our main analyses, as we do not know whether the respondents in the PASS notified their employer of their disability.

In the first step, we investigate how our criterion that workers be employed five consecutive years prior to disability onset affects the selection of individuals in our sample. Due to the limited number of observations with self-reported disabilities in the PASS, we cannot exactly mimic the conditions that we apply to the administrative data, but we can nevertheless approximate the criteria. We create three definitions for counting individuals as newly disabled in our data: (1) that they are disabled now and were nondisabled one year ago, (2) that they are disabled and employed now and were nondisabled and employed one year ago, and (3) that they are disabled and employed now and were nondisabled one year ago and employed over the last three years (the definition that comes closest to the administrative records). These definitions map to the corresponding column numbers in Table 3. Applying more restrictive definitions does not alter most of the average sample characteristics shown in Panel (a) of the table by status in meaningful ways. The mean age of disabled individuals is always around 47 at the onset of disability, around 50 percent are female, and the average years of schooling are around 11.5. However, whether children are present in the household varies between 45 and 56 percent, and the gross daily wages two years prior to onset increase under the more restrictive definitions. The difference is most pronounced between the first group and the other two groups. However, this is expected, as conditioning on prior employment status leads to a sample that is more attached to the labor market by construction.

In the next step, we investigate the types of disabilities that disabled individuals experience. Using the data, we can investigate the specific handicaps that individuals face. Here, we construct three groups of limitations: (1) physical limitations, such as missing limbs or damaged organs, (2) impaired hearing or vision and (3) psychological impairments. Furthermore, PASS surveys the disability degree. The descriptive statistics are displayed in Panel (b) of Table 3. The average disability degree is 49 for all newly disabled individuals (column (1)) and 45 conditional on prior employment (columns (2) and (3)). Concerning the types of limitations that the respondents face, physical disabilities are the most common, with around 87 percent of individuals experiencing them. These are followed by psychological disabilities, which around one-third of individuals report. Finally, around 16 percent of individ-

Table 3: Descriptives of Disabled Individuals from PASS

	(1)		(2)		(3)	
	Mean	SD	Mean	SD	Mean	SD
(a) Socioeconomic Characteristics						
Age	47.16	6.65	47.02	6.75	47.05	6.79
Female	0.48	0.50	0.48	0.50	0.49	0.50
(ln) Daily Wages in t-2 (admin)	3.43	1.18	3.72	1.08	3.76	1.08
Years of Schooling	11.31	2.41	11.45	2.43	11.56	2.51
Child in Household (0/1)	0.45	0.50	0.52	0.50	0.56	0.50
(b) Disability						
Disability Degree (30-100)	48.88	20.19	45.36	18.05	45.11	18.01
Physical Disability	0.87	0.34	0.86	0.34	0.87	0.34
Vision/Hearing Disability	0.17	0.38	0.16	0.36	0.16	0.36
Psychological Disability	0.38	0.48	0.31	0.46	0.30	0.46
Observations	1,198		353		281	

Notes: All aged 30–55; for disabled individuals: minimum disability degree of 30. Physical disabilities include organ damages and cancer. Analysis samples: column (1): disabled and nondisabled one year ago; column (2): the column (1) restrictions plus currently employed and employed one year ago; column (3): the column (2) restrictions plus employed during the last three years. Numbers of cases for the measurement of ln(Daily Wages) in t-2 are available only for a subset of respondents, by column: (1) 379, (2) 224, (3) 211.
Source: PASS0621v1 merged with administrative data, own calculations.

uals report impaired vision or hearing. Note that the disabilities are not mutually exclusive: the reported shares add up to above 140 percent in all columns, indicating that a substantial share of individuals experiences multiple limitations.[60] Nevertheless, the types of disabilities and disability degree remain largely stable across all three columns. We thus conclude that, consistent with our conclusions from the selectivity analysis with administrative records (see Section 4.4), the selection criteria that we apply in the main analysis do not seem to lead to a highly specific sample of eventually disabled individuals with regard to socioeconomic characteristics or types of disability. However, the sample seems to be slightly more attached to the labor market than all newly disabled employees, which is unsurprising given the restriction on employment.

As PASS also contains data on health outcomes, we can investigate whether the onset of disability is associated with a deterioration in one's health. To this end, we use individual information on three outcomes: (1) self-assessed subjective health on a scale from 1 (poor) to 5 (very good), (2) individual health satisfaction on a scale from 0 to 10 and (3) the number of days or nights spent at the hospital during the last 12 months. Table C.1 in the appendix shows the averages of these variables for the group of disabled individuals closest to our definition in the administrative data (being disabled and employed now and employed for the three years prior) over the five to three years before the onset of disability (the time frame prior to matching)

[60] These numbers differ from the numbers reported by Federal Statistical Office (2022) in Section 2.1, as PASS asks about multiple limitations while the Federal Statistical Office asks about the main limitation.

and from the onset up to five years afterwards. All outcomes deteriorate over time: general health decreases, health satisfaction decreases and days spent at the hospital increase after the onset of disability. This clearly shows that disability is associated with a severe health shock and that it is not the case that individuals who already reported lower health measures are only now claiming disability status.

Furthermore, we use the PASS data to investigate whether periods of nonemployment indeed capture sickness periods. To this end, we analyze whether an increase in time spent in nonemployment calculated from the administrative data correlates with worsening health outcomes in PASS. In this analysis, we simply generate a binary indicator variable for an increase in nonemployment days and regress it on increases in days spent in the hospital and decreases in health satisfaction and self-rated health. In Appendix Table C.2, we show the results from regressions for employed disabled individuals and the full sample of working individuals. For employed individuals with a disability, a worsening in health satisfaction from t-1 to t is associated with a 3.1 percentage point increase in the probability of experiencing an increase in nonemployment duration. The same holds true for a decrease in subjective health, while an increase in hospital days makes it 21.5 percentage points more likely to observe an increase in nonemployment days. The coefficients obtained from these estimations are comparable when we use the full sample of employed individuals. Thus, our analysis provides evidence that days in nonemployment correlate with worsening health and could thus reflect health issues.

5 Summary and Conclusion

Demographic change and the associated decline in the working-age population represent an increasing challenge in industrialized countries. In this context, the onset of a severe disability, for instance, due to an age-related chronic illness, can accelerate an early exit from working life and thereby the shortage of skilled workers. Our study shows that the onset of a disability strongly affects labor market performance as employment and annual labor earnings decline significantly. One important mechanism is transitions to nonemployment after disability onset: the probability of becoming nonemployed increases by 10 percentage points after one year and by 15 percentage points after five years in comparison to the probabilities in the control group. This mirrors a general picture present in all of our results: the consequences of disability are long lasting and do not reverse over time. The negative labor market effects of disability onset are more pronounced for severely disabled, older and low-skilled individuals.

For those individuals who stay in employment, a significant share reduce their working time. Individuals are also more likely to switch to less demanding jobs, both in terms of physical and psychosocial dimensions and in terms of formal requirement levels, while establishment changes play only a minor role. These findings indicate that part-time models and other forms of job adjustment are used but a significant proportion of people also drop out of the workforce altogether. However, our data do not allow us to analyze the extent to which disability pensions compensate for the loss of income.

Our findings deliver important insights into the discussion of incentives to transition early to disability pensions or other forms of social benefits and to exit the labor market permanently. Once individuals receive replacement benefits and have been out of the labor force for quite a while, barriers might appear too high to return to work. In line with this, we document that disability has virtually no impact on unemployment benefit receipt and thus on contact with the Federal Employment Agency and related support systems. Moreover, a recent report of the OECD documents that the impact of employment-oriented programs is limited in OECD countries (OECD, 2022). The authors conclude that employment-oriented efforts are coming too late as persons applying for disability benefits have typically been out of the labor force for a long time or have gone through repeated phases of employment interruptions. However, as compared to other developed countries, Germany has very low recipiency rates of government provided disability insurance benefits. Relatively restrictive coverage and eligibility conditions, a quota system for employing disabled workers and the large medical rehabilitation market might be reasons for that (see, e.g., Burkhauser et al., 2016; McVicar et al., 2022).[61] Nevertheless, reintegration efforts should be examined as fast as possible, for instance, during the period of sick leave. Furthermore, support services, clear responsibilities and low bureaucratic hurdles might be ways to facilitate the reintegration for individuals with disabilities. Successful reintegration also depends on the extent to which the required occupational tasks could still be performed or whether a professional reorientation is necessary. Therefore, further training measures, adult learning programs and career guidance should be designed such that they are accessible to disabled workers and specifically adapted to their needs.

Declarations of interest: none.

[61] Further efforts in Germany to take into account the high importance of vocational integration in medical rehabilitation are, e.g., through work-related services in the form of diagnosis, therapy and training offers (the MBOR program of the German pension insurance scheme).

Appendix

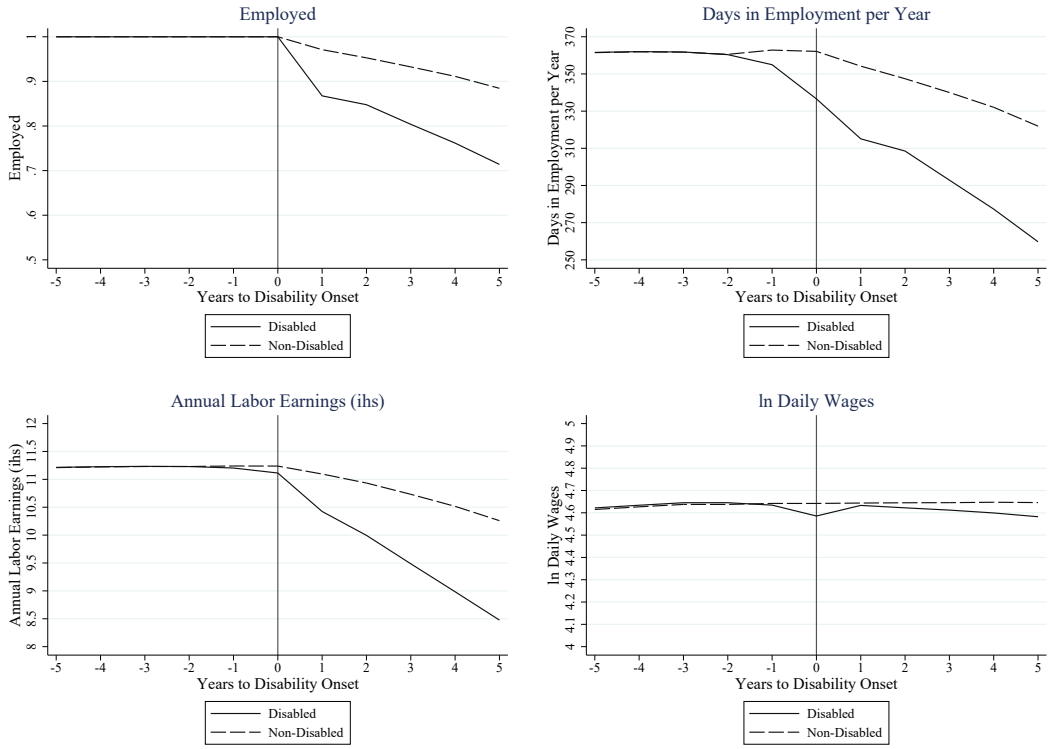
Appendix A: AKM Fixed Effects

Table A.1: Person and Establishment Fixed Effects ("AKM Effects")

AKM Effects
AKM individual and establishment fixed effects stem from a wage decomposition pioneered by Abowd et al. (1999), implemented for Germany by Card et al. (2013), and updated by Bellmann et al. (2020). These effects are derived from the following wage model: $$log(wage_{it}) = \alpha_i + \Psi_{J(i,t)} + x'_{it}\beta + \epsilon_{it},$$ where the log daily wages for worker i are the sum of a time-invariant person effect α_i, a time-invariant establishment effect $\Psi_{J(i,t)}$ for the establishment at which worker i is employed at time t, and time-varying worker characteristics $x'_{it}\beta$, which affect all workers' wages equally at all establishments, and an error component ϵ_{it}, which is assumed to be independent of the right-hand-side variables. The estimates for the individual effect α_i capture time-invariant individual characteristics that are rewarded equally across employers. Likewise, the index $x'_{it}\beta$ is interpreted as measuring the time-varying worker characteristics that affect the productivity of worker i in all jobs. In x_{it}, an unrestricted set of year dummies and of quadratic and cubic terms in age fully interacted with education is included. Last, the establishment effect $\Psi_{J(i,t)}$ is interpreted as a proxy for establishment productivity, as this effect represents the proportional pay premium (or discount) paid by establishment j to all individuals (i.e., all those with $J(i,t) = j$) (Bellmann et al., 2020, p. 7).

Appendix B: Further Analyses

Figure A.1: Descriptives: Employment and Earnings



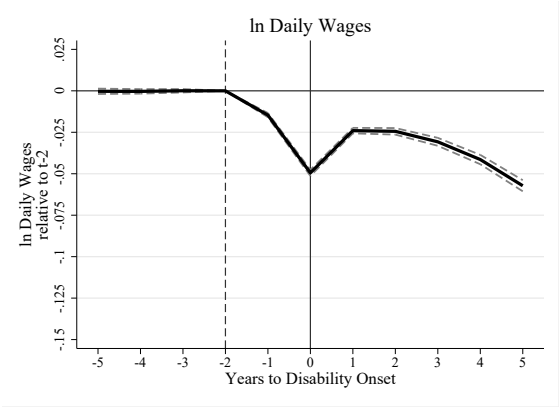
Notes: The figure shows the trends of employment and earnings for the disabled and the nondisabled sample five years before and after disability onset. Earnings and wages are deflated to 2015 prices. Number of treated (control) observations (in t): 148,660 (624,439).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Table A.2: Logit Regression: Employment Status in t+1

	Coefficient	S.E.
Male	0.187***	(0.021)
Age (Reference: 50–55 Years)		
30–34 Years	0.329***	(0.049)
35–39 Years	0.314***	(0.033)
40–44 Years	0.196***	(0.024)
45–49 Years	0.073***	(0.019)
Foreign	-0.002	(0.030)
Qualification (Reference: High-Skilled)		
Low-Skilled	-0.126***	(0.042)
Medium-Skilled	-0.103***	(0.031)
Occupation (Reference: Cleaning Services)		
Agriculture, Forestry, Horticulture	-0.006	(0.112)
Manufacturing	0.014	(0.061)
Production Technology	0.126**	(0.061)
Building and Interior Construction	-0.023	(0.068)
Food, Gastronomy, Tourism	-0.027	(0.070)
Medical and Nonmedical Healthcare	-0.139**	(0.060)
Social Sector and Cultural Work	-0.104	(0.066)
Commerce and Trade	-0.000	(0.068)
Business Management and Organization	0.115**	(0.058)
Business-Related Services	-0.010	(0.070)
IT Sector and Natural Sciences	0.066	(0.070)
Safety and Security	0.144*	(0.081)
Traffic and Logistics	-0.036	(0.062)
Job Requirement Level (Reference: Highly Complex)		
Unskilled/Semiskilled	-0.078	(0.052)
Specialist	-0.075**	(0.037)
Complex Specialist	-0.014	(0.044)
Industry (Reference: Public Sector (w/o PA))		
Agrarian/Fishery	-0.015	(0.147)
Energy Mining	0.054	(0.073)
Manufacturing	-0.067	(0.048)
Construction	-0.259***	(0.064)
Wholesale	-0.109*	(0.053)
Traffic/Communication	-0.048	(0.059)
Banking/Insurance	-0.113**	(0.064)
Other Services	-0.050	(0.053)
Public Administration (PA)	0.032	(0.047)
Location: East Germany	-0.038	(0.026)
Number of Employees in Firm (Reference: 1000+ Employees)		
20–49 Employees	-0.099***	(0.031)
50–99 Employees	-0.180***	(0.028)
100–199 Employees	-0.183***	(0.027)
200–499 Employees	-0.105***	(0.024)
500–999 Employees	-0.084***	(0.026)
Median Wages in Establishment	0.002***	(0.000)
Cum. Duration in Employment (Months)	0.000***	(0.000)
Cum. Duration in Nonemployment (Months)	0.001***	(0.000)
Cum. Duration in Establishment (Months)	0.000	(0.000)
Number of Nonemployment Spells	-0.018***	(0.003)
(ln) Annual Earnings in t-2	0.148***	(0.023)
Constant	0.165	(0.243)

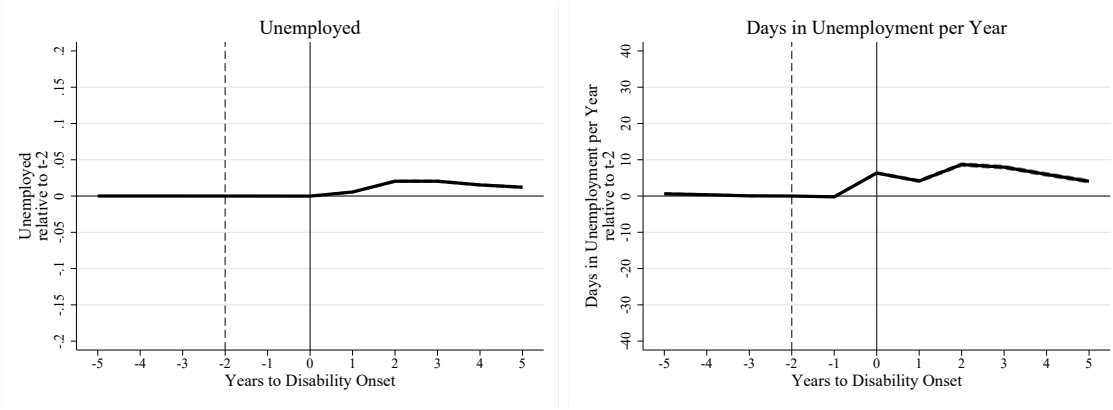
Notes: This table displays the results of a logit regression for being employed in t+1 as outcome variable (only disabled individuals). n=148,660 disabled individuals. Standard errors in parentheses. Significance levels:* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.2: Earnings (Sample: Employed in t+1)



Notes: The figure shows the effects of disability on ln daily wages (estimates of coefficient δ_k in equation 1) after propensity score matching as described in Section 3.3 for the sample of individuals employed in t+1 with 95 percent confidence intervals. Number of treated (matched control) observations in t-2: 128,973 (552,076).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.3: Channel: Unemployment



Notes: The figure shows the effects of disability on unemployment (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. Number of treated (matched control) observations in t-2: 148,660 (624,439). The unemployment indicator is measured at the reference date June 30th.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Table A.3: Characteristics of Establishments after Establishment Change

	Disability Estab.	New Estab.	Difference	SE
Median Daily Wages	104.545	102.578	-1.967***	0.223
Establishment Fixed Effect 1998–2004	0.149	0.062	-0.087***	0.002
Establishment Fixed Effect 2003–2010	-0.172	-0.264	-0.092***	0.002
Number of observations	19,974	20,959		

Notes: This table describes characteristics of establishments in which an individual becomes disabled ("Disability Establishment") and to which a disabled individual moves after disability onset ("New Establishment"). Significance level: *** $p < 0.01$.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Table A.4: Robustness Checks – Employment Outcomes

			Outcome: Employed				
Year to Disability Onset	-1	0	1	2	3	4	5
Baseline			-0.103***	-0.104***	-0.126***	-0.145***	-0.163***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R1: AKM Effects			-0.100***	-0.103***	-0.125***	-0.144***	-0.162***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R2: 1 Nearest Neighbor			-0.102***	-0.103***	-0.125***	-0.144***	-0.162***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R3: Drop Top 1%			-0.104***	-0.106***	-0.128***	-0.147***	-0.165***
Matching Weights			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R4: No Pre-event Wages			-0.103***	-0.105***	-0.126***	-0.145***	-0.163***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R5: Employment in t-3			-0.099***	-0.101***	-0.121***	-0.139***	-0.155***
Onward			(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
R6: No Crisis Years			-0.102***	-0.101***	-0.123***	-0.141***	-0.159***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
			Outcome: Days in Employment per Year				
Year to Disability Onset	-1	0	1	2	3	4	5
Baseline	-7.66***	-25.23***	-38.68***	-38.22***	-45.82***	-52.74***	-59.20***
	(0.098)	(0.156)	(0.293)	(0.331)	(0.372)	(0.402)	(0.425)
R1	-7.53***	-24.87***	-37.81***	-37.94***	-45.61***	-52.50***	-59.03***
	(0.104)	(0.167)	(0.313)	(0.355)	(0.397)	(0.431)	(0.455)
R2	-7.64***	-25.25***	-38.51***	-38.06***	-45.57***	-52.46***	-59.03***
	(0.106)	(0.164)	(0.313)	(0.361)	(0.412)	(0.450)	(0.480)
R3	-7.22***	-24.76***	-38.54***	-38.28***	-45.94***	-52.90***	-59.30***
	(0.095)	(0.154)	(0.290)	(0.326)	(0.367)	(0.396)	(0.418)
R4	-7.45***	-25.04***	-38.52***	-38.37***	-45.92***	-52.70***	-59.20***
	(0.097)	(0.156)	(0.293)	(0.330)	(0.371)	(0.402)	(0.424)
R5	-7.51***	-24.97***	-37.25***	-36.77***	-44.17***	-50.65***	-56.47***
	(0.167)	(0.254)	(0.544)	(0.659)	(0.839)	(0.946)	(1.084)
R6	-7.66***	-25.84***	-38.66***	-37.25***	-44.69***	-51.42***	-57.78***
	(0.124)	(0.199)	(0.366)	(0.410)	(0.461)	(0.498)	(0.529)

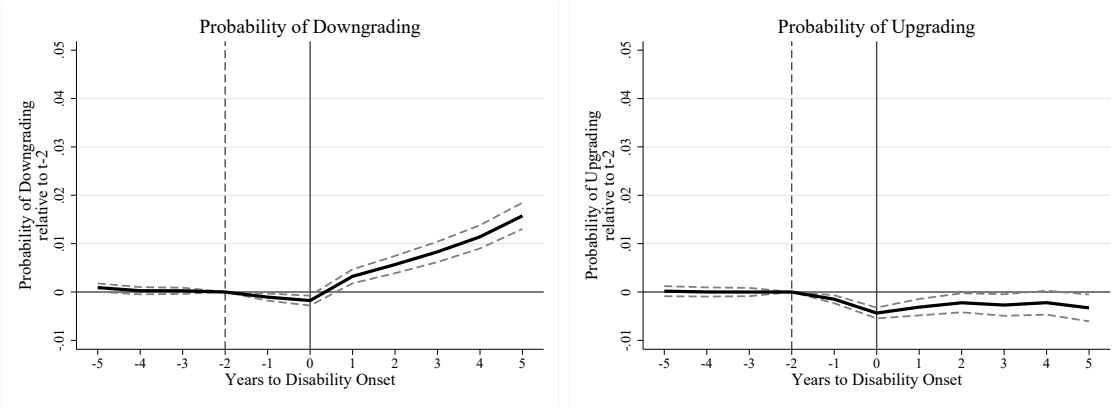
Notes: This table displays the results of the baseline model and five robustness checks. R1 uses AKM individual fixed and establishment fixed effects (1998–2004) as matching variables instead of the wage variables (n=128,994 disabled individuals); R2 uses a 1-nearest-neighbor matching (without replacement) algorithm; R3 drops the top 1 percent of matching weights; R4 does not include pre-event wages in the propensity score function; R5 restricts the sample to individuals employed in t-3, t-2 and t-1 (the baseline sample is restricted to individuals employed in t-5, t-4, t-3, t-2 and t-1) (n=149,701 disabled individuals); R6 excludes disability onsets in the crisis years 2005, 2008 and 2009 (n=94,250 disabled individuals). Standard errors in parentheses (clustered at the individual level). Significance level: *** $p < 0.01$.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Table A.5: Robustness Checks – Earning Outcomes

	Outcome: Annual Labor Earnings (ihs)						
Year to Disability Onset	-1	0	1	2	3	4	5
Baseline	-0.034***	-0.119***	-0.663***	-0.924***	-1.215***	-1.481***	-1.710***
	(0.001)	(0.001)	(0.007)	(0.009)	(0.011)	(0.012)	(0.013)
R1: AKM Effects	-0.034***	-0.118***	-0.655***	-0.921***	-1.215***	-1.479***	-1.710***
	(0.001)	(0.001)	(0.008)	(0.010)	(0.011)	(0.013)	(0.014)
R2: 1 Nearest Neighbor	-0.033***	-0.119***	-0.660***	-0.919***	-1.206***	-1.474***	-1.704***
	(0.001)	(0.001)	(0.008)	(0.010)	(0.012)	(0.013)	(0.014)
R3: Drop Top 1%	-0.032***	-0.118***	-0.670***	-0.936***	-1.230***	-1.496***	-1.727***
Matching Weights	(0.001)	(0.001)	(0.007)	(0.009)	(0.011)	(0.012)	(0.013)
R4: No Pre-event Wages	-0.034***	-0.120***	-0.665***	-0.931***	-1.225***	-1.489***	-1.718***
	(0.001)	(0.001)	(0.008)	(0.011)	(0.013)	(0.015)	(0.016)
R5: Employment in t-3	-0.032***	-0.117***	-0.636***	-0.888***	-1.177***	-1.439***	-1.652***
Onward	(0.001)	(0.002)	(0.013)	(0.019)	(0.025)	(0.029)	(0.033)
R6: No Crisis Years	-0.034***	-0.122***	-0.659***	-0.898***	-1.184***	-1.446***	-1.669***
	(0.001)	(0.001)	(0.009)	(0.011)	(0.013)	(0.015)	(0.016)
	Outcome: ln Daily Wages						
Year to Disability Onset	-1	0	1	2	3	4	5
Baseline	-0.015***	-0.064***	-0.020***	-0.030***	-0.041***	-0.056***	-0.072***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
R1	-0.015***	-0.065***	-0.019***	-0.028***	-0.039***	-0.054***	-0.071***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
R2	-0.015***	-0.064***	-0.020***	-0.029***	-0.040***	-0.054***	-0.070***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
R3	-0.015***	-0.063***	-0.020***	-0.029***	-0.041***	-0.055***	-0.071***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
R4	-0.014***	-0.064***	-0.021***	-0.031***	-0.043***	-0.058***	-0.076***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
R5	-0.013***	-0.062***	-0.016***	-0.024***	-0.035***	-0.046***	-0.062***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
R6	-0.016***	-0.065***	-0.019***	-0.028***	-0.038***	-0.055***	-0.068***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)

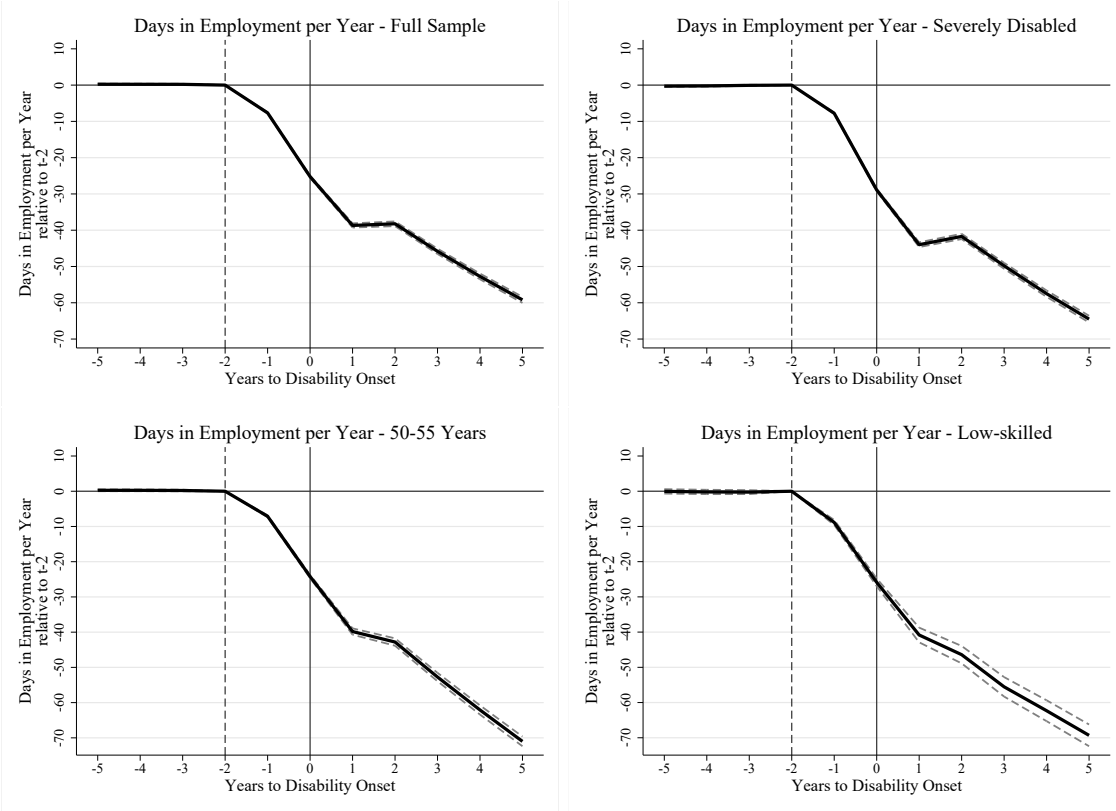
Notes: This table displays the results of the baseline model and five robustness checks. R1 uses AKM individual fixed and establishment fixed effects (1998–2004) as matching variables instead of the wage variables (n=128,994 disabled individuals); R2 uses a 1-nearest-neighbor matching (without replacement) algorithm; R3 drops the top 1 percent of matching weights; R4 does not include pre-event wages in the propensity score function; R5 restricts the sample to individuals employed in t-3, t-2 and t-1 (the baseline sample is restricted to individuals employed in t-5, t-4, t-3, t-2 and t-1) (n=149,701 disabled individuals); R6 excludes disability onsets in the crisis years 2005, 2008 and 2009 (n=94,250 disabled individuals). Standard errors in parentheses (clustered at the individual level). Significance level: *** $p < 0.01$.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.4: Channel: Vertical Occupational Changes



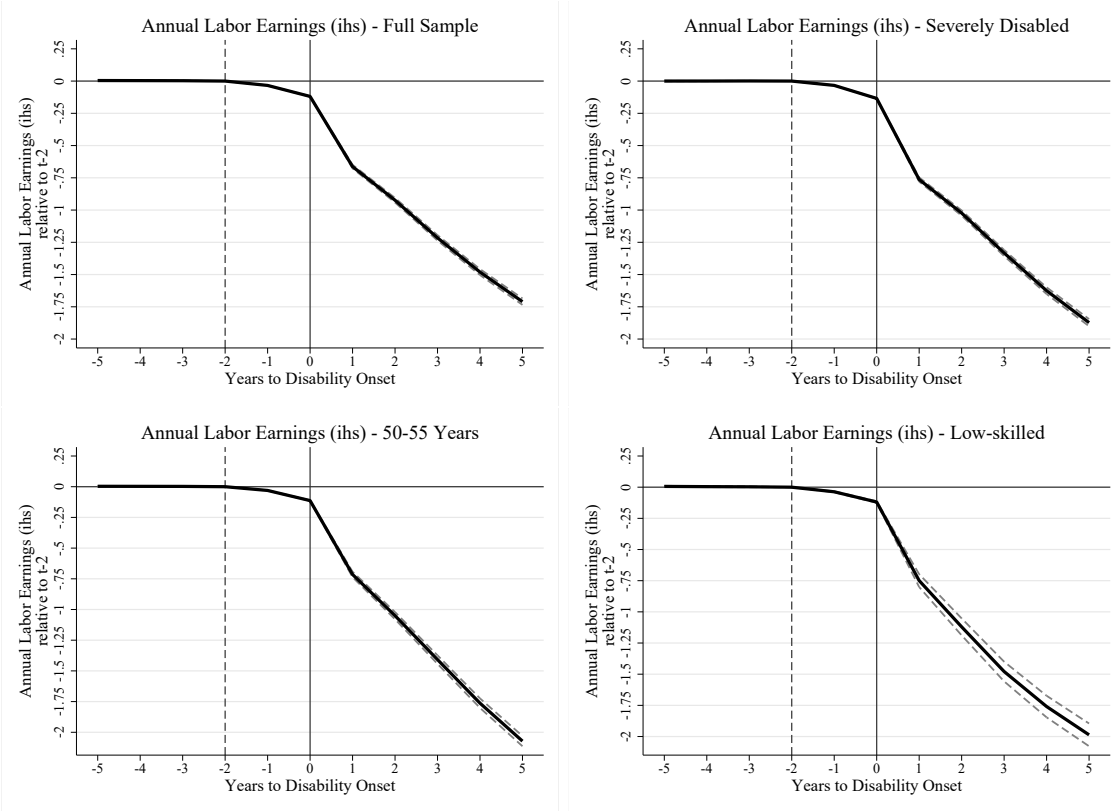
Notes: The figure shows the effects of disability on job downgrading and upgrading (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3. We define a vertical occupational change as an upward or downward change in the 5-digit level of the German Classification of Occupations 2010. The 5-digit level describes the job requirement level of an occupation with the categories unskilled/semiskilled, specialist, complex specialist and highly complex (Paulus and Matthes, 2013). Number of treated (matched control) observations in t-2: 148,660 (624,439).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.5: Heterogenous Effects (Outcome: Days in Employment per Year)



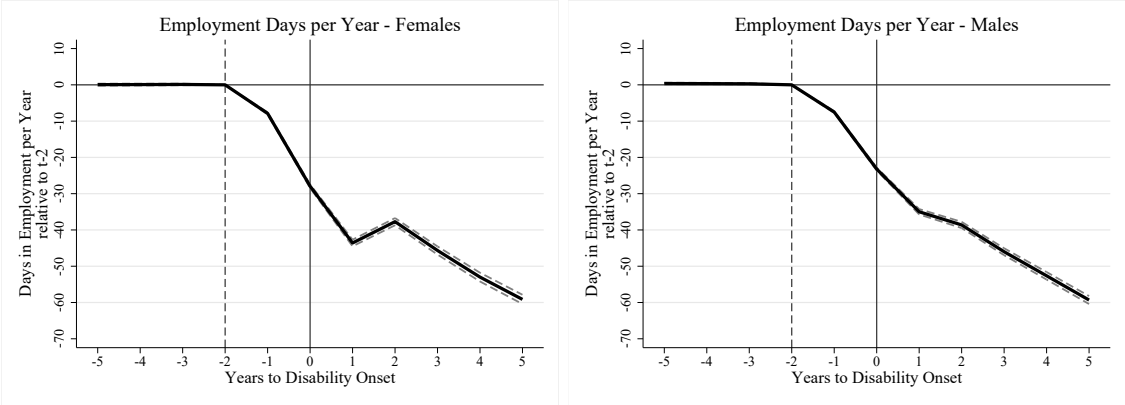
Notes: The figure shows the effects of disability on days in employment (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3 for different subgroups. Number of disabled individuals: Baseline: 148,660, severely disabled: 121,165 (81.50%), 50–55 years old: 66,387 (44.66%), low-skilled: 12,728 (8.56%).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.6: Heterogenous Effects (Outcome: Annual Earnings)



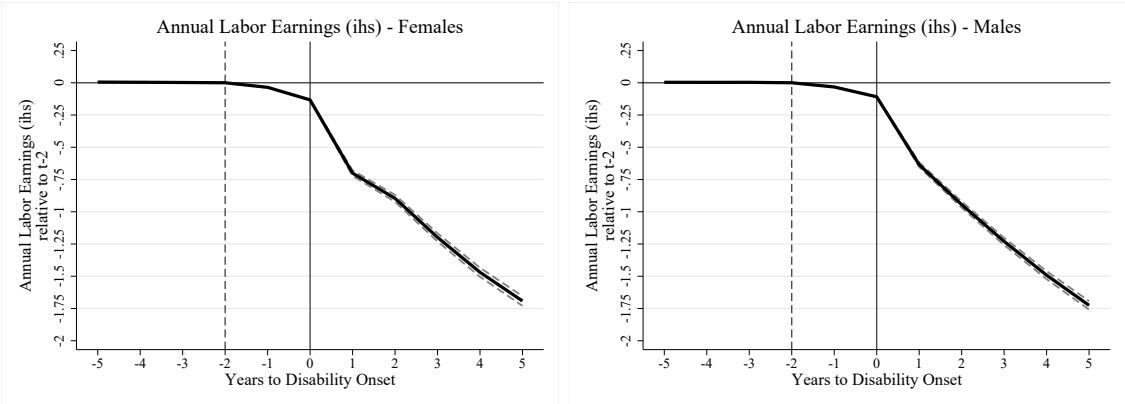
Notes: The figure shows the effects of disability on IHS-transformed annual earnings (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3 for different subgroups. Number of disabled individuals: Baseline: 148,660, severely disabled: 121,165 (81.50%), 50–55 years old: 66,387 (44.66%), low-skilled: 12,728 (8.56%). Earnings are deflated to 2015 prices.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.7: Effects on Days in Employment by Gender



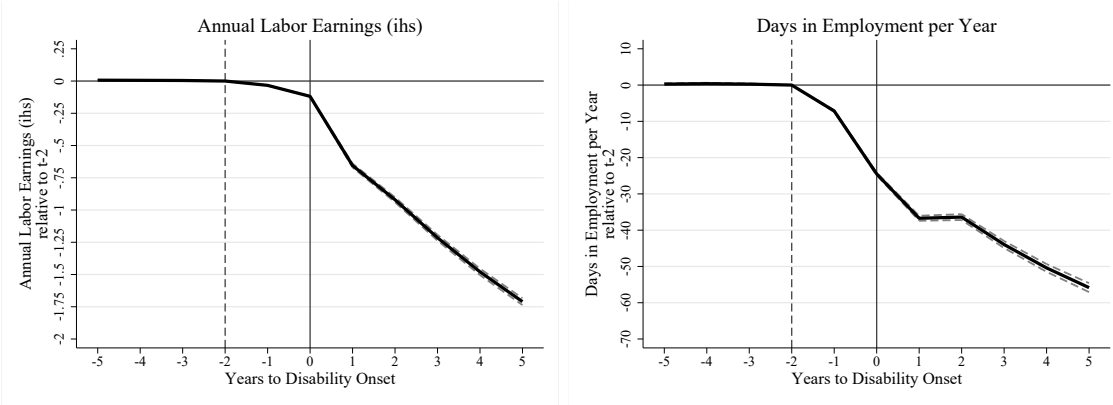
Notes: The figure shows the effects of disability on days in employment (estimates of coefficient δ_k in equation 1) after propensity score matching as described in Section 3.3 with 95 percent confidence intervals by gender. Number of disabled females (males) in t-2: 63,878 (84,782).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.8: Effects on Annual Earnings by Gender



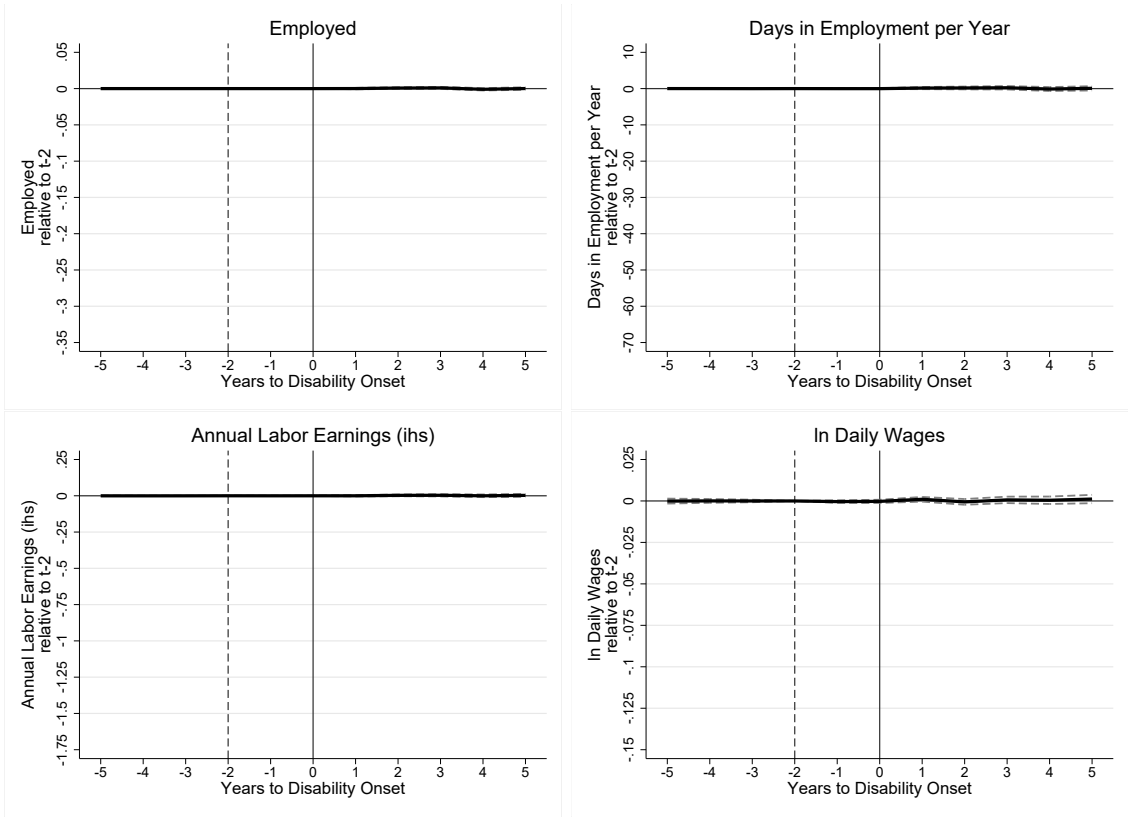
Notes: The figure shows the effects of disability on IHS-transformed annual earnings (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching as described in Section 3.3 by gender. Number of disabled females (males) in t-2: 63,878 (84,782). Earnings are deflated to 2015 prices.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.9: Robustness Checks: AKM Effects



Notes: The figure shows effects of disability on IHS-transformed annual earnings and on days in employment per year (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals after propensity score matching. This specification uses AKM individual fixed and establishment fixed effects (1998–2004) as matching variables instead of the wage variables, including only the daily wages in t-2 (n=128,994 disabled individuals). The effects are also shown in the second row (R1) in Tables A.4 and A.5.
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Figure A.10: Placebo Estimations



Notes: The figure shows placebo effects of disability on employment and earning outcomes (estimates of coefficient δ_k in equation 1) with 95 percent confidence intervals. We randomly assign 100,000 observations in our control group to a placebo treatment group and perform propensity score matching as described in Section 3.3. Number of placebo treated (controls) in t-2: 99,003 (479,620).
Source: BsbM and IEB, years of disability onset: 2005–2013, own calculations.

Appendix C: Further Descriptives Based on PASS

Table C.1: Health Outcomes before and after the Onset of Disability

	(1) 5–2 Years before Onset	(2) Onset and up to 5 Years after
Avg. General Health (1–5)	3.13	2.69
Avg. Health Satisfaction (0–10)	6.39	5.49
Avg. Days/Nights Spent at the Hospital	0.73	2.61
Observations	594	324

Notes: All aged 30–55, for disabled individuals according to column (3) of Table 3.
Source: PASS0621v1 merged with administrative data, own calculations.

Table C.2: Correlation between Nonemployment Duration and Worsening of Health Outcomes

	(1) Decrease in Health Satisfaction	(2) Increase in Hospital Days	(3) Decrease in Subjective Health
Currently Disabled & Employed (N=4,461)	0.031***	0.215***	0.036***
	(0.010)	(0.021)	(0.012)
All currently Employed (N=49,897)	0.023***	0.199***	0.017***
	(0.003)	(0.008)	(0.003)

Notes: This table displays the results of a regression of a binary indicator variable for observing an increase in nonemployment duration from t-1 to t on the worsening of the respective health indicator between t-1 and t. The sample of disabled and employed individuals contains all individuals who are disabled according to PASS and who are employed in the administrative records. The estimation controls for age, age squared, years of schooling, gender and presence of children in the household. Standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: PASS0621v1 merged with administrative data, own calculations.

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