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Retirement Pensions and Disability Insurance for the 21st Century

Tom Zawisza

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Tom Zawisza
University College London

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Michigan Retirement and Disability Research Center, University of Michigan, P.O. Box 1248. Ann Arbor, MI 48104, mrdrc.isr.umich.edu, (734) 615-0422

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Retirement Pensions and Disability Insurance for the 21st Century

Abstract

This project estimates the degree of disability risk among the United States and English over-50 populations. Using a disability measure that closely matches the criteria used by English and U.S. disability systems, we find both higher levels of disability in the U.S. and higher levels of disability risk in the U.S. Furthermore, we estimate spillovers between disability insurance and retirement pension program in the context of the increase in the United Kingdom retirement age for women in the years 2010 to 2019. We document that, despite a significant increase in disability benefit take-up among disabled individuals who would have been otherwise retired, these individuals experienced large losses in household income. Healthy individuals, in contrast, experienced much smaller losses in income, as they responded to the increase in the retirement age by increasing their labor-force participation. Finally, we develop a dynamic model of labor supply, social security benefits, and savings to evaluate the U.K. disability benefit system in the context of the U.K. retirement reform. This model uses as its inputs the parameters of the disability process we have estimated, and is estimated to match the responses to the reform. It can then be used to evaluate other joint reforms of disability and retirement program.

Citation

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1. Introduction

In order to alleviate fiscal pressures due to population aging, many OECD countries have increased the state pension age. *Prima facie,* most individuals affected by increases in the retirement age can continue to work if they are able to do so, or rely on their personal savings if they prefer retiring before the full retirement age. The subset of individuals unable work due to disability and without sufficient personal resources can instead apply for disability benefits until they reach the new retirement age.

However, the level of disability benefits are often lower than pension benefits. Moreover, since it is often impossible to perfectly screen for disability, disability systems exhibit type I and type II errors. Type I errors refer to false positive, i.e., individuals who are not disabled receiving disability benefits. Type II errors refer to false negatives, i.e., individuals who *are* disabled but who are denied disability benefits. In principle, therefore, the implications of retirement age reforms for those who are unable to continue working importantly depend on features of the disability benefit system, specifically their ability to obtain disability benefits and the level of these benefits, which now replace pensions as a source of income.

A key policy question therefore arises on whether government-provided disability benefit systems should change in the face of these retirement age increases. This is made all the more pressing as it is also well-known that the prevalence of disability increases with age. Thus, the further into old-age the retirement age is increased, the larger is the fraction of individuals who, in the absence of pension benefits, would need to rely on disability benefits for income. There is evidence that the large increase in retirement age from 65 to 66 in the United Kingdom has doubled poverty rates among those age 65 in the U.K.[1] What is unclear is whether this reflects individuals' choices to not work or retire early, or whether this stems from individual's being *unable* to work.

Using data sets from the United States and England, this project seeks to estimate to what extent increases in the retirement age, aimed at encouraging older workers to continue working in old age, have adverse consequences for disabled individuals. Furthermore, we aim to use these findings to understand whether certain disability benefit systems may be better at alleviating any adverse consequences of retirement age reforms. In contrast to many earlier papers, we look at disability and pension systems *together*. We focus on the U.S. and U.K. as the countries have disability insurance systems which differ in important ways, and therefore one of these may perform better than the other in the face of retirement age reforms. As a first step, we develop a disability measure using harmonized data for the U.S. and England, which closely matches the criteria used to ascertain disability in both countries. Second, we estimate the degree to which individuals switch between pension benefits and disability benefits in the context of a large increase in the retirement age for women in the U.K. These estimates, as well as our estimates of the disability benefit system, then allow us to develop a model of labor supply, benefit claiming, and savings behavior. This model can be used for evaluating how alternative disability insurance systems perform in the face of retirement age increases.

Looking at the U.K. and U.S. from a comparative perspective is fruitful because both state pensions and disability benefits differ significantly. In the U.S., both pensions and disability benefits are closely linked to past earnings. In contrast, in the UK,

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[1] See Cribb and O'Brien (2022) and Financial Times article https://www.ft.com/content/0466980f-8d92-425c-9930-8014a1c85da6

pensions and disability benefits are largely flat-rate. However, in contrast to the US, some disability benefits in the U.K. are not means tested and so, in principle, provide less of a work disincentive. Similarly, individuals are not penalized for working and drawing pensions at the same time. Which system performs better in the context of increases in the retirement age is a critical question. Moreover, it makes critical devising comparable disability measures, as to compare the systems it is important to control for differences in disability outcomes between the two countries.

This project links to several existing literature strands. A number of papers have focused on estimating the effects of the U.K. pension reforms on employment and retirement outcomes, including Cribb et al. (2016) and Maccuish (2022). In contrast, this project focuses on the implications of the pension reform on individuals with disabilities that may prevent them from finding employment in lieu of receiving the state pension. The model of measuring disability we use here relates to a large literature on disability measurement, a prominent recent example of which is Hosseini et al. (2022). Our emphasis is to approximate as closely as possible the assessment criteria for work capacity in our measure. However, like Hosseini et al., we derive time-series properties and measures of life-cycle disability risk. The comparative approach between the U.S. and England we adopt here resembles that taken by Banks et al. (2016), who examine health status differences between England and the U.S. Finally, the model of disability and retirement we develop relates to a literature that attempts to draw policy conclusions on disability systems using life-cycle models (Low and Pistaferri 2015; Chen and van der Klaauw 2008). Unlike these papers, we focus on the interaction between the retirement and disability insurance. A paper in a similar vein, albeit taking a theoretical mechanism-design approach, is Denk and Michau (2018). Our contribution is to evaluate disability and retirement age programs jointly in an empirically-grounded model.

The rest of the paper is structured as follows. Section 2 describes the main features of the U.S. and U.K. state pension systems and disability systems, as well as key system changes that occurred over time. In particular, it describes the largest change in either country, namely the increase in the retirement age for women from 60 to 66, which occurred in in the U.K. between 2010 and 2021. Section 3 describes the principal data sets we use in the project. In Section 4, we outline a lynchpin of our empirical analysis, namely how we estimate individuals' disability state using state-of-the-art factor analysis models. Our estimates of the effects of the U.K. retirement-age reform on individual and household outcomes, and in particular on substitution between pension and disability benefits, are presented in Section 5. Section 6 develops the life-cycle model which to be calibrated using our estimated disability process, and estimated to match the responses to the U.K. retirement reform. Section 7 summarizes the current main findings of the project.

2. Disability and retirement pension systems in the U.S. and U.K.

The state disability benefit and retirement pension systems in the U.S. and U.K. are different in important respects. The state pension in the U.K. is mostly a flat benefit, while in the U.S. it increases based on life-time earnings.[2] Specifically, in the US,

[2] The level of the basic state pension in the U.K. was £185.15 (about $229 in 2022 USD) per week in 2022 for individuals with 35 qualifying years. An exception to the pension being a flat-rate benefit in the U.K. are individuals who contributed to the State Earnings Related Pension Scheme (SERPS) in the years 1978 to 2002, and the State Second Pension between 2002 and 2016. The generosity of these additional pensions has declined with time. Additionally, the government has allowed individuals to "contract out" of these additional pensions if they join a private pension plan.

beneficiaries receive indexed monthly pension payments based on taxable earnings averaged over up to 35 years of earnings (so called Averaged Indexed Monthly Earnings or AIME). Contributions in the U.S. are paid up to the benefit base in each year ($147,000 for income in 2022). While in the U.K. individuals can receive retirement pensions and work without penalty, in the U.S. there is a limit to how much an individual can earn and receive pension benefits without penalty. In 2022, this limit on earnings was $51,960 for those who retire at full retirement age (FRA).

Retirement age reforms

Key changes have occurred in recent decades in both the U.S. and U.K. in terms of the retirement age. In the U.S,, based on 1983 Social Security Amendments, there has been a gradual increase in the Social Security FRA from 65 to 67 for both men and women. The changes are gradual, and increase the retirement age for men and women by two months for every birth-year cohort between 1938 (for whom the retirement age was increased to 65 years and two months) and 1943 (for whom the retirement age was 66), and between 1955 and 1960 (for whom it was increased from 66 years and two months to 67 years).

In the UK, the pension eligibility age is formally called the State Pension Age (SPA). The SPA is also the earliest age at which the state pension can be drawn, and so is therefore sometimes known as the “early retirement age.” Before 1995, the retirement age in the U.K. was 60 for women and 65 for men. A reform announced in 1995 increased women’s SPA from 60 to 66 between the years 2010 to 2020. The reform was introduced by cohort, such that only cohorts born after June 1950 were affected. A further reform introduced in 2011 implemented the increase of the SPA for even younger cohorts. Figure 1, drawn from Cribb et al. (2016), shows the retirement age for women for each cohort born between January 1950 and April 1955, according to both the 1995 reform and the 2011 reform.

Disability insurance systems

In the US, eligible disabled individuals can receive money through two programs: Social Security Disability Income (SSDI) and Supplemental Security Income (SSI). SSDI pays benefits to those who are "insured" based on their contributions to Social Security from via payroll taxes on their earnings. Benefit amounts are determined according to the same AIME formula as for retirement pensions. SSI provides additional income to those with limited income. The definition of disability is the same for both programs. Individuals must be unable to engage in "substantial gainful activity" (SGA) for medical reasons. In 2022, the SGA threshold for nonblind disabled was $1,350; individuals earning more than that amount are ineligible for SSDI. Nonmedical eligibility (age, Social Security coverage, etc.) is determined by local field offices and federally funded state agencies, known as Disability Determination Services (DDS), evaluate the medical evidence for disability. For 2022, the benefit amount for SSI is $841 for an individual and $1,261 for a couple.

While the U.S. federal disability program has a disability benefit system contingent on not being able to work[3], in the U.K. disability benefit system features benefits both contingent on not being able to work and unconditional benefits. The former type of U.K. disability benefit has been known in turn as Invalidity Benefit (1971 to 1995), Incapacity Benefit (IB, from 1995) and the Employment and Support Allowance (ESA, gradually replacing IB from 2008). Finally, from 2017 onward the ESA

[3] Specifically, they are contingent on not being able to receive a threshold of earnings known as Substantial Gainful Activity.

has gradually been replaced by the “limited capability for work-related activity” component of a new multipurpose benefit named Universal Credit (UC) for new applicants. Individuals receive this part of UC if they have a ”severe, lifelong disability,” and are placed in a category known as the Support Group. However, despite the changing names of these systems, their basic structure has remained unchanged. IB, ESA, and the disability component of UC have all been awarded subject to passing a Work Capability Assessment. As of 2022, the amount of UC an individual could receive amounted to £335+354 (about $415+$439 2022 USD) per month for a single individual and £526+354 ($652+$439) per month for an individual living with their partner.

Reassessments

In the U.K., individuals on UC in the Support Group are not required to undergo periodic reassessment. In the U.S., disability status is reviewed every five to seven years if the medical condition is not expected to improve, and at least once every three years otherwise.

The unconditional component of disability benefits is known as Personal Independence Payment (PIP).[4] It is an additional disability benefit designed to support disabled individuals facing higher living costs due to difficulties in mobility and carrying out everyday tasks. Individuals apply by providing information on how the disability impacts their life, and their applications are assessed by a health professional. Importantly, unlike IB/ESA/UC’s disability component, entitlement for PIP is unrelated to income and employment. Depending on the severity of the disability, individuals can

[4] Before 2013, the nonmeans-tested benefit was known as the Disability Living Allowance (DLA).

receive between £1,270 ($1,575) and £8,160 ($10,118) annually (see Joyce et al. 2022).

Interaction between disability and retirement systems

From 1995 onward, individuals cannot receive work-related disability benefits after reaching the SPA in the U.K. In the US, on reaching the full retirement age disability benefits automatically convert to retirement benefits. Since the formula for calculating SSDI and the U.S. retirement pension is effectively the same, the amount received remains unchanged. Thus, in both countries, disability benefits in general are a form of preretirement social insurance.

Assessing capacity to work

An individual's application for SSI/SSDI benefits in the U.S. goes to a state Disability Determination Service (DDS). The application is then scrutinized by DDS employees, as well as vocational and medical consultants if needed, to determine whether the person is disabled (see Chen et al. 2008, for details of the procedure). Eligibility is established based on whether the individual is capable of performing SGA, and depends on an estimate of the individual's residual functional capacity (RFC). In addition to the details of the individual's impairment, the assessment incorporates the applicant's age, education, past employment, and whether the individual has a condition which is listed in a special list of particularly severe impairments.[5] In the UK, the analogous procedure to determine eligibility for ESA and the disability component of UC

[5] The catalogue of listed impairments can be found on the SSA website: https://www.ssa.gov/disability/professionals/bluebook/general-info.htm

has been known since 2008 as the Work Capability Assessment (WCA).[6] The test seeks to establish whether, on balance of probabilities, an individual could not reasonably be expected to work. If evidence provided by the applicant is not deemed sufficient, a health care professional arranges a face-to-face assessment by a nurse, doctor, or physiotherapist. Unlike the U.S., testing in the U.K. is performed by a private company which relies on a computer program designed with input from the Department for Work and Pensions (called the "Logic-integrated Medical Assessment").

An examination of the forms filled out by applicants and assessors in the U.K. and U.S. show both systems crucially seek to establish an applicant's ability to perform basic daily functions. For instance, the Capability for Work questionnaire filled out by applicants undergoing WCA assessments in the U.K. asks whether the applicant can "move safely and repeatedly on level ground without needing to stop," "go up or down two steps without help from another person, if there is a rail to hold on to," whether they can lift one of their arms above their head, and how long can they "stay in one place and be pain free without the help of another person" while standing or sitting. Likewise, the form SSA-4734-BK used by U.S. assessors for the RFC test seeks to establish what weight an individual can occasionally and frequently "lift and/or carry," "push and/or pull (including operation of hand and/or foot controls)," how long they can "sit (with normal breaks) ," and how long they can "stand and/or walk (with normal breaks)." As will be seen in Section 4, we base our disability measure on survey questions concerning very similar capabilities.

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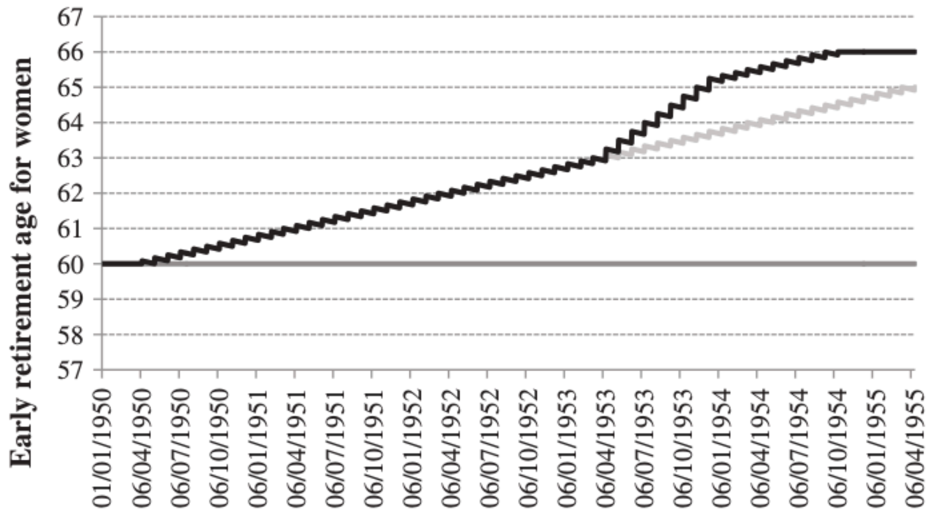
[6] Prior to 2008, eligibility for the earlier IB was determined on the basis of the All Work Test, carried out by doctors. However, officials could also award IB on the basis of information provided by applicants and their family doctors (General Practitioners, or GPs) without requiring the All Work Test. Individuals in our data set are all subject to the WCA.

Figure 1: Retirement age for women of different birth dates in the U.K.



Note: Women born in a given month were allocated a single "state pension date" at which they were eligible. Thus, women born later in a month have a slightly lower ERA than those born earlier in the month, leading to a "sawtooth" pattern. The light grey line denotes retirement age under the 1995 Pensions Act, while the black line denotes retirement age under the 2007 Pensions Act. Source: Cribb et al. (2016).

3. Data description

We use two principal data sets for our empirical analysis: the Health and Retirement Study (HRS) for the U.S. and the English Longitudinal Study of Ageing (ELSA) for studying the effects of the U.K. reform. Both of these data sets are nationally representative samples of people aged 50 and above, and have detailed socioeconomic outcome and functional limitation information. Since we are interested in comparability between the U.S. and English data sets, we leverage the fact that ELSA was deliberately designed to have a structure similar to the HRS. For measurement of the disability state, we make use of both men and women in ELSA and the HRS. For estimation of responses to the U.K. retirement age increase, as well as calibration and estimation of the life-cycle model, we focus solely on women in the ELSA sample.

HRS

We use the RAND version of the HRS data set, covering the years 1992 to 2018. The HRS originated in 1992 as a panel survey of a nationally representative sample of individuals ages 51 to 61. Since 1992, the sample has been supplemented with additional cohorts, such that by 2018 seven cohorts have been interviewed. It is currently a nationwide survey of individuals over age 50 and their spouses conducted every two years. It contains information about demographics, income, assets, health, cognition, family structure, health care utilization and costs, job status and history, expectations and insurance. Crucially, it contains detailed questions on the ability to perform functions very similar to those assessed in the U.K.'s WCA and at the U.S.' DDS stage. We also make use of information on labor market circumstances, earnings, as well as asset holdings.

ELSA

ELSA is a panel data set on a representative sample of the English population 50 and older. Like the HRS, on which it is modeled, it contains detailed information on demographics, income, assets, health, cognition, family structure, health care utilization and costs, job status and history, expectations and insurance. We use ELSA waves 5 (2010 to 2011) through to 9 (2018 to 2019), which cover the period during which the U.K. retirement reform was implemented. To ensure comparability, we select only the same functional limitation questions also found in the HRS.

4. Disability risk in the U.S. and U.K

In this section, we explain our methodology for constructing the disability indicator we use in our empirical analysis and our life-cycle model, and the relationship between our estimated indicator and the disability assessment criteria in the U.S. and U.K.

Factor model for measuring disability

Our goal is to obtain a disability measure that captures the functional limitations feature in both the U.S. and U.K. assessments of work capacity. To do so, we exploit the commonality between the ELSA and HRS data sets to arrive at a common disability measure for both the U.S. and U.K. populations, allowing comparisons between them. As there are multiple questions available in the data sets which are designed to capture different types of limitations, but which may be highly correlated, we use factor analysis methods following Cunha et al. (2010) and Agostinelli and Wiswall (2016a).

To obtain an estimate of disability we consider the following measurement model:

$$Z^*_{i,t,m} = \mu_m + \lambda_m \theta_{i,t} + \epsilon_{i,t,m} \tag{1}$$
$$Z_{i,t,m} = 1\left[Z^*_{i,t,m} > 0\right]$$

For each age t of individual i, $Z_{i.t.m}$ is a binary variable indicating some functional limitation m. This is determined by the latent variable $Z^*_{i,t,m}$, which is assumed to be a linear function of the parameter μ_m, and the factor loading $\lambda_m > 0$ associated with the underlying disability factor $\theta_{i,t}$. To estimate (1) within a logit framework, we assume that the individual measurement error $\epsilon_{i,t,m}$ follows a mean zero logistic distribution. In this way, we are able to capture the binary nature of the limitation indicators while allowing for a continuous underlying disability state.

In estimating (1), we maintain the following initial period normalizations, which are necessary for identification of the remaining parameters in the model (see Agostinelli and Wiswall 2016b):

i. $E[\theta_{i,50}] = 0$

ii. $Var[\theta_{i,50}] = 1$

We proceed in two steps. Firstly, we estimate the factor measurement model in (1) and obtain estimates of μ_m and λ_m for each limitation. Secondly, given these parameters, we use an Empirical Bayes procedure to get a prediction for the one-dimensional individual disability indicator, denoted by $\hat{\theta}_{i,t}$. We are then able to use this variable to estimate both the deterministic and stochastic components of the disability process.

We select the limitation indicators in our model to match most closely the functional criteria of the U.K. and U.S. disability assessments. To estimate this model, we use pooled data from HRS and ELSA and include the five measurement variables indicated in Table 1 that have harmonized definitions between the data sets. It is important to note that Equation (1) is estimated on the ELSA and HRS populations who are ages 50 to 51. By assumptions i. and ii. above, this means the disability indicator is centered on 0 and normalized to have a variance of 1 for those ages 50 to 51. In the second step, we predict the disability indicator for *all* individuals, irrespective of age. This means that for ages above 50-51 the mean and variance of the disability indicator can differ from 0 and 1, respectively. Table 1 presents our estimates of the parameters in the Equation (1).

Table 1: Factor measurement model, functional limitations

Pushing or pulling large objects	(1)
Latent factor loading, λ_1	5.136***
	(0.129)
Constant, μ_1	-7.539***
	(0.203)
Sitting for about 2 hours	
Latent factor loading, λ_2	2.016***
	(0.033)
Constant, μ_2	-3.419***
	(0.057)
Reaching arms above shoulder level	
Latent factor loading, λ_3	2.446***
	(0.043)
Constant, μ_3	-4.872***
	(0.080)
Lifting or carrying weights over 10 lbs	
Latent factor loading, λ_4	4.275***
	(0.091)
Constant, μ_4	-6.610***
	(0.153)
Stooping, kneeling, or crouching	
Latent factor loading, λ_5	2.179***
	(0.035)
Constant, μ_5	-2.516***
	(0.054)
N	41,216

Column (1) shows the point estimates from the regression; standard errors are below in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Deterministic component

To obtain the parameters from disability's deterministic component, we estimate the following model:

$$\hat{\theta}_{i,t} = \boldsymbol{x}'_{i,t}\boldsymbol{\beta} + \sum_{j=1}^{4} \gamma_j \, age_{i,t}^{j} + \sum_{j=y_1}^{Y} \delta_j D_{i,t}(j) + R_{i,t} \tag{2}$$

For each age t of individual i, we use predicted disability $\hat{\theta}_{i,t}$ as the dependent variable, a vector of deterministic covariates $\boldsymbol{x}_{i,t}$ including dummies for gender, marriage status, and educational level, a fourth-order age polynomial, and a set of year fixed-effects denoted by dummy variables $D_{i,t}(j)$ that equals 1 if $year = j$, and 0 otherwise. Finally, the stochastic portion of the disability measure is captured by $R_{i,t}$. The estimation of Equation (2) by OLS gives us the residuals $\hat{R}_{i,t}$ which we will use to estimate the parameters associated with the stochastic component of the disability process. Standard errors are clustered at the individual level.[7]

Our estimates of the coefficients on the deterministic drivers of disability are presented in Table 2. The first column shows our estimates for the U.S. using the HRS, while the second shows our estimates for England using ELSA. For interpretation of the coefficients, note that the disability indicator is normalized such that, by construction, it has a standard deviation of 1 for the population of individuals aged 50-51. Furthermore, an increase in the disability indicator represents a deterioration in functioning. Thus, based on the first row of Table 2, being female in the U.S. is associated with having a

[7] We currently do not control for selection due to death. We will do so in an extension of this paper following the methodology of Hosseini et al. (2022).

0.356 higher (worse) disability score, i.e., just over one-third of the standard deviation in the data at ages 50 to 51, while for England the number is 0.284 higher. Rows 3 and 4 of Table 2 also show a strong socioeconomic gradient in disability outcomes, and that this gradient is more severe in the U.S. than in England. For instance, college graduates in the U.S. have a disability score which is 0.505 lower than the reference group of those who did not graduate from high-school. In contrast, the disability score for college graduates in the U.K. is only 0.345 points lower.

The relationship between the disability score and age is illustrated graphically in Figures 2 and 3 using binned scatter plots. Figure 2 plots the mean disability score for women between the ages of 50 and 90 for the HRS and ELSA separately. Figure 3 does the same for men. The two figures show significant differences in disability scores by age and between countries. For women, we can see that the mean disability score steadily increases between ages 50 and 90 by about 1.0 to 1.2 of the standard deviation at ages 50 to 51. The decline is slightly smaller for men. Strikingly, we see very large difference in mean disability between England and the U.S. at almost all ages. For instance, for women, the average disability score in the U.S. at age 50 is equivalent to the average disability score in England at 67. Similarly, the average disability score for men in the U.S. at age 50 is equivalent to the average score in England 70.

Table 2: Disability process, deterministic component parameters

	U.S. (HRS)	U.K. (ELSA)
1. Male	-0.356***	-0.284***
	(0.008)	(0.012)
2. Married	-0.186***	-0.149***
	(0.009)	(0.015)
3. High school graduate or some college	-0.271***	-0.197***
	(0.011)	(0.015)
4. College graduate or above	-0.505***	-0.345***
	(0.012)	(0.017)
5. Constant	11.979*	0.729
	(6.116)	(9.313)
Fourth-order age polynomial	Yes	Yes
Year FE	Yes	Yes
N	119,889	40,192

Standard errors in parentheses are clustered at the individual level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 2: Disability life-cycle profile for women

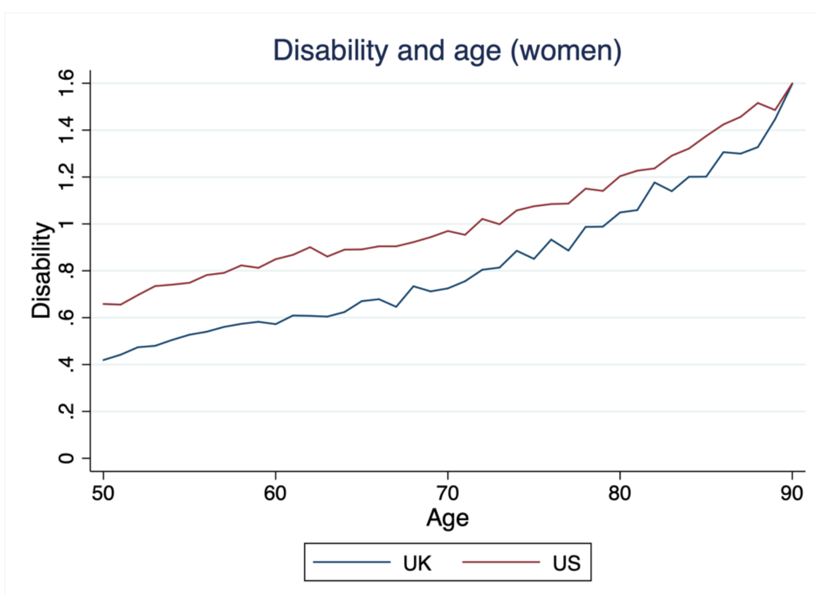
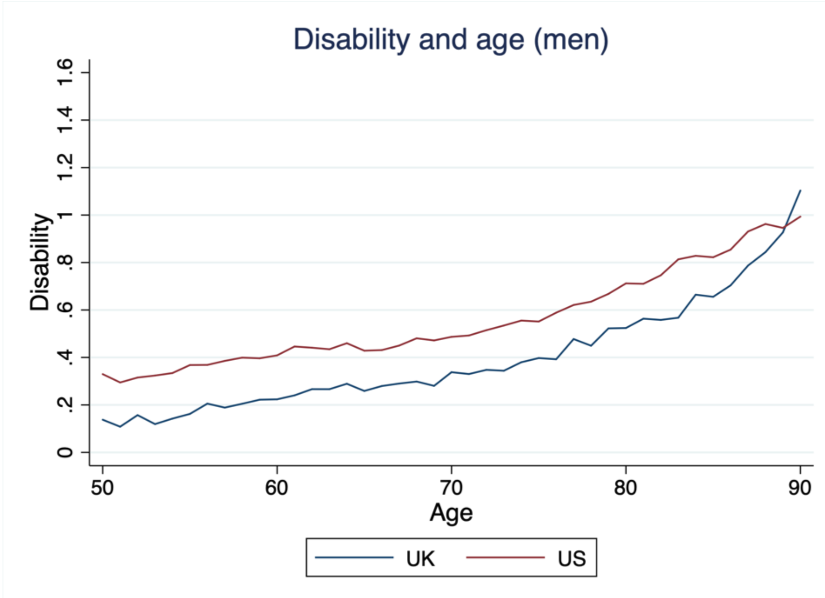


Figure 3: disability life-cycle profile for men



Stochastic component

To estimate the parameter of disability's stochastic component, we assume that the stochastic component of the disability factor $R_{i,t}$ follows the model given by:

$$R_{i,t} = \eta_{i,t} + u_{i,t}$$

$$\eta_{i,t} = \rho\, \eta_{i,t-1} + \varepsilon_{i,t}$$

where $R_{i,t}$ combines transitory and persistent shocks $u_{i,t} \sim N(0, \sigma_u^2)$ and $\varepsilon_{i,t} \sim N(0, \sigma_t^2)$, respectively. The distributions of these shocks are taken over individuals i, and, for ease of exposition, we omit the subscript i from here on.[8]

We are interested in estimating the persistence parameter ρ as well as σ_u^2 and σ_t^2 for $t = 0, \dots, T$. To do so, we derive from the model a set of equations describing the covariance structure of the disability process:

[8] Here, we omit the "hat" notation for $R_{i,t}$ — any measurement error involved in estimating this variable will be captured by the transitory component $u_{i,t}$.

$$E[R_t^2] = \sigma_u^2 + \underbrace{\sigma_t^2 + \sum_{j=0}^{t-1} \rho^{2(t-j)} \sigma_j^2}_{\sigma_{\eta_t}^2} \tag{3}$$

$$E[R_t R_s] = \rho^{s-t} \sigma_{\eta_t^2} \tag{4}$$

for $s > t$. Subsequently, we use these moments to estimate our parameters of interest in a generalized method of moments framework. See Appendix A for further details of the estimation procedure.

Table 3 shows our estimates of the parameters of the stochastic component of disability, i.e., the component of disability that cannot be explained by demographic variables we observe in the data. In the first row, we show estimates of the variance of the transitory component, which is slightly higher in the U.S. data set than in the English data set. The second row shows the variance of the persistent component of disability at age 50, the age we first observe individuals in either data set. Note that the dispersion of disability is over 40% higher in the HRS, at 0.414, than in ELSA, at 0.284. The estimates in the third row show that persistent shocks in ELSA have a higher degree of persistence, at 0.939, than in the HRS, at 0.904. On the other hand, the variance of the persistent shocks in the HRS is over 40% larger in the HRS, at 0.080, than in ELSA, at 0.056.

Table 3: Disability Process - Stochastic Component Parameters

	U.S. (HRS)	U.K. (ELSA)
$\boldsymbol{\sigma_u^2}$	0.175***	0.142***
	(0.008)	(0.011)
$\boldsymbol{\sigma_{50}^2}$	0.414***	0.284***
	(0.010)	(0.013)
$\boldsymbol{\rho}$	0.904***	0.939***
	(0.016)	(0.029)
$\boldsymbol{\sigma^2}$	0.080***	0.056***
	(0.014)	(0.020)
N	125894	43080

Standard errors in parentheses are clustered at the individual level.

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

5. Effects of U.K. retirement reform

In this section, we show how the increase in the U.K.'s state pension age affected healthy and disabled individuals in England using ELSA. The model we develop in Section 6 is estimated to match the observed responses documented here in terms of employment rates and the take-up of disability benefits.

We estimate responses to the U.K. retirement reform with the following two-way fixed effects model, based on Cribb et al. (2016):

$$y_{it} = \beta T_{it} + \gamma_t + \sum_{a}^{A} \delta_a \mathbf{1}(age_{it} = a) + \boldsymbol{x'}_{it}\boldsymbol{\alpha} + e_{i,t} \tag{5}$$

where y_{it} is the outcome of interest, T_{it} is a dummy for an individual being eligible for the state pension, γ_t are year fixed effects, δ_a are age dummies, and $\boldsymbol{x}_{it}$ is a vector control including marital status and education. Under the assumption of age-constant year effects and age-constant year effects, the parameter β is a difference-in-differences estimator where the treatment is being below the SPA. Identification stems from the fact that due to the cohort-based introduction of the reform, for neighboring cohorts, some individuals of a given age would have been eligible for the state pension, while younger cohorts at the same age were not. In order to minimize the risk of non-reform related interactions between age and cohort effects, we restrict the sample to those around the SPA, specifically to women ages 60 to 66, in the years 2010 to 2019. For our outcomes of interest, we focus on labor-force participation (working or looking for work), receiving the state pension, weekly earnings, whether or not individuals receive disability benefits (IB or ESA), as well as overall household income.

Table 3 reports our treatment effect estimates for the sample of all women. Column 1 shows that the reform had the effect of increasing labor-force participation by 12 percentage points from a baseline of 20%. In Column 2, we see that, as expected, increasing the state pension age almost completely deprived the affected individuals from access to the state pension, with state pension receipt falling from 93 percentage points to almost 0. In line with the increase in labor-force participation, weekly earnings increased by £28.70 ($35.59). However, in Column 5 we observe that the increase in earnings did not offset the reduction in transfers, with an overall fall in household income of £104.16 ($129.16). Column 4 reports the change in the take-up of disability benefits as a result of the reform, finding an increase of 7 percentage points from a baseline of 0. In Figure 4, we illustrate graphically how we arrive at this estimate.[9] We plot the disability benefit receipt rate between the ages of 60 and 70, in the year 2010

[9] Here, the larger sample of the Labour Force Survey (LFS) is used. Unfortunately, it does not have detailed information on disability status, hence we only use it for this graphical illustration.

(when the women's SPA was 60) and 2019 (when it had increased to 65). The observed increase in disability benefit closely matches the difference-and-differences estimate using ELSA data.

In Tables 4 and 5, we estimate the model for healthy and disabled individuals separately. We defined disabled individuals as having a disability score higher than the lowest possible value (in other words, they report at least one of the five limitations). This allows us to maximize the sample size of individuals in the disabled subsample, while still allowing us to examine heterogeneity between the two groups. Comparing Columns 2 in Tables 3 and 4, we can see that the SPA reform led to similar falls in levels of state pension receipt among both healthy and disabled individuals. However, Columns 1 and 3 show that the increase in labor force participation and earnings were concentrated in the subsample of healthy individuals. Specifically, healthy individuals reported an increase in participation of 14 percentage points, from a baseline of 21 percent, and an increase in weekly earnings of £34 ($42). By contrast, disabled individuals are estimated to have increased their participation by 8 percentage points from a baseline of 11%, and increased earnings by £16 ($20). However, these estimates are not statistically significant. We observe the greatest contrast between the two subsamples in disability benefit receipt and household income. Among healthy individuals, disability benefit receipt increased by 2 percentage points from a baseline of 0, while household income fell £86 ($107) from a baseline of £605 ($750). On the other hand, among disabled individuals, the SPA reform led to an increase in disability benefit receipt rates of 26 percentage points, from a baseline of 2%, and almost twice the drop in weekly household income of £152 ($189), from a baseline of £526 ($652). Overall, we find that disabled individuals were much more likely to transition onto disability benefit than into labor force participation in response to the reform. Nonetheless, they experienced a much higher reduction in incomes than healthy individuals.

It should be emphasized that the results on disability benefit receipt reported here do not only reflect the phenomenon of individuals who were previously on disability benefits simply continuing to receive disability benefits, instead of transitioning onto the state pension. If we change the dependent variable to be the *transition* onto disability benefits, as opposed to simply receiving them, we find an estimated treatment effect of a 6 percentage point increase in transitions onto disability benefits among disabled individuals. Due to small sample size, this effect is only statistically significant at the 20% level. Nonetheless, it suggests that the pension reform meant that individuals who would have previously received the state pension instead applied and received disability benefits.

These results do not necessarily demonstrate that some disabled individuals, who could not work, did not find an appropriate alternative to the state pension in the form of disability benefits and experienced a large fall in household income as a result. In principle, the reduction in household income could simply reflect the choice of individuals with some disability to not work, even though they could have sought out work. To evaluate the adequacy of disability insurance at the time of the U.K. pension reform, we turn in the next section to a quantitative life-cycle model, in which individuals make choices to work, consume, and apply for disability benefits. The estimated responses to the reform presented here in terms of labor force participation and disability benefit receipt will instead be used to estimate key parameters of the model.

Table 3: Responses to U.K. increase in SPA (all women)

	(1) LFP	(2) State pension	(3) W'kly earnings (£)	(4) Disability bft.	(5) HH income (£)
β	0.122** (0.043)	-0.895*** (0.020)	28.70* (16.36)	0.070*** (0.017)	-104.16*** (31.68)
Baseline av.	0.197	0.934	53.08	0.006	590.69
Individuals	1,504	1,504	1,504	1,504	1,494
Observations	2,312	2,312	2,312	2,312	2,284

Values in columns (1), (2), and (4) are probability of receipts; values in columns (3) and (5) are in GBP. Standard errors in parentheses are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Responses to U.K. increase in SPA (women with the lowest disability score)

	(1) LFP	(2) State pension	(3) W'kly earnings (£)	(4) Disability bft.	(5) HH income (£)
β	0.135*** (0.049)	-0.902*** (0.044)	34.16* (18.77)	0.022** (0.011)	-86.53** (35.88)
Baseline av.	0.214	0.954	59.33	0.002	604.67
Individuals	1,257	1,257	1,257	1,257	1,249
Observations	1,868	1,868	1,868	1,868	1,844

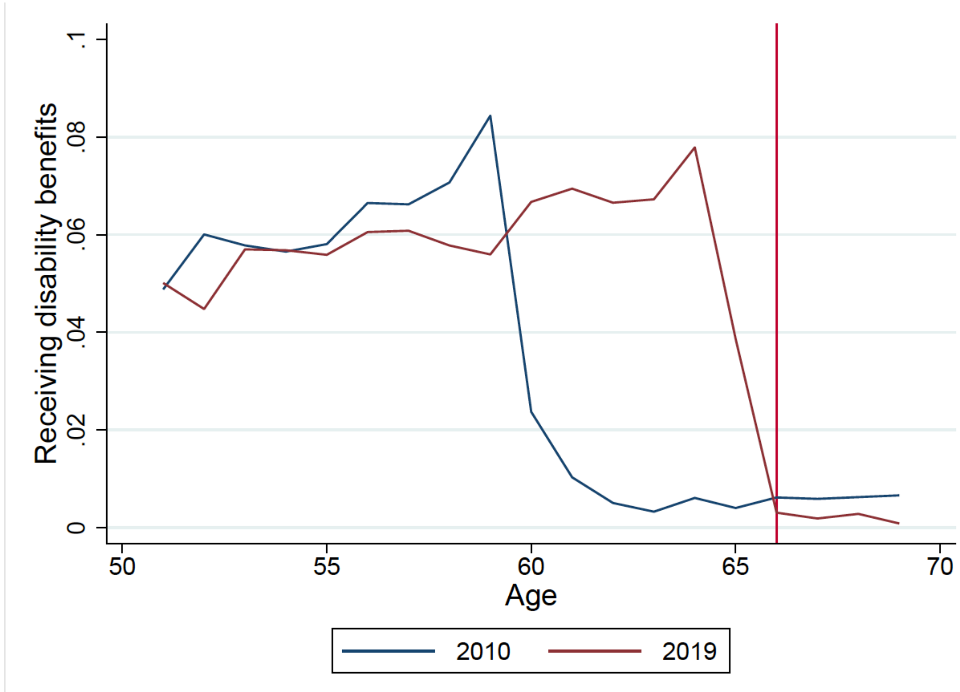
Values in columns (1), (2), and (4) are probability of receipts; values in columns (3) and (5) are in GBP. Standard errors in parentheses are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Responses to U.K. increase in SPA (women with some disability)

	(1) LFP	(2) State pension	(3) W'kly earnings (£)	(4) Disability bft.	(5) HH income (£)
β	0.084 (0.073)	-0.894*** (0.022)	15.50 (23.60)	0.258*** (0.065)	-152.49*** (58.10)
Baseline av.	0.114	0.930	23.90	0.023	525.90
Individuals	344	344	344	344	342
Observations	444	444	444	444	440

Values in columns (1), (2), and (4) are probability of receipts; values in columns (3) and (5) are in GBP. Standard errors in parentheses are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1

Figure 4: Response to women's U.K. retirement reform: benefit claiming



6. Life-cycle model

We now develop a quantitative life-cycle model to match the estimated responses to the U.K. pension reform. Since the reform affected women, the model concentrates on female decision-making. The purpose of the model is to evaluate the effects of alternative reforms to retirement pensions and disability insurance along two dimensions: 1) their effectiveness in encouraging work at older ages and 2) their ability to continue to provide insurance against old-age risks.

Our model considers the choices of an individual who maximizes lifetime expected utility in the form:

$$\max_{c,P,DB^{App}} V_{it} = E_t\left[\sum_{s=t}^{T} \beta^{s-t} S_t u(c_{is}, P_{is}; \theta_{is})\right], \tag{5}$$

where β is the discount factor, S_t is the probability of surviving until age t, E_t is the expectations operator conditional on information available at time t, P is a binary indicator of whether the individual is working or not, c_t is consumption, and θ_t denotes an individual's continuous disability state. The disability status corresponds to the latent factor we estimate in Section 4 and is calibrated with the estimated parameters presented in Table 3. Individuals live T periods, and become eligible for retirement pensions at time T^R, i.e., the retirement age. There is no bequest motive. We divide households into three educational categories (those with below-secondary education, secondary school graduates, and university graduates). While the data we observe is at an annual level, our model is adjusted such that the time-period is a quarter.

The intertemporal budget constraint is:

$$\begin{gathered} A_{it+1} = R\big[A_{it} + \ (w_{it}h(1-\tau) - F(\theta_{it})\big)P_{it} + \\ + \big(B_{it}Z_{it}^{UI}(1-Z_{it}^{DB}) + D_{it}Z_{it}^{DB}\big)(1-P_{it}) + welf_{it}Z_{it}^{W} + \mathbf{1}[t \geq SPA]S_i - c_{it}], \end{gathered} \tag{6}$$

where A_{it} are total assets, R is the interest rate, w_{it} is the hourly wage rate, h a fixed number of hours of work (corresponding to 2,000 per year), τ is a proportional tax that finances social insurance programs, F is the fixed cost of work which depends on disability state, D the amount of disability benefits received, S_i is the state pension, SPA denotes the state pension age, Z_{it}^{UI}, Z_{it}^{DB} and Z_{it}^{W} are binary indicators for receipt of unemployment benefits, disability benefits, and a means-tested welfare program, respectively. Unemployment benefits B_{it} are paid when an individual loses a job for the duration of one year, while the means-tested welfare is a program providing a floor to income.

The worker decides whether to work or not. When unemployed, if offered a job, the worker decides whether to accept it or wait longer. When unemployed, the individual has the opportunity to apply for disability benefits. In all periods, the individual decides how much to save and consume. We assume individuals cannot borrow, such that $A_{it} > 0$ for all t. This precludes borrowing against retirement benefits and means tested programs. After T^R, individuals are eligible to receive the state pension. This finances their consumption along with assets they have accumulated during their earlier life. However, after retirement age, individuals have the option of continuing to work in line with the existing U.K. and U.S. systems.

The period utility function has the form:

$$u(c_{it}, P_{it}; \theta_{it}) = \frac{(c_{it}\exp(d\theta_{it})\exp(\eta P_{it}))^{1-\gamma}}{1-\gamma} \tag{7}$$

The parameters $d < 0$ and $\eta < 0$ capture the disutility of disability and work, respectively. In particular, disability induces a utility loss in terms of consumption proportional to the level of disability. Consumption in Equation (7) is equivalized using the OECD equivalence scale, such that household size at each age mimics the average family size in the data.

The wage and unemployment process

The wage process is determined by observable characteristics and productivity shocks, as follows:

$$\ln w_{it} = \boldsymbol{x}'_{it}\beta + \varphi\theta_{it} + \varepsilon_{it} + \omega_{it}, \tag{8}$$

where:

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \zeta_{it},$$

and ζ_{it} is the persistent productivity shock and $\boldsymbol{x}_{it}$ contains a quadratic in age. We assume that ω_{it} reflects measurement error, and is independent of ζ_{it}. The persistent productivity shock has an initial distribution $\zeta_{50} \sim N(0, \sigma^2_{\zeta,50})$. In addition to stochastic wages, individuals face unemployment risk that evolves according to a conditional Markov process, where the probability of unemployment depends on current productivity and educational type. This Markov process is estimated using self-declared unemployment transitions, e.g., the probability of declaring unemployment in the next period, conditional on being employed today. Individuals receive a wage offer whenever they are employed, and do not do so if they are unemployed. Instead, they can claim unemployment benefit B_{it}, which enters the budget constraint stated in Equation (6).

The state pension

We assume that the individual receives the state pension when she reaches the SPA. This is without loss of generality, as in the data 95% of individuals claim the state pension at the SPA. The state pension is modeled as a flat-rate benefit whose level matches the observed historic pension rates.

Disability insurance program

We make the following assumptions to capture the disability insurance program in the U.K. We capture the nonmeans-tested component (i.e., the PIP and DSA described in Section 2) by allowing individuals to receive transfers as a linear function of their disability state θ_{it}, calibrated to match the regression of PIP and DSA levels observed in ELSA on the disability level. To capture the means-tested component, which is the focus of our analysis, we firstly require that individuals make the choice to apply for benefits. Secondly, since disability applications are assessed at least 13 weeks after an initial claim, we require that individuals need to have been unemployed for at least one quarter prior to being considered. Successful applicants begin receiving benefits in the second quarter. Finally, we assume that the probability of a successful application depends on the individual's disability state and educational group k, and follows a logit form:

$$\Pr(DI_{it} = 1 | DI_{it}^{App} = 1, \theta_{it}, k) = \Phi\big(\mu_{0,k} + \mu_{1,k}\theta_{it}\big). \tag{9}$$

We make the probability of a successful application for disability benefits depend on education because vocational criteria may be important in determining whether an individual can reasonably be expected to work, as is explicitly the case in the U.S. disability insurance system. For instance, an individual with education below a secondary level may find it more difficult to find work not requiring gross function. We set the value of benefits according to the actual levels in the U.K. disability programs for the cohorts affected (i.e., the IB and ESA). We assume that individuals who work do not also receive means-tested disability benefits, although they can receive the nonmeans-tested benefits.

Initialisation and solution

Since the ELSA data set contains only individuals 50 or older, our model starts at age 50. Once age 90 is reached, the individual dies with certainty. We construct initial conditions at age 50 for assets A_{it}, wages w_{it}, disability θ_{it}, and unemployment u_{it} as follows. Initial wages, assets, and disability state are drawn from the joint empirical distributions and all agents are employed. Our measure of households assets includes all assets except housing business wealth. Since there is no analytical solution for the model, it is solved numerically. We begin with the terminal condition on assets, iterating backward, and solving at each age for the value functions conditional on work status. The approach is similar to that in Low and Pistaferri (2015).

Estimation

Our identification procedure takes a mixed form. Firstly, some parameters are predetermined and calibrated using findings in the literature. Secondly, some parameters are estimated outside the model's structure. For instance, the disability process is estimated directly as presented in Section 4. Finally, the remaining parameters are estimated structurally using an indirect inference procedure. We set our predetermined parameters as follows. We set $\gamma = 1.5$ and $\beta = 0.9756$ following Low and Pistaferri (2015). The interest rate R is set to 1.02 on an annual basis to match realistic real returns during the 2010 to 2019 period in the U.K. Identification of the remaining structural parameters of interest $(\eta, d, \mu_{0,1}, \mu_{1,1,}\mu_{0,2}, \mu_{1,2}, \mu_{0,3}, \mu_{1,3})$ is achieved by indirect inference. Once estimated, our model can perform counterfactual policy analysis and, in particular, consider the welfare effects of having alternative disability insurance systems in at the time of the retirement age increase.

Indirect inference involves minimizing the distance between moments from our model (known as the *auxiliary model*) estimated from the simulated data with moments of the auxiliary model estimated from the observed data. The closer the link between the auxiliary equations and structural parameters, the more reliable is the estimation procedure.

Moments: disability insurance

We use a number of moments involving disability benefit receipt to match the parameters $(\mu_{0,1}, \mu_{1,1,}\mu_{0,2}, \mu_{1,2}, \mu_{0,3}, \mu_{1,3})$. Critically, we also use the changes in disability benefit take-up by disability status in response to the SPA reform reported in Tables 4 and 5. This helps us identify the fraction of disability benefit recipients who are not truly disabled and pins down the cost of the program. It also helps us identify coverage: The fraction of individuals who no longer have access to the state pension, and who receive benefits, and those who do not. To assist with assessing coverage, we also use the composition of disability scores among those who receive benefits and those who do not. Finally, we examine the rates at which individuals flow onto disability benefits.

Moments: Savings rates and employment response

We identify d by examining the regression of consumption on the disability status θ_{it}. Finally, the utility cost of working η is estimated by looking at the employment response by age and disability status to the SPA reform, reported in Tables 4 and 5.

7. Key findings

In this project, we have sought to evaluate different disability insurance systems in the face of increases in the retirement age. We adopted a comparative approach, examining the U.K. and U.S. systems together. In particular, we exploited a large U.K. reform increasing the retirement age for women in the years 2010 to 2019 to examine whether the U.K. disability insurance system provided a suitable alternative benefit for disabled individuals who no longer had access to the state pension. Our key findings can be summarized as follows:

- Our comparative exercise required the construction of a comparative measure of disability between the U.S. and England. We estimated the degree of disability risk among in the U.S. and English over-50 populations using a state-of-the-art factor model. We found that individuals in the U.S. have significantly poorer disability outcomes on average than individuals in England. For instance, 50-year-old U.S. women have the same disability scores as 67-year-old women in England. Furthermore, we found that individuals in the U.S. face higher risks of a persistent disability shock than in the U.K.
- We estimated significant spill-overs between disability insurance and retirement pension programs in the context of the increase in the U.K. retirement age for women in the years 2010 to 2019. We documented that despite a significant increase in disability benefit take-up among disabled individuals who would have otherwise been retired, these individuals experienced large losses in household income.
- Healthy individuals, in contrast, experienced much smaller losses in income, as they respond to the increase in the retirement age by increasing their labor-force participation.
- Finally, we develop a dynamic model of labor supply, social security benefits, and savings to evaluate the U.K. disability benefit system in the context of the U.K. retirement reform. This model uses as its inputs the parameters of the disability process we have estimated. Once estimated to match our estimated responses to the U.K. reform, it can evaluate the

performance of alternative disability insurance programs, such as the U.S. system.

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Appendix A – factor model estimation

Consider a simple case in which we have data available for $T = 2$. With the set of equations generated by (3) and (4) we establish the following set of moments:

$$E[R_0^2] - \sigma_0^2 - \sigma_u^2 = 0$$

$$E[R_1^2] - \rho^2\sigma_0^2 - \sigma_1^2 - \sigma_u^2 = 0$$

$$E[R_0 R_1] - \rho\sigma_0^2 = 0$$

$$E[R_0 R_2] - \rho^2\sigma_0^2 = 0$$

To produce the estimates, we replace R_t in the moment equations by $\tilde{R}_t$, defined as

$$\tilde{R}_{i,t} = \hat{e}_{i,t} - \frac{1}{N}\sum_{i=1}^{N} \hat{e}_{i,t}$$

where $\hat{e}_{i,t}$ is the residual obtained from the previous estimates. Thus, we apply a standard GMM technique to get the estimates for ρ, σ_u^2 and σ_t^2. The model can be further simplified by assuming that

$$\sigma_0^2 \neq \sigma_1^2 = \cdots = \sigma_T^2$$

and then set $\sigma_t^2 = \sigma^2$ for $t > 0$. This way, we only need to estimate four parameters: ρ, σ_u^2, σ_0^2 and σ^2. The estimation uses moments derived from all variance equations, all covariances $E[R_t R_{t+1}]$ and $E[R_0 R_2]$, since the latter improves the convergence of the algorithm used to obtain the estimates. The output in table (3) a total of $T = 8$ periods for both U.S. and U.K. results. This means the estimation of an over-identified model, where we have 16 moments and 4 parameters. Standard errors are clustered at the individual level.