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Behavioural Responses to Disability Insurance Generosity in a Work-Compatibility Setting

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Abstract

We investigate behavioral responses to the generosity of Disability Insurance (DI) within the context of work compatibility. Exploiting an institutional discontinuity leading to exogenous variation in replacement rates, we use rich administrative data on the work and health histories of Italian private sector workers and focus on individuals impacted by acute CVD shocks leading to unplanned hospitalizations. Using a Regression Discontinuity strategy, we identify a substantial DI response to benefit generosity, suggesting an elasticity of DI participation of 1.26. Additionally, we observe a smaller employment response, with an estimated elasticity of -0.15. Our findings indicate that the receipt of DI is widely perceived as a complement to labour income within a framework of work compatibility. These results carry significant implications for the design of labour-inclusive DI schemes.

Keywords: Disability Insurance, Elasticity, Replacement Rate, Labour Supply, Regression Discontinuity

JEL Codes: I38, J14, J22, H55

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I. Introduction

Population ageing and the related increase in retirement age induced by increasingly more stringent pension eligibility rules are leading to an extraordinary rise in the share of older people at work in developed countries[1]. For example, according to Centers for Disease Control and Prevention, the employment of workers aged 65 or older has grown by 117% in 20 years in the US, a trend which is unlikely to reverse in the coming years. With an ageing labour force, a key issue concerns the increase in the prevalence of chronic diseases (Crimmins and Saito, 2009), and disability (Beller and Epping, 2021) among workers. Indeed, an established stream of literature finds that health deterioration has significant effects on a variety of individual labour market outcomes such as employment, earnings and wealth (e.g. Garcia-Gomez et al. 2013, Halla and Zweimuller 2013, Dobkin et al. 2018, Jones et al., 2020).

Besides personal characteristics, workers' behavioural response to health shocks is crucially shaped by institutions. These encompass employment protection legislation, mandatory on-the-job accommodations and, most importantly, the availability and generosity of a Disability Insurance (DI) scheme. In developed countries, DI schemes represent the main form of insurance against workers' health risk and offers an earnings replacement that cushions and shapes the consequences of health shocks. The design of such schemes involves complex policy choices, having to trade off the underlying social protection aim that motivates their existence with the distortion deriving from the incentives that they bring. The availability of DI – as typical of insurance programmes under asymmetric information - might in fact result in moral hazard behaviour, i.e. individuals' reducing their labour search and supply effort because of DI availability and generosity. A large stream of studies, initially prevalent in the US and Canada but later expanded to a few European countries, consistently identify significant (dis)incentive effects of DI availability, as summarized by Bound and Burkhauser (1999) and more recently by Low and Pistaferri (2020). Strategies adopted to study the DI incentive effect include contrasting recipients with rejected or delayed claimants (Bound, 1989, Vu and Hyde, 2019), exploiting adjudicators' stringency (Maestaset al., 2013, French and Song, 2014), or assessors' schemes (Chen and van der Klaauw, 2008) turning similar applicants into recipients or not at the margin, exploring shifts in supply or demand factors (Author and Duggan, 2006) and variation in labour market conditions (e.g. Black et al., 2002, Benitez-Silva et al., 2010).

[1] The share of the population aged 65+ years in the OECD countries increased by 27% between 2000 and 2015 and is expected to rise by a further 39% by 2030.

A key research question in this literature involves measuring individuals' responsiveness to benefit generosity, as captured by the benefit replacement rate (RR). This poses several empirical challenges due to the need for credibly exogenous variation in replacement rates, which is often scarce as DI programs are typically national with limited local variation. Indeed, RR levels mostly reflect workers' previous earnings history, correlated with their work preferences (Gruber, 2000). Moreover, another challenge stems from the inherent unobservability of individuals' true disability, a key criterion for DI eligibility. Self-reported subjective disability measures in surveys are prone to biases, while objective indicators might fail to capture relevant health dimensions used by benefit adjudicators.

Perhaps due to these challenges, robust causal evidence on behavioral responses to DI generosity is limited. Existing studies (Gruber, 2000; Bell and Smith, 2005; Marie and Vall Castello, 2012; Borghens et al., 2014; Mullen and Staubli, 2016; Deucher and Euguster, 2018) estimate an elasticity of Labour Market Non-Participation (implicitly regarded as equivalent to DI participation) ranging between 0.1 and 0.4. However, these studies cover a restricted group of countries and institutional settings, with a significant paucity of evidence from work-compatible DI settings, despite the fact that they are not entirely uncommon among EU countries (MISSOCC, 2023). Notably, there is no joint evidence on both Labour Market Participation (LMP) and DI elasticities to DI benefit generosity, in a work-compatible DI setting.

In this paper, we aim to fill this gap studying behavioural responses to disability insurance generosity in a unique setting, where DI is work-compatible. The theme of work compatibility and incentives is gaining growing attention (Linhorst, 2005; Campolieti and Riddell, 2012; Kostal and Mogstad, 2014), especially in relation to the current policy emphasis on enhancing the labour inclusion of disabled workers. Moreover, in the light of the incentive/protection trade-off, it is very important to know both the labour supply and the DI participation elasticities to benefit generosity to inform the policy agenda on the schemes design.

We exploit a social security reform passed in Italy in 1995, which resulted in exogenous RR variation, and study the DI participation and employment response to DI generosity of workers hit by an acute CVD shock in later years (2003-2011). Our focus is on the extensive margin of labour supply, as previous evidence regarding Italian workers' responses to similar CVD shocks has highlighted that the primary adjustment in labour supply occurs through decreased employment rather than adjustments in hours or wages (Simonetti et al., 2022), in relation to the relatively rigid labour market context. Our study is possible due to the availability of a unique administrative dataset (Whip-Health) obtained by linking the work histories of a 7% random sample of private sector workers from the National Social Security Institute Archive to the Hospital Discharge Records Registry provided by the Italian Ministry of Health. We study the behavioural response of workers for whom DI eligibility becomes suddenly and

unexpectedly salient in relation to given types of acute and unanticipated CVD shocks, that is infarction and stroke. The focus on these workers is functional to significantly limiting unobserved heterogeneity. At the same time these individuals, potentially eligible for DI claims, find themselves facing variation in their prospective RR level based on a policy reform enacted at least 8 years prior to the onset of the health shock under consideration. The reform changed (making it less generous) the calculation method of the disability benefit entitlement for workers that had entered the labour market entry after 1995. The combination of these features is exploited in a Regression Discontinuity Design framework, centred around the timing of workers' first labour market entry.

We do find a significant and sizeable DI participation response, to reduced benefit generosity. A much smaller labour supply adjustment is detected, after the first year past the shock occurrence. Overall, results indicate that, in a context of work compatibility, the receipt of DI is widely perceived as a complement to labour income. Our findings may bear relevant implications for the design of labour inclusive DI schemes.

The remainder of the paper is structured as follows. Section II presents the institutional setting. Data, Descriptive Statistics and the empirical strategy are presented in Section III. Section IV presents the main results along with some robustness checks. The last section summarizes and concludes.

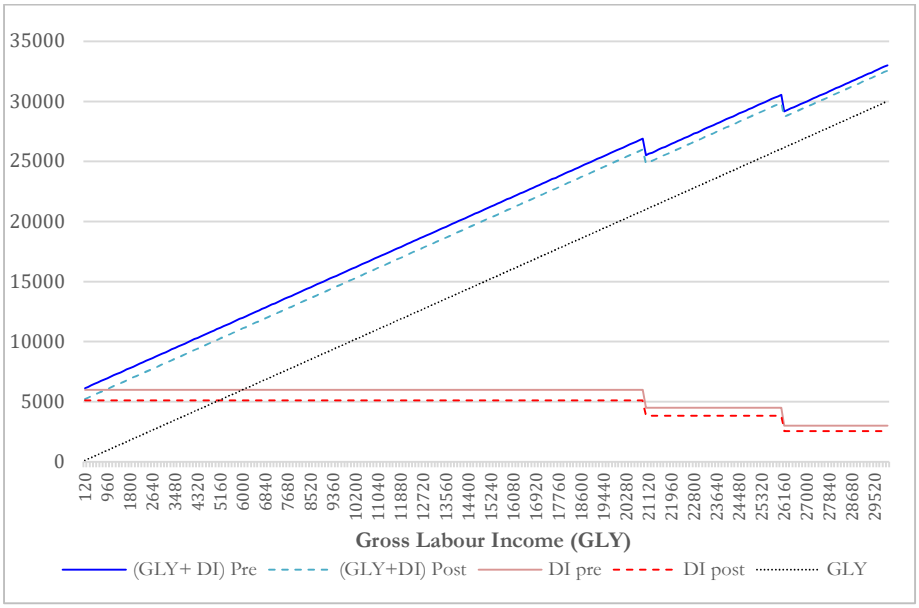
II. The Italian DI and the 1995 Reform

In Italy, income protection against workers' health-related risks is provided through two contributory DI schemes [2]. The first and relevant to our study is named "Assegno ordinario di invalidità", also known as the ordinary DI benefit. It is granted for impairments that reduce one's working ability by at least two-thirds. The benefit is awarded for a three-year period and then, through medical screening, it can be renewed two times before becoming a permanent payment. The second scheme is a disability pension ("Pensione di inabilità"), designed for individuals experiencing a permanent and total (i.e., 100%) inability to perform any kind of work. In both cases, once a claim is submitted, applicants can expect an adjudication decision within 85 days.

[2] Employees are entitled to sick leave for a maximum of 180 days per calendar year. After, the employer may rescind the contract in case the employee does not return to work, but if the employee returns to work, she cannot be dismissed on the grounds of health-related limitations, unless the employer proves that, given the health limitation and available tasks, no accommodation can be envisaged. Also, in Italy, mandatory employment quotas are provided for disabled workers, in relation to firm size (7% for firms employing more than 50 employees, decreasing to 2 employees for firms with 36-50 employees and to 1 for firms with 15- 35 employees, while no quota applies in the case of businesses with less than 15 employees.)

The benefit amount is determined based on the old-age pension formula, resulting in replacement rates that align broadly with those found in many other European countries.[3] While both programs require a minimum of five years of paid social security contributions (with at least three in the five years preceding the application), they differ in terms of work compatibility. The disability pension is entirely incompatible with any work activity. In contrast, the ordinary DI scheme is fully compatible with employment, a distinctive feature compared to many other countries where receiving the benefit is incompatible with earning a significant labour income (Low and Pistaferri, 2020).

Figure 1: Gross Labour Income and Disability Insurance



Importantly, the ordinary DI is never revoked based on working status or earnings. Benefit reductions of 25% or 50% apply when labour income reaches four or five times, respectively, the minimum pension amount. These thresholds are relatively generous, amounting to approximately 1.2 and 1.6 times the median income[4]. It is also worth stressing that these benefit reductions do not function as taper rates, as illustrated in Figure 1. When the first earnings threshold is reached and the one-fourth reduction applies, the benefit remains unchanged as earnings increase until the second threshold is reached. Similarly, when the second earnings threshold is achieved, and the benefit is halved, the amount remains constant as

[3] For example, under the ordinary DI scheme, a claimant aged 50, after thirty years of contributions, would be entitled to a gross replacement rate of about 60 percent. The disability pension is even more generous because it adds a sizeable contributory bonus (Belloni and Maccheroni, 2013). It is worth mentioning that, with respect to other countries, the Italian DI scores instead worse in terms of achieved coverage (5.5 percent, against the 9.9, 8.7 and 7.9 percent of Sweden, the Netherlands and Denmark (Applica & Cesep & European Centre, 2007)), possibly in relation to the level of incapacity required.

[4] In 2019, the thresholds were euros 26,676.52 and euros 33,345.65. Figure 1 depicts the amount of DI receivable under 2003 fiscal parameters (thresholds at euros 20,910 and euros 26,137 respectively).

earnings increase further. In other words, these two local downward jumps in the benefit amount do not directly[5] alter the effective marginal tax rate on labour income.

For identification, we do not exploit these discontinuities in the benefit amount receivable, since they relate to the earned income, which workers could possibly manipulate. Instead, we leverage a policy reform enacted in 1995 that modified the old-age pension formula across various social security schemes, including Disability Insurance (DI), resulting in reduced replacement rates. This reform, known as the Dini reform (Law No. 335/1995), aimed to bolster the long-term financial stability of the Italian pay-as-you-go social security system, which was significantly impacted by population aging and low economic growth. The law retained the PAYGO financial architecture of the previous system but replaced the defined benefit (DB) with a notional defined contribution (NDC) pension formula.

In more detail, the law categorized workers into three groups. The first group comprised workers who, by the end of 1995, had accumulated more than 18 years of contributions, ensuring their pension remained untouched (DB). The second group included workers with less than 18 years of contributions at that time, with their pension calculated using a mixed (or pro-rata) system applying old DB and new NDC rules proportionally to the years of contributions accrued before and after the end of 1995. The third group encompassed workers who commenced employment in January 1996 or later, with new NDC rules fully applied to them (refer to Appendix B for additional details on each pension formula).

As a result, the 1995 reform led to a reduction in the generosity of several social security benefits (and DI replacement rates) for individuals entering the labour market from January 1996 onwards. Consensus in the literature supports the actual occurrence of such replacement rate (RR) reduction. For instance, simulations by Forni and Giordano (2001) indicate a broad reduction in the old-age RR from 60-65% to 45-55%. Similarly, the representative agents model in Fornero and Castellino (2001) suggests that the RR of private sector employees retiring with 35 years of contributions decreased from 68% (DB) to 57% (NDC). The diminished generosity of the NDC scheme is also evident in the present value ratio indicator, i.e., the ratio between the present value of future pension benefits and the present value of contributions paid. According to Fornero and Castellino (2001), this indicator declined for the mentioned cohorts and years of work from 1.4 to 0.8. Belloni and Maccheroni (2013) report a decline from 1.3 to 0.9 for male blue-collar workers and from 1.1 to 0.9 for female white-collar workers. The microsimulation model of Borella and Coda Moscarola (2006) confirms these findings.

[5]A caveat is that because DI is taxable, DI receipt might ceteris paribus bring individuals to reach higher personal income tax brackets, where higher marginal tax rates apply to additional labour income earned, possibly resulting in labour disincentive. However, given the limited number of tax brackets and their width (e.g. in 2003:0-15,000; 15,000-29,000; 29,000-32,600; 32,600-70,000; above 70,000), this is likely affecting a very minor proportion of individuals.

III. Data, Variables and Empirical Strategy

We use WHIP-Health, an administrative dataset that compiles employment, social insurance, and health histories of a randomly selected 7 percent sample of private-sector workers covered by the national Social Security Institute (INPS), excluding those employed in agriculture. The dataset incorporates the Work Histories Italian Panel (WHIP), an extensive employer-employee panel spanning from 1990 to 2012, offering detailed information on each employment period and other types of spells. The data encompass receipt information (without specific amounts) for various social security programs, including Disability Insurance (DI), and demographic details such as birth and death years, place of birth, and gender. WHIP-Health links these labour market records with the registry of hospital discharge records provided by the Italian Ministry of Health. This registry covers hospitalizations between 2001 and 2012, detailing main and secondary diagnoses (ICD-IX codes), year and month of hospitalization, and type of dismissal.

In our analysis, we focus on blue- and white-collar workers aged 18 to 63, who experienced a Cardiovascular Disease (CVD) shock (ICD-9 codes 410-414 for ischemic diseases; 430-434 and 436-437 for cerebrovascular diseases) from 2003 to 2011. We focus on acute CVD shocks due to their major, unanticipated nature, leading to unplanned hospitalizations. This choice helps address concerns related to unobserved heterogeneity. The sample includes workers employed since the year before the shock, with no prior CVD shock in the preceding two years and no DI receipt before the shock. Only individuals meeting contributory requirements for DI in the shock year are retained. The resulting sample consists of over 9 thousand workers facing variation in prospective benefit replacement rates (RR) due to the impact of the 1995 reform and their entry year into the labour market.

We reconstruct each individual's RR in the year before the CVD shock, calculating the ratio between the accrued DI benefit (ordinary benefit) and the average wage of the last five years. We consider only the primary job spell for each year, annualizing it to an equivalent full-time 52-week-long spell to mitigate the impact of erratic wages. Detailed calculation rules, including minimums and ceilings, are applied to compute the accrued DI pension benefit. Workers are categorized under DB, pro-rata, or NDC rules, with contributory history before 1990 reconstructed using information from the Bank of Italy's Survey of Households, Income, and Wealth (SHIW) to approximate the number of contributory years accrued in 1990[6]. This is computed, taking into account an imputed starting age derived from SHIW, ranging

[6] We pool cross-sectional data from SHIW 1998, 2000 and 2002 and exploit the following two variables: the age at which each individual started working and the number of accrued years of contribution at the time of the interview. With this information, we first compute the potential years of contributions as the difference between the current age at the time of the interview and the starting age. We then compute the number of "holes" in the working career as the difference between potential and self-reported years of contributions. We estimate a

from 17 for male blue-collar workers to 24 for female executives, and the attributed age-gender-job position-specific years of interruptions. The observed years of contributions post-1990 are then added to compute the total number of contributory years accrued in the year prior to the shock, which, according to legislation, is capped at 40. Additional details on the RR calculation are provided in Appendix B.

Table 1 presents descriptive statistics for all the variables. In addition to demographics, health-related information covers CVD shock severity, a Charlson Index for comorbidities, days of hospitalization, whether acute at hospital discharge, whether previously ever hospitalized for a CVD shock until the year before the shock, and whether previously ever hospitalized for other types of diseases. Past labour history information is captured through a rich set of indicators, encompassing both the characteristics of the employment held at the time of the shock (qualification, region of work, tenure, sector, firm size, working hours, and earnings) and full working history indicators (number of previous employer changes, whether ever self-employed, number of previous employment contracts held, number of previous unemployment benefit spells). The computed RR level is also reported.

Descriptives are presented for the full sample and for two subsamples restricted to individuals entering the labour market closer to the discontinuity year. The first subgroup is defined using a bandwidth of four years before and after the threshold (i.e., 1992-1999), and the second subgroup is defined using a bandwidth of three years before and after (i.e., 1993-1998). Table A.2 in the Appendix displays the distribution of observed labour market entry years. Two facts are worth stressing: first, a significant proportion of individuals in our sample entered the labour market before 1991, leading to a non-trivial reduction in sample size when restricting the bandwidths around the discontinuity. Nevertheless, this reduction is crucial to enhance the credibility of our identification strategy, which relies on the local continuity of covariates. A compositional change is evident when considering the two subsamples in terms of demographic and work history characteristics compared to the full sample. As the bandwidth around the threshold tightens, the average age of individuals decreases from 50-51 in the full sample to 45-46 in the two narrower bands. The proportion of women and immigrants increases significantly in the two restricted subgroups, reflecting secular trends. The share of female individuals who experienced a CVD shock grows from 0.12 to 0.20, and the weight of immigrants more than doubles, rising from 0.07 to 0.19. Work history information reveals a shorter job tenure at the time of the CVD shock in the two subgroups (reducing from 120 months to around 64-65), as well as a decrease in labour income

Poisson model on the number of computed interruptions ("holes") explained by a full set of dummy variables for age, job position (blue-collar, white-collar, executive, manager) and gender plus their interactions. We finally predict the number of interruptions for all possible combinations of these variables and attribute them to the individuals in the WHIP-Health dataset based on the same characteristics.

presumably reflecting a younger age and lower experience. Relatedly, the average RR level lowers as the bandwidth tightens, and so does the gap between pre- and post-reform RR levels: from a 0.40 reduction in the full sample to 0.15 and 0.5 in the two subsamples. Overall, this suggests that individuals entering the labour market before or after 1996 are much more similar in observables (and presumably in unobservables) in the restricted subsamples.

The second aspect worth stressing is that the figures reported in Table A.2 suggest no manipulation in the individuals' year of first labour market entry around the reform, which, given the reduced generosity it brought, would be expected, if anything, to happen in terms of increased pre-1996 entry. Finally, the bottom part of Table 1 reports descriptives for the outcome variables. In the full sample, about 15% of workers hit by a CVD shock enter DI receipt in the following 12 months, while about 10% leave the labour market in the same time span (see Simonetti et al (2022) for evidence on the causal effect of these CVD shocks on labour supply). Figure A.1 in the Appendix displays the timing of DI entry in relation to the health shock occurrence and clarifies how the bulk of entries occurs within a year.

Table 1. Descriptive statistics: full sample and subgroups by years of entry into the labour market

	Full Sample *(#9,169)*		**1992 – 1999** *(#1,165)*		**1993 – 1998** *(#803)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Covariates:						
Age, t	50.59	7.354	46.25	9.256	45.74	9.375
Immigrant	0.074	0.262	0.196	0.397	0.198	0.399
Women	0.116	0.320	0.198	0.399	0.207	0.405
Severe CVD shock (yes/no) [a]	0.557	0.497	0.547	0.498	0.547	0.498
Charlson Index	0.947	0.224	0.943	0.231	0.935	0.246
Days of hospitalisation	7.090	9.060	7.736	10.35	7.983	11.23
Acute hospital discharge [b]	0.123	0.328	0.135	0.342	0.133	0.340
Ever hospitalised for a CVD shock until (t-1)	0.034	0.180	0.027	0.161	0.020	0.140
Ever hospitalised for other types of diseases until (t-1)	0.414	0.492	0.446	0.497	0.451	0.498
Piedmont	0.081	0.273	0.065	0.247	0.065	0.246
Valle D'Aosta	0.002	0.040	0.002	0.041	0.002	0.050
Lombardy	0.223	0.416	0.209	0.407	0.208	0.406
Trentino Alto Adige	0.015	0.123	0.015	0.123	0.015	0.121
Veneto	0.075	0.263	0.091	0.288	0.090	0.286
Friuli Venezia Giulia	0.020	0.139	0.022	0.148	0.019	0.135
Liguria	0.026	0.160	0.022	0.148	0.027	0.163
Emilia-Romagna	0.091	0.287	0.096	0.295	0.107	0.309
Tuscany	0.062	0.241	0.061	0.239	0.062	0.242
Umbria	0.014	0.119	0.012	0.109	0.010	0.099
Marche	0.027	0.161	0.029	0.168	0.020	0.140
Lazio	0.086	0.280	0.086	0.280	0.087	0.282
Abruzzo	0.021	0.142	0.021	0.142	0.020	0.140
Molise	0.006	0.074	0.005	0.072	0.005	0.070
Campania	0.097	0.296	0.087	0.282	0.081	0.273
Puglia	0.046	0.208	0.058	0.235	0.057	0.233
Basilicata	0.006	0.077	0.006	0.077	0.004	0.061
Calabria	0.021	0.142	0.031	0.173	0.036	0.187
Sicily	0.068	0.252	0.070	0.254	0.077	0.267
Sardinia	0.015	0.123	0.010	0.101	0.006	0.079
Blue-collar worker, t	0.674	0.469	0.746	0.436	0.742	0.438
Job tenure (with employer at time t)	120.9	98.46	64.99	52.10	64.60	50.91
Primary sector, t	0.006	0.079	0.003	0.059	0.002	0.050
Secondary sector, t	0.535	0.499	0.506	0.500	0.502	0.500
Tertiary sector, t	0.459	0.498	0.490	0.500	0.496	0.500
Firm size (0-15 employees), t	0.304	0.460	0.397	0.489	0.392	0.489
Firm size (16-249 employees), t	0.381	0.486	0.378	0.485	0.369	0.483
Firm size (250+ employees), t	0.315	0.465	0.226	0.418	0.239	0.427
Labour income (t-1)	29,744	25,727	22,310	17,287	22,053	16,579
Full-time (t-1)	0.904	0.295	0.841	0.366	0.832	0.374
# employers changed until (t-1)	2.344	1.704	2.407	1.630	2.399	1.647
Ever self-employed until (t-1)	0.121	0.327	0.123	0.328	0.118	0.323
# employment contracts until (t-1)	16.47	5.506	13.09	4.813	12.91	4.56
# unemployment benefits received until (t-1)	0.449	1.335	0.637	1.535	0.666	1.558
Replacement Rate, t	0.479	0.226	0.228	0.154	0.176	0.064
Replacement Rate: pre- versus post- reform (difference)	-0.407	-	-0.154	-	-0.051	-
Outcome Variables:						
DI Take-Up (12 months)	0.151	0.358	0.137	0.344	0.133	0.339
DI Take-Up (24 months)	0.184	0.388	0.178	0.383	0.170	0.376
LMP (T+1)	0.908	0.289	0.916	0.277	0.919	0.273
LMP (T+2)	0.802	0.399	0.810	0.393	0.816	0.388

Source: WHIP-Health. **Notes**: [a] ICD-9: 410/411/430/431; [b] equal to 1 if transferred to another institute or transferred to another hospital ward within the same institution or transferred to a rehabilitation institute.

For the identification of the effect of interest, we exploit the institutional discontinuity - introduced by the 1995 reform (described in Section II), which happened at least eight years before the individuals' CVD shock onset- resulting in an exogenous replacement rates variation. Therefore, the reform reduced DI replacement rates for those entering the labour market from January 1st, 1996 onwards.

Therefore, we apply a Regression Discontinuity Design, based on date of entry into the labour market (before/after 1st Jan 1996 i.e. DB/pro-rata versus DC system). Visually, a discontinuity in DI receipt around the threshold appears in Figure 2, with the three panels corresponding to the full sample and subsamples restricted to four and three years before and after the discontinuity point, respectively.

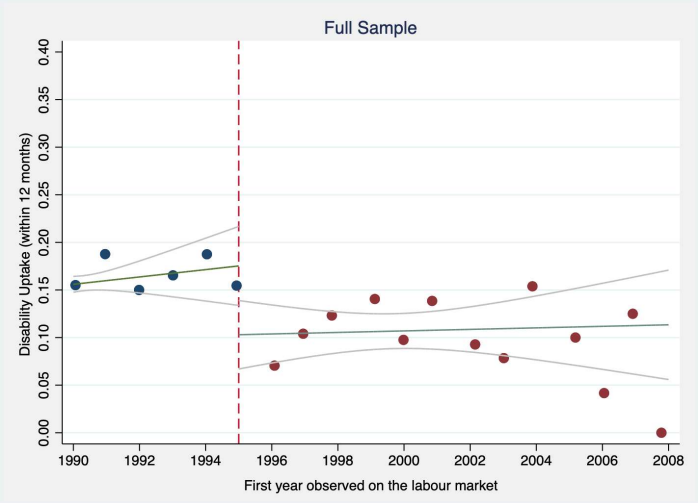
More formally, we estimate the following parametric model:

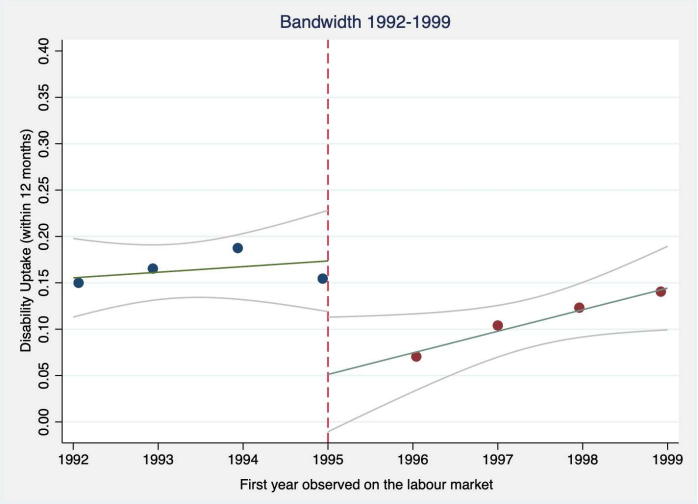
$$y_i = \beta_0 + \beta_1 After1995_i + f(x_i - 1995) + g(x_i - 1995) * After1995_i + z_i + \epsilon_1$$

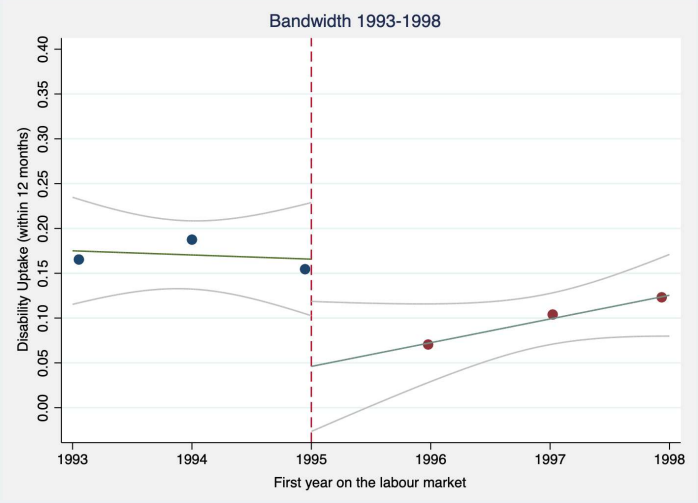
Where y_i measures our outcomes of interest, i.e. DI take-up and labour market participation, respectively. In these local regressions the specification is augmented with a dichotomous indicator equal to one if the worker entered the labour market after 1995 and two time polynomials (above the time discontinuity and below the time discontinuity), normalised to the threshold. The estimated coefficient on the dichotomous "After1995" indicator will reflect the causal effect of reduced benefit generosity (replacement rates) on the outcomes of interest among workers hit by an acute CVD shock, with reference to workers having entered the labour market in a neighbourhood of the 1995 discontinuity, and having later experienced an acute CVD shock between 2003 and 2011. We control for a set of covariates, z_i, referring to the individual health status and labour market characteristics (as detailed in Table 1) .

In such a local average treatment effect (LATE) estimation, identification relies on a standard continuity assumption (Imbens and Lemieux, 2008). In particular, one concern would be endogenous labour market entry of workers invalidating identification. We already showed in Table A.2 that there was no manipulation in the individuals' year of first labour market entry around the reform. We provide further evidence in support of our strategy credibility through a set of balancing tests for relevant covariates around the cut-off, which are reported in Appendix Table A.3. Reassuringly, workers' characteristics both in terms of health and labour activity display generally no systematic discontinuity around the threshold, with the only exception of the non-native indicator, which will be controlled for in the regressions. Overall, we do not seem to detect evidence of threshold assignment manipulation.

Figure 2 – Average (by year) Disability Take-Up Rate







IV. Results

The upper panel of Table 2 reports estimates on the causal effect (LATE) of the 1995 reform reducing DI generosity on the DI receipt within 12 and 24 months following the CVD shock; we consider the full sample of employees hit by acute CVD shocks between 2003 and 2011 (first two columns) and then two samples where bandwidths of time for labour market entry are restricted to 1992-1999 (four years before and after the 1996 discontinuity) and to 1993-98 (three years before and after the discontinuity). The marginal effect on "After 1995" captures the LATE of interest. The estimated specification allows for different trends on each side of the cut-off; covariates include all those reported in Table 1.

Estimates on DI receipt show that the reduced benefit generosity significantly reduces the likelihood for shocked individuals to enter DI both within one and two years past the health shock occurrence. The effect appears sizeable, spanning from a 5 to a 15 percentage points lower probability of receipt if entitled to less generous replacement rate. The point estimate is even larger in restricted bandwidths subsamples. In the 1992-1999 bandwidth sample, which seem to best trade-off sample size and credibility of identifying assumptions, the relative size effect (RSE=LATE/average outcome) amounts to a 85% reduction in DI participation (measured 24 months past the health shock). The corresponding estimated elasticity of DI receipt (again measured 24 months past the health shock) to the RR level amounts to 1.26, meaning that a 10% reduction in the RR level results in a 12.6% reduction in DI participation[7].

The lower panel of Table 2 reports results for labour market participation. We detect a significant increase in labour market participation only in the second year past the shock occurrence, emerging both in the full and restricted samples. The increase in labour supply takes longer to arise, possibly in relation to the timing of recovery. The RSE amounts to a 10% increase in employment in t+2 in the 1992-1999 subsample; the corresponding estimated elasticity amounts to -0.15, implying that a 10% decrease in RR levels results in a 1.5% increase in employment.

We perform a set of robustness checks. First, we find that the results are generally confirmed when adopting second order polynomials (Tables A.4 in the Appendix). Second, we perform two falsification tests, where the analysis is repeated under placebo discontinuities set in 1993 and 1996: in these cases, reassuringly, the marginal effect on the individuals entering the labour market after the discontinuity year, is never significant (Table A.5 in the Appendix). Next, we repeat the analysis excluding immigrant

[7] The Estimated elasticity increases when moving from the full sample (0.32) to the 92-99 subsample (1.14) and even more when considering the 93-98 sample (2.3) both because the LATE is larger in the subsamples (and so, correspondingly, the relative size effect) and because the reform-induced reduction in RR levels is lower.

workers: in this case (Table A.6 in the Appendix), while the sizeable DI response is confirmed, with larger points estimates, no (increased) employment response emerges, suggesting that for the native population the two choices are taken as separate decisions.

Finally, in Table 3 we show some heterogeneous effects of the responsiveness to DI generosity. More in detail we explore heterogeneity by gender, area of the country, blue- versus white-collars, firm size, natives versus immigrants and benefit reduction (which reflects higher income levels). We focus on t+2 outcomes and use the 1992-1999 subsample. Indeed, as DI receipt lasts for at least 3 years, the t+2 longer time horizon gives a fuller picture including also early DI recipients which have entered since t+1, while allowing for the timing of employment adjustment.

We find a lower DI participation elasticity among men, in line with their role of main earners, and among blue-collar workers (as in Muellen and Subli, 2016), which face less labour market opportunities. We also detect some geographical variation in DI elasticity, while no major differences arise long other heterogeneity dimensions.

As for labour market participation, a significantly larger elasticity is found among non-natives. This is a novel and interesting result which suggests that immigrants' labour market effort might be driven by the aim of achieving certain income levels. Higher labour supply elasticity is also detected among individuals entitled to the full benefit, for which the reform-induced benefit reduction is larger. These individuals are also those on lower incomes, for which again it might be important to maintain a certain overall income level. It is worth stressing that across all subgroups, DI elasticities are systematically (and often remarkably) higher than labour market elasticities.

Table 2. DI participation and Employment response

	No bandwidth		1992 - 1999		1993 - 1998	
	Disability Take-up *(within 12 months)*	**Disability Take-up** *(within 24 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 24 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 24 months)*
LATE (after 1995)	-0.060***	-0.056*	-0.112***	-0.151***	-0.128***	-0.106***
	(0.016)	(0.027)	(0.018)	(0.023)	(0.009)	(0.017)
Covariates	✓	✓	✓	✓	✓	✓
Region of work dummies	✓	✓	✓	✓	✓	✓
Linear trends	✓	✓	✓	✓	✓	✓
Obs.	9,150	7,946	1,161	998	800	684
R-squared	0.123	0.128	0.188	0.199	0.220	0.224
	Employment *(t+1)*	**Employment** *(t+2)*	**Employment** *(t+1)*	**Employment** *(t+2)*	**Employment** *(t+1)*	**Employment** *(t+2)*
LATE (after 1995)	0.009	0.084***	-0.015	0.082**	-0.001	0.079
	(0.023)	(0.028)	(0.033)	(0.033)	(0.038)	(0.045)
Covariates	✓	✓	✓	✓	✓	✓
Region of work dummies	✓	✓	✓	✓	✓	✓
Linear trends	✓	✓	✓	✓	✓	✓
Obs.	9,150	7,946	1,161	998	800	684
R-squared	0.054	0.109	0.082	0.144	0.101	0.148

Notes: standard errors clustered by year of first labour market entry in parentheses. *** p<0.01, ** p<0.005, * p<0.1

Table 3. Heterogeneity analyses

	Disability Insurance Participation (24 months) 1992-1999					Employment, t+2 1992-1999				
	N. Obs.	LATE	S.E.	Test on diff	Est. Elasticity	N. Obs.	LATE	S.E.	Test on diff	Est. Elasticity
Women	205	-0.264***	(0.054)	**	2.49	205	0.089	(0.096)		-0.14
Men	793	-0.128***	(0.030)		1.01	793	0.076*	(0.035)		-0.14
North	530	-0.090**	(0.034)		1.01	530	0.073	(0.050)		-0.13
Centre	195	-0.336***	(0.061)	*** [a]	2.34	195	0.063	(0.121)		-0.11
South	273	-0.207	(0.119)		1.16	273	0.097	(0.090)		-0.18
Blue-collar	751	-0.135***	(0.026)		0.92	751	0.095**	(0.030)		-0.17
White-collar	247	-0.282***	(0.061)	**	4.63	247	-0.031	(0.112)		0.05
0-15	403	-0.226***	(0.065)		1.85	403	0.028	(0.031)		-0.05
16-250	385	-0.157***	(0.037)		1.13	385	0.159	(0.115)		-0.27
250+	210	-0.122*	(0.059)		1.20	210	-0.035	(0.084)		0.06
Immigrant	198	-0.071	(0.110)		0.45	198	0.268**	(0.091)	***	-0.36
Native	800	-0.210***	(0.031)		1.69	800	0.046	(0.047)		-0.08
Full benefit	647	-0.180***	(0.042)	* [b]	1.30	647	0.127**	(0.039)	** b	-0.24
Reduced benefit 25%	175	0.020	(0.098)		0.16	175	-0.044	(0.062)	*	0.07
Reduced benefit 50%	176	-0.135*	(0.058)		1.93	176	-0.092	(0.120)		0.14
Reduced benefit≥25%	351	-0.051	(0.064)		0.52	351	-0.024	(0.079)		0.04

Source: WHIP-Health. Notes: [a] test against North.; [b] test of no reduction against a 25% reduction.

V. Conclusions

In this paper, we provide novel evidence on workers' responsiveness to DI generosity in a setting where DI receipt is fully compatible with working activity. Therefore, both DI participation and Employment elasticities are of interest. Thanks to the availability of a rich administrative dataset covering the employment, social security and hospital history of a random sample of private sector employees, we have the opportunity to study the case of workers experiencing an acute CVD shock resulting in hospitalization. Focusing on their case allows addressing unobserved heterogeneity, also in the light of the unanticipated nature of these major health events, which translates in DI eligibility becoming unexpectedly salient.

We exploit exogenous variation in replacement rates introduced by a major social security reform happened at least eight years before the CVD shocks occurrence, generating variation in RR levels in relation to the year of first labour market entry for each individual. We exploit the RR level discontinuity in a RDD framework and measure the LATE for both DI participation and employment, which is fully compatible with DI receipt (the benefit amount being simply reduced by one fourth or one half in case relatively generous income thresholds are achieved). We provide novel evidence on the relative size of the DI participation and employment response, which, differently from most previous works, cannot be regarded as two sides of the same coin here.

Our results suggest that Italian workers hit by a major CVD shock respond, in terms of claiming behaviour, to DI generosity. We detect an immediate and sizeable response in DI participation, which decreases in response to a less generous RR, with our preferred DI elasticity estimate amounting to 1.26. Our estimated elasticity is consistent with the DI elasticity reported by Mullen and Staubli (2016) for the universe of Austrian workers, which in their context, they deem equivalent to the elasticity of labour force withdrawal. This result is fully in line with the behavioural modelling of the take-up of social security and welfare benefits, which since Moffit's (1983) seminal contribution identifies benefit generosity as key determinant of claiming, a decision taken when the expected utility gain is enough to overcome the fixed utility cost of undertaking the application process. It is worth mentioning that social security substitution in response to DI decreased generosity - along the lines of Borghens et al. (2014)- is not plausible in our context, as the replacement rate reduction enacted with the 1995 reform would also apply to other pension schemes (including early retirement) while the unemployment benefit would anyway pay less generous amounts that the reformed DI.

We also detect a smaller increase in employment, driven by immigrant workers, arising after the second year past the shock occurrence, with our preferred employment elasticity estimate amounting to -0.15. The increase in employment is ultimately due to an income effect, i.e. lower prospective replacement rates imply a reduction in non-labour income, which might be compensated (income effect) with an

increase in the income production effort, i.e. increased labour supply. At the same time, we acknowledge that, because DI is taxable, a lower DI payment could possibly bring - ceteris paribus – individuals taxable income to reach a lower top personal income tax bracket, implying ultimately lower marginal tax rates applying to extra labour earnings and a possible substitution effect. However, in our context, given the tax brackets number (4 or 5 in total in those years) and width, such reduction in e.m.t.r would only affect a marginal number of individuals passing the brackets thresholds because of the DI amount reduction, suggesting that the substitution effect, if present at all, would be a second-order effect.

Our estimated employment elasticity is relatively low compared to the range of non LMP elasticities offered by previous studies. There are multiple possible explanations for our lower magnitude. The first explanation is the work compatibility of the Italian ordinary DI which, making the work-receipt trade-off less stringent, plausibly reduces the magnitude of labour supply responsiveness to benefit generosity. Indeed, cross-countries comparative analyses of employment responses to health shocks provide evidence that the size of the labour supply adjustment is inversely related to labour integration policies, and work compatibility (Garcia Gomez, 2011, Trevisan and Zantomio, 2016).

An additional reason concerns the particular sample studied here i.e. workers hit by acute CVD shocks, as opposed to the samples of male workers (Bell and Smith, 2005, Gruber, 2000, Mullen and Staubli, 2016) or benefit recipients (Marie and Vall, 2012; Borghens et al., 2014, Kostol and Mogstad, 2014) typically considered in previous similar studies. Our sample of severely health-shocked individuals is less likely to include marginal applicants, known to exhibit larger elasticities.

Our work is the first to offer jointly DI and employment responses estimates to social security generosity, in a setting of DI and work compatibility where the two outcome decisions cannot be regarded as two sides of the same coin, as done in previous works. Such settings are common among EU countries (MISSOC, 2023). In contexts where the benefit is never lost in relation to labour earnings, DI benefit income gets close to comparable to other forms of non-labour income. The elasticity of DI participation is remarkably and systematically larger than the elasticity of employment, suggesting that that, in this setting, DI entitlement is broadly seen as a complement, rather than a substitute, to labour income. Overall, our results stress the importance of work compatibility as a route to the labour inclusion of disabled workers. Work compatibility could apparently reduce the fiscal advantage of more selective programmes, increasing the number of DI claimants and recipients. However, benefit generosity is another lever, that could be adjusted to accompany an increase in work compatibility, with possible beneficial effects for labour inclusion and related fiscal gains. These are important lines of study that further research on Disability Insurance should continue to address.

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Appendix A – Additional Tables and Figures

Figure A.1: time to DI receipt, in months since the shock occurrence

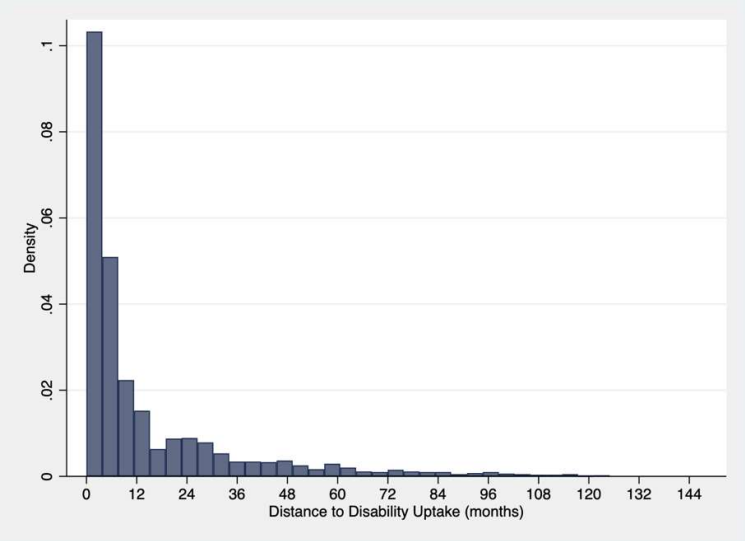

Table A1. Year of the CVD shock

	Freq.	%	Cum.
2003	879	9.59	9.59
2004	962	10.49	10.08
2005	984	10.73	30.81
2006	1,033	11.27	42.08
2007	1,050	11.45	53.53
2008	1,048	11.43	64.96
2009	1,084	11.82	76.78
2010	1,066	11.63	88.41
2011	1,063	11.59	100.00
	9,169		

Source: WHIP-Health

Table A2. First year observed on the labour market

	Freq.	%	Cum.
1990, or before	7,106	77.50	77.50
1991	341	3.72	81.22
1992	241	2.63	83.85
1993	128	1.40	85.24
1994	144	1.57	86.81
1995	111	1.21	88.02
1996	156	1.70	89.73
1997	126	1.37	91.10
1998	138	1.51	92.61
1999	121	1.32	93.93
2000	164	1.79	95.71
2001	130	1.42	97.13
2002	97	1.06	98.19
2003	52	0.57	98.76
2004	39	0.43	99.18
2005	30	0.33	99.51
2006	24	0.26	99.77
2007	16	0.17	99.95
2008	5	0.05	100.00
	9,169		

Source: WHIP-Health

Table A.3 – Covariates balance

	Full Sample		1992 – 1999		1993 – 1998	
	After95	*p-value*	*After95*	*p-value*	*After95*	*p-value*
Covariates:						
Age, t	1.196	**0.039**	-0.270	0.817	0.525	0.710
Immigrant	0.101	**0.000**	0.280	**0.000**	0.268	**0.000**
Women	0.001	0.975	0.019	0.706	-0.007	0.905
Severe CVD shock (yes/no) [a]	-0.049	0.233	-0.030	0.636	0.004	0.961
Ln(Days of hospitalisation)	-0.010	0.874	0.066	0.539	0.059	0.649
Charlson index	0.049	**0.008**	-0.027	0.364	-0.055	0.138
Acute hospital discharge [b]	0.010	0.710	-0.063	0.145	-0.076	0.137
Ever hospitalised for a CVD shock until (t-1)	0.004	0.766	-0.021	0.307	-0.036	0.089
Ever hospitalised for other types of diseases until (t-1)	0.054	0.184	0.035	0.576	0.073	0.328
Blue-collar worker, t	-0.050	0.195	0.024	0.666	0.017	0.792
Region of work, t:						
Piedmont	-0.013	0.566	-0.043	0.170	0.004	0.919
Valle D'Aosta	-0.004	0.288	-0.002	0.660	0.003	0.673
Lombardy	0.095	**0.006**	0.112	**0.029**	0.087	0.152
Trentino Alto Adige	0.014	0.183	0.027	0.083	0.021	0.240
Veneto	-0.021	0.343	-0.043	0.241	-0.078	0.069
Friuli Venezia Giulia	0.0003	0.974	-0.001	0.952	-0.005	0.800
Liguria	-0.017	0.195	-0.015	0.427	-0.026	0.293
Emilia-Romagna	-0.004	0.863	0.025	0.510	0.047	0.318
Tuscany	0.024	0.227	0.057	0.058	0.057	0.116
Umbria	0.003	0.786	-0.001	0.927	0.011	0.483
Marche	-0.007	0.583	0.009	0.710	0.001	0.963
Lazio	-0.004	0.868	-0.029	0.410	-0.037	0.389
Abruzzo	-0.007	0.574	-0.0004	0.984	-0.012	0.558
Molise	0.005	0.453	0.003	0.775	0.001	0.911
Campania	-0.047	0.057	-0.065	0.066	-0.055	0.179
Puglia	-0.010	0.558	-0.056	0.058	-0.030	0.386
Basilicata	0.005	0.394	0.018	0.069	0.013	0.159
Calabria	-0.013	0.281	0.008	0.700	-0.002	0.946
Sicily	0.001	0.947	0.012	0.716	0.006	0.891
Sardinia	-.00002	0.999	-0.012	0.358	-0.007	0.583
Abroad	-0.002	0.503	-0.001	0.756	0.002	0.766
Job tenure (with employer at time t)	31.98	**0.000**	1.936	0.768	6.534	0.391
Primary sector, t	0.002	0.753	0.003	0.683	0.010	0.168
Secondary sector, t	0.102	**0.014**	0.102	0.108	0.111	0.140
Tertiary sector, t	-0.104	**0.012**	-0.105	0.098	-0.121	0.107
Firm size (0-15 employees), t	-0.033	0.390	**0.110**	0.075	0.141	0.054
Firm size (16-249 employees), t	0.021	0.608	-0.002	0.979	0.080	0.271
Firm size (250+ employees), t	0.012	0.754	-0.108	**0.040**	-0.222	**0.001**
Labour income (t-1)	5.235	**0.013**	2.621	0.230	3.287	0.187
Full-time (t-1)	0.055	**0.023**	0.077	0.096	0.093	0.098
# employers changed until (t-1)	-0.205	0.146	-0.133	0.517	-0.091	0.713
Ever self-employed until (t-1)	-0.100	**0.000**	-0.072	0.082	-0.056	0.246
# employment contracts until (t-1)	0.245	0.537	0.081	0.887	0.320	0.625
# unemployment benefits received until (t-1)	-0.174	0.116	0.186	0.338	0.129	0.581

Source: WHIP-Health.

Table A4. DI participation and Employment response *Quadratic Trends*

	No bandwidth		1992 - 1999		1993 - 1998	
	Disability Take-up *(within 12 months)*	**Disability Take-up** *(within 24 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 24 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 24 months)*
LATE (after 1995)	-0.082***	-0.108***	-0.117***	-0,013	-0.078**	-0.066**
	(0.019)	(0.024)	(0.016)	(0.030)	(0.0166)	(0.025)
Covariates	✓	✓	✓	✓	✓	✓
Region of work dummies	✓	✓	✓	✓	✓	✓
Linear trends	✓	✓	✓	✓	✓	✓
Quadratic trends	✓	✓	✓	✓	✓	✓
Obs.	9,150	7,946	1,161	998	800	684
R-squared	0.123	0.129	0.188	0.202	0.220	0.225
	Employment *(t+1)*	**Employment** *(t+2)*	**Employment** *(t+1)*	**Employment** *(t+2)*	**Employment** *(t+1)*	**Employment** *(t+2)*
LATE (after 1995)	-0.024	0.044	0.036	0.079	0.150***	0.203***
	(0.027)	(0.026)	(0.039)	(0.048)	(0.018)	(0.016)
Covariates	✓	✓	✓	✓	✓	✓
Region of work dummies	✓	✓	✓	✓	✓	✓
Linear trends	✓	✓	✓	✓	✓	✓
Quadratic trends	✓	✓	✓	✓	✓	✓
Obs.	9,150	7,946	1,116	998	800	684
R-squared	0.054	0.109	0.086	0.148	0.105	0.150

Notes: standard errors clustered by year of first labour market entry in paretheses. *** p<0.01, ** p<0.005, * p<0.1

Table A5. Placebo results

	No bandwidth	**1992 - 1999**	**1993 - 1998**
	Disability Take-up *(within 12 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 12 months)*
LATE **(threshold 1993)**	-0.009	0.009	0.014
	(0.024)	(0.032)	(0.028)
LATE **(threshold 1996)**	-0.011	-0.034	-0.051
	(0.027)	(0.029)	(0.029)
Covariates	✓	✓	✓
Region of work dummies	✓	✓	✓
Linear trends	✓	✓	✓
Obs.	9,150	1,161	800

Notes: standard errors clustered by year of first labour market entry in parentheses. *** p<0.01, ** p<0.005, * p<0.1

Table A6. DI participation and Employment response *without immigrant population*

	No bandwidth		1992 - 1999		1993 - 1998	
	Disability Take-up *(within 12 months)*	**Disability Take-up** *(within 24 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 24 months)*	**Disability Take-up** *(within 12 months)*	**Disability Take-up** *(within 24 months)*
LATE (after 1995)	-0.075***	-0.079**	-0.138***	-0.210***	-0.149***	-0.154***
	(0.022)	(0.036)	(0.014)	(0.031)	(0.016)	(0.022)
Covariates	✓	✓	✓	✓	✓	✓
Region of work dummies	✓	✓	✓	✓	✓	✓
Linear trends	✓	✓	✓	✓	✓	✓
Obs.	8,474	7,389	934	800	642	544
R-squared	0.123	0.129	0.208	0.221	0.245	0.247
	Employment *(t+1)*	**Employment** *(t+2)*	**Employment** *(t+1)*	**Employment** *(t+2)*	**Employment** *(t+1)*	**Employment** *(t+2)*
LATE (after 1995)	-0.004	0.037	-0.007	0.046	0.005	0.031
	(0.029)	(0.034)	(0.039)	(0.047)	(0.039)	(0.056)
Covariates	✓	✓	✓	✓	✓	✓
Region of work dummies	✓	✓	✓	✓	✓	✓
Linear trends	✓	✓	✓	✓	✓	✓
Obs.	8,474	7,389	934	800	642	544
R-squared	0.055	0.110	0.090	0.167	0.106	0.174

Notes: standard errors clustered by year of first labour market entry in paretheses. *** p<0.01, ** p<0.005, * p<0.1

Appendix B

Pension calculations under different schemes

The DB benefit resulted from the product of three factors: pensionable earnings, years of contributions, and annual return. Slightly different rules apply for years of work until 1992 (quota A) and afterwards (quota B). Pensionable earnings are the average wage of the last years of work. Included wages are converted in real terms and supplemented with a further return of 1% per year (only quota B). For private sector employees, the number of years to account for in the computation of pensionable earnings was equal to five until 1992 (quota A), and gradually increased up to ten in the following years (quota B). Years of contributions are topped to 40. In addition to regular payments, they include notional payments from selected welfare schemes such as maternity leave and unemployment. Annual return is a decreasing function of pensionable earnings, equal to 2 per cent for a large part of the earnings distribution.

The NDC pension formula is based on the contributions of the entire working career (plus notional contributions). The payroll tax rate has dramatically increased over the last decades, reaching a value of 33% of the wage since 1995. Payroll taxes are capitalized at the GDP nominal growth rate. The notional capital which is available at the time of DI receipt or at retirement is converted into an actuarially fair annuity through claiming age-specific coefficients. Actuarial fairness is guaranteed in that retiring or receiving a DI pension earlier in life is associated with a lower coefficient and thus pension for a longer period. Conversion coefficients are updated annually to reflect changes in life expectancy.

As said earlier, the same computational rules apply to old-age, survivors', early retirement and the ordinary DI benefit. The disability pension is even more generous because a "contributory bonus" - equal to the years of contributions from the age of claiming to the age of 60 - is added to the contributory years (slightly different formulas are applied to account for this bonus in the DB and NDC schemes).