An Evaluation of Social Security Reforms: Policy Substitution and Redistributive Consequences*

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(preliminary and incomplete)

Abstract

We study the effects of a Social Security reform in the United States in conjunction with Disability Insurance (DI). The 1983 Social Security Amendments raised the full retirement age and increased the early claiming penalty for Social Security benefits, making the DI program relatively more attractive for individuals nearing retirement. We empirically document that cohorts impacted by the reform are more likely to receive DI benefits, begin DI at an earlier age, and substitute early claiming of Social Security benefits for DI. These effects are more pronounced among less-educated workers. The behavioral responses to the reform have fiscal, welfare, and redistributive implications. First, the increase in DI enrollment reduces the fiscal gains of the reform. Second, while the Social Security reform may adversely impact less-educated workers, the DI program helps buffer its adverse welfare effects on them. Third, the earlier and more frequent receipt of DI by less-educated and less-healthy individuals may mitigate the regressivity of Social Security program. We quantify and evaluate these effects of the Social Security reform using a life-cycle model that incorporates endogenous DI applications and Social Security claiming decisions.

JEL Codes: H55, J26, I18, I38
Keywords: Social Security, disability insurance, labor supply, inequality

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1 Introduction

As the population is aging in most developed countries, policymakers and researchers are increasingly focused on improving the fiscal sustainability of the public old-age pension programs. The United States is no exception, leading to the introduction of the 1983 Amendments to Social Security, the government-run public old-age pension program formally known as the Old–Age and Survivors Insurance (OASI). These amendments included a gradual increase in the full (normal) retirement age (FRA), the age at which individuals become eligible to receive 100% of their retirement benefits. Additionally, the reform adjusted benefit schedules to discourage early claiming of benefits and encourage delayed claiming of benefits. Although there are active discussions on the effects of the reform, there is limited understanding of how these reforms may interact with other social insurance programs that may complement or substitute for OASI.

In this paper, we provide a unified framework to jointly study Social Security (SS) and Disability Insurance (DI), two major social insurance programs for households in retirement phase in the United States. The OASI program accounts for about a quarter of the federal budget, making it one of the largest components. In 2022, 29% of individuals aged 62 claimed SS benefits and 61% claimed benefits before reaching their full retirement age of 66. Although the DI program, income insurance for working-age population with work disabilities, does not directly target older workers, it supports a significant share of individuals nearing retirement: approximately 17% of workers aged 60 to 66 benefits from the program. As such, these two programs are crucial in shaping individuals' retirement.

Given the overlap in the beneficiary population, the Social Security reform such as the 1983 Amendments can affect the claiming behaviors of both the retirement benefits and DI. Specifically, the amendment implicitly increases the relative generosity of the DI program because workers can receive DI benefits until FRA, which extends the duration of DI benefits. Additionally, DI benefits are not subject to early retirement penalties like the Social Security benefits, providing greater incentives to utilize DI instead of claiming Social Security benefits early. Such an impact may vary depending on worker characteristics. In particular, both DI participation and early Social Security claiming are more common among low-educated workers. An increased early retirement penalty may induce larger behavioral responses from these workers and those who are marginally attached to the labor market due to health reasons, leading to potential redistributive consequences. Our goal in this paper is to evaluate the 1983 Social Security reform in light of the potential interactions between Social Security and DI. How does the reform heterogeneously impact individuals' decisions to apply for DI? What is the aggregate fiscal consequence of

the reform in the presence of substitution to the DI program? What are the welfare and redistributive impacts of such policy substitutions? Specifically, (how much) does the DI program help buffer the adverse welfare effects of the Social Security reform? Does the utilization of the DI program by less-educated and less-healthy individuals mitigate the potentially regressive effects of the Social Security program? We answer these questions by empirically analyzing DI program utilization behaviors among cohorts impacted by the Amendment and evaluating the effects of the reform in a life-cycle model.

In our empirical analysis, we use the Health and Retirement Study (HRS) data to conduct a cohort-level analysis exploiting the 1983 Amendment. Per the Amendment, the full retirement age (FRA) for the 1943-1954 ("young") birth cohorts became 66, one year older than that of the 1931-1937 ("old") birth cohorts whose FRA is 65. Further, when the young cohort claims SS benefits at the early retirement age (ERA) of 62, the youngest age at which he can do so, his benefit is reduced by 25%; whereas the benefit reduction is 20% for the old cohort.[1] We first document whether the DI and early SS claiming behaviors differ between these two cohorts and quantify the impact of changes in the early SS claiming penalty on these patterns.

Across these two cohorts, we observe varying patterns in DI and SS benefit receipts between the ERA and FRA. In this age range, individuals can claim SS at reduced benefits (since he is older than ERA) or receive DI benefits (since he is younger than FRA). We observe that while the share of individuals receiving either SS or DI benefits are similar across cohorts at each age, the composition of benefits differ. Among the old cohort, about 6% of individuals aged between 62 and 64 receives DI, whereas among the young cohort, the share is around 12%. The discrepancy is more pronounced among high school dropouts than among those with college education. Further, we find that the age at which individuals begin receiving DI benefits is lower among the young cohort.

To further evaluate the extent to which the retirement policy reform impacts the behaviors of those nearing retirement, we utilize the linked HRS-Social Security Earnings Records data. This linked data allows us to calculate the present values (PV) of DI and claiming SS benefits at age 62 for all individuals at each age. We then construct the percent difference between present values of DI and early SS claiming. This relative DI generosity variable measures the financial trade-offs individuals face, which was impacted by the 1983 Amendments (increased for the young cohort). Our analysis suggests that the relative DI generosity has a statistically significant positive association with DI receipt status.

[1] The FRA increases by two months for each birth year for cohorts 1938-1942. The early claiming penalties and delayed retirement credits are also impacted that differ across cohorts, which we detail in the Appendix. For simplicity, we compare two birth cohorts, 1930-37 and 1943-1954, within which each cohort has the same FRA.

In particular, individuals with a 8 percentage point (pp) higher relative DI generosity (the difference in the average across two cohorts) are about 7pp more likely to receive DI than claim SS early. Moreover, the DI-receipt probabilities are significantly higher even among those nearing retirement: A 8pp higher relative generosity of DI implies a 4.5pp higher DI receipt probability among individuals aged 60–62. The latter result reflects the dynamic, pre-retirement behavioral response to SS reform. It may be that workers are more likely to opt in for DI program when he experiences a disability shock, when FRA and early retirement penalties are higher.

These empirical findings suggest that the SS reform may have spillover effects on DI resulting in fiscal, welfare, and redistributive consequences that have yet to be comprehensively explored in the literature. From a fiscal perspective, the substitution from early retirement to DI may lessen the fiscal gains of the SS reform. However, because less-educated and less-healthy individuals can utilize DI when facing more stringent SS benefits, their welfare losses from the reform may be mitigated. Further, the earlier and more frequent receipt of DI by these group of individuals may reduce the regressivity of the SS program that is due to, for example, heterogeneous mortality rates across education and health statuses of individuals. To answer these questions, we need to construct a model that captures the dynamic trade-offs individuals face, which is our next step.

We develop a life-cycle model to understand individual behaviors and evaluate the macroeconomic consequences of the SS reform in the presence of DI program. The model incorporates workers of heterogeneous education statuses who face health and labor market risks. Importantly, they make labor supply, DI application, and SS claiming decisions, and we model key policy features, including the distinct benefit calculation formula for SS and DI programs and risks associated with DI application process. We calibrate the model to match the key empirical features of the old cohort, including the age distribution of the Social Security claimants, the share DI recipients by age, and the heterogeneity in outcomes by education statuses. Then, we use the model to simulate the 1983 Amendments and conduct counterfactual analyses. [TBC]

Related Literature. Our paper contributes to the vast literature studying public pension and disability insurance.

Recent empirical studies utilizing administrative data have examined the effects of public pension reforms across European countries. For example, Lalive et al. (2023), Rabate et al. (2024), and Geyer et al. (2020) estimate the effects of increased FRA in Switzerland, Netherlands, and Germany, respectively. Notably, Geyer et al. (2020) document evidence of program substitution, specifically into unemployment and other transfer pro-

grams within households, which aligns with our observed substitution into DI. Andersen et al. (2021), provides further relevant findings, showing that a Norwegian early retirement incentive change increased working hours of high-wage earners, thereby increasing inequality. Additionally, studies have explored the effects of transitioning from defined contribution to notional defined benefit pension systems in Sweden (e.g., Kolsrud et al., 2024) and Poland (e.g., French et al., 2023). French et al. (2023) highlight dynamic employment responses to pension reform. This aligns with our focus on individuals making dynamic policy and labor market decisions in response to the Social Security reform in the US. There are also a substantial body of research using structural models to evaluate Social Security including French (2005), French and Jones (2011), Imrohoroglu and Kitao (2012), Kitao (2014b), Jones and Li (2023), Pashchenko and Porapakkarm (2023), and Bairoliya and McKiernan (2023). As summarized in French and Jones (2017), the interaction between health and retirement decisions, influenced by policy environments, is well-established. These papers often incorporate health and medical expenditure risks the elderly face to better understand their retirement behaviors and evaluate the effects of policies. Collectively, previous literature documents a range of public pension reform effects—policy substitutions and dynamic responses at the individual level; and its distributional consequences—which are consistent with the mechanisms and outcomes that we aim to capture in this work. Our work extends the literature by providing coherent empirical and structural analyses of SS reforms, in combination with DI, a policy that individuals may substitute into.

Studies on disability insurance have extensively examined its effects on labor supply, consumption, and mortality, among others (see e.g., Bound and Burkhauser, 1999 for a summary of the literature, and Maestas et al., 2013; French and Song, 2014; Autor et al., 2019; and Gelber et al., 2023). Further, recent structural analysis, including Low and Pistaferri (2015), Kim and Rhee (2022), Hosseini et al. (2024), and Aizawa et al. (2025), focus on DI policy design and its macroeconomic effects, particularly on working-age individuals. We complement this literature by analyzing how DI influences worker decisions near retirement.

Among few studies that investigate the interaction between Social Security and DI as we do, are Duggan et al. (2007), Coe and Haverstick (2010), Li (2018), and Laun et al. (2019). We complement Duggan et al. (2007) that utilizes policy variations across birth cohorts induced from the 1983 Amendments to find that it increased DI enrollment significantly. While they analyze the average outcomes across cohorts, our access to the Social Security Earnings Records linked to HRS enables us to measure these effects while accounting for micro-level heterogeneity. This approach is similar to that of Coe and Haver-

stick (2010) and Li and Maestas (2008), but the availability of recent data provides a more complete understanding of the behaviors of the cohorts under study. Among structural studies, Li (2018) and Laun et al. (2019) are two most closely related, modeling the substitution between DI and SS to evaluate fiscal consequences of SS reforms. In comparison, our work enhances the understanding of the SS reform in the presence of DI in several key aspects. First, we provide empirical evidence of substitution patterns between DI and early SS claiming. Second, by incorporating detailed education and health statuses, we deepen the understanding of the welfare and redistributive consequences of the SS reform, specifically accounting for the spillover effects to DI.

The rest of the paper is organized as follows. We summarize the institutional background in Section 2 and discuss our empirical analysis that exploits the Social Security Amendments of 1983 in Section 3. We describe the model environment and the calibration strategy in Sections 4 and 5 respectively, and conduct counterfactual analyses in Section 6 before we conclude in Section 7.

2 Institutional Background

In the United States, the Social Security Administration (SSA) administers the federal Old-Age, Survivors, and Disability Insurance (OASDI) program. The OASDI program provides benefits for retired workers, survivors and individuals with disabilities. In 2022, the program provided payments to 66.0 million people—57.2 million individuals received old-age and survivors insurance and 8.8 million people received disability insurance—with its total cost at 5.2% of GDP ($1.2 trillion dollars). The program is funded by payroll taxes on wage and salary earnings with contributions from both employers and employees. In 2024, the OASDI tax rate is 12.4%, up to a maximum earnings of $168,600.

Within the broader OASDI program, we distinguish between the Disability Insurance (DI) and Old-Age Survivors Insurance (OASI), where we also refer to OASI as Social Security (SS) or the retirement benefits program. In the next, we discuss institutional details of each program, outline the key components of the Social Security Amendments Act of 1983, and summarize the resulting discrepancies in policy environments across cohorts, which we utilize for our empirical analyses.

2.1 Disability Insurance

Disability Insurance (DI) program is aimed at helping working-age individuals who are unable to work due to disabilities. To be insured, a worker needs to accumulate enough

"credits," where one credit is awarded for a certain amount of earnings ($1,730 in 2024) for a maximum of four credits per year.[2] The Social Security Act defines disability as an "inability to engage in any substantial gainful activity by reason of any medically determinable physical or mental impairment which can be expected to result in death or which has lasted or can be expected to last for a continuous period of not less than 12 months."[3] In 2024, the substantial gainful activity (SGA) amount was $1,550 per month for non-blind individuals. A worker who is disabled and has the number of credits necessary to be insured sends his application to the Disability Determination Services. The decision for benefits are determined following evaluation of the individual's ability to work, the severity of condition, the type of impairments, and the ability of the individual to continue his past work or do other type of work. Once the application is submitted, it takes around six to eight months for an initial decision, five months before the first benefit is paid, and 24 months to become eligible for Medicare benefits.[4] The DI benefits may be terminated if upon a review by an examiner, the beneficiary is deemed no longer disabled, or he dies. Otherwise, when he reaches a full-retirement age, the benefit automatically changes to retirement benefits.

The DI benefits are calculated based on each workers' average indexed monthly earnings (AIME). AIME is determined as the average earnings (indexed to reflect wage levels in each year) over the computation years. For DI, the years with the highest indexed earnings between the age of 22 and the disability onset are used, excluding a maximum of five years of earnings.[5] Given the AIME, the primary insurance amounts (PIA) is determined as 90% replacement of the AIME up to the first bend point, 32% replacement between first and the second bend points, and 15% replacement beyond the second bend points, with a maximum benefit amount.[6]

2.2 Old-Age and Survivors Insurance

Individuals who have worked and paid Social Security taxes for 10 years (40 credits) or more, and are 62 (the Early Retirement Age, ERA) or older, are eligible for Social Security (SS) retirement benefits. Similar to DI, the size of the retirement benefit is determined

[2] The number of credits necessary to be insured depends on the individual's age at the onset of disability. For example, if a disability developed at age 42, five years of work is required, whereas nine years of work is required for those whose disabilities started at age 58.

[3] Section 223(d)(1) of the SSA. There is a separate definition for those who are blind.

[4] If the individual is denied the benefits, he is allowed to appeal the decision.

[5] The number of "drop-out" years is the minimum of 5 and a fifth of elapsed years: $\min\{5, 0.2 \times (\text{disability onset age} - 22)\}$. According to this formula, the number of drop-out years is five for anyone who develops a disability on or after age 47.

[6] The two bend points of the 2024 monthly benefit formula are $1,174 and $7,078, and the maximum benefit amount is $3,822.

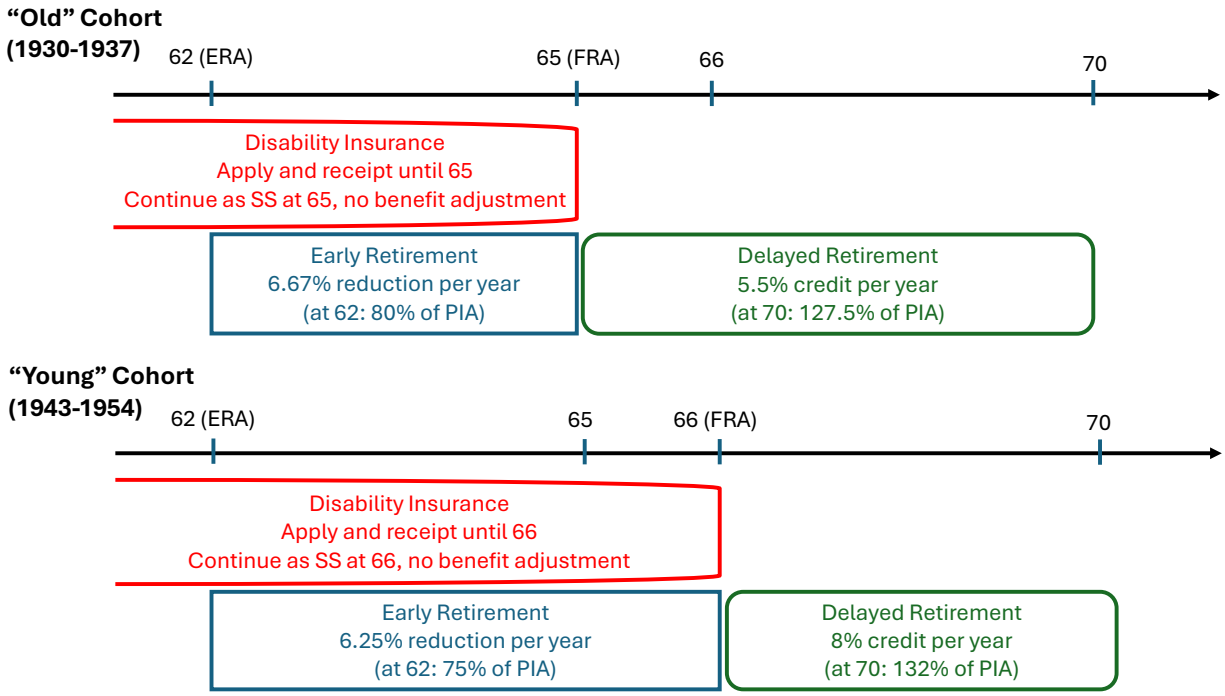
by AIME. However, unlike AIME for DI, which is based on the highest earnings before the onset of disability, AIME for SS is calculated as the average of the highest 35 years of indexed earnings during a worker's working-age life. Thus, if a worker worked for only 30 years, then five years of earnings are recorded as zero in calculating his AIME for SS. The PIA is then determined following the same formula as in DI.

There are two additional adjustments to the actual benefit amount that retirees receive. First, the benefit amount depends on the age at which the benefits are claimed. Workers receive the PIA as their benefits if they claim SS at Full Retirement Age (FRA). Claiming retirement benefits before reaching FRA results in reduced monthly benefit payments, while delaying benefits beyond FRA can increase them up to age 70. The FRA and the penalty (credit) from early (delayed) claims depend on the beneficiary's year of birth. Second, the retirement earnings test (RET) reduces benefits for those with earnings above a certain threshold. For instance, RET deducts $1 from your retirement benefits for every $2 of labor income above the annual limit if you started receiving SS before FRA. The withheld benefits are given back to beneficiaries once they reach FRA.

2.3 Social Security Amendments of 1983

In April 1983, the Social Security Amendments of 1983 was signed into law to restore the program's financial stability. Among the changes were increases in the full retirement age (FRA), enhancements to the early retirement penalty, and adjustments to the delayed retirement credit. First, the FRA for workers born in 1937 and prior is 65. For those born after 1937, the FRA gradually increases by two months per birth year, reaching 66 for those born between 1943 and 1954, and 67 for those born 1960 and later. Secondly, the early retirement penalty for those born in 1937 or before is 6.67% per year, that is, if he claims benefits at age 62 (ERA), his benefit is reduced by 20%. For 1943-1954 birth cohorts, the benefit is reduced by 25% if he claims benefits at 62. Lastly, among those who claim benefits after the FRA, there is a credit to their benefits. These credits gradually increased from 4.5% per year for 1929-1930 birth cohorts with a maximum of 22.5% at age 70, to 8% for 1943 and later cohorts with a maximum of 32% at age 70.[7] Combined, these policy adjustments are aimed at incentivizing longer working years.

Figure 1: Disability Insurance and Social Security Options by Cohorts



2.4 Policy Environments Across Cohorts

Given the Amendment, Figure 1 summarizes the DI and SS policy environments faced by two cohorts—those both between 1930 and 1937 whom we denote as the "old" cohort, and those born between 1943 and 1954, the "young" cohort. The DI option is available until the worker reaches the FRA. As discussed, the early claiming of the Social Security benefits is available at age 62 (ERA), at differential penalty rates across cohorts. Additionally, the delayed claiming of SS benefits is rewarded differentially across cohorts, with the maximum reward at age 70.[8]

Overall, the retirement reform may have increased the relative attractiveness of DI for the young cohort for several reasons. First, note that the PIA of DI may be higher than that of SS benefits, especially among workers with (potentially) shorter years of work history. This is because when a worker with less than 35 years of experience receives DI, his AIME is not penalized as much as it is for retirement benefits, due to differences in computation years between DI and SS. Secondly, the PIA effect is amplified by higher FRA and a larger

[7]It increases 0.5% per year for every two-year birth cohorts, e.g., 5% for 1931-1932 cohorts and 5.5% for 1933-1934 cohorts.

[8]There are differences in early and delayed retirement benefit adjustments within our two cohort groups ("young" and "old"), in which case, we take simple averages. The exactly policy parameter for each birth year cohort is summarized in https://www.ssa.gov/oact/ProgData/ar_drc.html.

early claiming penalty. As noted, DI benefits are automatically transferred to retirement benefits at FRA without adjustments in their benefit amounts. Therefore, a higher FRA implies longer expected duration of DI receipt. Further, a higher early retirement penalty increases the relative generosity of the DI. These factors may induce higher utilization of the DI program.

3 Empirical Motivation

Our goal in this section is to empirically test whether there is a connection between retirement benefits and the utilization of DI. Specifically, we investigate whether more stringent retirement policies (e.g., higher penalty from early retirement) induce individuals to choose DI (substitute early retirement with DI). We do so by leveraging the policy reform described in Section 2.3 that resulted in differential policy environments across cohorts, as summarized in Section 2.4. In the next, we first describe the datasets used for the analyses, present the behaviors of individuals near retirement by cohort, and conduct econometric analyses to measure the effects of changes in SS benefits on DI utilization and early retirement decisions of workers.

3.1 Data

Our main data source for empirical analysis is the Health and Retirement Study (HRS), linked with the administrative data from the Social Security Administration (SSA). The HRS data is a biennial longitudinal dataset representing individuals aged 51 or older. We combine the publicly available HRS data for years 1992 and 2020 that contains detailed demographic and health information with restricted SSA datasets. In particular, we use the Cross-Year Benefits data and the Cross-Year Summary Earnings data to further investigate and understand the factors determining workers' labor market, DI, and SS receipt statuses.

The HRS is suitable for our analysis as we analyze behaviors of individuals near retirement. Further, as the HRS started in 1992, we can utilize a long panel dimension to gather information over individuals' lives. Of particular interest are the health and work disability statuses, important determinants for DI and retirement decisions. Although DI benefit decisions are based on whether a worker has a work disability, there is a large spectrum in severity of such disabilities or health statuses. Thus, capturing health statuses of individuals at finer levels is crucial. To do so, we utilize two measures in our analysis. First is the work disability variable, a binary variable indicating whether an individual has a work disability or not. The second is "frailty" index that is constructed to capture the number of

health problems (e.g., specific diagnosis like diabetes and restrictions in activities of daily living) an individual has, which was shown to be a good measure of health status (see, e.g., Mitnitski et al., 2002). Specifically, the index is an unweighted average of the sum of health conditions (one if you have a condition, zero otherwise), so the lower the frailty index, the healthier the individual. We use a total of 36 conditions following Hosseini et al. (2022) that does not include work disability. In addition to disability and health-related variables, we also utilize other individual-level characteristics such as education and marital statuses.

We combine this data with the Cross-Year Benefits data from the SSA. In it, we observe the types of benefits (DI and SS) an individual receives (if at all), the benefit starting month and year, as well as the benefit amounts. These are important outcome (e.g., whether one receives benefits) and explanatory (e.g, how benefit amounts impact the decision to claim SS benefits) variables for our analyses. A limitation, however, is that the benefit amount is available only for those who are receiving DI or SS, which makes it difficult to fully understand how the reform impacted behaviors. We address this shortcoming by further utilizing the Cross-Year Summary Earnings data. The Cross-Year Summary Earnings data from the SSA provides earnings records of the HRS respondents for those who have provided permission to match their SSA records with HRS data. For those who consent to provide earnings record, we have annual earnings data for years from 1951 to 2020. Earnings are recorded to zero for those who have no reported earnings; earnings below $49.99 were recorded as "N" to preserve confidentiality; and earnings above $50 are rounded to the nearest $100. We use this data to construct the potential (hypothetical) PIAs for each individual at a given age, providing us with a measure that captures the financial benefits of receiving DI or SS. We explain in detail how we use this data to construct a variable measuring the relative generosity of DI compared to claiming Social Security early in Section 3.3, with more detailed descriptions of the datasets relegated to the Appendix.

We restrict our sample to males, as female employment rates among the studied birth cohorts are significantly lower than those of males (unlike females in the most recent birth cohorts), which may confound the analyses. We also drop individuals who started receiving DI before 50 as we are interested in DI application decisions near retirement.

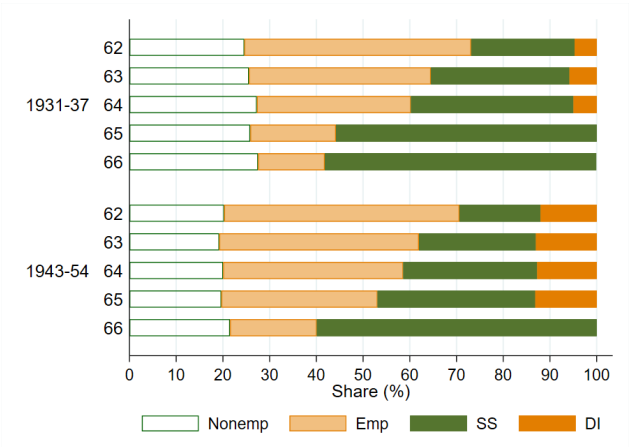
3.2 Stylized Facts

In this section, we examine whether there are any behavioral differences across cohorts facing differential SS benefit schedules. Based on policy discussions in Section 2.4, we denote individuals born between 1931 and 1937 as an "old" cohort and those born between 1943 and 1954 as a "young" cohort.

Figure 2 plots the share of workers by their labor market and benefit receipt statuses,

for ages between the ERA (62) and FRA (65 for old cohort and 66 for young cohort) within each cohort; and Figure 3 plots the same statistics by three education groups, high school dropouts (HSD), high school graduates (HSG), and those with some college education (COL). We focus on behaviors between ERA and FRA, since that corresponds to the age range in which individuals can utilize either DI (since it is before the FRA) or claim SS benefits (since one can start receiving SS benefits at ERA). For example, the first bar in Figure 2 represents the share of individuals who are employed, unemployed, receiving SS benefits, or receiving DI benefits at age 62, among the old cohort.[9]

Figure 2: Share of Workers by Labor Market, SS, and DI Status, by Cohort



Note: Figure 2 shows the share of individuals by their statuses using the restricted HRS dataset.

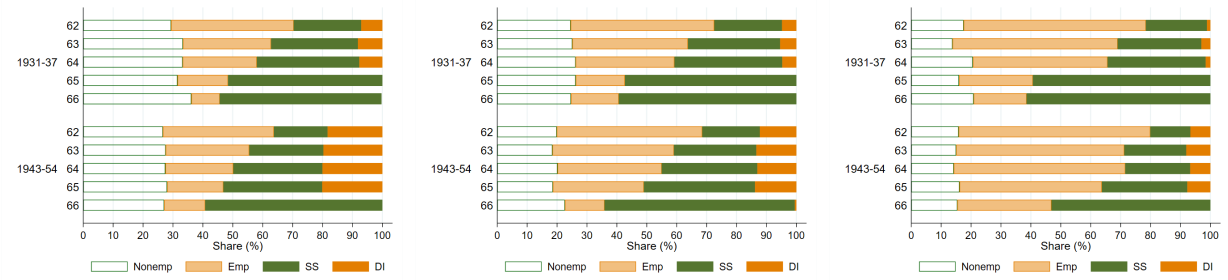
We make two observations from these plots. First, as shown in Figure 2, there is a growing share of individuals receiving any benefits (DI or SS) as they approach their FRA, and this is common in both cohorts. However, the composition of benefits differ across cohorts. Among 62-year-old individuals, 5% of those in the old cohort receives DI and 23% receives SS, whereas 12% of those in the young cohort receives DI and 18% receives SS.[10] Thus, we see stark compositional differences in benefit types across cohorts. Note that at the FRA, DI benefits automatically become SS benefits, and therefore DI shares are no longer relevant. Second, in Figure 3, we see a large heterogeneity in these shares across education groups.

[9]These categories are not necessarily mutually exclusive as those who receive DI and SS can also work. For a clear illustration, we categorize employed and unemployed among those not receiving any benefits. Practically, DI recipients earning more than the Substantial Gainful Activity ($1,550 per month in 2024) lose their benefits. Thus, in our data, the share of DI recipients who also work is small at around 10%, while the share of employed individuals among SS recipients is higher and varies across ages. In Appendix A.3, we provide further statistics distinguish employment statuses of SS recipients. We find that the qualitative patterns across cohorts are robust to using more disaggregated categories.

[10]It is important to note, however, that this does not necessarily imply that individuals "work" longer. Recent papers (e.g., Deshpande et al., 2024) have found that while younger cohorts delay SS claiming, the retirement age (as measured by labor supply) is sticky at 65.

Figure 3: Share of Workers by Labor Market, SS, and DI Status, by Education and Cohort

(a): High School Dropouts (b): High School Graduates (c): Some College

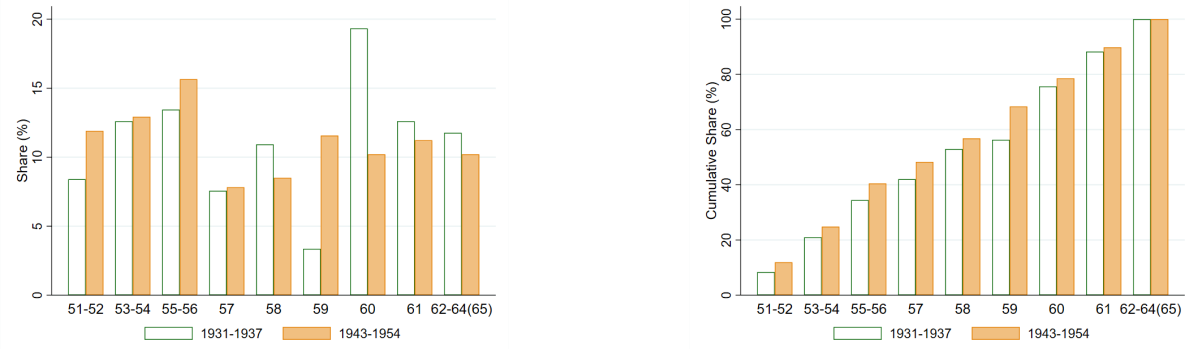


Note: Figure 3 shows the share of individuals by their statuses, by education group using the restricted HRS dataset.

Less-educated workers (HSD or HSG) are more likely to receive DI benefits and retire early than their more educated counterparts (COL) who are more attached to the labor market as shown by high share of employed workers. Further, the difference in DI shares across cohorts is more pronounced among the less-educated, implying that less-educated workers may be more responsive to SS benefit changes with regards to DI utilization.

Figure 4: Distribution of DI Starting Age by Cohort

(a): Share of Each Age (b): Cumulative Shares

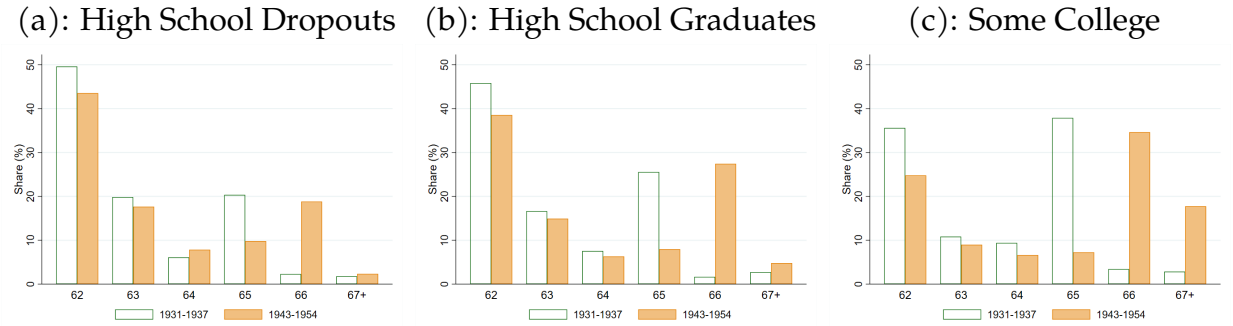


Note: The data is from the restricted HRS dataset. Figure 4(a) illustrates the share of individuals with a specific DI starting age among DI recipients within each cohort; and Figure 4(b) plots their cumulative shares.

We now document DI starting age and SS claiming age distributions by cohort. It is important to note that one can apply for DI upon experiencing a disability shock and that the process is costly. When one encounters a disability shock, the choice to apply for DI hinges upon the values of the alternative, e.g., staying in the labor market and/or retiring early. Thus, the change in the retirement benefits may impact the age at which an individual applies for and starts receiving DI. In Figure 4(a), we plot the share of DI recipients by

DI starting age and in Figure 4(b), their cumulative shares, by cohort.[11] Figure 4(b) shows that the DI starting age among the young cohort is lower in our sample, which may suggest that the young cohort is more likely to opt in for DI when they experience disability shocks.

Figure 5: Distribution of SS Claiming Age by Education and Cohort



Note: Figure 5 illustrates the distribution of SS benefit claiming age by education and cohort from the restricted HRS dataset.

Figure 5 represents the share of individuals claiming SS benefits at each age by education and cohort. As is well-known in the literature, there are two modes in the distribution—one at ERA and another at FRA—and there are large differences in retirement behaviors across education groups. Less (highly)-educated individuals are more likely to choose early (delayed) claiming of SS. Further, we see a lower early claiming share and a higher delayed claiming share among the young cohort.

Overall, the discrepancies in DI recipiency rates across cohorts that we document may be primarily driven by worker behaviors. However, it is also possible that DI program changes impacted such heterogeneity. The latest reform in the DI program is the Disability Benefits Reform Act that was implemented in 1984. It broadened the definition of disability providing more flexibility in DI acceptance decisions. In our sample, 1934 birth cohorts were 50 years old when the Act was implemented, suggesting that all cohorts, with the exception of 1930-1933 birth cohorts, were subject to the same DI policy in our sample. Importantly, this reform did not impact DI benefits formula, which we use in Section 3.3 to understand behavioral differences across cohorts. Additionally, von Wachter et al. (2011) finds that the annual DI allowance rates have not change much for older male workers between 1982 and 1999.[12] These observations thus suggest that the discrepancy of the DI

[11] Following the HRS data export rules, we use two age groups for ages younger than 57 and older than 62, as the sample sizes are too small at each age within the two age groups. Additionally, we do not report education-specific distributions due to sample size issue.

[12] von Wachter et al. (2011) use merged administrative data of DI applications and their benefit receipt status, and documents allowance rates by age groups. The average allowance rate on first-time applicants

beneficiary shares across cohorts may not have been solely driven by a relaxation of DI screening policies.

Next, we further explore to what extent changes in retirement benefit policies that increased the generosity of DI relative to early retirement are associated with the observed patterns in DI utilization across cohorts.

3.3 Descriptive Evidence

We aim to further investigate the relationship between the policy change and the observed behavioral differences across cohorts documented in Section 3.2. Our goal is to compare the expected present values (PV) of DI and SS benefits to measure the economic incentives of opting in to these programs and relate them to worker outcomes, the approach initially suggested by Duggan et al. (2007) and also used by Li and Maestas (2008) and Coe and Haverstick (2010). Our analysis leverages the micro-level data to construct individual-level incentives to analyze individual-level outcomes, in contrast to Duggan et al. (2007) who use average economic incentives and outcomes across cohorts. Additionally, as our data spans 1992 to 2020, we can observe the decisions of the young (birth years 1943-1954) cohort until up to between ages 66 (1954 birth cohort) and 77 (1943 birth cohort).[13]

To conduct our analysis, we first calculate hypothetical AIME and PIA at the individual level utilizing Social Security earnings records merged with the HRS, and compute the present values of DI (PVDI) and SS (PVSS). We then use these values to construct a measure of relative generosity of DI to understand its effects on individual behaviors.

Constructing the Present Values of DI and SS Benefits. The present values of DI and SS benefits capture the economic values of enrolling in these programs. In the Cross-Benefits data, the benefit amounts (PIA) are only available for those who start receiving benefits and only in the person's first year of benefit receipt. Our goal is to construct the PIA and subsequently, the present values of enrolling in policies for *each individual at each age* to

at the Disability Determination Services level for age group 45-64 between years 1982 and 1992, the years in which the 1931-1937 cohorts are between 51 and 61 years old, is 0.54. In years 1993–1999, the years in which the 1943 cohort becomes 51 years old, the average allowance rate for age group 45-64 is 0.56. The data is contained in their Appendix Section C. Disability Determination Services level screening includes initial stage and the reconsideration phase. There are applications that require additional hearing and appeals process that may take several years until a final determination. The allowance rate at all stages of men in age group 45-64 also have not changed much over the years: it is 0.78 between 1982 and 1992, and 0.82 between 1993 and 1999.

[13] Li and Maestas (2008) and Coe and Haverstick (2010) use individual-earnings records from the HRS from 1992 through 2006 and 2008 respectively to construct the values of DI and SS. Thus, the samples in these studies are limited to those born in years 1935-1941 and 1935-1943. Both studies find increases in DI application probabilities in response to the rise in FRA.

understand its role in worker decisions.

Using the earnings history from the Cross-Year Summary Earnings data, we calculate AIME for DI and AIME for SS for each individual at each age. As discussed in Section 2, the computation year of DI may be lower than that of SS, thus the AIME depends on the type of benefit.[14] We then use the AIME for each policy to construct the corresponding PIA, which is determined as a piece-wise linear function of the AIME. We describe the detailed construction process of the AIME and PIA in Appendix A.2, where we also confirm the validity of our measure of PIA using the observed PIA variables (available only for a small subsample of individuals in the data).[15]

Given the calculated hypothetical PIA's for DI and SS, the expected present value of DI benefit of individual i at age a is defined as

$$\text{PVDI}_{i,a} = \sum_{t=a}^{T} \sigma_{a,t} \cdot \frac{\widehat{\text{PIA}}^{\text{DI}}_{i,a}}{(1+r)^{t-a}}, \tag{1}$$

where $\sigma_{a,t}$ is the survival probability between age a and t, and $\widehat{\text{PIA}}^{\text{DI}}_{i,a}$ is the PIA of DI at age a based on his earnings record. Future benefits are discounted with an interest rate r of 3% and the maximum age T is set at 95.

As described in Section 2.3, whereas DI benefit formula has not changed across cohorts, the SS benefits vary by the individual's birth year. In particular, we are interested in the expected present value of claiming SS benefit at age 62, the ERA. We focus on benefits at age 62, because the early claiming penalty differs across cohorts due to policy change. Further, since 62 is the earliest age at which workers can claim benefits, individuals considering DI may also consider the option to claim SS at age 62, representing the differential trade-offs individuals face by their birth years. The present value of claiming SS benefits at age 62 for an individual i of cohort y at age a is expressed as

$$\text{PVSS}_{i,y,a} = \frac{\sigma_{a,62}}{(1+r)^{62-a}} \cdot \left\{ \sum_{t=62}^{T} \sigma_{62,t} \cdot \frac{\delta_y \cdot \widehat{\text{PIA}}^{\text{SS}}_{i,62}}{(1+r)^{t-62}} \right\}, \tag{2}$$

where δ_y is the early claim reduction rate for cohort y. Since the ERA is 62, the expected

[14] The computation years for SS is 35 years with the highest indexed earnings, whereas for DI, it is the years with the highest indexed earnings between the age of 22 and the disability onset excluding a maximum of five years of earnings.

[15] Specifically, we run the regression of observed PIA on our hypothetical PIA by benefit types—SS at FRA, early SS, and DI beneficiaries. The coefficients on hypothetical PIA are 0.96, 0.70, and 0.91 with R^2 ranging between 0.83 and 0.93. The coefficient on early claimants reflects early claiming penalty of around 30%, consistent with the SS policy specifics described in Section 2.2. Overall, this confirms that our constructed PIA is a reliable measure of the benefit amounts that a worker would have received, if he were to enroll in these programs.

present value of SS benefits at age a reflects the waiting period between age a and 62, taking into account both the interest rate r and survival probability between age a and 62, $\sigma_{a,62}$.

Relative Generosity of DI. Now, we construct the relative DI generosity as

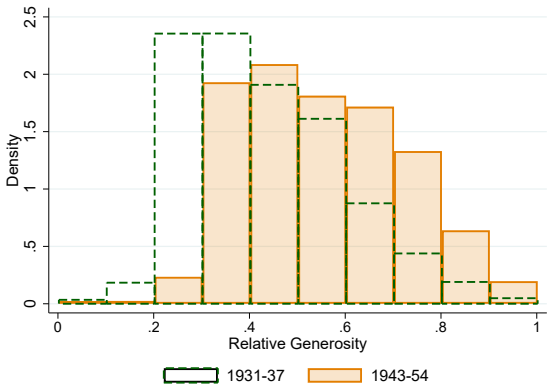
$$\text{PVDR}_{i,y,a} \equiv \frac{\text{PVDI}_{i,a} - \text{PVSS}_{i,y,a}}{\text{PVSS}_{i,y,a}}, \tag{3}$$

which represents the relative difference between the PV of receiving DI (PVDI) and the PV of claiming SS benefits at age 62 (PVSS), for an individual of current age a of cohort y.[16] Table 1 illustrates the average relative DI generosity by education and cohort at age 62 (top panel) and for those between ages 55 and 62 (bottom panel). There is a substantial

Table 1: Relative DI Generosity
Mean (Standard Deviation)

		Birth Years	
		1931-37	1943-54
At 62	All	0.248 (0.035)	0.332 (0.035)
	HSD	0.249 (0.035)	0.333 (0.042)
	HSG	0.248 (0.033)	0.331 (0.033)
	COL	0.246 (0.037)	0.332 (0.032)
Ages 55-62	All	0.289 (0.060)	0.395 (0.067)
	HSD	0.293 (0.064)	0.399 (0.075)
	HSG	0.289 (0.058)	0.396 (0.065)
	COL	0.285 (0.056)	0.392 (0.065)

Figure 6: Relative DI Generosity
Distribution by Cohort



Note: Table 1 documents the average and standard deviation of PVDR at age 62 and for those aged between 55-62, defined in Equation (3), by education and cohort. Figure 6 shows the distribution of PVDR for 55-62-year-olds by cohort.

heterogeneity in the relative DI generosity across cohorts driven by the differences in the early claiming penalty δ_y: the average relative DI generosity of the old cohort is 0.25 (0.29) and that of the young cohort is 0.33 (0.40) at age 62 (for those aged 55-62). The average PVDR at age 62 is smaller than that of ages 55-62, because individuals can start receiving SS at ERA (so there is no waiting period for SS claiming). While the raw differences between PVDI and PVSS vary across education, when normalized by PVSS as in Equation (3), the average relative DI generosities are similar across education. In Figure 6, we plot the distribution of relative DI generosities across cohorts for those aged 55-62, where we

[16] After constructing PVDR, we drop those at the top 1% of the distribution. Further details regarding the construction of these variables are summarized in Appendix A.1.

see a shift in the distribution of PVDR across cohorts. This across-cohort heterogeneity provides us with the variation we can exploit to study individual behaviors.

Relative Generosity of DI and Early Claiming of Social Security. By exploiting policy-driven variations in PVDR, we analyze the relationship between relative DI generosity and early SS claiming to investigate the extent to which DI and early SS claiming are substitutes. We estimate the following logistic regression model in a sample of individuals who receive DI or claim SS early, using two measures of early SS claiming: (i) claiming at ERA (62); and (ii) claiming between the ERA and one year before the FRA (64 for the old cohort and 65 for the young cohort):

$$\text{logit}\,(y_i) \quad = \quad \beta_0 + \beta_c \cdot \text{Cohort}_i + \beta_t \cdot t + \beta_X \cdot X_i + \gamma \cdot \text{PVDR}_{i,62} + \varepsilon_i. \tag{4}$$

Specifically, the outcome variable is recorded as one if he receives DI and zero if he claims SS early (either at the ERA or anytime before the FRA). Our coefficient of interest is γ that captures the effect of PVDR on a worker's DI receipt status. Therefore, a positive coefficient implies that those with high relative DI generosity may be substituting out of early SS and towards DI. We use PVDR at age 62 to more accurately capture the exact trade-off at ERA. We add cohort dummy variable, Cohort_i; a linear trend, t; and individual-level characteristics in X_i that include education, marital status, and health statuses, as controls. To control for health, we use the average frailty index and work limitation around ERA (between 58 and 66). We use averages over several ages because health-related variables are not reported every year and this approach allows us to increase the sample size. The linear trend captures the steady increase in the enrollment in DI programs documented in Autor and Duggan (2006).[17]

In Table 2 are the results from the two outcome variables and in Figure 7 are the corresponding marginal effects of PVDR on worker decisions from specifications with health controls. Under both the narrow (SS at age 62, first two columns in Table 2 and Figure 7(a)) and broad (SS before FRA, last two columns in Table 2 and Figure 7(b)) definitions of early claiming, we observe that highly educated individuals are less likely to receive DI benefits. Across specifications, we see that relative generosity of DI has a significantly positive impact on DI receipt of individuals even after controlling for health statuses. That is, those whose financial incentives from DI are high opt out of claiming SS early and are more likely to enroll in DI, a suggestive evidence of substitutability between DI and early

[17] We use the observation at age 62 for this analysis (so age dummies are not necessary). It is also possible to conduct the analysis at varying ages of an individual (e.g., the first observation of each individual) and add age dummies. The results are robust to such choices.

Table 2: Relative DI Generosity and DI Receipt (versus Early SS Claiming)

	DI Status versus			
	SS Claiming at 62		SS Claiming before FRA	
High school grad.	-0.489***	-0.241	-0.435***	-0.048
	(0.148)	(0.224)	(0.138)	(0.207)
Some college	-0.980***	-0.454*	-0.949***	-0.187
	(0.206)	(0.273)	(0.194)	(0.254)
Relative DI generosity at 62	14.859***	10.711***	16.443***	12.047***
	(2.678)	(3.426)	(2.563)	(3.059)
Frailty		3.849***		3.363***
		(0.921)		(0.796)
Work Limitation		3.494***		3.641***
		(0.280)		(0.250)
Observations	1,475	1,266	2,204	1,872

Note: Table 2 documents regression coefficients from estimating Equation (4) on sample of individuals who either receive DI or retire early. The two outcome variables are constructed as one if the individual receives DI and zero if he claim SS at 62 (the first two columns) or if he claim SS before FRA (the last two columns). Frailty and work limitation are averages between the ages of 58 and 66. Robust standard errors are in parentheses. $*p < 0.10; **p < 0.05; ***p < 0.01$

SS claiming. Quantitatively, an increase in the PVDR at age 62 from 0.25 (average of old cohort in Table 1) to 0.33 (average of the young cohort) is associated with a 8pp (31%) increase in claiming SS at age 62 and 7pp (40%) increase in claiming SS before FRA.[18]

Relative Generosity of DI and DI Receipt of Individuals Nearing Retirement. Previous analysis suggests a potential substitution effect: individuals may opt for DI when early SS benefits are reduced. However, it is important to note that DI benefits are awarded to those who have disability that limits their ability to work. That is, when a worker experiences a health or disability shock, they decide whether to apply for DI, a decision also influenced by the value of alternatives such as claiming SS early. Therefore, the change in SS benefit schedules are likely to impact workers' behaviors even prior to reaching retirement age, which we now analyze.[19]

We estimate the following equation on a sample of individuals younger than ERA:

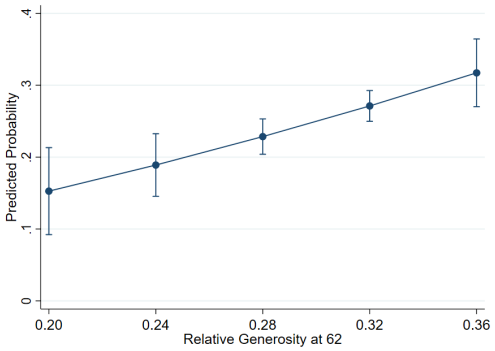
$$\text{logit}\left(y_{it}\right) = \beta_0 + \beta_a \cdot \text{Age}_{it} + \beta_c \cdot \text{Cohort}_i + \beta_t \cdot t + \beta_X \cdot X_{it} + \gamma \cdot \text{PVDR}_{it} + \varepsilon_{it}. \quad (5)$$

[18] In the sample of DI recipients and those claiming SS at 62, 26% receives DI; and in the sample of DI recipients and early SS claimants, 17% receives DI.

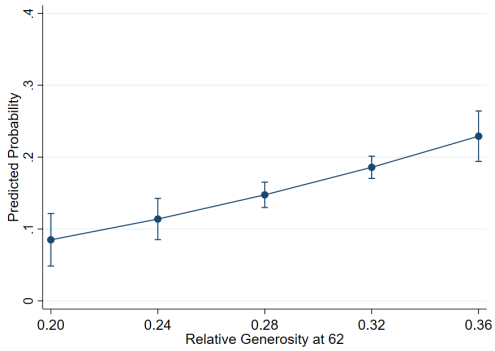
[19] The dynamic employment responses to changes in public pension system in Poland have been empirically documented in French et al. (2023).

Figure 7: Marginal Effects of Relative DI Generosity on DI Receipt vs. Early SS Claiming

(a): DI vs. SS at Age 62



(b): DI vs. SS between 62 and FRA



Note: Figure 7 plots the marginal effects of PVDR at 62 on DI receipt status based on coefficients from Table 2, with (a) and (b) corresponding to results from first and second column of the table, respectively.

Our first outcome of interest is whether an individual receives DI in a given year. We assign a value of one if an individual receives DI and a value of zero otherwise (e.g., working or not working). We estimate the effect of PVDR of an individual in year t (PVDR_{it}) instead of PVDR at age 62 ($\text{PVDR}_{i,62}$) as we do in Equation (4), to reflect the relative DI generosity at the time of worker's decision. In addition to cohort dummies and linear trend, we control for age dummies, Age_{it}, and also estimate specifications with additional health controls—the frailty index and a binary measure of work disability.

In essence, our analysis examines the following scenario. Consider a 60-year-old individual who experienced a disability shock. He has a choice to apply for DI, or he may stay in the labor market and claim SS when he becomes eligible. If the individual faces a higher early SS claiming penalty like the young cohort, is he more likely to choose DI? How responsive is he with respect to the relative generosity of DI? For those near the ERA, our measure of relative generosity captures the trade-off well. However, for a younger individual, like a 55-year-old, PVDR is a less precise measure of the trade-off, because PVDI and PVSS at age 55 cannot capture their numerous potential choices between ages 55 and 62. Therefore, we posit that the PVDR is a more relevant determinant for DI decisions for those closer to age 62. Considering this, we conduct analyses on three age-based subsamples: 60-62, 58-62, and 55-62.

In Table 3, we report our empirical results for the three subsamples, from a specification that does not include measures of health status as well as a specification with health controls. Because health measures are only available biennially, the sample size is substantially lower when we include health controls in the estimation. We first note that a higher-educated individual is less likely to receive DI; and that an individual with a higher frailty

Table 3: Relative DI Generosity and DI Receipt Near Retirement Age

	Age 60-62		Age 58-62		Age 55-62	
	(1)	(2)	(3)	(4)	(5)	(6)
HS grad.	-0.620***	-0.380*	-0.582***	-0.265	-0.578***	-0.234
	(0.127)	(0.194)	(0.130)	(0.183)	(0.133)	(0.180)
Some college	-1.561***	-0.718***	-1.461***	-0.491**	-1.440***	-0.522**
	(0.187)	(0.242)	(0.191)	(0.238)	(0.197)	(0.234)
Rel. DI generosity	12.235***	10.978***	12.771***	9.626***	12.452***	6.233***
	(1.507)	(2.048)	(1.228)	(1.857)	(1.167)	(1.935)
Frailty		3.745***		3.875***		4.199***
		(0.548)		(0.505)		(0.502)
Work disability		3.304***		3.306***		3.320***
		(0.217)		(0.190)		(0.183)
Observations	10,754	4,386	17,631	6,577	27,678	8,879

Note: Table 3 documents the regression coefficients from estimating Equation (5). Standard errors clustered at individual-level are in parentheses. $*p < 0.10; **p < 0.05; ***p < 0.01$

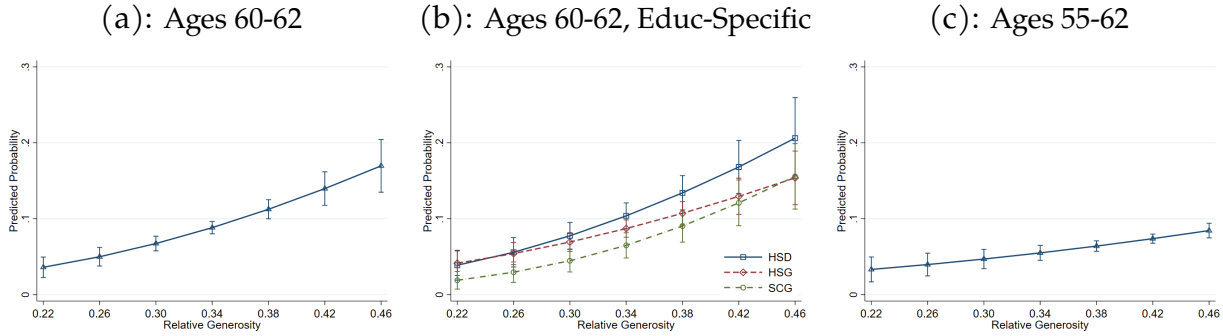
index (meaning more health conditions) or an individual who has a work disability is more likely to receive DI. In columns (1) and (2), we see that PVDR has statistically significant positive effects on the probability that an individual receives DI, even after controlling for health and disability. This result implies that an individual of age between 60 and 62 may be more inclined to opt in for DI when hit with a disability shock, if his value of retiring at 62 (an alternative to starting DI now) is lower. When we expand the age ranges to include younger individuals as presented in columns (3)–(6), the importance of PVDR explaining DI receipt status after controlling for health statuses, while still statistically significant, declines.[20]

To investigate whether the PVDR effect differs by education, we estimate Equation (5), allowing for education-specific PVDR effects with full results reported in Table A2 in Appendix A.3. Among 60-62-year-old individuals, we see that high school graduates are less responsive to PVDR, after controlling for health statuses. However we do not see statistical difference among individuals with college education. When we include younger individuals, we do not find heterogeneity across PVDR effects by education.

Figure 8 summarizes our key findings in these analyses by visualizing the marginal effects of relative DI generosity on DI receipt under three specifications with health controls: (a) the benchmark regression in Equation (5) for the 60-62 subsample (column (2) in Table 3); (b) the results with education-specific PVDR effects for the 60-62 subsample (column

[20]In Appendix A.3, we show results from estimating Equation (5) with employment as outcome. We see that PVDR has significant negative impacts on employment, suggesting that individuals are shifting away from employment to DI.

Figure 8: Marginal Effects of Relative DI Generosity on DI Receipt, Working-Age



Note: Figure 8 plots the marginal effects of PVDR on DI receipt status under specifications with health controls. Figures (a) and (c) correspond to 60-62 and 55-62 subsample results from specifications in column (2) and (6) in Table 3 from estimating Equation (5). Figure (b) is from Equation (5) that allows for education-specific effects of PVDR.

(2) in Table A2); and (c) the benchmark regression for the 55-62 subsample (column (6) in Table able A2). The estimated effects illustrated in Figure 8(a) imply that a 8 percentage point higher relative generosity (the difference in average PVDR between old and young cohort as shown in Table 1) is associated with around a 4.5 percentage point higher probability of receiving DI for individuals aged between 60 and 62, after controlling for health. This gradient is smaller for a subsample of individuals aged 55-62 as shown in Figure 8(b). Additionally, Figure 8(c) demonstrates that high school dropouts are both more likely to receive DI and are more responsive to PVDR than their higher-educated individuals.

3.4 Taking Stock

We document heterogeneity in DI and SS claiming behavior across cohorts (Section 3.2) and show evidence that these behaviors are driven, at least partially, by the SS reform (Section 3.3). Specifically, the empirical analyses suggest that the SS reform has not only shifted individuals from early SS to DI, but also impacted their pre-retirement behaviors. When the value of DI program is relatively higher than alternatives like the early SS claiming, individuals experiencing a disability shock before the retirement age are more inclined to choose DI, a decision consistent with dynamic optimization. The results also align with the observed decline in DI starting age among the young cohort in Figure 4. These further imply that workers may opt for DI with milder or less verifiable health conditions. Indeed, we observe a higher prevalence of reported psychiatric condition, which is associated with larger labor disincentive effects according to Maestas et al. (2013), among DI recipients in the young cohort compared to the old cohort, reinforcing the idea that the SS

reform-driven changes in financial incentives impact DI utilization.[21]

Thus, the empirical analysis in this section shows suggestive evidence of the behavioral response of forward-looking individuals and highlights its economic significance for evaluating SS reform. However, it is limited in that it cannot capture the full dynamic impact of the policy change. A structural model is necessary to understand these dynamic trade-offs, which we develop in the following section.

4 The Model

We construct a stochastic life-cycle model of labor supply, consumption and savings, DI application, and SS claiming, with agents subject to health (disability) and labor market risks. The model builds upon a life-cycle model with endogenous DI application (e.g., Low and Pistaferri, 2015; Kim and Rhee, 2022) by incorporating detailed Social Security programs and endogenous SS claiming decisions (e.g., Li, 2018; Pashchenko and Porapakkarm, 2023; Bairoliya and McKiernan, 2023).

4.1 The Model Environment

4.1.1 Demographics, Endowments, and Preferences

Time is discrete, and a model period is a year. Each individual of a given education status s (high school dropouts, high school graduates, or some college), starts his life at age 25 ($j = 25$), works at most 45 years (mandatory retirement at age 70, $j^R = 70$), and can live at most 70 periods (maximum age $J = 95$). The conditional survival probability depends on his age j, education s, and disability status h, where h is either non-disabled (ND), moderately disabled (MD) or severely disabled (SD).[22] We denote the survival probability from age j to age $j+1$ as $\delta^h_{s,j} \in (0,1)$ with $\delta^h_{s,J} = 0$, and specify the transition of h as an age and education-specific Markov chain denoted by $\pi^{ab}_{s,j} = \Pr\left(h_{j+1} = b \middle| h_j = a\right)$. We model three education statuses in light of the empirical observations in Section 3.2, which further allows us to evaluate redistributive consequences of Social Security reforms in our counterfactual analyses. Additionally, modeling three disability categories (relative to two) is essential as it allows us to capture the behavior of individuals who are at the margin of DI application

[21] The HRS reports incidence of seven specific diagnoses—arthritis, high blood pressure, lung disease, cancer, emotional or psychiatric problems, stroke, and diabetes—that we use to construct the frailty index. We detail their distributions across cohort and by DI receipt status in Appendix A.3.

[22] Empirically, we combine the frailty index and the binary measure of work disability to discretize the disability status of workers, the details of which are presented in Section 5.

and/or Social Security benefit claiming.[23]

Individuals' periodic utility is determined by the amount of consumption c, employment status l (one if employed), and their disability status h. We use the following specification

$$u(c,l;h) = \frac{\left(c \cdot \exp\left(\eta_{s,h} \cdot l\right)\right)^{1-\gamma}}{1-\gamma}, \tag{6}$$

with a time discount factor of β. The utility specification allows for education- and disability-specific disutility from work through $\eta_{s,h}$. We assume $\eta_{s,SD} < \eta_{s,MD} < \eta_{s,ND} < 0$, implying that work reduces utility and more so for disabled workers. Individuals incur an education and disability-specific fixed monetary cost of $F_{s,h}$, together with the work disutility, when working.[24]

A working-age individual ($j < 70$) is endowed with one unit of labor and makes a labor supply decision $l \in \{0,1\}$ subject to labor market risks. He receives a job offer with probability $\chi^a_{s,h}$ that depends on his education, health status, and previous period's labor market status a—rejected DI applicant (A), terminated DI beneficiaries (D), unemployed (0), or employed workers (1). The wage offer $w^h_{s,j}$ is determined by worker's education, age, and disability status. Upon receiving an idiosyncratic productivity shock ν with variance σ^2_ν, the worker decides whether to work or not. Although there is an extensive margin choice for labor supply, we abstract from the intensive margin decision of individuals and exogenously set the hours worked as disability and age-dependent λ^h_j. Thus, the labor income is $y^h_{s,j} \equiv \left(w^h_{s,j} \cdot \nu\right) \cdot \lambda^h_j$ if an individual works ($l = 1$). Importantly, individuals younger than FRA j^F who are moderately or severely disabled can also decide whether to apply for DI benefits. When they do, they need to forego some of their current income; in particular, we assume that a DI applicant's earnings (hours), disutility of work, and fixed costs are a $\kappa < 1$ share of those of employed workers, capturing missed work in DI application process. Once the individual reaches early retirement age (ERA) j^E, he can claim SS benefits, and the mandatory retirement age (MRA) j^R is 70.

Lastly, all agents have access to risk-free bonds with a time-invariant interest rate r, and face borrowing constraints. At death, assets of the deceased are distributed equally to all

[23] We assume that the disability process is first-order Markov, a commonly used assumption in the literature (e.g., French, 2005; Kitao, 2014a). A recent paper (De Nardi et al., ming) captures both the short- and long-run dynamics of health by allowing for history-dependence of health shocks. Although the rich modeling would be preferable, we adopt a simpler disability transition technology for tractability. Accounting for the rich dynamics could amplify the degree of heterogeneity in the labor market responses to the DI program across disability statuses.

[24] Low and Pistaferri (2015) shows that these components are necessary for replicating the employment patterns.

surviving members of the economy as an accidental bequest, beq.

4.1.2 Medical Expenditures and Health Insurance

An individual is subject to medical expenditure risks m whose process depend on worker's age and labor market statuses. We assume that employed workers have access to health insurance consistent with the employer-sponsored health insurance system in the US. They pay insurance premium p_E (constant across all workers) and have a coinsurance rate of $q_E(m) < 1$ that may depend on the size of the medical expenditure. Thus, an employed individual's out-of-pocket expenditure is $oop_E(m) \equiv p_E + q_E(m) \cdot m$. For simplicity, we assume that unemployed individuals and DI beneficiaries not yet qualified for Medicare benefits do not have access to insurance. However, we empirically capture other sources of insurance the uninsured workers have, through, e.g., spousal or public insurance, by allowing for their out-of-pocket expenditures to be $q_U(m) < 1$ share of total medical expenditures. Thus, an unemployed individual's out-of-expenditure is $oop_U(m) \equiv q_U(m) \cdot m$. Lastly, qualified DI beneficiaries and individuals aged 65 or older receive Medicare benefits, a public health insurance program with a premium of p_M and a coinsurance rate $q_M(m) < 1$ and thus out-of-pocket expenditure $oop_M(m) \equiv p_M + q_M(m) \cdot m$.

4.1.3 Government Policies

The government policies are modeled based on our discussion in Section 2, and policy options at each age by cohort follow the description in Figure 1.

Disability Insurance. The government runs the DI program for working-age individuals. Agents can apply for the DI program if they are moderately or severely disabled; however, this does not guarantee receipt of DI benefits. The application process is successful with probability $\pi^{DI,h}$ that differs across disability status, and the accepted workers receive DI benefits $DI(\omega_{DI})$ that replace the recipient's foregone labor income proportional to their previous earnings history ω_{DI}. Further, DI recipients become eligible for Medicare after they receive DI benefits for 24 months. For consistency with the institutional feature, we assume that DI recipients receive Medicare benefits with probability π^M with an expected waiting period of two years. The beneficiary may receive a reassessment of disability status with probability π^{RE}. If the individual is not deemed eligible to receive DI (i.e., he is non-disabled) upon reassessment, his benefit will be terminated. Individuals can apply for DI up to their FRA, j^F. Once a DI recipient reaches FRA, his benefit automatically becomes SS benefits, without adjustments in the benefit amounts.

Social Security. Social Security benefits differ across cohorts due to the 1983 Amendments. Here, we briefly describe the general structure of SS, and specify the policy parameters across cohorts in the next section. Individuals can claim SS benefits starting at ERA, j^E. We consider the claiming decision as irreversible, and thus collecting SS benefits is an absorbing state. An individual's benefit size is determined by his past earnings summarized by ω_{SS} and the age at which the individual claims the benefits. If an individual claims benefits at FRA j^F, his benefits are equal to the primary insurance amount that depend on ω_{SS}, PIA(ω_{SS}). If he claims benefits before (after) reaching j^F, the benefits are reduced (increased). The latest age in which individuals claim benefit is j^R, and we assume that all individuals stop working and receive SS benefits at age j^R (MRA) at the latest.[25]

AIME Updating and DI and SS Benefits AIME summarizes an individual's earnings history that determines DI and SS benefits. As discussed in our policy specifics, the AIME for DI may not be the same as the AIME for SS, due to computation year differences across policies. For computational tractability, instead of tracking the entire earnings history, we approximate an individual's AIME for SS using the average earnings as in French (2005). Further, we use the AIME for SS to construct the AIME for DI. More specifically, the state variable ω is updated as the average earnings until age 60, and then it is updated only if the new earnings exceed the previous average after age 60. That is,

$$\omega' = \begin{cases} \omega + \dfrac{\min\{y, \bar{y}_{ss}\}}{35}, & j < 60 \\ \omega + \dfrac{1}{35}\max\{0, \min\{y, \bar{y}_{ss}\} - \omega\} & j \geq 60, \end{cases} \tag{7}$$

where $\bar{y}_{ss}$ is the income limit subject to SS contribution. For those who do not work, zero is used to update the state variable. For DI applicants, a reduced annual earnings (by κ) is used to update ω. We let the AIME for SS ω_{SS} be ω, and separately construct ω_{DI} using ω, accounting for earnings history up to disability onset age. We translate ω into total earnings until age j and divide it by the number of working years until age j, that is,

$$\omega_{DI} \quad = \quad \frac{35 \cdot \omega}{\text{computation year}_j}, \tag{8}$$

where the computation year is defined as the years worked between age 22 and the onset of disability after subtracting the dropout year.[26]

[25] For now, we abstract from retirement earnings test (RET), which lowers SS benefits when an individual's earning exceeds a certain threshold.

[26] DI applicants typically have shorter earnings records up until the onset of their disability. Consequently, the AIME for DI recipients is calculated after dropping a number of low-earnings

Using the respective ω for SS and DI, the annual primary insurance amount (PIA) is determined as

$$\text{PIA}(\omega) = \begin{cases} 0.90 \times \omega & \text{if } \omega < b_1 \\ 0.90 \times b_1 + 0.32 \times (\omega - b_1) & \text{if } b_1 \leq \omega < b_2 \\ 0.90 \times b_1 + 0.32 \times (b_2 - b_1) + 0.15 \times (\omega - b_2) & \text{if } \omega \geq b_2, \end{cases} \tag{9}$$

where the replacement rate starts at 90% but drops to 32% and 15% for AIME above bend points b_1 and b_2. Thus, DI benefit $DI(\omega_{DI})$ is equal to $\text{PIA}(\omega_{DI})$. And the SS benefits $SS(\omega_{SS})$ for those at claiming age j is $\text{PIA}(\omega_{SS}) \cdot \psi_j$, where ψ_j reflects the early claiming penalties and delayed claiming credits that we specify for young and old cohorts in Figure 1.

Other Social Insurance Programs and Taxes Unemployed workers receive unemployment insurance (UI) benefits proportional to their labor market income $UI(y)$. Other welfare programs (e.g., the Supplemental Nutrition Assistance Program) are captured by a consumption floor of amount $\underline{c}_f$ and all other government expenditures are denoted as G. These government programs are funded by labor income tax $\tau_y(y)$, capital income tax τ_k, Social Security tax τ_{ss}, and Medicare tax τ_{med}, which we collectively denote as τ.

4.1.4 Timing of Events

Each period is divided into four stages: realization of health and death shocks, DI status determination (among applicants and current recipients), decisions in the labor market including SS claiming and DI application, and consumption and savings.

At the beginning of each period, death shocks occur and disability status is updated for survived agents. Based on disability status, DI application results are released for previous applicants, and reassessments results are determined for randomly selected current DI enrollees. Subsequently, job-offer and productivity shocks arrive, and individuals make labor supply decisions. At this stage, working-age individuals younger than FRA with moderate and severe disabilities can also consider applying for DI. Furthermore, individuals between the ages of j^E and j^R can also consider claiming SS benefits, regardless of their disability statuses. Then, income (e.g., government benefits and labor income) is allocated, and individuals consume and save.

records to better reflect their average lifetime earnings. For more details about the 1-for-5 rule, see https://secure.ssa.gov/poms.nsf/lnx/0300605230.

4.2 Individual Problems

An individual's life cycle can be characterized into four phases depending on their eligible social insurance programs: (i) young working-age with DI eligibility ($j < j^E$); (ii) older working-age with both DI and early SS claim options ($j^E \leq j < j^F$); (iii) age after full retirement with delayed SS claiming option ($j^F \leq j < j^R$); and (iv) retirement phase after mandatory retirement, the latest age that workers claim SS ($j \geq j^R$). For each phase, we formulate the value function at the beginning of the consumption-savings stage, suppressing education-dependence for notational simplicity. The state variables are age j, asset a, health h, AIME ω,medical expenditure m, and labor productivity ν. For expositional purpose, we let $x \equiv (j, a, \omega, m, \nu)$ denote all state variables except health status h, as choice sets for individuals (e.g., DI application availability) explicitly depend on his health status. For all workers, the AIME ω' evolves following Equation (7), AIME for DI given ω is determined as in Equation (8), and the government's welfare program ensures that the worker is able to consume at least the amount of the consumption floor so that $tr = \max\{\underline{c}_f - c, 0\}$. Given these common constraints for all workers, we now lay out value functions in each age group, specifically highlighting the trade-offs each worker faces.

4.2.1 Workers Aged $j < j^E$ (ERA): Work or Apply for DI?

Workers in the labor market. Workers who are currently employed ($l = 1$) or unemployed ($l = 0$) solve the following problem:

$$V^l(x,h) = \max_{c,a' \geq 0} u(c + tr, l) + \beta \delta_j^h \pi_j^{h,ND} \left[\chi_{h'}^l \mathbb{E} \max_{l \in \{0,1\}} V^l(x', ND) + \left(1 - \chi_{h'}^l\right) \mathbb{E} V^0(x', ND) \right] \quad (10)$$

$$+\beta \delta_j^h \sum_{h' \in \{MD, SD\}} \pi_j^{h,h'} \left[\begin{array}{l} \chi_{h'}^l \ \mathbb{E} \max \left\{ \max_{l \in \{0,1\}} V^l(x', h'), V^A(x', h') \right\} \\ + \left(1 - \chi_{h'}^l\right) \mathbb{E} \max \left\{ V^U(x', h'), V^A(x', h') \right\} \end{array} \right] \quad (11)$$

with the budget constraint for employed workers being

$$c + a' = \tilde{y} - F_h - oop_E(m) + (1 + \tilde{r}) a + beq \quad (12)$$

and that for unemployed workers,

$$c + a' = UI(y) - oop_U(m) + (1 + \tilde{r}) a + beq. \quad (13)$$

The utility this period is drawn from consumption and disutility from work. In the next period, if he survives (with probability δ_j^h) and turns out to be non-disabled ($\pi_j^{h,h'=ND}$),

there are two possibilities (line (10)): he may receive a job offer with probability $\chi^l_{h'}$ or he is left unemployed with probability $1-\chi^l_{h'}$. Note that the job offer arrival rates χ depends on his disability status in the next period and labor market status in the current period to capture the impacts of labor market attachment on future labor market opportunities. When the individual receives the offer and productivity shock, he makes the labor market participation decision, with its value $\mathbb{E}\max_{l\in\{0,1\}} V^l(x',h')$, where expectations (here and in problems to follow) are taken with respect to medical expenditure and labor productivity shocks. For a worker who becomes moderately or severely disabled, his choice set expands as he can also choose to apply for the DI program (line (11)).

As seen in the budget constraints (Equations (12) and (13)), expenditures include consumption c, savings a', fixed costs of work F_h if employed, and employment-dependent out-of-pocket expenditures. The total resources for the employed are from after-tax labor income $\tilde{y}\equiv y-\tau_y(y)$, after-tax capital income $(1+\tilde{r})a$, and bequests beq. The before-tax labor earnings are $y\equiv w^h_j \nu \lambda^h_j$, where ν is the productivity shock that follows an AR(1) process and λ^h_j is the hours worked. Additionally, $\tilde{r}\equiv(1-\tau_k)r$ denotes the after-tax rate of return of capital. An unemployed worker's income source is unemployment insurance $UI(y)$, instead of after-tax labor earnings.

DI applicants. Moderately and severely disabled workers, i.e., those with $h\in\{MD,SD\}$ have an option to apply for DI benefits, and their value reads[27]

$$\begin{aligned} V^A(x,h) \quad = \quad & \max_{c,a'\geq 0} u(c+tr,\kappa) \\ & +\beta\delta^h_j \sum_{h'} \pi^{hh'}_{j+1} \left[\pi^{DI,h} V^{D,i_M=0}(x',h') + \left(1-\pi^{DI,h}\right) \left[\begin{array}{c} \chi^A_{h'} \mathbb{E}\max_{l\in\{0,1\}} V^l(x',h') \\ +\left(1-\chi^A_{h'}\right)\mathbb{E}V^0(x',h') \end{array} \right] \right] \\ s.t. \qquad & c+a' = \widetilde{\kappa y} - \kappa F_h - oop_E(m) + (1+\tilde{r})a + beq. \end{aligned} \tag{14}$$

The applicant works for κ share of his time, lowering his after-tax labor income, work disutility, and monetary costs from work by the same proportion. As a partially attached worker, he has access to health insurance, in accordance with COBRA continuation coverage. In the next period, if successful (with probability $\pi^{DI,h}$), the worker becomes a DI recipient without Medicare denoted by value $V^{D,i_M=0}$. If not successful, he becomes unemployed, unless he is given the opportunity to enter the labor market.

[27] We do not allow non-disabled workers to apply; however, it may be that endogenously, it is not in their best interest to do so. In some sense, our notion of disability (from the PSID at least) may extend beyond those who actually receive DI.

DI beneficiaries with $(i_M = 1)$ and without Medicare $(i_M = 0)$. The value of being a DI beneficiary depends on whether he receives Medicare benefits $(i_M = 1)$ or not $(i_M = 0)$. Their values are

$$
\begin{aligned}
V^{D,i_M}(x,h) \quad = \quad & \max_{c,a' \geq 0} u(c+tr,0) \\
& + \beta \delta_j^h \left(\left(1-\pi^{RE}\right) + \pi^{RE} \sum_{h'=MD,SD} \pi_{j+1}^{hh'} \right) \mathbb{E} V^{D,i_M}(x',h') && (15) \\
& + \beta \delta_j^h \pi^{RE} \ \pi_{j+1}^{h,ND} \left[\chi^D \mathbb{E} \max_{l \in \{0,1\}} V^l(x',ND) + \left(1-\chi^D\right) \mathbb{E} V^0(x',ND) \right] && (16) \\
s.t. \qquad & c + a' = DI(\omega_{DI}) - (i_M \cdot oop_M(m) + (1-i_M) \cdot oop_U(m)) + (1+\tilde{r})\, a + beq. && (17)
\end{aligned}
$$

In the following period, if the worker is not reassessed $(1-\pi^{RE})$ or is reassessed and he is moderately or severely disabled $(\pi^{RE} \sum_{h'=MD,SD} \pi_{j+1}^{hh'})$, he remains a DI recipient with expected value $\mathbb{E}V^{D,i_M}(x',h')$ (line (15)). The expected value additionally incorporates Medicare acceptance probability π^M in addition to medical expenditure and productivity shocks. If the beneficiary does not pass the reassessment (i.e., he is non-disabled when reassessed), his benefits are terminated (line (16)). Then, he either receives a job offer with probability χ^D or becomes unemployed. Unlike χ_h^0, χ_h^1, or χ_h^A, which are disability-dependent, all workers leaving DI after reassessment are non-disabled and thus face the same job offer arrival rates. As DI beneficiaries only leave the program upon failing the reassessment, non-disabled workers may continue receiving DI benefits. Whether the beneficiary receives Medicare impacts his medical expenditures through the budget constraint (line (17)).

4.2.2 Workers Aged j^F (FRA) $\leq j < j^R$ (MRA): Claim SS Benefits?

We have discussed the working-age individual's problem with DI option. We now describe the decision process of an individual in age between j^F and j^R who has the option to claim SS. Then we will return to the case for age between j^E and j^R with both DI and SS options. DI benefits of previous DI recipients are automatically converted into SS at age j^F. We assume that they do not re-enter the labor market, thus their value function is equivalent to the value function in retirement phase where agents make only consumption and savings decision. For non-DI beneficiaries, they make two choices, SS claiming and labor supply.

Claimed SS benefits. Once SS claiming decision is made, then the agent cannot revoke his decision. Thus, his value function becomes a life-cycle model with labor supply, consumption, and savings decisions, with the two distinctions being that now they have

additional income from SS benefits and access to Medicare. Thus, for individuals receiving SS, the value function is given as

$$\begin{aligned} V^{S,l}(x,h) &= \max_{c,a'\geq 0} u(c+tr,l)+\beta\delta_j^h\sum_{h'}\pi_j^{h,h'}\left[\begin{array}{c}\chi_{h'}^l\mathbb{E}\max\limits_{l\in\{0,1\}}V^{S,l}(x',h')\\ +\left(1-\chi_{h'}^l\right)\mathbb{E}V^{S,0}(x',h')\end{array}\right] \qquad (18)\\ s.t. &\quad c+a'=SS(\omega)+(\tilde{y}-F_h)\cdot\mathbb{I}_{l=1}+UI(y)\cdot\mathbb{I}_{l=0}-oop_M(m)+(1+\tilde{r})a+beq. \end{aligned}$$

Did not claimed SS benefits yet. Individuals without SS can determine their benefit status after the labor market uncertainty resolves. Since the individual passed the FRA for DI application, his option is limited to either claiming the benefits this period or delaying it. The value function of individuals with postponed SS claim, $V^{P,l}$ with $l\in\{0,1\}$ is

$$\begin{aligned} V^{P,l}(x,h) &= \max_{c\geq 0,a'\geq 0} u(c+tr,l) \qquad (19)\\ &\quad +\beta\delta_j^h\sum_{h'}\pi_j^{h,h'}\left[\begin{array}{c}\chi_{h'}^l\mathbb{E}\max\left\{\max\limits_{l\in\{0,1\}}V^{S,l}(x',h'),\max\limits_{l\in\{0,1\}}V^{P,l}(x',h')\right\}\\ +\left(1-\chi_{h'}^l\right)\mathbb{E}\max\left\{V^{P,0}(x',h'),V^{S,0}(x',h')\right\}\end{array}\right]\\ s.t. &\quad c+a'=(\tilde{y}-F_h)\cdot\mathbb{I}_{l=1}+UI(y)\cdot\mathbb{I}_{l=0}-oop_M(m)+(1+\tilde{r})a+beq. \qquad (20) \end{aligned}$$

These agents weigh the benefits of claiming SS in the next period, $V^{S,l}(x',h')$, or postponing it, $V^{P,l}(x',h')$, incorporating the SS benefit adjustments by claiming age.

4.2.3 Workers Aged j^E (ERA) $\leq j < j^F$ (FRA): Apply for DI or Claim SS Benefits?

Relative to individuals past the FRA, these individuals have an additional option, as they can also apply for DI benefits like those in the working age ($j < j^E$), further expanding the choice set beyond those older than FRA we described in the previous section. For brevity, we discuss their choices in the main text and relegate the problem specifications to Appendix B.

Claimed SS benefits. If the individual claimed benefits, he can still work, but cannot apply for DI. Thus, his decision problem is the same as Equation (18), except for the fact that his benefits are reduced according to policy, and that he is not eligible for Medicare. Therefore, the out-of-pocket medical expenditures in their budget constraint are determined based on their labor market status.

Did not claimed SS benefits yet. If the individual has not yet claimed benefits, he can still apply for DI if his disability status is *MD* or *SD*. Thus, the value function is a combination of

Equations (11) and (19), as he can make labor supply choices in conjunction with whether or not to claim SS, and whether to apply for DI.

DI beneficiaries. For simplicity, we assume that once an individual is past the age of j^E, he continues receiving DI (does not get reassessed) until the benefit gets transferred to SS (without any cuts in benefits) at age j^F. Therefore, the only choices are consumption and savings with the budget constraint in Equation (17).

DI applicants. DI applicants in this age range incorporate the possibility of claiming SS benefits if he is not accepted to DI, with the budget constraint specified in Equation (14).

4.2.4 Workers Aged $j \geq J^R$: Retired

Once retired, the individual receives Social Security benefits based on his earnings history and makes optimal consumption and saving decisions:

$$\begin{aligned} V^R(x,h) &= \max_{c\geq 0, a'\geq 0} u(c+tr,0) + \beta \delta_j^h \mathbb{E} V^R\left(x',h'\right) \\ s.t. &\quad c + a' = SS(\omega_{SS}) - oop_M(m) + (1+\tilde{r})\, a + beq. \end{aligned}$$

For these individuals, ω_{SS} does not change for the rest of his life.

Our model specifies the distinct choice sets individuals face due to DI and SS policy features, making it a suitable laboratory for quantifying the effects of the SS reform. We now discuss how we map the model to data.

5 Calibration

We describe how we map our model to the data to evaluate Social Security reforms in the presence of DI. We calibrate the model to 1930-1937 cohorts, utilizing additional data sets—the Panel Study of Income Dynamics (PSID) and the Medical Expenditure Panel Survey (MEPS)—which complement the Health and Retirement Study (HRS) data as they include samples across all ages. We first document the parameters calibrated outside the model, describe the within-model calibration process and the model's performance on targeted moments, and then externally validate the model.

5.1 Exogenously Calibrated Parameters

Following the literature, we set the constant relative risk aversion (CRRA) parameter γ in the utility function exogenously at 2 and the annual return of the risk-free bonds r at 3%.

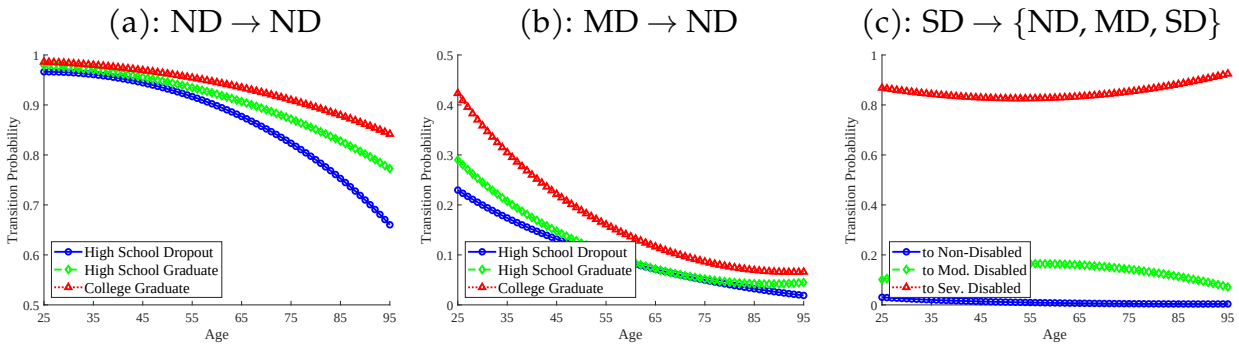
Disability statuses. We classify disability status (h) into three categories, non-disabled (ND), moderately disabled (MD) and severely disabled (SD), based on a binary measure of work disability status and frailty index, an index representing the number of health conditions an individual has that we describe in Section 3. Because we model DI, whether a worker has a work disability or not is an important aspect of a worker's characteristic that impacts his choice set. It is also true that there is a varying degree of work disabilities that cannot perfectly be captured by the binary measure of work disability. For the purpose of understanding the policy effects, differentiating workers based on the severity of his work disability is crucial for capturing the heterogeneous behavioral responses of workers. That is why we incorporate the frailty index to categorize workers into three disability statuses. The frailty index is useful as it can be constructed from the three data sources that we are using, HRS, PSID, and MEPS, as documented in Hosseini et al. (2022).

We define a worker to be *non-disabled* if he does not have a work disability and his frailty is in the lower 90% of the frailty distribution. Specifically, we use the 90th-percentile of the frailty distribution among individuals aged 25 and 67 from the PSID, the main dataset for the calibration of parameters for working-age individuals (e.g., wage and disability status transitions). He is *severely-disabled* if he has a work disability and his frailty is in the top 10% of the frailty distribution, and all others are defined to be *moderately disabled*. Using this definition, the shares of workers in each disability category are 72%, 15% and 13% among those aged between 50 and 67. We report more detailed statistics about the data in the Appendix.

Disability status in the model impacts the worker's (i) survival probability; (ii) evolution of future disability statuses; (iii) medical expenditures; earnings through (iv) hours worked and (v) wage offer profiles; (vi) job offer arrival rates; and (vii) disutility and fixed costs from work. We exogenously calibrate the parameters (i) through (v), and calibrate (vi) and (vii) endogenously within the model, which we discuss in Section 5.2. Most of the parameters in (i) through (vii) except for (iii), the medical expenditure profiles and (v), hours worked, are also education-dependent (whenever the sample sizes are sufficiently large) to capture the substantial heterogeneity in health and labor market outcomes across education status of workers.

We now describe the external calibration processes of these parameters. As we cali-

Figure 9: Disability Transitions



brate to old (1930-1937 birth year) cohort, we use cohort-level parameters. In the main text, we focus on the key features of model parameters, relegating detailed descriptions to Appendix C.

Survival probability and disability evolution. First, following the strategy of Attanasio et al. (2011), we estimate conditional survival probabilities by disability and education statuses using the life table from the Social Security Administration and micro-level data from the PSID. The estimated survival probabilities and the procedure are documented in Appendix C.

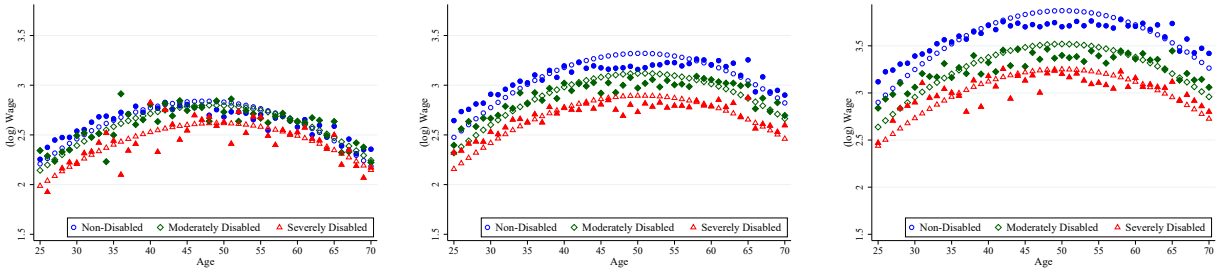
Second, the disability status in the model evolves stochastically and depends on worker's age, education, and current disability status.[28] Utilizing the panel dimension of PSID, we estimate a multinomial logit model to predict the future disability status, and fit these moments to a quadratic function of age to produce smooth transitions over the life cycle. In Figure 9, we plot selected disability transitions. In Figures 9(a) and 9(b) are probabilities of transitioning to non-disabled, from non-disabled and moderately-disabled, respectively, by education statuses. These figures show the education- and age-dependence in disability transitions. In Figure 9(c) are probabilities of transitioning to three disability statuses for severely disabled workers, where, due to sample size issues, we do not model education-dependence. The estimated transitions show persistence in disability statuses, which is more pronounced for severely disabled workers.

Wage offer profiles and hours worked. We estimate hourly wage offer profiles externally, using a two-step estimation procedure of Heckman (1979). To control for selection into employment, we follow the approach by Low and Pistaferri (2015), where we uti-

[28] A recent work De Nardi et al. (ming) estimates a second-order Markov process for health statuses (health measures are different from ours). In this work, for quantitative tractability given large state space, we assume a first-order Markov process in disability statuses.

Figure 10: Wage Offer Profiles by Education

(a): High School Dropouts (b): High School Graduates (c): Some College



lize the cross-state variations in social insurance and welfare programs to construct an instrumental variable for the employment regression. The estimated wage offer profiles are presented in Figure 10 with the detailed first and second-stage estimation procedures reported in Appendix C. Each plot in Figure 10 shows life-cycle profiles by education and disability statuses. Conditional on working, we assume that individuals work for a fixed number of hours. For each age and disability status, we construct working hours as the average working hours among the employed with more than 700 hours per year (plotted in Appendix C).

Medical expenditures and health insurance. Medical expenditure risks differ by age and disability statuses. We use medical expenditures from the Medical Expenditure Panel Survey (MEPS) to construct these variables. Similar to Attanasio et al. (2011), we use three medical expenditure bins representing the average total expenditures in the 1st–50th percentile, 51st–90th percentile, and 91th–99th percentile by age and disability status. We then utilize the total amount paid by self to construct coinsurance rate—amount paid by self divided by total medical expenditures—for the insured (employed) who are younger than 65 ($q_E = 0.30$) and for those older than 65 and DI beneficiaries who are covered by Medicare ($q_M = 0.24$). Further, to capture other sources of insurance not directly captured in our model (e.g., spousal health insurance or public insurance programs) for the uninsured individuals, we construct a similar ratio to obtain $q_U = 0.68$. The out-of-pocket medical expenditures by age, health, and insurance (employment) statuses are then constructed as $oop_i(m) \equiv p_i + q_i \cdot m$, for $i \in \{E, U, M\}$ where health insurance premium for the employed and Medicare enrollees, $p_E = \$1,530$ and $p_M = \$1,740$, are taken from those reported in Kaiser Family Foundation (and $p_U = 0$).[29] These are plotted in Appendix C (Figure A6).

[29]The premium for the employed p_E is the average annual single premium per employee for employer-based health insurance. We use the average employee contribution in 2021 from KFF (constructed from the MEPS Insurance Component, a survey of establishments) to capture the out-of-pocket expenditures on the worker-side. The Medicare premium p_M is an annual average of Medicare Part B.

Government policies. We discuss parameters for government policies: Disability Insurance, Unemployment Insurance, Social Security, Medicare, tax policies, and welfare programs.

Disability Insurance. Five parameters fully describe the DI program: application penalty parameter κ, application success probability π^{DI}, the probability of qualifying for Medicare benefits π^{M}, reassessment probability π^{RE}, and benefit schedule as a function of previous earnings $DI(\omega)$.

DI applicants have a waiting period of around five months to receive DI benefits; thus, we assume that applicants earn 60% of their labor income and that their disutility and monetary costs of work are also scaled down by the same proportion. The DI receipt probabilities are set at 18% for moderately disabled workers and 45% for severely disabled workers, within the ranges estimated by Low and Pistaferri (2015).[30] The Medicare receipt probability is 50% to capture the beneficiary's expectation to qualify for the benefits after two years. Further, the reassessment probability is set at 6%, similar to that used by Low and Pistaferri (2015). Lastly, the DI payments are determined by the following Primary Insurance Amount (PIA) formula (in 2020 dollars, annually): where ω reflects the worker's average indexed monthly earnings (AIME) out of his 35 highest years of earning.

Social Security. The PIA in Equation (9) also determines Social Security payments. For ω_{SS}, we use a similar approximation as that for DI, but we require 35 years of work experience.[31]

Unemployment insurance, welfare programs, and taxes. UI benefits are paid to unemployed workers. With about a 45% replacement rate that pays up to six months, the overall yearly replacement rate is set at 23% of the worker's annual income. We set the consumption floor as $\underline{c}_f = \$4,180$ to capture other unmodeled government's welfare programs.[32] Labor income tax is progressive, with after-tax income expressed as $\tau_{y,0} \cdot \left(\bar{y}^{1-\tau_{y,1}}\right)$ following Holter et al. (2019). Parameters $\tau_{y,0} = 0.818$ and $\tau_{y,1} = 0.111$ represent level and curvature of the tax function where $\bar{y}$ is income expressed as a multiple of average income. The capital income tax rate is set at $\tau_k = 0.1$.[33] Social Security taxes are set at $\tau_{ss} = 0.124$, levied on labor

[30] Unlike in our model, Low and Pistaferri (2015) only uses high school graduates. Although their DI acceptance probability is age-dependent (younger or older than 45), we use constant probabilities that are approximately the average of their estimates.

[31] As years of experience is our state variable, we can capture the impact of years of experience on workers' Social Security benefit determination: if a worker worked for 20 years, for example, we use (as does the US policy) zero as earnings for 15 years. The work requirement for DI benefits are a lot more relaxed; thus, we do not impose such experience restrictions for the approximation of ω_{DI}.

[32] This is within the range used in the literature: the annual consumption floor is set at \$4,000 in Kitao (2014a) and estimated to be \$1,540 (in 2003 dollars) in Pashchenko and Porapakkarm (2017) and \$3,593 in De Nardi et al. (ming).

[33] We assume a constant capital income tax rate, similar in level to the long-term capital gains tax rate.

earnings, with maximum taxable earnings of $y_{ss} = \$137,700$. Meanwhile, the Medicare tax rate is $\tau_M = 0.029$, levied on labor earnings.

We summarize the values of all exogenously calibrated parameters in Table 4.

Table 4: Parameters Calibrated Outside the Model

Parameter	Description	Value	Parameter	Description	Value
Demographics, Preferences, Technology			Policies: UI, Welfare, Tax		
$\delta^h_{s,j}$	Survival rates	Fig. A3	b	UI replacement rate	0.23
γ	Risk aversion	2	$\underline{c}_f$	Consumption floor	\$4,180
r	Interest rate	0.03	$\tau_{y,0}$, $\tau_{y,1}$	Labor income tax	0.818, 0.111
			τ_k	Capital income tax	0.10
Health and Medical Expenditures			τ_M	Medicare tax	0.029
$\pi^{h,h'}_{s,j}$	Health transition	Fig. A4	τ_{SS}, y_{SS}	SS tax, max earnings	0.124, \$137,700
$oop(m)$	OOP expenditures	Fig. A6			
			Policy: Disability Insurance		
Wage and Hours			κ	Application penalty	0.6
$w^h_{s,j}$	Wage process	Fig. 10	$\pi^{DI,MD/SD}$	DI receipt prob.	0.18; 0.45
ρ_v, σ^2_v	Productivity shock	0.65; 0.71	π^M, π^{RE}	Medicare, reexamine prob.	0.5, 0.06
λ^h_j	Hours	Fig. A5	b_1, b_2	PIA bend points	\$11,520, \$69,420

5.2 Endogenously Calibrated Parameters [TBC]

5.3 Model Validation [TBC]

6 Counterfactual Analysis [TBC]

7 Conclusion [TBC]

References

Aizawa, N., S. Kim, and S. Rhee (2025). Labour market screening and the design of social insurance: An equilibrium analysis of the labour market for the disabled. *Review of Economic Studies 92*, 1–39.

Andersen, A. G., S. Markussen, and K. Roed (2021). Pension reform and the efficiency-equity trade-off: Impacts of removing an early retirement subsidy. *Labour Economics 72*.

Attanasio, O., S. Kitao, and G. L. Violante (2011). *Demography and the Economy*, Chapter Financing Medicare: A General Equilibrium Analysis, pp. 333–366. University of Chicago Press.

Autor, D., A. Kostøl, M. Mogstad, and B. Setzler (2019, July). Disability benefits, consumption insurance, and household labor supply. *American Economic Review 109*(7), 2613–2654.

Autor, D. H. and M. G. Duggan (2006). The growth in the social security disability rolls: A fiscal crisis unfolding. *Journal of Economic Perspectives 20*(3), 71–96.

Bairoliya, N. and K. McKiernan (2023). Revisiting retirement and social security claiming decisions. *Working Paper*.

Bound, J. and R. V. Burkhauser (1999). *Handbook of Labor Economics*, Volume 3C, Chapter Economic Analysis of Transfer Programs Targeted on People with Disabilities, pp. 3417–3528. Amsterdam: Elsevier Science.

Coe, N. B. and K. Haverstick (2010). Measuring the spillover to disability insurance due to the rise in the full retirement age. *Boston College CRR working paper* (2010-21).

De Nardi, M., S. Pashchenko, and P. Porapakkarm (forthcoming). The lifetime costs of bad health. *Review of Economic Studies*.

Deshpande, M., I. Fadlon, and C. Gray (2024, March). How sticky is retirement behavior in the u.s.? *The Review of Economics and Statistics 106*(2), 370–383.

Duggan, M., P. Singleton, and J. Song (2007). Aching to retire? the rise in the full retirement age and its impact on the social security disability rolls. *Journal of Public Economics 91*, 1327–1350.

French, E. (2005). The effects of health, wealth, and wages on labour supply and retirement behaviour. *Review of Economic Studies 72*, 395–427.

French, E. and J. B. Jones (2011, May). The effects of health insurance and self-insurance on retirement behavior. *Econometrica 79*(3), 693–732.

French, E. and J. B. Jones (2017). Health, health insurance, and retirement: A survey. *Annual Review of Economics 9*, 338–409.

French, E., A. Lindner, C. O'Dea, and T. Zawisza (2023). Labor supply and the pension contribution-benefit link. *NBER Working Paper 30184*.

French, E. and J. Song (2014, May). The effect of disability insurance receipt on labor supply. *American Economic Journal: Policy 6*(2), 291–337.

Gelber, A., T. Moore, Z. Pei, and A. Strand (2023). Disability insurance income saves lives. *Journal of Political Economy 131*(11).

Geyer, J., P. Haan, A. Hammerschmid, and M. Peters (2020). Labor market and distribu-

tional effects of an increase in the retirement age. *Labour Economics 65*.

Heckman, J. J. (1979, January). Sample selection bias as a specification error. *Econometrica 47*(1), 153–161.

Holter, H., D. Krueger, and S. Stepanchuk (2019). How does tax progressivity and household heterogeneity affect laffer curves? *Quantitative Economics 10*, 1317–1356.

Hosseini, R., K. Kopecky, and K. Zhao (2022). The evolution of health over the life cycle. *Review of Economic Dynamics 45*, 237–263.

Hosseini, R., K. Kopecky, and K. Zhao (2024). How important is health inequality for lifetime earnings inequality? *Working Paper*.

Imrohoroglu, S. and S. Kitao (2012). Social security reforms: Benefit claiming, labor force participation, and long-run sustainability. *American Economic Journal: Macroeconomics 4*, 96–127.

Jones, J. B. and Y. Li (2023). Social security reform with heterogeneous mortality. *Review of Economic Dynamics 48*, 320–344.

Kim, S. and S. Rhee (2022, October). Understanding the aggregate effects of disability insurance. *Review of Economic Dynamics 46*, 328–364.

Kitao, S. (2014a). A life-cycle model of unemployment and disability insurance. *Journal of Monetary Economics 68*, 1–18.

Kitao, S. (2014b). Sustainable social security: Four options. *Review of Economic Dynamics 17*(4), 756–779.

Kolsrud, J., C. Landais, D. Reck, and J. Spinnewijn (2024). Retirement consumption and pension design. *American Economic Review 114*(1), 89–133.

Lalive, R., A. Magesan, and S. Staubli (2023). How social security reform affects retirement and pension claiming. *American Economic Journal: Economic Policy 15*(3), 115–150.

Laun, T., S. Markussen, T. C. Vigtel, and J. Wallenius (2019). Health, longevity and pension reform. *Journal of Economic Dynamics and Control 103*, 123–157.

Li, X. and N. Maestas (2008). Does the rise in the full retirement age encouraege disability benefit applications? evidence from the health and retirement study. *University of Michigan Retirement Research Center Working Paper 2008-198*.

Li, Y. (2018). Paradoxical effects of increasing the normal retirement age: A prospective evaluation. *European Economic Review 101*, 512–527.

Low, H. and L. Pistaferri (2015, October). Disability insurance and the dynamics of the incentive-insurance tradeoff. *American Economic Review 105*(10), 2986–3029.

Maestas, N., K. J. Mullen, and A. Strand (2013). Does disability insurance receipt discourage work? Using examiner assignment to estimate causal effects of SSDI receipt. *American Economic Review 103*(5), 1797–1829.

Mitnitski, A. B., J. E. Graham, A. J. Mogilner, and K. Rockwood (2002). Frailty, fitness and late-life mortality in relation to chronological and biological age. *BMC Geriatrics 2*(1).

Pashchenko, S. and P. Porapakkarm (2017). Work incentives of Medicaid beneficiaries and the role of asset testing. *International Economic Review 58*(4).

Pashchenko, S. and P. Porapakkarm (2023, February). Accounting for social security claim behavior. *International Economic Review 65*(1), 505–545.

Rabate, S., E. Jongen, and T. Atav (2024, Feb). Increasing the retirement age: Policy effects and underlying mechanisms. *American Economic Journal: Economic Policy 16*(1), 259–291.

von Wachter, T., J. Song, and J. Manchester (2011). Trends in employment and earnings of allowed and rejected applicants to the social disability insurance program. *American Economic Review 101*(7), 3308–29.

Appendix

A Additional Details on Empirical Analysis

A.1 Data [TBC]

A.2 Construction of Hypothetical Primary Insurance Amount

We use the earnings record from the SSA to construct the PIA amount for SS early claimers, full retirement, and DI recipients. The benefit amounts depend on the lifetime earnings of a recipient. We follow the process provided by SSA for constructing Average Indexed Monthly Earnings (AIME), the average lifetime earnings measured around the time of your retirement, and Primary Insurance Amount (PIA), the monthly amount of insurance benefits depending on his lifetime earnings.

PIA for Social Security. We merge the publicly available HRS dataset with the SSA's restricted nominal earnings dataset for years from 1951 to 2020. For older cohort born in years 1931, it means their earnings records between age 20 and 88 are available. For later cohort born in years 1954, their earnings record starts at age 3 and available until age 66. For each matched respondent, we keep their earnings records between age 21 to their full retirement age to compute AIME.

To compute AIME, we first convert the nominal earnings across different years into real term using the Average Wage Index (AWI) series, which measures the national wage level over time. For retirement benefits, the year a respondent turned to age 60 is used as a basis. For example, if a respondent turned into 60 in year 2020, then his earnings in year $t < 2020$ is converted into 2020 US dollars by $\frac{AWI_{2020}}{AWI_t}$. For earnings after age 60, the indexing factor is 1.[A1]

After indexing the nominal earnings in basis year, we compute AIME based on the maximum 35 years of indexed earnings. For those who have less than 35 years with positive earnings, zero will be substituted instead. Then, the total sum of these 35 observations of annual earnings is divided by 420 $(= 35 \times 12)$ to obtain AIME.

Once the AIME is ready, we can now compute the Primary Insurance Amount (PIA), which is a progressive piece-wise linear function of AIME. The replacement rate for the first bend point is 90%, and the replacement up to second bend point is 32%. The replacement

[A1] COLA adjustment will be applied for earnings between 62 and NR. More about this later.

beyond the second bend point is 15% . These bend points differ over time, and the year a respondent become 62 is used as a basis.

Additional adjustment of PIA: For early retirees, their benefits get reduced. Furthermore, earnings test allow your PIA at full retirement age differ from PIA used to calculate SS benefits between age 62 and 65. Also, SSA withholds $1 in benefits for every $3 of earnings in excess of the higher exempt amount. Earnings in or after the month you reach NRA do not count toward the retirement test.

PIA for Disability Insurance. Compared to SS benefits that have earnings record until claiming age, DI applicants have shorter earnings records until the onset of their disability. Therefore, PIA for DI recipients is calculated after dropping a number of low earnings records[A2] in calculating their average lifetime earnings. More specifically, out of elapsed years from age 22 to the disability onset, we decide the number of dropout earnings using the following formula:

$$\text{Dropout year} \quad = \quad \min\{5, \min\{62, 0.2 \times (\text{Disability Onset Age-22})\}\}.$$

Thus, the dropout year is capped at five for recipients whose onset of disability occurs after age 47. For those who are younger, their dropout year is less than five years. Then numerator for AIME is calculated based on the total of earnings record during the computation year, which is defined as the number of years between age 22 and the disability onset age after subtracting the dropout year. The denominator for AIME will be the computation year times 12.

Validating our measure of PIA. To confirm the reliability of our measured PIA, we compare this hypothetical PIA with the actual PIA from the dataset, where the latter is only available for a subset of individuals. In particular, we run the following regression by program type and claiming age:

$$\text{PIA}_{i,t} \quad = \quad \alpha + \beta \cdot \widehat{\text{PIA}}_{i,t} + \varepsilon_{i,t},$$

where $\text{PIA}_{i,t}$ is the actual PIA for those available and $\widehat{\text{PIA}}_{i,t}$ is the calculated PIA of individual i based on his earnings up to age t. Table A1 shows that the relationship between the calculated PIA and observed PIA among the SS beneficiaries who claimed at FRA is close to one, while the early claimants exhibit a reduction of about 30%, consistent with the benefit schedules for SS described in Section 2.2. Furthermore, we find that the relationship

[A2] For more details about the 1-for-5 rule, see https://secure.ssa.gov/poms.nsf/lnx/0300605230.

between the observed PIA and calculated PIA for DI beneficiaries exhibits a significantly high correlation, aligning with the institutional features of DI discussed in 2.1. Therefore, we conclude that our measure of PIA which determines the relative generosity of DI that we explain below, reliably captures individual-level incentives between the two programs.

Table A1: Relation between the Observed and Calculated PIA

	SS Beneficiaries		DI Beneficiaries
	FRA Claim	Early Claim	
β	0.959	0.703	0.911
	(0.011)	(0.010)	(0.020)
R^2	0.927	0.877	0.828
Observations	559	667	431

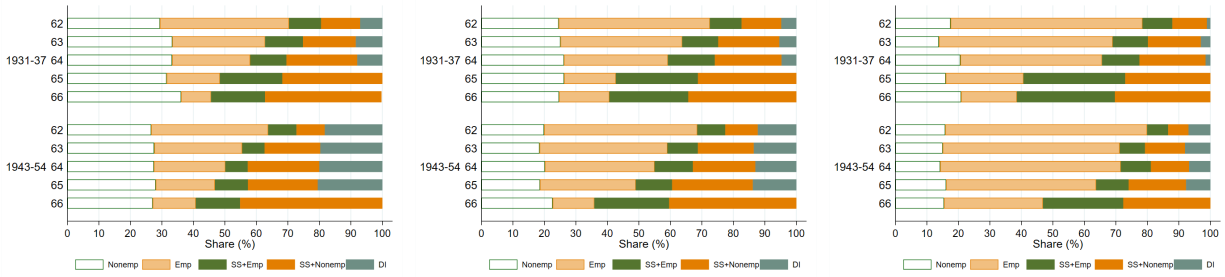
Note: Table A1 documents the coefficients of regression between the observed and calculated PIA, which is constructed based on individual-level earnings history from the SSA administration data.

A.3 Additional Empirical Results

Worker Compositions by Cohort Complementing worker composition statistics in Section 3.2, we plot workers by five statuses—not employed, employed, employed with SS benefits, not employed with SS benefits, and DI recipients. We observe that even with more disaggregated status categories, young cohort's benefit compositions differ from those of the old cohort.

Figure A1: Share of Workers by Five Statuses, by Education and Cohort

(a): High School Dropouts (b): High School Graduates (c): Some College



Note: Figure A1 shows the share of individuals by their statuses, by education group using the restricted HRS dataset.

Relative DI Generosity and DI, by Education Table A2 reports coefficients from estimating Equation 5, allowing for education-specific effects of PVDR.

Table A2: DI and Relative Generosity, Education-Specific Effects

	Age 60-62		Age 58-62		Age 55-62	
	(1)	(2)	(3)	(4)	(5)	(6)
HS grad.	-0.781*	0.807	-1.022***	-0.197	-0.800***	-0.196
	(0.418)	(0.657)	(0.275)	(0.480)	(0.211)	(0.391)
Some college	-2.031***	-1.057	-2.369***	-1.413**	-2.026***	-0.888**
	(0.658)	(0.792)	(0.421)	(0.550)	(0.309)	(0.427)
Rel. DI generosity	11.841***	12.403***	12.043***	9.444***	12.116***	6.185***
	(1.685)	(2.556)	(1.263)	(2.060)	(1.157)	(1.915)
Rel. DI × HSG	0.440	-3.275*	1.028	-0.154	0.442	-0.077
	(1.121)	(1.827)	(0.629)	(1.133)	(0.407)	(0.804)
Rel. DI × SC	1.237	0.840	2.071**	2.177*	1.155**	0.760
	(1.690)	(2.118)	(0.899)	(1.279)	(0.570)	(0.847)
Frailty		3.800***		3.891***		4.210***
		(0.553)		(0.507)		(0.505)
Work Disability		3.315***		3.314***		3.320***
		(0.218)		(0.191)		(0.184)
Observations	10,754	4,386	17,631	6,577	27,678	8,879

Note: Table A2 documents the regression coefficients from estimating Equation (5), allowing for education-specific PVDR effects. Standard errors clustered at individual-level are in parentheses. $*p < 0.10; **p < 0.05; ***p < 0.01$

Relative DI Generosity and Employment Table A3 presents regression coefficients from estimating Equation (5) with employment as an outcome. Relative DI generosity has statistically significant negative impact on employment outcomes, that is, individuals near retirement are substituting out of employment into DI.

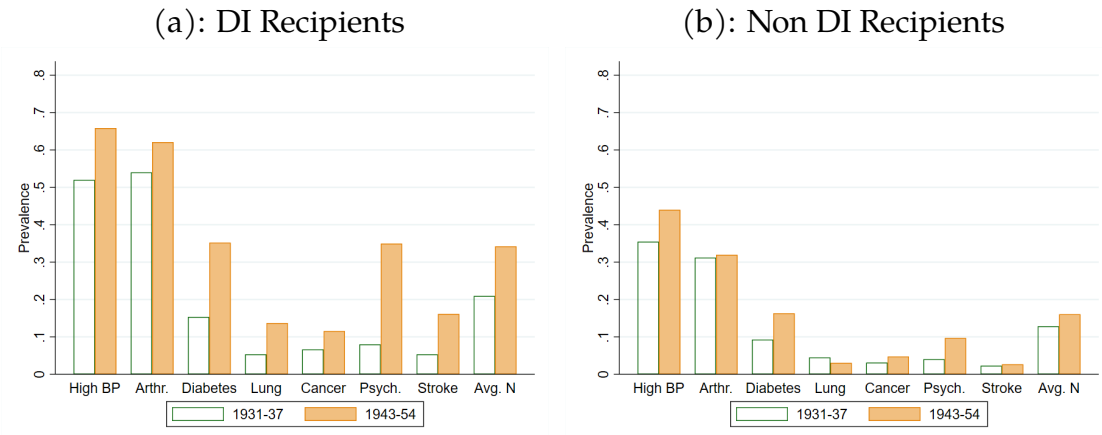
Table A3: Relative DI Generosity and Employment Near Retirement Age

	Age 60-62		Age 58-62		Age 55-62	
	(1)	(2)	(3)	(4)	(5)	(6)
HS grad.	0.192**	0.057	0.197**	0.019	0.230***	0.002
	(0.081)	(0.102)	(0.077)	(0.097)	(0.072)	(0.095)
Some college	0.537***	0.261**	0.483***	0.159	0.465***	0.117
	(0.097)	(0.122)	(0.094)	(0.116)	(0.087)	(0.113)
Rel. DI generosity	-8.478***	-7.594***	-11.758***	-10.961***	-10.060***	-11.078***
	(1.054)	(1.168)	(0.918)	(1.170)	(0.712)	(1.179)
Frailty		-0.908**		-1.187***		-1.325***
		(0.357)		(0.327)		(0.321)
Work disability		-1.414***		-1.434***		-1.464***
		(0.104)		(0.091)		(0.086)
Observations	10,754	4,386	17,631	6,577	27,678	8,879

Note: Table A3 documents the regression coefficients from estimating Equation (5) with employment as an outcome. Standard errors clustered at individual-level are in parentheses. $*p < 0.10; **p < 0.05; ***p < 0.01$

Diagnoses by DI Receipt Status In Figure A2, we plot the prevalence of seven specific diagnoses that are available in HRS—high blood pressure, arthritis, diabetes, lung disease, cancer, psychiatric conditions, and stroke—and average of the (normalized) sum of these seven conditions, by cohort. According to Maestas et al. (2013), labor supply disincentive effects from DI differ by diagnoses. For example, arthritis are associated with smaller labor supply disincentive effects unlike, e.g., psychiatric conditions.

Figure A2: Disease Prevalence, by DI Status and Cohort



Note: Figure A2 shows the share of individuals with specific diagnoses by DI status and cohort using the restricted HRS dataset. For DI recipients, we construct prevalence within 10 years ($\pm$5 years) of DI starting age to allow for more sample. The last bar in the plot ("Avg. N") presents the average of the sum of conditions divided by the number of conditions (7).

Figure A2(a) plots the diagnoses among DI recipients within 10 years of the DI starting age. Because health related data is not reported every year, we use a longer time horizon. In Figure A2(b) is the analogous data for individuals who are not DI recipients. In general, we see the young cohort reporting higher number of conditions. However, among DI recipients (Figure A2(a)), there is a larger discrepancy in the prevalence of psychiatric condition, which is less verifiable and associated with a larger labor supply disincentive effect according to Maestas et al. (2013). On the other hand, the cross-cohort difference in arthritis, a condition with a smaller labor supply disincentive effects, is smaller. These may be suggestive of the higher likelihood of the young cohort opting in for DI when faced with a less severe or difficult-to-verify disability shock.

B Individual Problems between ERA and FRA

We specify worker problems for those between the ages of j^E, the ERA and j^F, the FRA. These individuals have three choice sets: whether to work, apply for DI or claim Social Security benefits. As discussed in the main text, their choice sets are combination of those in the working age ($j < j^E$) and those past FRA ($j > j^F$). We specify the value functions of those who have not yet claimed SS benefits and DI applicants, which are omitted from main text.

Claimed SS benefits. If the individual claimed benefits, he can still work, but cannot apply for DI. Thus, his decision problem is the same as Equation (18), except for the fact that his benefits are reduced according to policy, and that he is not eligible for Medicare. Therefore, the out-of-pocket medical expenditures in their budget constraint are determined based on their labor market status.

$$\begin{aligned} V^{S,l}(x,h) &= \max_{c,a'\geq 0} u(c+tr,l) + \beta\delta_j^h \sum_{h'} \pi_j^{h,h'} \left[\begin{array}{c} \chi_{h'}^l \mathbb{E} \max_{l\in\{0,1\}} V^{S,l}(x',h') \\ + \left(1-\chi_{h'}^l\right) \mathbb{E} V^{S,0}(x',h') \end{array} \right] \\ s.t. \quad & c + a' = SS(\omega) + \{\tilde{y} - (F_h + oop_E(m))\} \cdot \mathbb{I}_{l=1} + \{UI(y) - oop_U(m)\} \mathbb{I}_{l=0} + (1+\tilde{r})a + beq. \end{aligned}$$

Did not claimed SS benefits yet. If the individual has not yet claimed benefits, he can still apply for DI if his disability status is *MD* or *SD*. Thus, the value function reads

$$\begin{aligned} V^{E,l}(x,h) &= \max_{c,a'\geq 0} u(c+tr,l) + \beta\delta_j^h \pi_j^{h,ND} \left[\chi_{h'}^l \mathbb{E} \max_{l\in\{0,1\}} V^l(x',ND) + \left(1-\chi_{h'}^l\right) \mathbb{E} V^0(x',ND) \right] \\ &\quad + \beta\delta_j^h \sum_{h'\in\{MD,SD\}} \pi_j^{h,h'} \left[\begin{array}{c} \chi_{h'}^l \ \mathbb{E}\max\left\{ \max_{l\in\{0,1\}} V^{E,l}(x',h'), \max_{l\in\{0,1\}} V^{S,l}(x',h'), V^A(x',h') \right\} \\ + \left(1-\chi_{h'}^l\right) \mathbb{E}\max\left\{ V^{E,0}(x',h'), V^{S,0}(x',h'), V^A(x',h') \right\} \end{array} \right] \\ s.t. \quad & c + a' = \{\tilde{y} - (F_h + oop_E(m))\} \cdot \mathbb{I}_{l=1} + \{UI(y) - oop_U(m)\} \mathbb{I}_{l=0} + (1+\tilde{r})a + beq. \end{aligned}$$

The problem is a combination of Equations (11) and (19), as he can make labor supply choices in conjunction with whether or not to claim SS, and whether to apply for DI.

DI beneficiaries. For simplicity, we assume that once an individual is past the age of j^E, he continues receiving DI (does not get reassessed) until the benefit gets transferred to SS (without any cuts in benefits) at age j^F. Therefore, the only choices are consumption and savings, and the budget constraint is equivalent to the one faced by DI beneficiaries in the

working age, Equation (17).

$$\begin{aligned} V^{E,D,i_M}(x,h) &= \max_{c,a'\geq 0} u(c+tr,0)+\beta\delta_j^h \ \mathbb{E}V^{E,D,i_M}(x',h') \\ s.t. &\quad c+a' = DI(\omega_{DI})-(i_M\cdot oop_M(m)+(1-i_M)\cdot oop_U(m))+(1+\tilde{r})a+beq \end{aligned}$$

DI applicants. The problem of DI applicants reads as the following that also incorporates the possibility of claiming SS benefits in the next period:

$$\begin{aligned} V^{E,A}(x_A) &= \max_{c,a'\geq 0} u(c+tr,\kappa) \\ &\quad +\beta\delta_j^h\sum_{h'}\pi_{j+1}^{hh'}\left[\begin{array}{c} \pi^{DI,h}V^{D,i_M=0}(x',h') \\ +\left(1-\pi^{DI,h'}\right)\left[\begin{array}{c} \chi_{h'}^A\mathbb{E}\max\left\{\max_{l\in\{0,1\}}V^{E,l}(x',h'),\max_{l\in\{0,1\}}V^{S,l}(x',h')\right\} \\ +\left(1-\chi_{h'}^A\right)\mathbb{E}\max\left\{V^{E,0}(x',h'),V^{S,0}(x',h')\right\}\end{array}\right]\end{array}\right] \\ s.t. &\quad c+a' = \widetilde{\kappa y}-\kappa F_h-oop_E(m)+(1+\tilde{r})a+beq. \end{aligned}$$

The budget constraint is the same as that of the applicants in the working age, Equation (14).

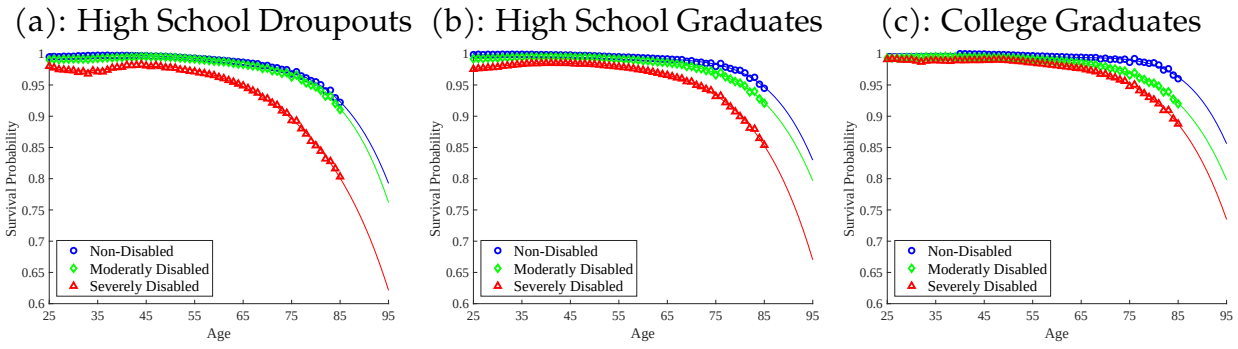
C Calibration

C.1 Construction of Exogenously Calibrated Parameters and Values

The exogenously calibrated parameters include: (i) survival probabilities, (ii) disability transition probabilities, (iii) wage offers and hours worked, and (iv) medical expenditures. We use PSID for (i)-(iii) and MEPS for (iv). Below, we describe their construction processes, which broadly follow Pashchenko and Porapakkarm (2023). Whenever applicable, we control for cohorts using 5-year birth cohort dummies with the exception of the oldest (1930 and before) and the youngest (1985 and later) cohorts in the data, as well as the "old" (1931-1937) and "young" (1943-1954) cohorts as defined in our empirical analyses.

Survival probabilities. Survival probabilities over the life-cycle differ by education and disability statuses. Following Attanasio et al. (2011), we estimate conditional survival probabilities by education and disability status, using the life table from the Social Security Administration and micro-level data from the PSID. Specifically, from the PSID, we estimate a probit model of death with cohort dummies, disability interacted with education dummies, age (quadratic), race, schooling (in years), marital status, and region. We then construct the predicted values for the old and young cohorts, and obtain disability and education-specific survival premia to be consistent with life tables. These are then smoothed out by fitting polynomials in age, and extrapolated for individuals older than 85. Figure A3 plots the survival probabilities by education for the old cohort.

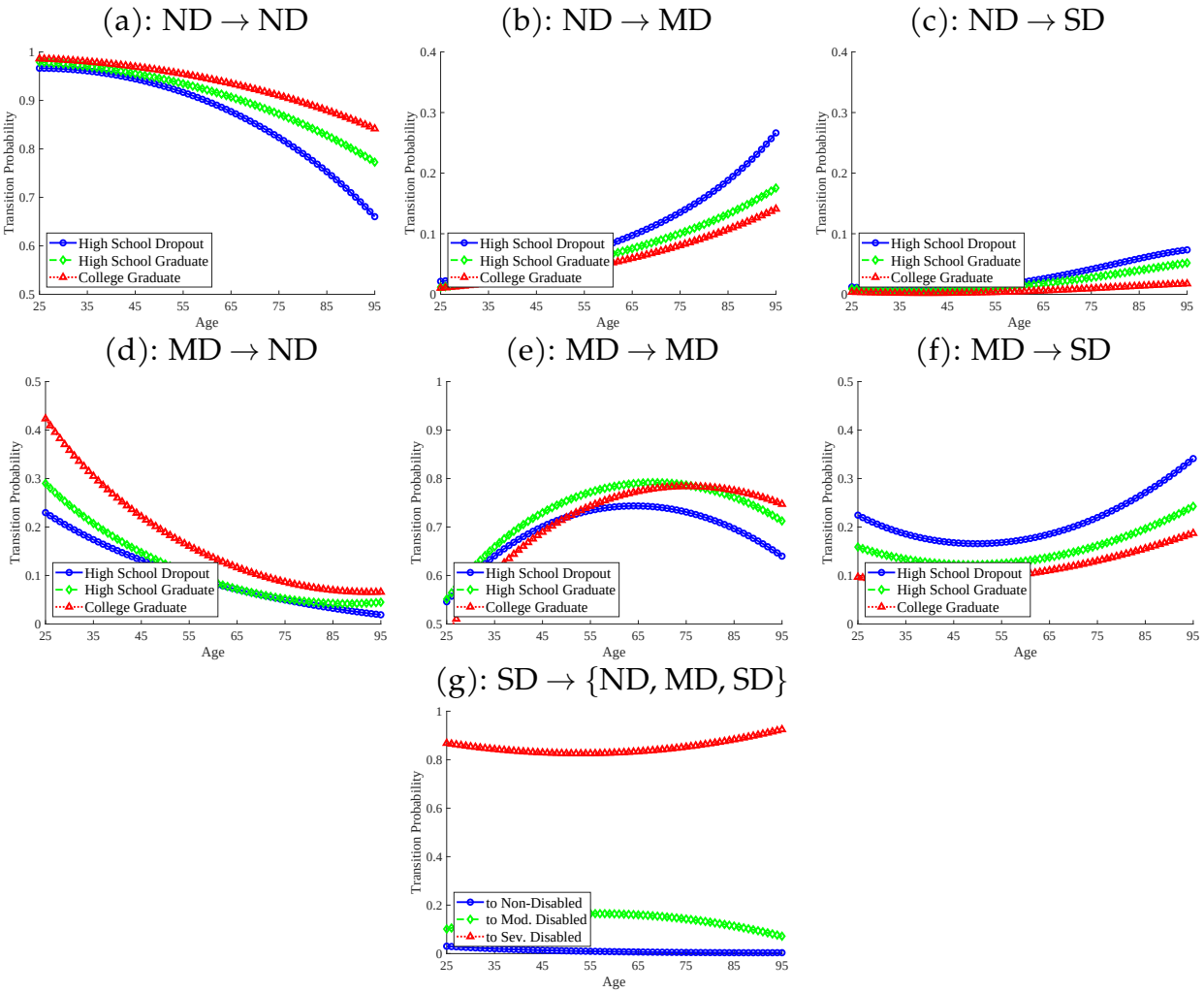
Figure A3: Survival Probability by Education



Disability transition probabilities. Disability transition probabilities follow a first-order Markov process and are calibrated using the panel dimension of the PSID data. We allow for education-dependence for the non-disabled and moderately-disabled individuals. Due

to sample size issues, transition probabilities of severely disabled individuals do not depend on education. Similar to the calibration of the survival probabilities, we estimate a multinomial logit model with future disability status as the dependent variable. We then predict disability transitions, which are fitted to polynomials in age, extrapolated beyond age 85. Figure A4 plots the calibrated life-cycle disability transition probabilities (which we assume to be the same across cohorts).

Figure A4: Disability Transition Probabilities

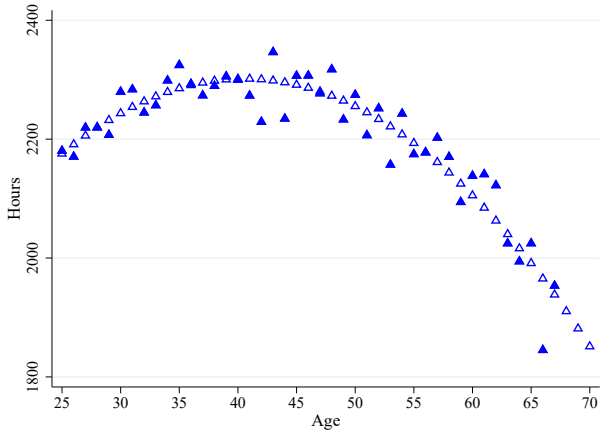


Wage offers and hours worked. We estimate the wage offer profiles following Heckman (1979) to control for selection into employment, where we use welfare benefits as an instrument in employment equation. Following Low and Pistaferri (2015), we construct transfers—Earned Income Tax Credit, unemployment insurance, Supplemental Nutrition Assistance Program, and Aid to Families with Dependent Children (subsequently, Temporary Assistance for Needy Families)—of a representative earner, utilizing their variations

across state and year. These are used in the selection equation, in addition to cohort dummies, disability dummies, age (quadratic), race, years of schooling, marital status, and region. In the second stage, we regress log hourly wage on individual characteristics and disability interacted with education dummies. Their predicted values for the old cohort are then smoothed out by fitting polynomials in age, which are plotted in Figure 10.

Conditional on employment (which we assume to be more than 700 hours), hours worked do not vary much across disability and education statuses. We thus use the average hours over the life-cycle, fitted to polynomials in age as shown in Figure (A5).

Figure A5: Hours of Employed Workers



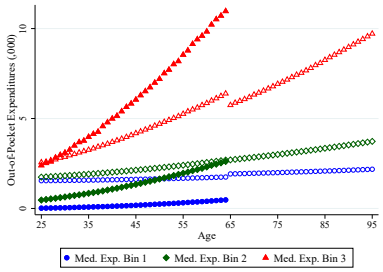
Medical expenditures. To discretize medical expenditure risks to three bins as in Attanasio et al. (2011). Specifically, we assign individuals into three medical expenditure bins—1-50th percentiles, 51-90th percentiles, and 91-99th percentiles—within 9 age groups (8 age groups of 5 years and one age group consolidating individuals older than 65) and disability statuses. Then, we regress medical expenditures on observables—cohort dummies, age (quadratic), education, and marital status—by disability and medical expenditure bins to predict cohort-specific total medical expenditure profiles. We then utilize the total expenditures by self to construct the average coinsurance rates by insured who are younger than 65 ($q_E = 0.30$) and those with Medicare ($q_M = 0.24$). We further calculate the self-pay share of total medical expenditures for the unemployed ($q_U = 0.68$) to capture any other sources of insurance that unemployed may have access to. We then add the premium for the employed and Medicare enrollees $p_E = \$1,530$ and $p_M = \$1,740$ from Kaiser Family Foundation.[A3] The resulting out-of-pocket expenditure profiles are plotted

[A3] See https://www.kff.org/other/state-indicator/single-coverage/ and https://www.cms.gov/newsroom/fact-sheets/2024-medicare-parts-b-premiums-and-deductibles, adjusted for 2020 dollars.

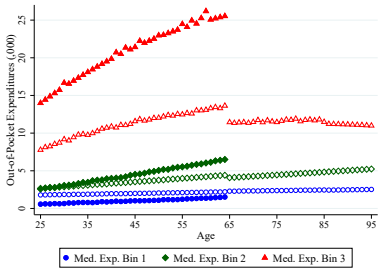
in Figure A6: hollow markers are for the uninsured (unemployed) and filled markers are for the insured (employed), with those older than 65 are universally covered by Medicare.

Figure A6: Out-of-Pocket Medical Expenditures by Disability Status

(a): Non-Disabled



(b): Moderately Disabled



(c): Severely Disabled

