Why Are Older Men Working More? The Role of Social Security

Zhixiu Yu*

November 2023

Abstract

This paper investigates the role of Social Security reforms in explaining the increase in labor supply of older men across cohorts and evaluates the labor response by health status. I develop and estimate a rich dynamic life-cycle model of labor supply, savings, and Social Security application that captures the key structure of Social Security retirement benefits, disability insurance, and pension systems, while accounting for uncertainties in health, survival, wages, and medical expenditures. The model matches well the observed life-cycle profiles of employment, hours per worker, and savings for men in the 1930s cohort from the Panel Study of Income Dynamics. I find that Social Security reforms account for over 77% of the observed rises in employment and hours worked by the 1950s cohort, with the retirement earnings test reforms being the most important. The labor response is smaller for unhealthy individuals due to the work disincentives provided by disability benefits.

JEL Classification: D15, H55, I12, J14, J22
Keywords: Social Security reform, retirement, labor force participation, health, older workers

*Affiliations: Louisiana State University. Address: 2300 Business Education Complex South, 501 South Quad Drive, Baton Rouge, LA 70803. Email: zhixiuyu@lsu.edu. I would like to thank Mariacristina De Nardi for her valuable advice. I am grateful to Jeffrey Brown, Wei Hu, and Kathleen McKiernan for their great discussions. I also thank Neha Bairoliya, Areendam Chanda, Fatih Guvenen, Selo Imrohoroglu, Larry Jones, Loukas Karabarbounis, Karen Kopecky, Oksana Leukhina, Qingxiao Li, Jeremy Lise, Nicole Maestas, Hannes Malmberg, Rory McGee, Jo Mullins, Amanda Michaud, James Poterba, David Wiczer, and participants at the Minnesota Workshops, APPAM, SEA, ASSA, ESPE, HHEI Alumni Conference, AMES, CMES, YES, EGSC, Federal Reserve Bank of Atlanta, Labor, Firms, and Macro Reading Group, the Colloquium on Pensions and Retirement Research, EWMES, City University of Hong Kong, University of Queensland, Mississippi State University, University of Missouri, Louisiana State University, University of South Carolina, Florida State University, MEA, NASMES, SAET, Annual Congress of IIPF, NBER conference, and Stanford University, SIEPR conference for valuable comments. Special thanks to Margherita Borella, Eric French, Zidong Jiang, and Nicolò Russo for their helps with the data and computation. First draft: May 2021.

I gratefully acknowledge fellowship support from grant RDR18000003 from the US Social Security Administration (SSA) funded as part of the Retirement and Disability Research Consortium. The opinions and conclusions expressed are solely those of the author and do not represent the opinions or policy of SSA, any agency of the Federal Government, or National Bureau of Economic Research (NBER).

1. Introduction

Over the past several decades, the labor supply of older men in the United States has been rising dramatically, along both extensive and intensive margins. For instance, data from the Panel Study of Income Dynamics (PSID) show that between 1995 and 2015, the labor force participation rates of men aged 60-69 rosed by 10 percentage points (p.p.): from 47% in 1995 to 57% in 2015. Furthermore, annual hours worked by older workers increased by 9.2%, from 1,748 hours in 1995 to 1,909 hours in 2015.[1] This trend is particularly remarkable as it stands in contrast to the decline in work hours among other age groups, such as younger men aged 21-55, during the same period (Aguiar et al. (2018)).[2]

The significant changes in Social Security (SS) rules in the United States over this time period may have contributed to the increase in labor supply at older ages. These changes include the gradual increase in the normal retirement age (NRA) from 65 to 67 for recent birth cohorts, the increase in delayed retirement credits (DRC) from 3% to 8% for new cohorts, and the removal of the retirement earnings test (RET) beyond the NRA for those 65 and older beginning in 2000.[3]

To what extent do those past policy changes in the SS program account for the rise in the labor supply of older workers? Social Security provides retired workers benefits that constitute the majority of their retirement income and plays a crucial role in their work decisions (Dushi et al. (2017)).[4] In 2019, the federal government spent about 25% of its annual budget on providing insurance benefits to 64 million beneficiaries, which accounted for 5% of the nation's gross domestic product.[5] However, with the increasing life expectancy and the rapid aging of the U.S. population, the fiscal solvency of public pension systems is under threat. Thus, changes to the scheduled benefits and policies for the SS program are necessary (see Social Security Administration (2019)). Understanding the roles of existing SS rules and their changes on the recent labor supply trends of older workers is essential for policymakers' decisions on future policy reforms.

This research develops and estimates a rich structural model of labor supply, savings, and SS benefit claims that incorporates social insurance programs to: 1) examine the extent to which three past SS reforms, including an postponed NRA, elimination of the RET beyond the NRA,

[1] Author's calculations from the PSID. Similar increases are documented in the Current Population Survey (CPS), revealing a 10 p.p. rise in participation rates and a 15% increase in hours per worker (refer to figures in Section 2.3 of the online appendices for details). The labor supply trends of the elderly have been documented in the previous literature, e.g., Blau and Goodstein (2010), Coile (2019), and Rogerson and Wallenius (2021).

[2] Using data from the CPS, Aguiar et al. (2018) show that, from 2000 to 2015, the annual hours worked by men aged 21-30 decreased by 203 hours, about 11.8%, and those by men aged 31-55 decreased by 168 hours, about 8.2%.

[3] Refer to Section 3 for detailed information on Social Security rules.

[4] About 50% of Americans aged 65 or older live in households receiving over 50% of their family income from Social Security retirement benefits, and about 25% of them live in households receiving over 90% of their family income from retirement benefits. See more on Dushi et al. (2017).

[5] Source: `https://www.cbpp.org/research/federal-budget/where-do-our-federal-tax-dollars-go`.

and an increased DRC, alongside increased life expectancy and other contributing factors, account for the rise in the labor supply of older men over time; and 2) investigate the labor responses to these SS reforms by health status. To do so, I focus on two cohorts of American men: those born in the 1930s and 1950s, which correspond to men aged 60-69 in the mid-1990s and mid-2010s, respectively. In addition, I disaggregate each cohort by health status because health has a sizable impact on labor supply behaviors over the life cycle, especially at older ages (e.g., French (2005)).

There are facts about these two cohorts that are important for analysis. Data from the PSID reveal that, compared to the 1930s cohort, the 1950s cohort supplied more labor from age 60 to age 69, along both extensive and intensive margins. For instance, on average, the labor force participation rates at ages 60-69 for the 1950s cohort were 9.6 p.p. higher than those for the 1930s cohort, and hours worked by workers increased by 14.3% for the same age group between the two cohorts. Moreover, my analysis finds a new fact that these increases in participation rates and hours per worker at older ages across cohorts were primarily driven by individuals who were in good health (measured by their work limitation conditions). In addition, the 1950s cohort faced different SS rules than the 1930s cohort: the NRA was postponed from age 65 to age 66; the DRC was raised from around 4.5% to 8%; and the RET was eliminated for individuals at the NRA or older.

To examine the role of changes in the SS rules and other contributing factors on the increase in the labor supply of older men across cohorts, I first develop a rich dynamic life-cycle model for men born in the 1930s, which incorporates numerous details about social insurance programs, including SS retirement benefits and disability insurance (DI). Individuals in my model make decisions about how much they will work (including whether or not to participate in the labor market) and consume, as well as when to apply for SS retirement benefits after becoming eligible. Individuals have the option to receive higher retirement benefits by delaying their application, and they can also work after receiving benefits but will be subject to the earnings test.

My model framework builds upon the work French (2005), who develops a realistic life-cycle model of labor supply, SS application, and savings behaviors that accounts for uncertainties in health status, survival rates, and wages. I further develop this model by adding heterogeneity in health and incorporating the key features of disability insurance, health- and age-dependent medical expenditures, and a time-varying sequence of income taxes faced by a specific cohort. More specifically, my model incorporates the following key innovations.

First, I include a disabled state as part of the health status and explicitly model the DI system for two purposes: 1) to distinguish between unhealthy individuals who are temporarily sick and those who are disabled (e.g., Low and Pistaferri (2015)); and 2) to account for the fact that disabled and non-disabled individuals face different economic environments over their lifetime, which can lead to different responses to policy changes. For instance, the U.S. government provides DI benefits to people who are unable to work due to severe disabilities, allowing them to receive the benefits and leave the labor market. Therefore, in some sense, SS retirement policies are less important for them. By incorporating the disabled state and DI benefits, my model matches the observed life-cycle participation profile of unhealthy individuals (including those with temporary illness and disabilities) much more closely than a model that fails to account for DI benefits.

Second, my model includes out-of-pocket medical expenditures to capture the fact that unhealthy individuals face higher medical costs over their lifetime (e.g., De Nardi et al. (2018)). Incorporating the health gap in medical expenditures helps the model match the observed differences in savings profiles between healthy and unhealthy individuals over the life cycle.

Third, instead of using tax structures from a single year to calibrate the model's tax parameters as in previous work, e.g., French (2005) and Bairoliya (2019), my model adapts a time-varying sequence of income tax rates faced by a specific cohort at each age during their lifetime, which is a function of annual earnings. It is intended to capture the progressive income taxes that change every year for a specific cohort (e.g., Borella et al. (2019a)). Hence, not only is my model richer, but it can also match more important life-cycle outcomes.

Next, I estimate my model for the 1930s cohort using the Method of Simulated Moments (MSM) and data from the PSID and the Medical Expenditure Panel Survey (MEPS). My estimated model matches the observed life-cycle profiles of employment, hours per worker, and assets for healthy and unhealthy men in the 1930s cohort very well. It also generates the labor supply elasticities by age and health, showing that elasticities rise with age and are lower for men in good health before reaching retirement age. Incorporating DI benefits into the model is crucial for capturing the declines in participation of unhealthy men starting in their 50s, as receiving DI benefits serves as an alternative pathway to retirement for workers facing health challenges. This also sheds light on the higher labor supply elasticities exhibited by unhealthy men prior to retirement age. This finding, to the best of my knowledge, has not been previously documented in the existing literature.

Following the successful estimation of the model for the 1930s cohort, I employ it to examine the role of SS policy changes and other potential factors on the increased labor supply of older men between the 1930s and 1950s cohorts. Taking the estimated preference parameters from the 1930s cohort as given, I apply the changed policy rules or parameter values faced by the 1950s cohort to the estimated model of the 1930s cohort, and I simulate how the older cohort would behave if they had the same values for those factors as the younger cohort.

My model shows that three past SS reforms account for the majority of labor dynamics at older ages. Specifically, they explain 77.5% of the observed rises in participation and 89.8% of the observed increases in annual hours per worker at ages 60-69 across cohorts. Among these policy reforms, the elimination of the RET beyond the NRA contributes the most, accounting for over 71% of the rise in older-age labor supply along both margins. This change substantially reduces the effective tax rates on earnings for benefit claimers working after their NRA, incentivizing the elderly to claim benefits as soon as they reach the NRA and work more thereafter. Shifting the NRA from 65 to 66 contributes to over 18% of the between-cohorts rise in older-age labor supply. This reform reduces SS retirement benefits, encouraging delayed claiming and extended labor market participation until age 66 to qualify for the full benefit amount. However, it does not provide additional work incentives after reaching the new NRA. Raising the DRC from 4.5% to 8% incentivizes delayed benefit claiming, but its labor impact is relatively small, mainly falling on the intensive margin between the NRA and claiming age since the RET does not apply before claiming benefits.

Additionally, my model suggests that lower mortality rates lead individuals to delay benefit claiming and extend labor market participation, in order to receive higher retirement benefits for longer periods. In particular, a 25% reduction in mortality rates leads to a 2.3 p.p. increase in participation at ages 60-69, contributing to 21% of the overall rise in older-age participation across cohorts. Moreover, individuals with longer expectancies respond more to the increased DRC in terms of benefit claiming and labor supply, as they stand to gain more from the reform.[6]

My findings provide new insights into the impact of SS reforms through the DI margin. Specifically, the labor responses to the NRA and DRC reforms are smaller for unhealthy men, whereas those to the RET reform are similar across health groups. These disparities arise from the availability of DI benefits before the NRA. With the DI program rules unchanged, raising the NRA or the DRC makes claiming SS benefits before the NRA less attractive. This leads disabled workers to leave the labor market to qualify for DI benefits, resulting in a limited increase in participation for unhealthy men. However, the RET reform takes effect only after reaching the NRA when DI is no longer unavailable, leaving the comparison of retirement and DI benefits unaffected. To emphasize the importance of including DI for policy evaluations, I estimate an alternative model that abstracts from DI benefits and use it to evaluate the same set of SS reforms. The results show the model without DI overestimates participation responses for unhealthy workers and the average level.

My model further assesses the labor impact of altering DI program rules, including receipt difficulty, income thresholds, and addressing moral hazard. Results show that doubling DI receipt difficulty or income thresholds significantly raises the participation rates of disabled individuals aged 50-64, by more than 20 p.p. A higher threshold allows more DI recipients to work but restricts the ability to work longer hours, reducing hours per worker by 23%. The presence of moral hazard leads non-disabled workers to exit the labor market for benefit eligibility. From a policy perspective, to enhance labor supply in the early 60s, raising the DI income threshold or implementing stricter screening processes to reduce benefit receipt and mitigate moral hazard may be necessary.

This paper contributes to the literature on trends in older men' labor supply and retirement in

[6]The paper also investigates the potential impact of other contributing factors, including changes in DI program rules, health dynamics, income tax rates, and national wage growth index across cohorts. My results suggest that their impact on older-age labor supply is considerably smaller when compared to the effects of SS reforms.

three major ways: 1) it investigates the increase in the labor supply of older workers; 2) it employs a structural model to explain these changes; and 3) it complements broader research on Social Security reforms in the United States and globally.

More specifically, first, this study contributes to a large body of literature documenting and explaining the increase in the labor supply of older men in the United States. For instance, Schirle (2008) documents that this rise has primarily been driven by married men and examines the shared leisure effects of increased wives' participation, and Maestas and Zissimopoulos (2010) study the impact of shifts in the workforce skill composition. More recently, Rogerson and Wallenius (2021) emphasizes older female employment and institutional changes as the driving forces; while Cajner et al. (2021) find that changes in occupation, education, and the spousal employment did not significantly explain the trends.[7] My paper contributes to this string of literature by: 1) documenting a new fact that the increases in the labor supply of older workers are primarily driven by individuals in good health, in terms of both extensive and intensive margins; 2) estimating the contribution of SS reforms using a structural model; and 3) demonstrating that the RET reform explains over 70% of the labor dynamics at older ages. Compared to reduced-form approaches (e.g., Engelhardt and Kumar (2014) and Gelber et al. (2018)), a structural framework allows individuals to optimally choose and adjust their decisions when facing different shocks and work incentives provided by social insurance programs over their lifetime. Disentangling these competing incentives is difficult when they are not explicitly modeled in non-structural analyses. Hence, we are able to investigate individuals' responses to policy changes using estimated parameters in structural models.[8]

Second, this paper is the first to analyze the contribution of past SS policy changes across different cohorts on observed changes in the labor supply of older workers along both margins in a structural framework including the DI margin. Most existing studies have examined a specific or representative cohort for the entire population to study behavioral responses to economic environment changes using structural models, such as Groneck and Wallenius (2017) and Fan et al. (2019). My research contributes to the literature by filling this gap. Even though the labor supply across cohorts has been studied in, e.g., Attanasio et al. (2008) and Park (2018), the population of interest is different. They investigate the changes in women's behaviors, while my paper focuses on the rise in older men's labor supply across cohorts, which few scholars have explored. Specifically, Bairoliya

[7] While this study focuses on explaining the impact of SS policies on the increasing trend of older-age labor supply, previous studies have explored their influence on labor supply around retirement, including Lumsdaine and Mitchell (1999), Gruber and Wise (2007), and Benítez-Silva and Heiland (2008). Other factors affecting work and benefit claiming, such as labor market shocks (e.g., Merkurieva (2019), Rutledge and Coe (2012), and Card et al. (2014)) and fluctuations in stock and home values (e.g., French and Benson (2011) and Zhao (2018)) have also been studied.

[8] Examples of such framework-based research include Rust and Phelan (1997) and Casanova (2010). Many papers have studied the effects of public pensions in a general equilibrium life-cycle framework, e.g., Imrohoroğlu and Kitao (2012) and Fuster et al. (2007), which account for general equilibrium effects such as price changes. However, as French and Jones (2012) discuss, the predicted values of those studies largely depend on the calibrated model parameters, which lack sufficient empirical justification, and most of them ignore the age-varying labor supply elasticities.

(2019) estimates a structural model over older ages to assess the impact of pension composition changes on labor supply trends. My paper develops a whole life-cycle model that includes disability benefits for analyzing the impact of SS reforms. This approach helps explain the labor behaviors of unhealthy people and captures the dynamic effects at earlier stages for policy counterfactuals. Further, instead of explaining between-cohort labor behaviors, Borella et al. (2019b) document the between-cohort changes in life expectancies, medical expenses, and wages and uncover their effects on labor market outcomes. My approach, by contrast, documents changes in the labor supply across cohorts and explains these changes using the changing economic environment.

Finally, my paper complements the literature on analyzing the SS reforms. For instance, French (2005) highlights the work disincentives of the RET reform; French and Jones (2011) suggest a larger impact of raising the eligibility age for SS than that for Medicare at older ages; and Li (2018) emphasizes the importance of including DI when evaluating SS reforms.[9] My work complements these studies by exploring different questions—assessing the actual SS changes on observed labor supply trends—and comparing two cohorts over time using a richer model. My paper provides additional insights into the labor responses to SS reforms in different health groups through the DI margin. As the model fits well the 1930s cohort's behaviors by construction and explains well the behaviors of the 1950s cohort after changing the SS rules that are not matched by construction, it provides a valid benchmark to evaluate further policy proposals.

The rest of the paper is organized as follows. Section 2 documents the recent trends in the labor supply across cohorts. Section 3 describes the changes in SS rules faced by the 1950s cohort in comparison to the 1930s cohort. Section 4 presents the structural model used in this study. Section 5 details the estimation procedure. Section 6 presents the estimation results of the model. Section 7 uses the estimated model to examine how those changes in SS rules and other contributing factors explain the between-cohort increases in labor supply. Section 8 concludes.

2. Labor Market Outcomes Across Cohorts

In this section, I document the changes in labor supply that occurred between the 1930s and 1950s cohorts over the life cycle, as well as the changes by health status across cohorts.

2.1. Data

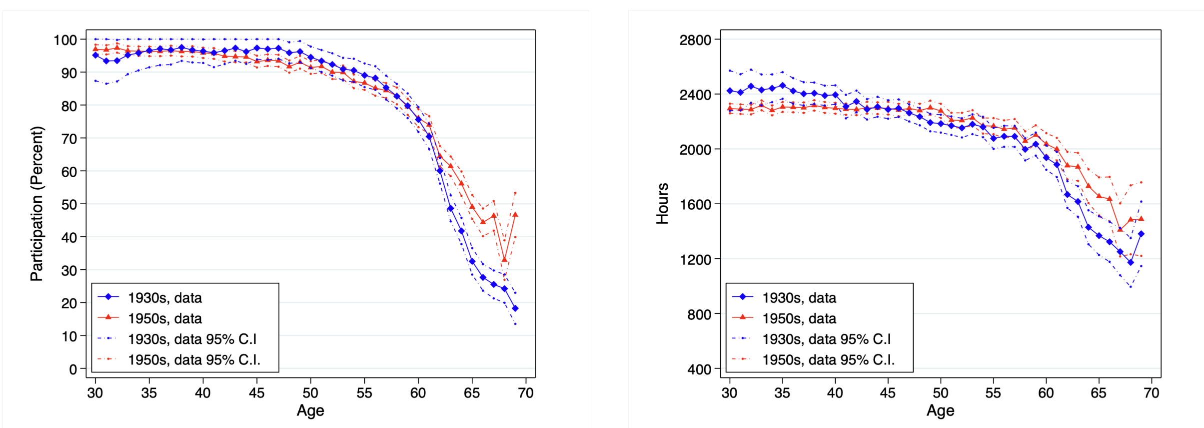
The PSID is a U.S. longitudinal study that started in 1968 with a nationally representative sample of 18,000 individuals from 5,000 families. It involves annual interviews (biennial since

[9] Instead of the U.S. economy, papers including Erosa et al. (2012) and Laun and Wallenius (2016) study the role of social insurance programs in explaining the cross-country differences in the labor supply of older workers.

1997) of these individuals and their descendants, collecting information on, among other thins, labor market behaviors, income, and demographic characteristics. For this study, I utilize data from the 1968-2015 waves of the PSID, focusing on two cohorts: one born in the 1930s (between 1920-1935) and the other born in the 1950s (between 1945-1960), resulting in an initial sample of 76,880 individuals and 3,075,200 observations.

Following French (2005) and Borella et al. (2019b), I drop the Survey of Economic Opportunity sample to make the data more representative of the U.S. population, keep male household heads and their spouses if present, and limit the age range to 20-90. The final sample includes 984 individuals with 20,091 observations for the 1930s cohort and 2,844 individuals with 45,945 observations for the 1950s cohort. Refer to the online appendices for details and sample sizes before and after applying my selection criteria. To construct the life-cycle profiles of labor behaviors, I use working hours, income, and health variables for the male household head from the PSID.[10]

2.2. Life-Cycle Patterns: American men



(a) Labor Force Participation

(b) Hours Worked by Workers

Fig. 1. Labor Supply Across Cohorts

Notes: Data profiles of life-cycle labor force participation (panel a) and hours conditional on working (panel b), comparing the 1930s (blue) and the 1950s (red) cohorts for American men. The 95% confidence intervals are represented by dotted lines.

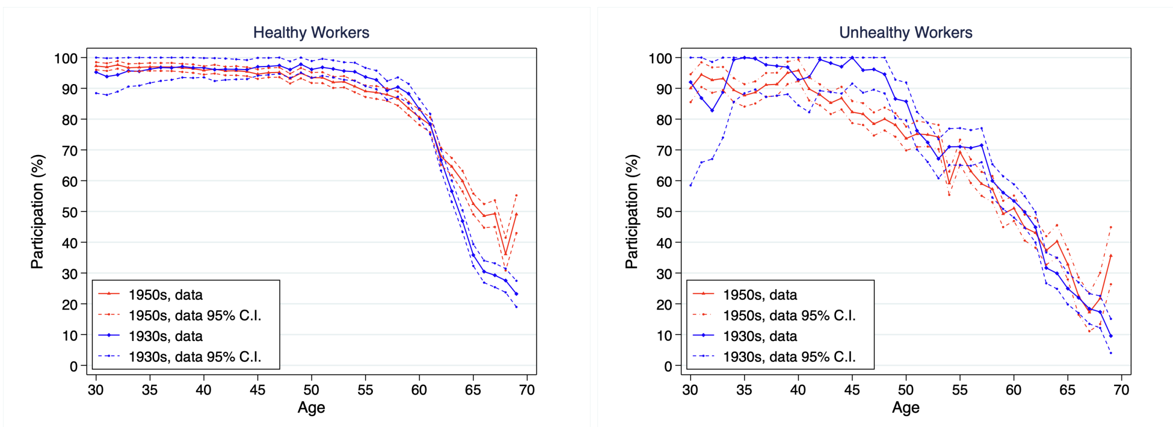
Data Source: Panel Study of Income Dynamics, author's calculations.

Figure 1 illustrates the data profiles of labor force participation and hours worked among workers aged 30-70 (left and right panels, respectively) for both cohorts. The data indicate that

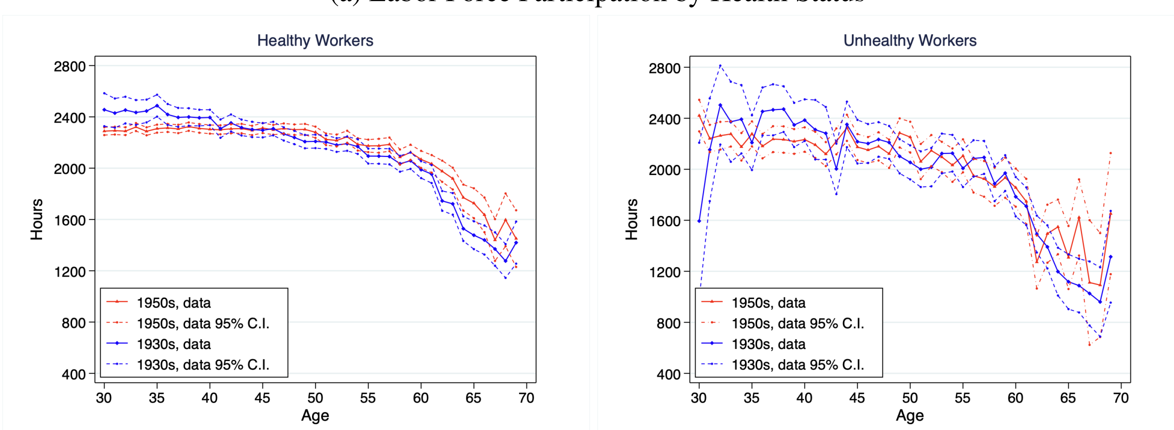
[10]Hours worked is measured as of the survey, and labor force participation is defined as the fraction of individuals whose annual hours worked were more than 300. The profiles are estimated using fixed-effect regression, controlling for the birth-year effect, family effect, year effect, and individual effect. The average profile are obtained based on weighted health levels. The estimation is detailed in Section 4.1 of the online appendices.

participation and hours worked per worker decline sharply after age 60 for both cohorts, but the 1950s cohort consistently has higher participation rates and hours worked at older ages compared to the 1930s cohort. For example, on average, the participation rates at ages 60-69 for the 1950s cohort are 9.6 p.p. higher than those for the 1930s cohort (increase by 22.61%) and 15 p.p. higher for the age group 65-69 (increase by 55.60%). Additionally, between the two cohorts, the hours worked per worker increased by 14.3% and 18.1% for the age groups 60-69 and 65-69, respectively.

2.3. Life-Cycle Patterns: By Health



(a) Labor Force Participation by Health Status



(b) Hours Worked by Health Status

Fig. 2. Labor Supply Across Cohorts By Health Status

Notes: Data profiles of life-cycle labor participation (panel a) and hours conditional on working (panel b), comparing the 1930s (blue) and the 1950s (red) cohorts for healthy workers (left panels) and unhealthy workers (right panels). The 95% confidence intervals are represented by dotted lines.
Data Source: Panel Study of Income Dynamics, author's calculations.

Figure 2 further explores the life-cycle profiles of participation and hours per worker by health status (left panels: healthy; right panels: unhealthy), which is measured using the self-reported work limitation questions from the PSID. I define individuals as healthy if they report no limitations and as unhealthy if they report limitations. Refer to Appendix A for details.[11]

There are several noteworthy patterns observed in the data. First, the impact of health on labor supply is sizable over the life cycle. Specifically, participation rates among healthy individuals begin to decline around age 60 and decline steeply in the 60s. In contrast, participation rates among those in poor health start declining from age 40 and do so more slowly. At age 55, for example, the participation rate of unhealthy individuals is 23 percentage points lower than that of healthy individuals in the 1930s cohort. Second, the increases in participation rates and hours worked by older workers occurring between the 1930s and 1950s cohorts are largely driven by individuals in good health. The behavior of unhealthy people did not significantly change across cohorts.

These observed changes in labor force participation and hours worked profiles both motivate my research and are the target moments for my structural estimation.[12] In the following section, I discuss the changes in Social Security rules that the two cohorts faced and discuss how these changes likely influenced labor supply choices.

3. Background: Changes in Social Security Rules

Social Security, the largest income-maintenance program in the United States, provides insurance benefits to eligible workers and their families in cases of retirement, disability, or death. The SS trust funds consist of The Old-Age and Survivors Insurance (OASI) program, providing retirement benefits to retirees and their families, and the Disability Insurance (DI) program, offering disability benefits to disabled workers and their families.

Workers become eligible for SS benefits by contributing payroll taxes on their earnings during their working years. The benefit amount depends on the Average Indexed Monthly Earnings (AIME), which is roughly a worker's average income over his highest 35 years of earnings.[13] A formula is then applied to the AIME to calculate the worker's basic benefit, known as Primary Insurance Amount (PIA), which is the amount to be received if claiming benefits at the NRA.

[11] Section 2 of the online appendices also presents the labor supply trends between the 1930s and 1950s cohorts among different demographic groups, such as educational attainment and employment sector. The analysis demonstrates that the data profiles of labor supply across cohorts do not vary significantly by educational or occupational groups.

[12] Similar trends in the labor supply of older men by health status are evident in data from the Health and Retirement Study (HRS) and presented in Section 2.3 of the online appendices. Regression tables using the HRS and the PSID to support the documented facts are included. While the HRS has previously been employed to document changes in the labor supply of older workers, such as in Jacobs and Piyapromdee (2016), it primarily focuses on older individuals. Given that my research models the entire life cycle of the 1930s cohort, this dataset is not suitable for my analysis.

[13] An individual's earnings up to two years before eligibility (currently age 60) are indexed to average wage growth to ensure that a worker's future benefits reflect the general rise in the standard of living that occurred during his working lifetime. Years with no earnings are entered into the average as 0s. After age 60, nominal earnings are used in the benefit formula without any indexation. See Social Security Advisory Board, December 2010 for more information.

Workers can begin claiming retirement benefits at the ERA of 62, but these benefits will be lower due to an actuarial reduction for early retirement if the worker claim them before the NRA. In contrast, benefits will be higher (by a certain percentage – known as DRC) if the worker delays the application beyond the NRA and up until the age of 70. These actuarial adjustments to benefits are designed to provide the worker with roughly the same lifetime SS benefits, regardless of claiming age, based on average life expectancy and interest rates at the time of enactment (i.e., actuarial fairness). Both the NRA and DRC vary by year of birth, whereas the ERA is the same for everyone.

In addition, workers are allowed to work for pay after receiving retirement benefits, but they are subject to the RET, which reduces their benefits level if their earnings exceed certain thresholds during that period. Therefore, the NRA, DRC, and the age at which the RET applies are all essential factors that influence workers' labor supply and claim decisions at older ages.

In what follows, I describe the observed changes in SS rules faced by American men born in the 1950s in comparison to those born in the 1930s, using data from the Social Security Administration (SSA). Compared to the 1930s cohort with NRA of 65 and DRC of 4.5% on average, the younger cohort has NRA at age 66 and DRC of 8% on average. Refer to Table C.1 for detailed information on NRA and DRC for people born between 1920 and 1960.

Table 1: Effects of Early or Delayed Social Security Claiming

			Benefit, as a percentage of PIA, payable at age								
Cohort	NRA	DRC	62	63	64	65	66	67	68	69	70
1930s	65	4.5	80	86.67	93.33	100	104.5	109	113.5	118	122.5
1950s	66	8	75	80	86.67	93.33	100	108	116	124	132

[1] Abbreviation: NRA = Normal Retirement Age; DRC = Delayed Retirement Credit (percentage point); PIA = Primary Insurance Amount.
[2] Notes: Table shows the Social Security retirement benefits, expressed as the percentage of Primary Insurance Amount, that an individual can receive if he claims at ages 62-70.
[3] Source: Social Security Administration, author's calculations.

Table 1 summarizes the effects of claiming retirement benefits at ages 62-70, which are expressed as the percentage of unreduced benefits at the NRA, under different rules of NRA and DRC faced by the two cohorts. Workers from the 1930s cohort can get 80% of their full retirement benefits at 62 and 122.5% of benefits at 70, whereas workers from the 1950s cohort can only receive 75% of their full retirement benefits at 62, which is 5 p.p. lower than the older cohort, but 132% of benefits at 70, which is 9.5 p.p. higher than 1930s cohort.

Moreover, there has been a change in the RET starting from the year 2000. Prior to 2000, workers who had reached age 62 but had not yet reached 70 were subject to the RET. More specifically, for retired workers from the 1930s cohort who had already collected their retirement benefits, if their earnings exceeded certain thresholds, they would face a 50% tax rate on their labor income between age 62 and the NRA and a 33% tax rate between the NRA and age 70, until their benefits were completely taxed out. Although the benefits that were lost due to the earnings test could be recouped in the future for the remainder of the individual's life span, these high earnings test tax rates on benefits (plus Federal and state income taxes and payroll tax) discouraged labor supply among older workers.[14] Following 2000, however, this earnings test was removed for individuals who have reached the NRA and beyond. Now, only workers below the NRA are subject to the RET.[15] Hence, the workers in the younger cohort who have reached the NRA are now able to retain both their retirement benefits and their earned labor income without any additional earnings test tax penalty, as long as their income falls below a certain threshold.

As a result, these changes in the NRA, DRC, and RET could have encouraged the younger cohort to work more at older ages.

4. The Model

This section describes a dynamic life-cycle model of consumption, labor supply, and Social Security claiming for male household heads which incorporates the key aspects of social insurance programs, such as Social Security retirement benefits, disability insurance, and pension.

Time is discrete and indexed by t. A model period is one year long. Consider a male household head seeking to maximize his expected lifetime utility at age $t, t = t_0, t_1, t_2 \ldots, T$. Individuals enter the model at age 25 and live up to a maximum age of 95. In each time period (or age) t, they face uncertainties in health and disability status, mortality risk, wages, and medical expenditure. Individuals make decisions on how much to consume, how much to work (including both participation and hours worked), and whether to apply for SS retirement benefits (if eligible).[16]

4.1. ***Preferences***

Each individual in period t derives utility from consumption, c_t and leisure, l_t. The within-period utility function from consumption and leisure is given by:

$$u(c_t, l_t) = \frac{1}{1-\nu}(\, c_t^{\gamma} \, l_t^{1-\gamma} \,)^{1-\nu} \tag{1}$$

[14]For example, benefits are recalculated at the NRA to account for periods in which earnings tests were applied. This benefit re-computation adjusts the actuarial reduction for early application. A loss of one year's benefits results in a small upward adjustment in future benefits. Refer to SSA for details.

[15]The ages at which the RET is removed for people born between 1920 and 1960 are summarized in Table C.1.

[16]The model framework follows French (2005) and French and Jones (2011). It focuses on explaining the behaviors of men due to the complexity of women's work decisions linked to family and SS spousal benefits (e.g., Attanasio et al. (2008), Groneck and Wallenius (2017), and Park (2018)). In addition, it abstracts from heterogeneities in education, marital status, and occupation since their changes have limited explanatory relevance for increased older men's participation, as shown in Cajner et al. (2021). Future research could extend the model to explain women's behaviors and explore more household heterogeneity.

where $\gamma \in [0, 1]$ is the weight on consumption, and ν is the coefficient of relative risk aversion (CRRA) and controls the intertemporal substitutability of consumption and leisure.

Leisure in period t is given by:

$$l_t = L - n_t - \theta_p^{h_t} p_t - \phi \mathbb{1}_{\{h_t \neq 0\}} \tag{2}$$

where L is an individual's total annual time endowment; n_t is hours worked; p_t is a 0-1 indicator of labor force participation that is equal to 1 when n_t is positive and zero otherwise; θ_p is the fixed cost of working (measured in hours per year). It includes time spent getting ready for work, including commuting time. I allow the fixed cost to depend on health status, h_t. In this model, retirement arises endogenously as part of the labor participation decision, and individuals can reenter the labor market.[17] Moreover, there will be an amount of leisure loss due to unhealthy status, ϕ, which is measured in hours per year. It captures the time spent in physical therapy, doctor visiting, etc.[18] Therefore, compared to healthy individuals, people who are unhealthy face different fixed costs of working and annual available time even if they do not work.

4.2. ***Health, Disability, Mortality, and Medical Spending***

In each time period, individuals face uncertainty in health, $h_t \in \{0, 1, 2\}$, which takes three values: with 0 being in good health (healthy) , 1 being in bad health (unhealthy) , and 2 being disabled (unhealthy). Health in the next period, h_{t+1}, depends on the individual's current health and age, and evolves according to the Markov chain between three states, with an age-dependent Markov transition matrix. A typical element of the health transition matrix at age t is given by:

$$\pi_{j,i,t+1} = Pr(h_{t+1} = j | h_t = i, t + 1), \qquad i, j \in \{0, 1, 2\} \tag{3}$$

The parameter s_{t+1} denotes the probability that an individual is alive at age $t + 1$ conditional on being alive at age t. The survival probability depends on age and previous health status, as: $s_{t+1} = S(h_t, t + 1)$. Because individuals live up to a maximum age T, $s_{T+1} = 0$ for any h.

Let m_t denote the out-of-pocket medical expenditure at age t, which depends on age and health status, i.e., $m_t = M(h_t, t)$. The m_t is defined as the individual's total medical expenditure net of medical coverage provided by insurance, such as Medicaid, Medicare, etc.[19] Age- and

[17]Reentering the labor market does not incur additional costs. While previous studies like French and Jones (2011) and Jacobs and Piyapromdee (2016) have incorporated re-entry costs and age-varying costs of working into their models, including previous employment as a state variable would significantly increase the computational burden. The current health-specific and age-invariant fixed costs of working enables my model to match observed key patterns of savings and labor supply by health under a rich social insurance structure while keeping the model framework tractable.

[18]Due to limited observations of disabled people in the PSID, their labor supply profiles are not clear and hard to use for estimation. Thus, to keep the model simplified, individuals in bad health and with disabilities (h=1,2) share the same fixed cost of working $\theta_p^{h_t}$ and leisure loss ϕ, which are estimated to match the labor profiles of unhealthy people.

[19]Health insurance is explicitly modeled in Imrohoroğlu and Kitao (2012), Kitao (2014), French and Jones (2011), and Blau and Gilleskie (2008). My model abstracts from heterogeneity in insurance to make the model tractable.

health-dependent medical expenditure are intended to capture the fact that people spend more on out-of-pocket medical services as they age or health status gets worse (e.g., De Nardi et al. (2018)).

4.3. *Wages and Spousal Earnings*

The logarithm of hourly wages at age t, $\ln w_t$, is a function of health status and age, $W(h_t, t)$, and an autoregressive component of wages, ω_t, as follows:

$$\ln w_t = W(h_t, t) + \omega_t \tag{4}$$

$$\omega_t = \rho\omega_{t-1} + \eta_t, \quad \eta_t \sim N(0, \sigma_\rho^2) \tag{5}$$

where ω_t has the correlation coefficient, ρ, and a normally distributed innovation, η.

Spousal earnings can serve as insurance against uncertainties over the lifetime and are modeled as a function of a male household head's wages, age, and health status, such as:

$$ys_t = ys(w_t, h_t, t) \tag{6}$$

4.4. *Social Security, Disability Benefits, and Pension*

Social Security benefits are modeled in great detail to match the current U.S. system, which are discussed earlier in Section 3. Once an individual reaches the ERA, he becomes eligible to claim SS retirement benefits. SS application decision is a one-time decision and irreversible. Upon applying, individuals collect the benefits (subject to the actuarial adjustment and the RET), ss_t, until their death. The lifetime career earnings ($AIME_t$), claiming age, and labor income after collecting benefits (through the RET) are the three main factors affecting a person's benefit level.

First, the level of retirement benefits depends on an individual's $AIME$, which are calculated using the average of his highest 35 years of earnings. Since individuals are assumed to enter the model at age 25, $aime_t$ evolves according to

$$aime_{t+1} = \begin{cases} \min\{aime_t + \frac{w_t n_t}{35}, aime_{max}\} & \text{if age} < 60 \\ \min\{aime_t + \max\{0, \frac{w_t n_t - aime_t}{35}\}, aime_{max}\} & \text{if age} \geq 60 \end{cases} \tag{7}$$

where $aime_t$ denotes the annualized measure of $AIME$, and $aime_{max}$ denotes the threshold in which $aime_t$ is capped.[20] This causes work disincentives after 35 years in the labor market, since after that, working an additional year will increase their $AIME$ only if their labor income exceeds the lowest earnings in some previous years.

[20] When modeling retirement benefits, to reflect the general rise in the standard of living during working periods, the AIME is adjusted for the inflation using the Personal Consumption Expenditure price index (PCE) through wages. Alternatively, in Appendix D.4, the AIME is indexed to the average wage growth instead of PCE, and the model evaluates the impact of changes in wage growth index across cohorts on labor supply.

The PIA_t is computed using a piecewise linear function of $aime_t$ given as follows.

$$\begin{aligned} PIA_t = &\ 0.9 * \min\{aime_t, aime_0\} \\ &+ 0.32 * \min\{\max\{aime_t - aime_0, 0\}, aime_1 - aime_0\} \\ &+ 0.15 * \max\{aime_t - aime_1, 0\} \end{aligned} \tag{8}$$

where $aime_0$ and $aime_1$ denote the bend points in the PIA formula, following SSA. This formula replaces a higher percentage of the pre-retirement earnings for workers with low average career earnings than for workers with high average career earnings.

Second, the age at which individuals apply for retirement benefits also affects the level of benefits through the actuarial adjustments. These effects are summarized in Table 1 in Section 3.

Third, beneficiaries under age 70 are subject to the RET. That is, if they receive labor income that exceeds the earnings threshold y_{ret} after they collect retirement benefits, each dollar of labor income above y_{ret} leads to a τ_{ret} dollar decrease in retirement benefits until all the benefits have been taxed away. Thus, the final amount of benefits, ss_t, that an individual receives at age t is

$$ss_t = \max\{0, ssb_t - \tau_{ret} * \max\{0, (w_t n_t - y_{ret})\}\} \quad \text{if age} < 70 \tag{9}$$

where ssb_t is the amount of PIA_t adjusted by early/delayed application for retirement benefits. Note that those benefits lost due to the RET are credited to future benefits.[21]

DI benefit application is not an endogenous choice.[22] Disabled individuals can receive DI benefits prior to the NRA if their labor income is below a certain threshold y_{db}. Upon reaching the NRA, DI benefits automatically convert to retirement benefits. The benefit amount db_t is set at the level an individual would receive if they claim retirement benefits at the NRA. To account for the probability of disabled individuals receiving benefits, the amount db_t is discounted as

$$db_t = \pi^{db} PIA_t \mathbb{1}_{\{h_t=2\}} \mathbb{1}_{\{w_t n_t \leq y_{db}\}} \quad \text{if age} < NRA \tag{10}$$

where π^{db} is the probability for old age groups with severe work limitation, estimated by Low and Pistaferri (2015). This is to capture average amount of DI benefits received by disabled individuals.

Pension benefit, pb_t, is modeled to specifically capture the basic features of defined benefit plans.[23] Similar to SS benefits, pension it is based on the individual's work history and is illiquid

[21] Following French and Jones (2011), if a year's worth of benefits are withheld due to the RET between the ERA and (NRA-1), benefits in the future are increased by 6.67%, the actuarial reduction factor for early application. If a year's worth of benefits withheld due to the RET between the NRA and 70, benefits in the future are increased by DRC.

[22] DI application is not an endogenous choice in the model since it is not the primary focus of my paper and obtaining relevant data is challenging. In the literature that explicitly models DI applications, e.g., Low and Pistaferri (2015), Li (2018), and Michaud and Wiczer (2019), the probability of applying for disability insurance successfully depends on age and health status. Since disabled individuals are more likely to qualify for DI benefits, to keep the model simplified, I assume that DI benefits are exclusively granted to disabled individuals if the income requirements are met.

[23] Pension excludes the structure of defined contribution plans, mainly due to the low participation of the 1930s birth cohort in defined contribution plans and the lack of sufficient data in the PSID to distinguish between the two types of plans. For research that examines both pension plans, refer to Bairoliya (2019) and Friedberg and Webb (2005).

until a certain age (assumed to be 62). Unlike SS benefits, pension plans offer different incentives for workers to exist the labor force at specific ages through accrual rates (e.g., Ippolito (1997) and Gustman et al. (2000)). To account for these factors, pb_t is imputed as a function SS benefits and modeled in the same way as French (2005),

$$pb_t = pb(PIA_t) + \epsilon_t \tag{11}$$

which is a regressive function of lifetime earnings $pb(PIA_t)$ and is adjusted by ϵ_t to reflect age-specific pension accrual.[24] French (2005) provides a detailed description of these procedures.

4.5. ***Budget Constraint***

In each time period, an individual receives income through interest on assets, ra_t; labor income, $w_t n_t$; spousal earnings, ys_t; pension benefits, pb_t; SS retirement benefits net of the RET (if applicable), ss_t; DI benefits (if applicable), db_t; and government transfers (if applicable), tr_t.

The budget constraint faced by a household head is given by:

$$\begin{aligned} a_{t+1} =& a_t + Y_t(y_t, \tau_t, \tau_t^{ss}) + (b_t * ss_t) + db_t \mathbb{1}_{\{h_t=2\}} + tr_t - m_t - c_t \\ & y_t = ra_t + w_t n_t + ys_t + pb_t \\ & Y_t(y_t, \tau_t, \tau_t^{ss}) = y_t - T_t(y_t, \tau_t) - T_t^{ss}(w_t n_t, \tau_t^{ss}) \end{aligned} \tag{12}$$

The variable $b_t \in \{0, 1\}$ is an indicator variable that takes a value one if the individual has claimed the retirement benefits and zero otherwise. The term y_t is the annual taxable income in period t, where r is the pre-tax risk-free interest rate; $T_t(\cdot)$ presents taxes paid on income in period t, which is a function of taxable income y_t and tax rate τ_t; T_t^{ss} denotes the payroll tax paid on labor income, which depends on labor income $w_t n_t$ and tax rate τ_t^{ss}; and $Y_t(\cdot)$ denotes the after-tax income.

It is illegal to borrow against Social Security benefits and difficult to borrow against most forms of pension wealth. Individuals also face the borrowing constraint,

$$a_{t+1} \geq 0. \tag{13}$$

Government transfers, tr_t, ensures individuals have access to a minimum level of consumption, $\underline{c}$, as in Hubbard et al. (1995) and De Nardi et al. (2010). It captures the safety net programs in the United States, such as Food Stamps and Supplemental Security Income.[25]

$$tr_t = \min\{0, \underline{c} + m_t - (a_t + Y_t + ss_t + db_t)\}. \tag{14}$$

[24]The parameters used in $pb(PIA_t)$ are based on estimates by Gustman and Steinmeier (1999), who demonstrate that the pension to SS wealth ratio rises with SS benefits. Age-specific pension accrual rates are taken from Gustman et al. (2000). The adjustment ϵ_t is made to account for the difference in accrual between SS and pension wealth at different ages, which tends to be positive at older ages.

[25]Braun et al. (2017) and Kopecky and Koreshkova (2014) explicitly model those safety net programs.

4.6. ***Taxes***

Individuals in a cohort face the effective time-varying income tax rate over their life cycle. As in Bénabou (2002), Heathcote et al. (2020), and Borella et al. (2019a), effective tax rates depend on age (time) and taxes paid on annual income y_t are given by:

$$T_t(y_t, \tau_t) = (1 - \lambda_t y_t^{-\tau_t}) * y_t \tag{15}$$

where τ_t denotes the degree of progressivity; and λ_t denotes the average level of taxation. For tractability, I assume that individuals anticipate changes in the effective tax rates on total income.

Moreover, workers pay the payroll taxes on labor income to help finance Social Security and Medicare, hence, there is a payroll tax rate τ_t^{ss} on the worker's labor income $w_t n_t$, up to a threshold $\bar{y}_t^{ss}$ in each period. Then the amount paid for the payroll tax at age t are given by:[26]

$$T_t^{ss}(w_t n_t, \tau_t^{ss}) = \tau_t^{ss} * \min[w_t n_t,\ \bar{y}_t^{ss}] \tag{16}$$

4.7. ***Recursive Formulation***

The life cycle can be divided into three stages. The first stage is between ages 25 and 61, a working period where individuals are not eligible for pension and SS retirement benefits and only decide on consumption and work. The second stage is between ages 62-69, a transition period where they choose consumption, work, and whether to apply for SS retirement benefits. The third stage is between ages 70-95, an entire retirement period where individuals only decide on consumption.

In general, the value function of an individual in state (X_t) and age t can be written as:

$$\begin{aligned} V_t(X_t) = \max_{c_t, n_t, b_t} \{ & \frac{1}{1-\nu} (c_t^{\gamma} [L - n_t - \theta_p^{h_t} p_t - \phi \mathbb{1}_{\{h_t \neq 0\}}]_t^{1-\gamma})^{1-\nu} \\ & + \beta s_{t+1} \int V_{t+1}(X_{t+1}) dF(X_{t+1} | X_t, t, c_t, n_t, b_t) \\ & + \beta (1 - s_{t+1}) B(a_{t+1}) \} \end{aligned} \tag{17}$$

subject to Equations (3)-(16).

where the parameter β is the discount factor, and the state vector is $X_t = (a_t, w_t, h_t, b_{t-1}, aime_t)$. Variables such as ys_t, m_t, pb_t are not included in X_t explicitly since they depend on other state variables. The function $F(\cdot|\cdot)$ determines the conditional distribution of state variables, given (3)-(16). When an individual dies, any remaining assets, a_t, are left to his heirs. Following De Nardi (2004), an individual who dies values the leftover assets according to the bequest function $B(a_t)$:

$$B(a_t) = \theta_b \frac{(a_t + \kappa)^{(1-\nu)\gamma}}{1-\nu} \tag{18}$$

[26] I do not model the budget for the government because I consider only one cohort, and it is unclear that whether the budget constraint is balanced at the cohort level.

where the parameter θ_b is the bequest weight, which determines the strength of the bequest motive, and κ is the bequest shifter, which measures the curvature of the bequest function.[27]

The model is solved backwards using value function iteration. An individual's decisions in period t depend on his state variables, preferences, and parameters that determine the data generating process for the state variables. Refer to Section 3 of the online appendices for more details on recursive formulation and computations.

5. Estimation

I estimate my model using a two-step Method of Simulated Moments (MSM) estimation strategy, as standard in the literature, e.g., Gourinchas and Parker (2002), Cagetti (2003), French (2005), and Haan and Prowse (2014). In the first step, I estimate or calibrate the parameters that can be cleanly identified without explicitly using my model. These parameters are derived directly from data, based on existing literature evidence, or calculated from program rules.

In the second step, taking the parameters that were estimated in the first step as given, I use the Generalized Method of Moments (GMM) techniques to estimate the remaining preference parameters: $\Theta = (\gamma, \nu, \theta_p^{h=0}, \theta_p^{h\neq 0}, \phi, L, \beta, \theta_b, \kappa)$. The objective is to find a vector of parameters Θ that generates simulated decision profiles that *best match* (measured by a GMM criterion function) the corresponding profiles from the data. I require my model to match the life-cycle profiles of participation, hours worked by workers, and savings by health from the PSID for the 1930s cohort.

5.1. ***First-Step Estimation***

I primarily use two data sets for the first-step estimation: the Panel Study of Income Dynamics (PSID) and the Medical Expenditure Panel Survey (MEPS). In addition, I borrow parameters, such as the consumption floor ($\underline{c}$) and the pre-tax interest rate (r), from previous literature, and I compute the SS related parameters using the information from the SSA.[28] Table 2 provides a summary of the first-step inputs. All the estimation process of inputs, including health transitions, survival probabilities, out-of-pocket medical spending, spousal earnings, wage profiles, wage process, initial distributions, and SS program rules are detailed in Section 4.2 of the online appendices.

[27]Individuals with a higher value of κ treat the bequest more like a luxury good. There is infinite disutility of leaving non-positive bequests if $\kappa = 0$, while the utility of a zero bequest if finite if $\kappa > 0$. French and Jones (2011) show that the parameters θ_b and κ are identified largely from the top asset quantile. When κ is large, the marginal utility of bequests will be lower than that of consumption, unless the individual is rich.

[28]In addition to fixing the interest rate, I tried computing time-varying interest rates faced by the 1930s cohort using the procedure adopted in De Nardi et al. (2010). I computed the real return over the years 1976-2016 using returns from stock (adjusted using S&P 500 indexes), CD, bond, and housing (adjusted using FHFA). The computed time-varying interest parameters did not change the estimation results.

Table 2: First-Step Parameters Summary

Parameter	Description	Value		Source
Budget Constraints				
r	Real interest rate	4%		French (2005)
$ys(\cdot)$	Spousal earnings	text		PSID
$\underline{c}$	Consumption floor	$3,500		French and Jones (2011)
$aime_t$	Social Security wealth	text		SSA
ss_t	Social Security retirement benefits	text		SSA
db_t	Social Security disability benefits	text		SSA
π^{db}	discount factor for average DI benefits	0.63		Low and Pistaferri (2015)
pb_t	Pension benefits	text		French (2005)
Wage-Related Parameters				
$W(\cdot)$	Deterministic wages	text		PSID
ρ	Autoregressive coefficient	0.981		PSID
σ_ρ^2	Variance of innovation	0.0157		PSID
Mortality and Health Transitions				
s_{t+1}	Survival probabilities	text		PSID
$\pi_{h_t,h_{t-1},t}$	Health transitions	text		PSID
$m(\cdot)$	Out-of-pocket medical expenses	text		MEPS
Tax Related Parameters				
τ_t, λ_t	Income tax structure	text		PSID, Borella et al. (2019a)
τ_t^{ss}	Payroll tax rate	text		SSA
$\bar{y}_t^{ss}$	Threshold, payroll tax	text		SSA
Social Security Rules Related Parameters				
y_{db}	Disability benefits income threshold	$3,600		SSA
$aime_0$	1st bend point in PIA formula	$3,720		SSA
$aime_1$	2nd bend point in PIA formula	$22,392		SSA
$aime_{max}$	Maximum Social Security wealth	$43,800		SSA
ERA	Early retirement age	62		SSA
NRA	Normal retirement age	65		SSA
DRC	Delayed retirement credits	4.5%		SSA
	Retirement Earnings Test	Under NRA	NRA-69	
τ_{ret}	Tax rate	50%	33%	SSA
y_{ret}	Threshold	$6,000	$8,186	SSA

[1] Notes: Monetary values are expressed in 1987 dollars.

[2] Data Source: Medical Expenditure Panel Survey (MEPS), Social Security Administration (SSA), and Panel Study of Income Dynamics (PSID), author's calculations.

5.1.1. ***Data***

I primarily use the PSID and supplement it with data from MEPS to estimate medical expenditure profiles. The MEPS is a U.S. nationally representative survey providing detailed information on medical expenditures, sources of payment, insurance coverage, health status, and demographics. Following Pashchenko and Porapakkarm (2019), I collect the 1999–2012 waves and drop the observations with missing values of relevant variables such as medical spending or health insurance. The resulting sample comprises 120,731 persons with 211,709 observations. Refer to Section 1 of the online appendices for detailed data and sample selection.

5.1.2. **Health and Disability Measurement**

Health and disability status is measured based on the following set of self-reported work limitation questions from the PSID.[29] Respondents in year t report (1) *Do you have any physical or nervous condition that limits the type of work or the amount of work that you can do*? (2) *Does this condition keep you from doing some types of work*? (3) *For work you can do, how much does it limit the amount of work you can do – a lot, somewhat, or just a little*?

I categorize individuals' health status following Low and Pistaferri (2015): good health ($h_t = 0$) if individuals respond "No" to the first question or "Not at all" to the third question; bad health ($h_t = 1$) if they answer "Yes" to the first question and "Somewhat" or "Just a little" to the third question; with disabilities ($h_t = 2$) if they answer "Yes" to the first question, "Can do nothing" to the second questions, and "A lot" to the third question, in accordance with the SSA criterion for disability insurance qualification. Refer to Appendix A for detailed measurement.

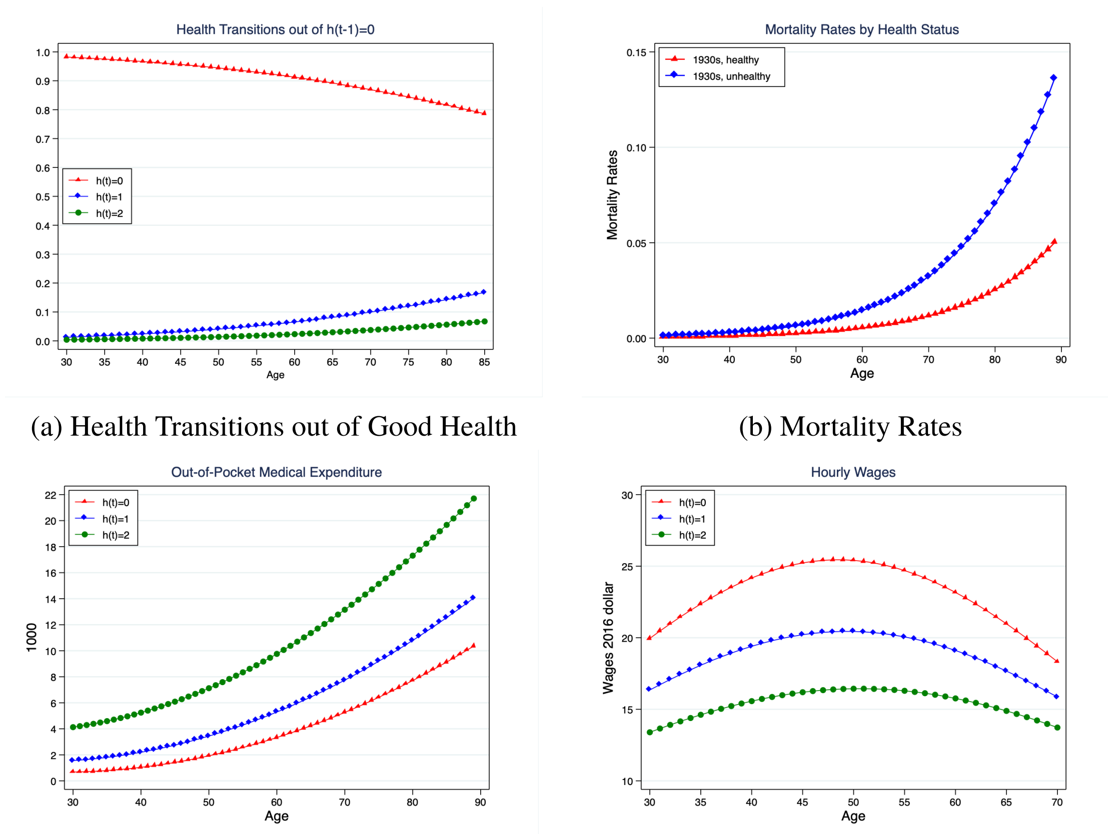
5.1.3. **Estimated Profiles by Health**

Further, based on health measurements, I estimate those age- and health-dependent inputs from the data. Figure 3 display resulting life-cycle profiles of health transitions, mortality rates, out-of-pocket medical expenditure, and hourly wages by health status. The estimation process is detailed in Section 4 of the online appendices.

Panel a presents the health transitioning out of good health $\Pr(h_t|h_{t-1} = 0)$, highlighting a declining probability of staying healthy with age. For instance, the probability drops from over 95% at age 30 to 80% around age 80. The decline is primarily absorbed by increasing probabilities of transitioning into bad health, which rise with age, especially at older ages.

[29] Alternatively, Hosseini et al. (forthcoming) construct frailty index to measure health status using the PSID survey questions, which have been available since 2003. The PSID also has included survey questions on self-reported health rank since 1984. However, these measurements cannot be adopted in this paper because I focus on the health dynamics for the 1930s cohort over the entire life cycle. Consequently, these PSID survey questions are not feasible.

In panel b, mortality rates increase with ages for both health types.[30] The increase is extremely rapid for unhealthy people at older ages, even though both types start from similar levels.



(a) Health Transitions out of Good Health

(b) Mortality Rates

(c) Out-of-Pocket Medical Expenditure

(d) Hourly Wages

Fig. 3. First-Step Estimation, Profiles by Health Status

Notes: Panel a displays the probabilities of transitioning out of good health: $Pr(h_t = j|h_{t-1} = 0), j = \{0, 1, 2\}$. The red/blue/green line shows the transition probabilities from good health to good health ($j = 0$)/bad health ($j = 1$)/with disabilities ($j = 2$). Panel b displays the mortality rates by health status. The blue (red) line shows the probability of dying next period when unhealthy (healthy). Panel c and panel d show the out-of-pocket expenditure and hourly wages by health status. The red/blue/green lines represent for people in good health/bad health/with disabilities. Monetary values are expressed in 2016 dollars.

Source: Panel Study of Income Dynamics, Medical Expenditure Panel Survey, author's calculations.

Panel c displays out-of-pocket medical expenses, calculated as total medical expenditure net of health insurance coverage, based on MEPS data. The difference in medical cost by health is sizable. For example, the medical expenses are about $17,000 for disabled people at age 80, which are $6,000 higher than those in bad health and $9,000 higher than those in good health.

[30]Due to the small sample size of joint event ($s_t = 0|h_{t-1} = 2$) in PSID, I assume that unhealthy individuals ($h = 1, 2$) face the same survival/mortality rates. As French (2005) discussed, the PSID underestimates mortality rates by 25%. I adjusted my estimated mortality rates by multiplying 1.25 for my model estimation.

Panel d presents several features that are worth noticing from deterministic wage profiles. First, hourly wage rates peak around age 50 for men. Second, healthy individuals consistently earn higher hourly wages than those in bad health, who, in turn, earn more than disabled individuals throughout their lives. For instance, around age 50, a healthy individual's hourly wages are \$5 higher than those of people in bad health and \$9 higher than those of disabled individuals.

5.2. Second Step Estimation

In the second step, I use GMM techniques to estimate the remaining nine preference parameters: $\Theta = (\gamma, \nu, \theta_p^{h=0}, \theta_p^{h=1,2}, \phi, L, \beta, \theta_b, \kappa)$. The objective is to find a vector of preference parameters $\hat{\Theta}$ that minimizes the weighted distance between the estimated target profiles from the PSID and the simulated profiles generated by the model. The estimator $\hat{\Theta}$ is given by the minimized GMM criterion function:

$$\hat{\Theta} = \arg\min_{\Theta} \frac{I}{1+\tau} \hat{\varphi}(\Theta;\chi)' \hat{\mathbf{W}}_I \hat{\varphi}(\Theta;\chi) \tag{19}$$

where τ is the ratio of the number of observations to the number of simulated observations and $\hat{\varphi}(\Theta;\chi)$ is a $6\mathbb{T}$-element vector of moment conditions, such that

$$\hat{\varphi}(\Theta;\chi) = \begin{bmatrix} E[p_{iht}|h,t] - \int p_t(X,\Theta,\chi)dF_{h,t}(X|h,t) \\ E[n_{iht}|h,t] - \int n_t(X,\Theta,\chi)dF_{h,t}(X|h,t) \\ E[a_{iht}|h,t] - \int a_t(X,\Theta,\chi)dF_{h,t-1}(X|h,t) \end{bmatrix}_{t\in\{30,\ldots,69\},h\in\{healthy,unhealthy\}}$$

where $E[p_{iht}|\cdot]$, $E[n_{iht}|\cdot]$, and $E[a_{iht}|\cdot]$ are the moments that my model is estimated to match:

1. Labor force participation by health status (healthy and unhealthy) and ages (30-69), resulting in $2\mathbb{T}$ moment conditions.
2. Hours worked conditional on participation by health status (healthy and unhealthy) and ages (30-69), resulting in $2\mathbb{T}$ moment conditions.
3. Mean non-pension assets by health status (healthy and unhealthy) and ages (30-69), resulting in $2\mathbb{T}$ moment conditions.

This gives a total of $6 \times \mathbb{T} = 240$ moment conditions. In additions, $\int p_t(X,\Theta,\chi)dF(\cdot)$, $\int n_t(X,\Theta,\chi)dF(\cdot)$ and $\int a_t(X,\Theta,\chi)dF(\cdot)$ are generated by the model. $F_{ht}(\cdot)$ indicates the CDF of the state variables at period t given health status h. Further, the estimated weighting matrix, $\hat{\mathbf{W}}_I$, is the inverse of a $6\mathbb{T} \times 6\mathbb{T}$ diagonal matrix, which consists of the elements of the variance-covariance matrix from the data along its main diagonal. For more information on the target moments and MSM estimation process, refer to Section 4 in the online appendices.

6. Estimation Results

The estimated structural parameters are presented in Table 3, which are consistent with the results of a large body of previous life-cycle literature, including De Nardi et al. (2010) and Bairoliya (2019).[31] The discount factor is estimated at 0.95, identified through intertemporal substitution of consumption and leisure, and thus, by assets and labor supply profiles. My estimated CRRA for flow utility and consumption weight are 4.75 and 0.53, respectively. The CRRA for consumption can be approximated as $-\frac{(\partial^2 u/\partial c_t^2)c_t}{\partial u/\partial c_t} = 2.987$, identified by assets level and labor supply profiles. Greater risk aversion leads individuals to accumulate more assets against future risks, driving increased work hours at younger ages. This estimate is close to the results presented by French and Jones (2011) and within the range of estimates from previous studies. Furthermore, annual time endowments are estimated at 5,268 hours, and the hours of leisure loss due to unhealthy status, which can be identified by the fact that unhealthy individuals work fewer hours than healthy individuals, are estimated at 105 hours. They imply that individuals in bad health and those with disabilities experience roughly a 2% loss in their total available time per year, on average, on activities such as doctor visits and undergoing physical therapy, even though they are not working.

Table 3: Estimated Structural Parameters

Parameter	Definition	Estimates	S.E.
γ	Consumption weight	0.53	0.0039
ν	CRRA for flow utility	4.75	0.0560
β	Time discount factor	0.95	0.0031
L	Leisure endowment	5268	50.30
ϕ	Hours of leisure lost, unhealthy	105	6.31
$\theta_p^{h=0}$	Fixed cost of work, healthy	936	14.68
$\theta_p^{h=1,2}$	Fixed cost of work, unhealthy	755	14.87
θ_B	Bequest weight	0.039	0.0001
κ	Curvature of the bequest	45k	2k
χ^2 statistic (degrees of freedom = 231)		851	
Coefficient of relative risk aversion		2.987	

As discussed in Section 2, participation rates decline significantly at older ages, while hours worked per worker decrease much more modestly. The fixed cost of working helps capture the limited variability in labor supply along the intensive margin, where only a small fraction of individuals work very few hours. The fixed cost generates a reservation number of working hours

[31] To identify the preference parameters in Θ, following French (2005), I make the assumptions that health status and wages are not affected by working hours decisions and that preferences vary with age only due to changes in health status. That is, age changes the incentives for labor supply and savings decisions but does not change preferences. Refer to French (2005) and French and Jones (2011) for a detailed discussion on identifying preference parameters. Table 3 displays over-identification test statistics. Similar to the previous work, even though the model is formally rejected, the life cycle profiles generated by the model closely match the life cycle profiles generated by the data.

Table 4: Labor Supply Elasticity to a 20% Wage Increase

	Age 40	Age 50	Age 60	Age 65
Average Hours				
Overall	0.43	0.60	1.16	3.97
Healthy	0.42	0.49	1.00	4.03
Unhealthy	0.52	1.35	1.98	3.80
Participation				
Overall	0.01	0.12	0.56	3.12
Healthy	0.01	0.02	0.39	3.20
Unhealthy	0.05	0.79	1.35	2.91

and can be identified by the life-cycle profile of hours per worker. Additionally in the data, unhealthy workers work fewer hours than healthy workers over the life cycle. While it is often assumed to be the same for workers regardless of health status (e.g., French (2005), Bairoliya (2019)), my estimates show that the fixed costs of working differ for healthy and unhealthy workers, with values of 936 and 755 hours per year, respectively. This suggests that unhealthy workers may prefer to work in a job with less commuting time or a part-time position with a more flexible schedule. Data from the PSID validates this, showing that unhealthy workers spend roughly 80 hours less annually commuting to work than healthy workers, supporting my estimation.[32]

Furthermore, Table 4 presents labor supply elasticities at ages 40, 50, 60, and 65, as well as their values by health status, given an anticipated transitory wage increase.[33] Some key features are worth noting. Elasticity rises with age, regardless of health status, and trends to be lower for workers in good health before retirement age. Specifically, the elasticity of average hours increases gradually from 0.43 at age 40 to 1.16 at age 60 and further to 3.97 at age 65. However, the patterns by health status are different. For healthy men, the elasticity of average hours remains fairly stable at ages 40 and 50, surpassing 1.0 in the early 60s; while for unhealthy men, the elasticity starts at 0.52 at age 40 and grows rapidly in the 50s, reaching 1.35 at age 50.[34]

Labor supply elasticities vary with age and health due to the fixed cost of working and the sensitivity to the incentives generated by social insurance programs at different life stages. At younger ages with fewer assets, the benefits of working typically outweigh the costs. Individuals need to build up a butter stock of wealth against shocks, so wage changes have little effect on their work decisions (e.g., participation elasticity is merely 0.01 at age 40). However, as they reach

[32]The question in the PSID is *Head's travel to work time in annual hours*.

[33]To calculate the labor elasticities at certain ages, I first use the model to simulate average work hours across all the targeted individuals. Then, holding other model parameter values unchanged, I repeat the simulation with wages increasing by 20% at that age and calculate how total work hours change at each age. Participation elasticities are calculated using the same steps as average working hours. Table 4 reports the values in the year of wage change.

[34]Similarly, the elasticity patterns given a permanent wage change are rising with age and varying by health status. Refer to Table 6 in the online appendices.

their 60s, the payoffs from working diminish due to lower wages, declining health, accumulated assets, and work disincentives of pension and retirement benefits. As older workers are closer to the participation margin, their labor supply elasticities rise, aligning with previous research in a similar model framework, e.g., French and Jones (2012), and Jones and Li (2018).[35] Moreover, at age 65, the elasticities of average hours and participation are 3.97 and 3.12, respectively, implying that wage changes have a large labor impact because of the participation margin. This sheds light on the substantial labor supply impact of SS reforms for men in their 60s.

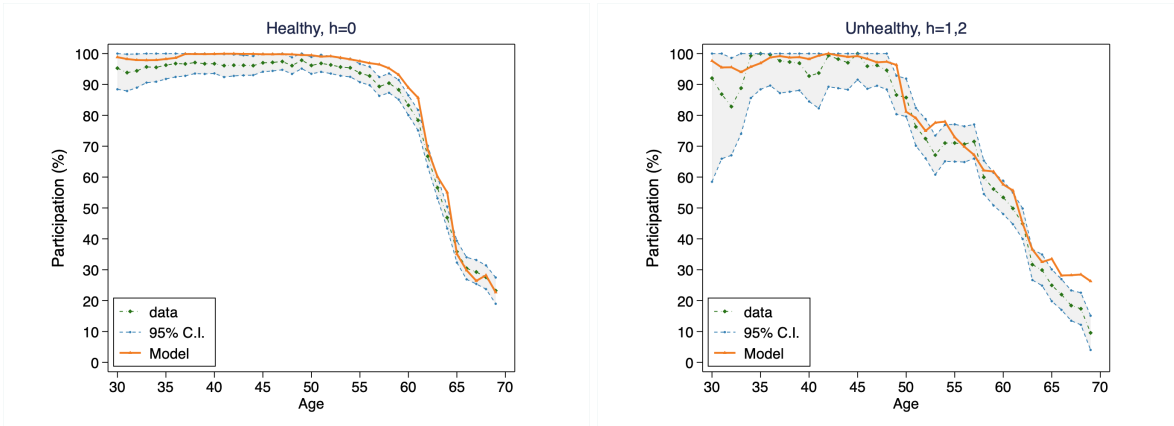
In addition, individuals in good health have smaller labor supply elasticities before becoming eligible for retirement benefits. For instance, at age 50, the elasticity of average hours is 1.35 for unhealthy men, whereas it is much lower at 0.49 for healthy men. This difference can be attributed to the availability of DI benefits for workers with disabilities, providing them with the options to exit the labor market. And due to the fixed cost of working, it is not optimal to work for only a few hours. Thus, their labor supply elasticities rise significantly with a large increase in current wages. This finding, to the best of my knowledge, has not been previously documented in the literature.

6.1. **Model Fit**

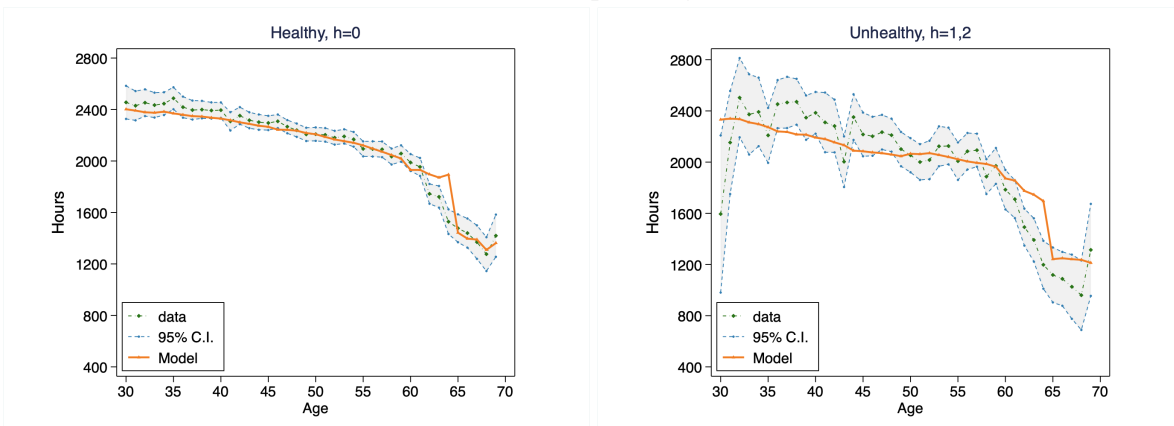
Figure 4 displays the life-cycle profiles of decision variables from the PSID (including 95% confidence intervals) alongside profiles generated from the model estimation for the 1930s cohort. The model fits these targeted data profiles very well and reproduces the observed key patterns of participation, hours per worker, and savings for individuals by health over their life cycle.

The model precisely reproduces participation patterns: flat high rates among individuals in their 30s and 40s, declines in the 50s for unhealthy men, and sharp drops in the 60s for men in all health statuses. In particular, it fits the labor supply profiles of unhealthy men much more closely compared to previous work, such as French (2005). Including disabled state and DI benefits into the model is crucial for capturing the observed declines in participation among unhealthy men starting in their 50s. This is noteworthy as DI provides an alternative pathway to retirement for workers with disabilities. To emphasize the importance of DI benefits in matching data profiles, I estimate an alternative model without disabled states and DI benefits. The estimation results show that it fails to match the participation drop in the 50s, as both healthy and unhealthy workers stay in the labor market until reaching retirement age (refer to section 6 of the online appendices for detailed results). This is consistent with previous research, such as French and Song (2014), which has highlighted DI as a major cause of declined labor supply among American men aged 55-64. In

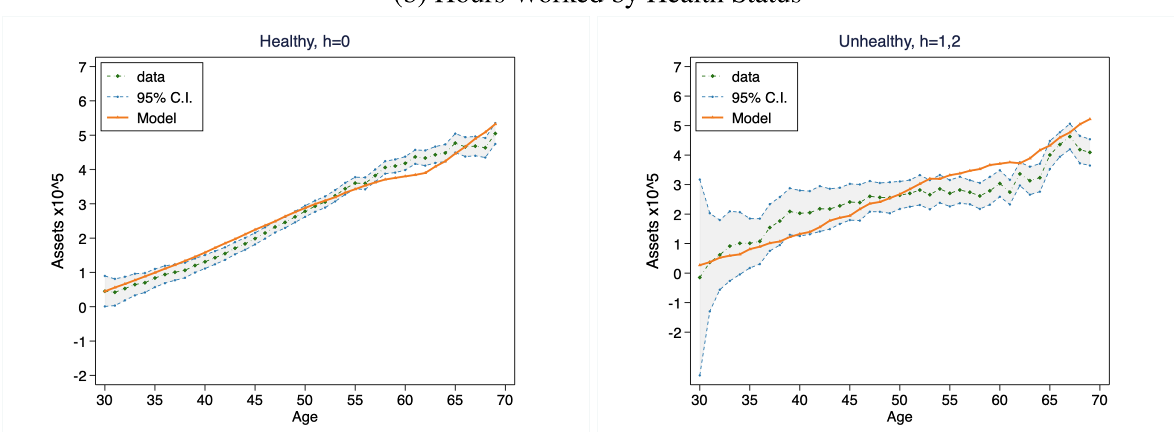
[35]Previous studies that model human capital accumulation have also emphasized that elasticities vary over ages and by education, e.g., Keane and Wasi (2016), Keane (2016), Keane and Imai (2004), Rogerson and Wallenius (2009). In their work, younger workers are not very sensitive to changes in current wages because the return on human capital is substantial for the young and is less critical at older ages. Moreover, given that human capital return is more pronounced among highly educated workers, they are relatively less sensitive to the wage rate changes.



(a) Labor Force Participation by Health Status



(b) Hours Worked by Health Status



(c) (Non-Pension) Assets by Health Status

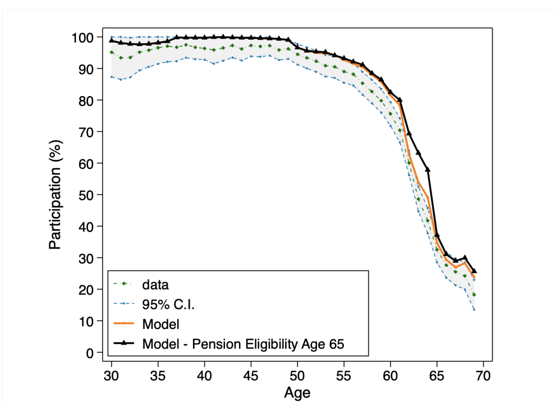
Fig. 4. Model v.s. Data Profiles: Targeted Moments

Notes: Panel a shows the model fit for labor force participation by health status. Panel b shows the model fit for hours worked conditional on participation by health status. Panel c shows the model fit for non-pension assets by health status. Profiles for healthy people ($h = 0$) are on the left, whereas profiles for unhealthy people ($h = 1, 2$) are on the right. Model profiles are represented by the orange lines. Data profiles with 95% confidence intervals are represented by the shaded area. Monetary values are expressed in 2016 dollars.

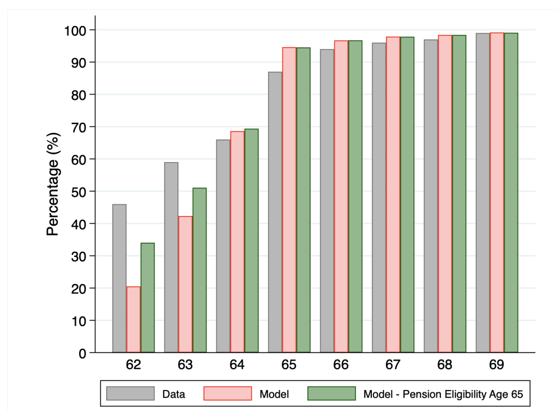
Data Source: Panel Study of Income Dynamics, author's calculations.

addition, accounting for medical expenditure disparities across health states helps match savings profiles. Individuals save against risks and for retirement; thus, matching assets for healthy and unhealthy individuals is important to evaluate the effect of policy instruments and other forces, as discussed in Borella et al. (2019b).

For labor behaviors in all health groups, the ages at which hours worked and participation rates decline most rapidly coincide with the ages of decreasing hourly wages and the presence of work disincentives provided by pensions and SS retirement benefits (Anderson et al. (1999)). Extensive literature has addressed the substantial work disincentives provided by defined benefit plans upon reaching pension eligibility age (PEA). For instance, Kotlikoff and Wise (1988) and Friedberg and Webb (2005) have shown that defined benefit pension accruals embed significant work disincentives at older ages through an implicit tax on earnings, greatly increasing early retirement. My model incorporates a pension structure that generates similar work disincentives at the PEA, set at 62. This point can be illustrated through individuals' behavioral responses when shifting the PEA to 65. As shown in Figure 5 (panel a), this experiment leads to an increase of 6.7 p.p. in participation at age 62, followed by a sharp decline of 19.4 p.p. at the new PEA of 65.



(a) Labor Force Participation



(b) Cumulative Social Security Claiming

Fig. 5. Effects of Increasing Pension Eligibility Age

Notes: This figure shows the effects of shifting the pension eligibility age from 62 to 65 on labor force participation (panel a) and cumulative Social Security claiming (panel b) at the average level. In panel a, the orange (black) line shows the model-simulated profiles for the 1930s cohort before (after) the change; data profiles with 95% confidence intervals are represented by the shaded area. In panel b, the grey bar refers to the benefit claiming percentage in the data; the pink (green) bar refers to the claiming percentage for the 1930s cohort before (after) the change.

Data Source: Panel Study of Income Dynamics, author's calculations; Health and Retirement Study, Bairoliya and McKiernan (2021).

Evidence of how my estimated model precisely matches average data profiles of labor supply and savings behaviors is provided in Appendix B.1. Moreover, cumulative benefit claiming across eligible ages is presented in Figure 7 (panel b). Though the model is not estimated to match claiming behaviors, it fits quite well the data starting at age 64 and beyond, correctly capturing the spike in claims at the NRA of 65, with nearly everyone claiming benefits thereafter.[36] It under-predicts the claims at ages 62 and 63, possibly due to the availability of pensions at age 62 and benefit discount factors in the early 60s. In particular, Figure 5 (panel b) shows that shifting the PEA to 65 leads to a 14 p.p. increase in SS claims at age 62. Other studies such as Pashchenko and Porapakkarm (2020) and Bairoliya and McKiernan (2021) effectively match early claiming behavior without incorporating retirement benefits other than Social Security. Additional factors such as misinformation on benefits adjustments (Bairoliya and McKiernan (2021)) and illiquid housing wealth (Kahn (1988) and Li (2022)) may also explain early claiming behaviors.

Overall, the estimation results provide strong evidence that the model precisely captures the key patterns of labor supply and savings decisions for individuals throughout their life cycle, making it a useful instrument for analyzing the impact of policy reforms on individuals' behaviors.

7. Explaining Trends in Labor Supply of Older Men

In this section, the estimated model is employed to evaluate the extent to which changes in SS rules and other potential factors account for the observed rises in labor supply among older individuals between the 1930s and 1950s cohorts, as outlined in Section 2. I take the estimated preference parameters from the 1930s model as given and replace the changed policy rules or parameter values with those faced by the 1950s cohort in the model. Then I simulate how the 1930s cohort would behave if they had the same values for those factors as the 1950s cohort. To isolate the impact of these factors, I keep all other policy rules and model parameters unchanged when conducting each experiment. The resulting labor and benefit claiming responses at older ages to each change in comparison to the estimated model are summarized in Table 5.

7.1. Effects of Social Security Reforms

Figure 6 illustrates the effects of each SS reform on participation and hours per worker over the life cycle and compares the model-simulated changes with the data profiles between the two cohorts.[37] To better understand the impact of SS policies, Table 6 presents their labor impact by health and age groups, and Figure 7 displays the effects on benefit claiming across eligible ages.

[36] Claiming behaviors are not targeted moments since they are not the main focus of the study and the available information on benefits claiming from the PSID is limited. In Figure 7 (panel b), I compare my model-generated profile of cumulative benefits claims to the data profile estimated by Bairoliya and McKiernan (2021), who construct their profile using the HRS for the 1930s cohort. The patterns of SS claiming behaviors have been discussed elaborately in, e.g., Pashchenko and Porapakkarm (2020), Imrohoroğlu and Kitao (2012) and Waldron (2004).

[37] Appendix B.2 displays their effects by health and the joint impact on labor supply behaviors over the life cycle.

Table 5: Effects on Labor Supply at 60-69 and Benefit Claiming in Alternative Economies

Baseline	Benchmark Economy								
Change	NRA	DRC	RET	SS	Mortality	Threshold	Rolls	Health	Tax
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Participation (p.p.)	1.99	0.23	7.53	8.21	2.28	0.36	0.25	0.70	1.65
% Δ Participation	4.24	0.49	16.07	17.52	4.86	0.77	0.53	1.50	3.52
% Δ Hours Worked	2.75	1.30	12.11	12.85	0.19	-0.23	-0.06	2.42	0.0
Claiming after 65 (p.p.)	27.43	12.37	0.00	14.34	6.51	5.37	5.34	6.66	5.71
Δ Claims at 65 (p.p.)	-22.06	-7.00	5.37	-8.97	-1.14	0.00	0.03	-1.29	-0.34

Baseline	Model without Disability				MH 30s	NWG 30s	Mortality	$\beta\uparrow 10\%$
Change	NRA	DRC	RET	SS	MH 50s	NWG 50s	DRC	RET
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Δ Participation (p.p.)	2.77	0.53	8.09	9.36	0.00	3.02	0.21	2.80
% Δ Participation	6.15	1.17	17.96	20.76	0.02	7.40	4.19	9.83
% Δ Hours Worked	2.05	2.17	10.00	10.17	0.01	0.69	1.78	6.36
Claiming after 65 (p.p.)	21.94	17.26	0.00	5.06	5.40	4.66	15.71	6.40
Δ Claims at 65 (p.p.)	-14.60	-9.90	7.34	2.29	0.00	-0.63	-9.20	6.40

[1] Abbreviation: NRA = Normal Retirement Age; DRC = Delayed Retirement Credit; RET = Retirement Earnings Test; SS= Social Security; MH = Moral Hazard; NWG = National Wage Growth; p.p.= percentage points.
[2] Columns (1)-(9): Baseline: the benchmark economy; Changes: (1) NRA raised from 65 to 66; (2) DRC increased from 4.5%to 8%; (3) RET removed for beneficiaries beyond the NRA; (4) SS policy rules in (1)-(3) simultaneously; (5) Mortality rates decreased by 25% for individuals aged over 50; (6) Income threshold of disability benefits program faced by the 1950s cohort; (7) Disability rolls across cohorts; (8) Health dynamics faced by the 1950s cohort; (9) Tax rates faced by the 1950s cohort.
[3] Columns (10)-(13): Baseline: the model without disability benefits and disabled states; Changes: repeat (1)-(4).
[4] Column (14): Baseline: the benchmark economy with moral hazard faced by the 1930s cohort; Change: moral hazard faced by the 1950s cohort. Column (15): Baseline: the benchmark economy with AIME adjusted by the national wage growth index faced by the 1930s cohort; Change: national wage growth index faced by the 1950s cohort. Column (16): Baseline: the benchmark economy with β increased by 10%; Change: repeat (2). Column (17): Baseline: the benchmark economy with mortality decreased by 25%; Change: repeat (3).

Shifting the NRA from 65 to 66 leads to a 2 p.p. increase in participation and a 2.8% rise in hours per worker aged 60-69 (Table 5). This reform induces a decline in retirement benefits. Individuals have to wait until age 66 to start collecting benefits in order to qualify for the full benefit amount. As shown in Figure 6 (panel a) and Figure 7, it encourages postponed benefit claiming and labor market participation until age 66, but it does not provide additional work incentives after reaching the new NRA. The modest labor effect of raising retirement age is consistent with results from French (2005) and Gustman and Steinmeier (2015). Moreover, Table 6 columns1-4 reveal a notably smaller participation response for unhealthy men compared to healthy men. This is mainly driven by individuals with disabilities who reduce their participation due to the availability of DI benefits before the NRA. With DI program rules remaining unchanged, postponing the NRA makes

DI more attractive prior to the new NRA, leading to more disabled workers exiting the labor market to qualify for DI benefits. Previous studies by Duggan et al. (2007) and Li (2018) have also shown that reduced generosity in retirement benefits results in a significant increase in SSDI enrollment, which further discourages work (see Maestas et al. (2013)).

Raising the DRC from 4.5% to 8% encourages delayed benefit claiming but has a relatively small impact on labor supply on average.[38] As illustrated in Figures 7 and 6 (panel b), a 3.5 p.p. increase in DRC leads to about 7 p.p. more individuals claiming benefits beyond the NRA, and its labor effects mainly fall on the intensive margin between the NRA and claiming age since the RET does not apply before claiming benefits. The minor labor impact on the extensive margin is consistent with findings in Duggan et al. (2023), which suggest that the increase in average employment from new late claimers is offset by the income effect on those late claimers before the policy reform. Moreover, healthy individuals respond more to the DRC reform because they have a higher life expectancy and stand to gain more from the increase in DRC.[39] This is visualized in Figure 8, where an increased DRC, in the context of longer life expectancies (lowering mortality rates), has a stronger impact on delayed claims and working hours (Table 5 column 16). In addition, unhealthy individuals react less to the DRC reform, partly driven by those with disabilities who reduce their labor supply (Table 6 column 5-8). A higher DRC makes early-claiming retirement benefits less attractive, leading disabled workers to exit the labor market for DI benefits.

The elimination of the RET beyond the NRA results in a 7.5 p.p. increase in participation and a 12% rise in hours per worker aged 60-69. This reform accounts for over 71% of the observed rises in labor supply of older men across cohorts along both extensive and intensive margins. It allows individuals to keep their earnings while simultaneously collecting retirement benefits after reaching the NRA without facing additional tax penalties, substantially reducing effective tax rates on their earnings. This incentivizes the elderly to claim benefits as soon as they reach the NRA and supply more labor thereafter (as shown in Figure 6 (panel c) and Figure 7). The substantial labor impact of the RET is consistent with previous literature, such as Friedberg (2000), Benítez-Silva and Yin (2009), and Gelber et al. (2018). Moreover, labor responses to this reform are similar across health groups, because it takes effect only after reaching the NRA when DI becomes unavailable, leaving the comparison between retirement and DI benefits prior to the NRA unaffected. Further, while individuals can gradually recoup withheld benefits due to RET in later years, keeping total lifetime benefits roughly unchanged, this redistribution results in a small amount of upward adjustment in

[38] Earlier studies, such as French (2005), Li (2022), Munnell and Chen (2019), Gruber and Wise (2007), and Heiland and Yin (2014), have argued that retirement benefits are roughly actuarially fair for early claiming, but are actuarially unfair for delayed claiming. This provides an incentive for individuals to exit the labor force when they reach the NRA.

[39] Recent research, such as Dushi et al. (2021) and Duggan et al. (2023), uses SSA data and finds that late claimers of retirement benefits have higher lifetime earnings and lower mortality because their delayed benefits exceed the actuarially fair amounts.

future benefits. Table 5 column 17 shows that more patient individuals (i.e., $\beta \uparrow$) respond less to the RET reform in terms of older-age labor supply and benefit claiming at the NRA.

Overall, the three SS changes jointly explain the majority of labor dynamics at older ages – accounting for 77.5% of the observed rise in labor force participation and 89.8% of the observed increase in hours per worker at ages 60-69 across cohorts (Table 5 column 4). Among these three reforms, the elimination of the RET beyond the NRA is the main contributor. The impact of the increased DRC is offset by the RET reform because these two policies provide opposing incentives for delaying benefit claims. Together the NRA postponed by one year, most individuals claim benefits after reaching the new NRA and supply more labor thereafter. The model highlights the significant labor impact of SS rules for men in their 60s when labor supply becomes highly elastic.

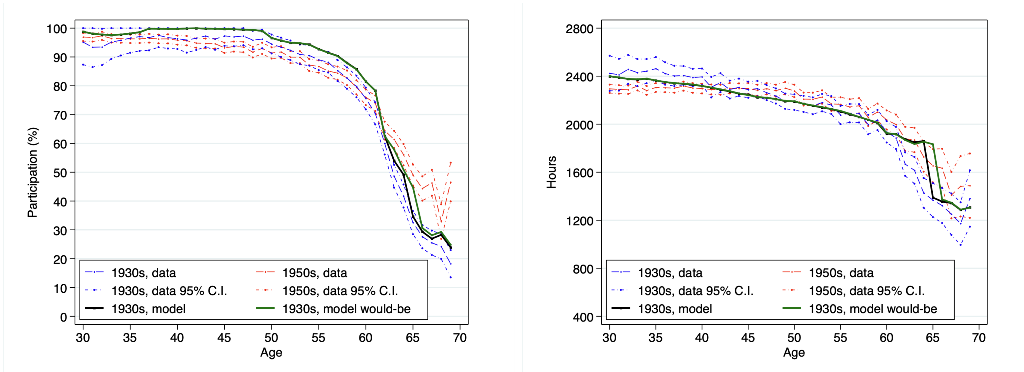
Table 6: Effects of Changing Social Security Rules on Labor Supply by Health Status

Benchmark	NRA 65 → 66				DRC 4.5% → 8%				RET 70 → 65			
	h=0 (1)	h≠0 (2)	h=1 (3)	h=2 (4)	h=0 (5)	h≠0 (6)	h=1 (7)	h=2 (8)	h=0 (9)	h≠0 (10)	h=1 (11)	h=2 (12)
Change in Participation (p.p.)												
60-69:	2.57	0.46	1.64	-0.90	0.33	-0.05	0.10	-0.20	8.56	5.14	6.13	3.58
60-64:	1.25	0.64	1.72	-0.50	0.02	-0.19	0.21	-0.62	-0.66	-0.40	-0.55	-0.25
65-69:	3.88	0.28	1.56	-1.30	0.65	0.10	-0.02	0.22	17.78	10.68	13.61	7.42
Change in Hours Worked (%)												
60-69:	2.45	3.52	3.80	2.65	1.27	1.44	1.73	1.20	11.41	13.50	14.22	12.38
60-64:	-0.34	0.30	0.36	-0.26	-0.35	0.12	0.04	0.57	-0.30	-1.01	-1.10	-0.77
65-69:	6.30	8.18	8.77	6.90	3.50	3.33	4.16	2.12	27.57	34.49	36.43	31.58
Model w/o DI	NRA 65 → 66				DRC 4.5% → 8%				RET 70 → 65			
	h=0 (13)	h≠0 (14)	h=1 (15)	h=2 (16)	h=0 (17)	h≠0 (18)	h=1 (19)	h=2 (20)	h=0 (21)	h≠0 (22)	h=1 (23)	h=2 (24)
Change in Participation (p.p.)												
60-69:	2.74	2.80	2.80	NA	0.54	0.50	0.50	NA	7.59	8.59	8.59	NA
60-64:	1.12	2.01	2.01	NA	-0.38	0.27	0.27	NA	-1.02	-0.90	-0.90	NA
65-69:	4.37	3.59	3.59	NA	1.47	0.73	0.73	NA	16.20	18.80	18.80	NA
Change in Hours Worked (%)												
60-69:	1.84	2.43	2.43	NA	2.19	2.06	2.06	NA	9.14	11.49	11.49	NA
60-64:	-0.44	-0.40	-0.40	NA	-0.25	-0.25	-0.25	NA	-0.64	-0.69	-0.69	NA
65-69:	4.71	6.23	6.23	NA	5.25	5.17	5.17	NA	21.39	27.87	27.87	NA

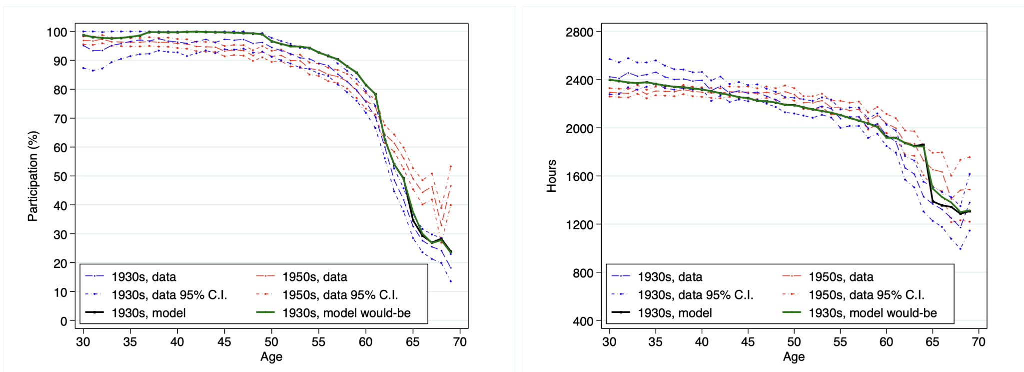
[1] Abbreviation: NRA = Normal Retirement Age; DRC = Delayed Retirement Credit; RET = Retirement Earnings Test; p.p. = percentage points.

[2] Columns (1)-(12): Baseline: The estimated model for the 1930s cohort. Columns (1)-(4): Effects of shifting the NRA from 65 to 66 for people who are healthy (h=0), unhealthy (h≠0), in bad health (h=1), and with disabilities (h=2). Columns (5)-(8): Effects of increasing the DRC from 4.5% to 8% for individuals in the four health groups. Columns (9)-(12): Effects of eliminating the RET beyond 65 for individuals in the four health groups.

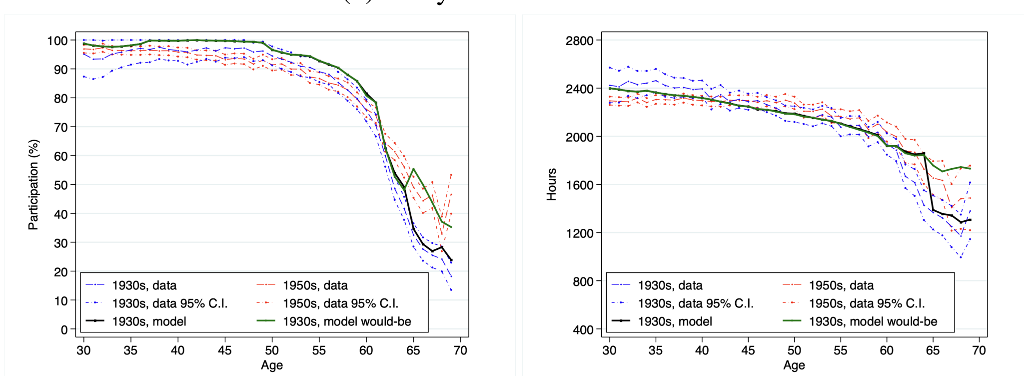
[2] Columns (13)-(24): Effects of changing the same set of Social Security rules (NRA, DRC, RET) in an economy without disabled states and disability insurance of the 1930s cohort.



(a) Normal Retirement Age



(b) Delayed Retirement Credits



(c) Retirement Earnings Test

Fig. 6. Model v.s. Data Profiles: Effects of Changing Social Security Rules

Notes: Effects of the corresponding policy changes on labor force participation (left panels) and hours worked by workers (right panels) at the average level. The black (green) lines show the model-simulated profiles for the 1930s cohort before (after) implementing policy changes. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.

Policy Experiments: increasing the NRA from 65 to 66 (panel a); increasing the DRC from 4.5% to 8% (panel b); removing the RET from 70 to 65 (panel c).

Data Source: Panel Study of Income Dynamics, author's calculations.

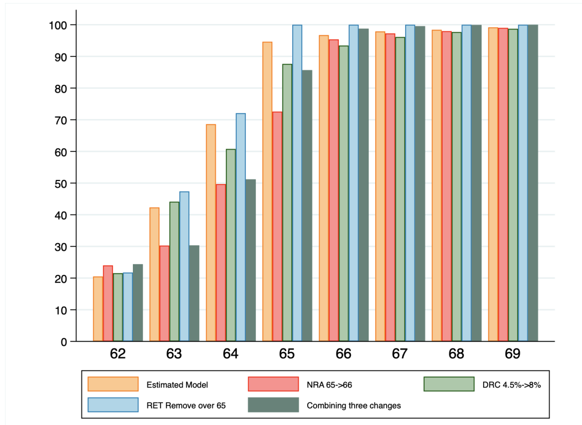


Fig. 7. Effects of Changing Social Security Rules on Benefit Claiming

Notes: This figure illustrates model-predicted fraction of individuals who had applied for Social Security retirement benefits at ages 62-69. The orange bar refers to the percentage under the estimated model for the 1930s cohort. The red bar shows the effects of increasing the NRA from 65 to 66. The green bar shows the effects of increasing the DRC from 4.5% to 8%. The blue bar shows the effects of removing the RET from 70 to 65. The teal color bar shows the joint effects of three changed policies.

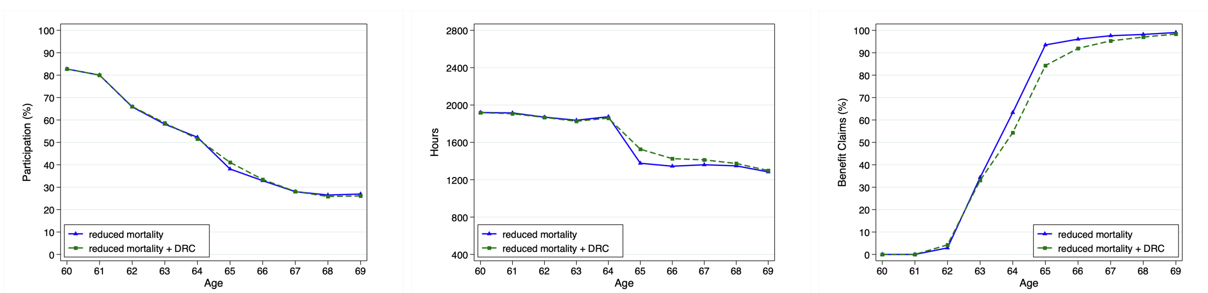


Fig. 8. Effects of Increasing DRC When Mortality Rates Decline

Notes: The effects reducing mortality rates on labor force participation (left), hours worked by workers (middle), and Social Security Claiming (right) over ages 60-69 at the average level. The blue lines represent the model-simulated profiles for the 1930s cohort after reducing mortality rates. The green lines represent the model-simulated profiles for the 1930s cohort after reducing mortality rates and implementing new DRC.

7.2. **Effects of Disability Benefits**

The work disincentives provided by DI lead to a smaller labor supply response to SS reforms for unhealthy individuals, particularly those affecting decisions before the NRA. This helps explain why the increases in labor supply among older workers across cohorts are primarily driven by men in good health. Therefore, it is important to employ a model that includes DI when evaluating policy reforms aimed at addressing the SS solvency problem. To emphasize this, I estimate an alternative model that abstracts from DI and disabled state but is otherwise identical to the baseline model for assessing the same SS reforms. The experiment results are shown in Table 6 columns 13-24 and Table 5 columns 10-13, showing that the model without DI overestimates participation responses for unhealthy workers and those at the average level, compared to the baseline model.[40]

I further use the model to explore how changes in DI program rules affect work decisions at different life stages, including increasing the benefit receipt difficulty, raising the income threshold for qualification, and addressing moral hazard concern within the program.[41] Table 7 summarizes their impacts on participation and hours worked for individuals in different health and age groups.

Columns 1-4 report that doubling the difficulty of obtaining DI benefits (effectively halving the value of π^{db}) significantly increases the labor supply of disabled workers aged 50-64 through the extensive margin. This adjustment leads to a 24 p.p. rise in participation in the 50s and a 19 p.p. increase in the early 60s, and does not affect work decisions of non-disabled workers.

Because of the income threshold (y_{db}), disabled workers who aim to receive DI benefits need to drop out of the labor market or work only a few hours. Doubling the threshold affect their labor behaviors along both the extensive and intensive margins. As shown in columns 5-8, it raises the participation rates by 31 p.p. in the 50s and 22 p.p. in the early 60s, while reducing hours per worker by more than 23% over ages 50-64. The higher threshold allows more benefit receipts to work but limits their ability to work longer hours, resulting in decreased annual hours worked.

In addition, there exists a potential issue of moral hazard within the DI program ($db\mathbb{1}_{\{h\neq 0\}} > 0$). Data from the PSID indicates that 1.4% of individuals in good health and 16% of those in bad health from the 1930s cohort receive DI benefits over ages 50-64. To account for it, I allow non-disabled workers who meet the income requirement to qualify for DI benefits, which are subject to a discount to reflect the average amount received by them, i.e., $\pi^{db}_{h=0} = 0.014, \pi^{db}_{h=1} = 0.16$. Columns 9-12 illustrate that the possibility of receiving DI benefits incentives non-disabled workers to drop out of the labor force for benefits. In particular, with $\pi^{db}_{h=1} = 0.16$, this decreases participation rates for workers in bad health by 3 p.p. in their 50s and 9 p.p. in their early 60s.

Furthermore, I document changes in DI program between the 1930s and 1950s cohorts and investigate their impact on the observed labor supply trends. Based on data from PSID and SSA, the 1950s cohort facing an income threshold roughly 1.15 times higher on average than the 1930s

[40]The estimation results of the model without DI are presented in Section 6 of the online appendices. It also displays the labor effects of each SS reform, making comparisons of the simulated changes with the life-cycle data profiles across cohorts. Additionally, using both a model without DI and a model with DI that abstracts from the RET, Li (2018) shows that the model without DI overestimate the labor response to the NRA reform. My paper complements it by evaluating effects of additional SS policies, such as the DRC and RET reforms, and their impact by health.

[41]The experiments of changing receipts difficulty and address moral hazard cannot be directly implemented through DI application since the model abstracts from it. To explore their impact, I modify the discount parameter (π^{db}) on DI benefits for the corresponding health groups, reflecting the average amount received by them.

cohort, with no significant changes in disability rolls and moral hazard across cohorts.[42] As shown in columns 6, 7, and 14 of Table 5, these small changes in DI program factors have minimal impact on work decisions at older ages.[43]

In summary, the findings highlight the strong labor responses to the DI program policy changes for recipients before reaching the NRA, as DI benefits are no longer applicable thereafter. However, due to the small proportion of disabled individuals in the population, the overall labor supply impact of DI program changes is not substantial (as seen in Table 7). From a policy perspective, raising the DI income threshold or implementing stricter screening processes to reduce benefit receipt and mitigate moral hazard would increase labor supply before the NRA.

Table 7: Effects of Altering DI Rules on Labor Supply in Various Age Groups

	DI Receipts Difficulty $\pi^{db}/2$				Income Threshold $y_{db} \times 2$				Moral Hazard $db\mathbb{1}_{\{h\neq 2\}}$			
	h=0	h=1	h=2	All	h=0	h=1	h=2	All	h=0	h=1	h=2	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Change in Participation (p.p.)												
50-59:	-0.06	0.36	24.44	1.99	0.02	0.00	31.14	2.61	-0.08	-3.36	0.20	-0.45
60-64:	0.16	-0.08	18.92	2.31	0.09	0.04	22.02	2.61	-0.33	-9.40	0.06	-1.53
65-69:	-0.15	0.87	0.78	0.14	0.03	0.08	0.44	0.10	-0.03	-0.18	0.51	0.03
Change in Hours Worked (%)												
50-59:	-0.04	0.00	-1.96	-0.26	-0.01	0.02	-22.65	-1.49	0.05	-0.54	-0.08	0.00
60-64:	-0.05	-0.22	-3.95	-0.44	0.03	0.08	-25.94	-1.78	0.07	1.84	-0.13	0.37
65-69:	-0.40	-1.01	-0.68	-0.62	-0.25	-0.24	-0.53	-0.30	0.07	-0.16	0.01	0.01

[1] Abbreviation: DI = Disability Insurance; p.p. = percentage points.
[2] Columns (1)-(4): Effects of doubling the DI receipts difficulty (altering π^{db} from 0.63 to 0.315) for people grouped as healthy (h=0), in bad health (h=1), with disabilities (h=2), and at an average level. Columns (5)-(8): Effects of doubling the income threshold for qualifying for DI (changing y_{db} from 3600 to 7200) for people falling into the same four categories. Columns (9)-(12): Effects of allowing moral hazard for qualified non-disabled people ($db\mathbb{1}_{\{h\neq 0\}} > 0$, $\pi^{db}_{h=0} = 0.014, \pi^{db}_{h=1} = 0.16$) in the same four categories.

7.3. Effects of Mortality Risks and Other Contributing Factors

In addition to SS reforms, there have been significant changes in the mortality rates of Americans over time. Data from the National Center for Health Statistics (NCHS) shows that the death

[42]The changes are specified in Table C.2. Obtaining data on DI applications can be challenging, as discussed in Low and Pistaferri (2015). To address it, I attempt to document the changes in DI program rules across cohorts by using available information from the PSID. Specifically, I estimate disability rolls and moral hazard based on data concerning the fraction of respondents in different health groups who receive DI benefits. Information regarding income threshold is taken from SSA, as detailed in `https://www.ssa.gov/oact/cola/sga.html`. The SS disability rolls have been documented and analyzed in previous studies, such as Autor and Duggan (2006).

[43]The simulated profiles of participation and hours worked are displayed in Section 5 of the online appendices.

rates among men have decreased by about 25% since the 1990s, with this decline being primarily driven by older men. Similar trends in mortality rates between the 1930s and 1950s cohorts can be estimated using the Human Mortality Database (HMD).[44]

Table 5 column 5 shows that a 25% reduction in mortality rates over age 50 leads to a 6.5 p.p. rise in delayed benefit claiming beyond the NRA, along with a 2.3 p.p. increase in participation at ages 60-69, accounting for 21% of the overall rise in older-age participation across cohorts. Lower mortality rates increase life expectancy, encouraging individuals to delay benefit claiming and extend labor market participation to receive higher retirement benefits for a longer time.

Moreover, as noted in the literature (e.g., Coile (2019)), other demographic and economic factors may have contributed to the rising labor supply among older individuals. For instance, Bairoliya (2019) finds that a 24% shift in pension plans (from Defined Benefit to Defined Contribution) accounts for 14% of the increased participation at ages 60-69, while Cajner et al. (2021) indicate that changes in occupation, education, and spousal employment status do not play a statistically significant role in explaining the increase in participation of older men across cohorts.

This model further investigates the penitential impact of other factors that could explain the observed increases in labor supply, including changes in health dynamics, income tax rates, and national wage growth index across cohorts, which are detailed in Appendix D. Table 5 summarizes the behavioral responses to each change in columns 8, 9, and 15, suggesting smaller labor impacts of those factors at older ages when compared to the effects of SS reforms.

8. Conclusion

Compared to the 1930s cohort, men born in the 1950s worked more at older ages, primarily driven by healthy individuals. This paper investigates the role of three actual SS policy changes—postponed NRA, raised DRC, and elimination of RET beyond NRA—in explaining these facts. To that end, I develop and estimate a rich dynamic life-cycle model that incorporates heterogeneity in health and disability, medical expenditures, and key features of SS retirement and disability benefits. The model matches well the observed life-cycle profiles of labor supply and savings by health status for the 1930s cohort.

My results show that three SS reforms jointly explain most of the labor dynamics at older ages and indicate the significant labor impact of the RET reform. Moreover, the labor response to SS reforms is smaller for unhealthy individuals due to the work disincentives provided by disability benefits before the NRA. My findings highlight the importance of accounting for the impact of DI when evaluating policies addressing SS solvency issues.

[44]Human Mortality Database (HMD). Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France). Available at www.mortality.org.

References

M. Aguiar, M. Bils, K. K. Charles, and E. Hurst. Leisure luxuries and the labor supply of young men. *Working paper*, February 2018.

P. M. Anderson, A. L. Gustman, and T. L. Steinmeier. Trends in male labor force participation and retirement: Some evidence on the role of pensions and social security in the 1970s and 1980s. *Journal of Labor Economics*, 17(4):757–783, 1999.

O. Attanasio, H. Low, and V. Sánchez-Marcos. Explaining changes in female labor supply in a life-cycle model. *American Economic Review*, 98(4):1517–1552, 2008.

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

N. Bairoliya. Pension plan heterogeneity and retirement behavior. *European Economic Review*, 116:28–59, 2019.

N. Bairoliya and K. McKiernan. Revisiting retirement and social security claiming decisions. *Working Paper*, 2021.

R. Bénabou. Tax and education policy in a heterogeneous-agent economy: What levels of redistribution maximize growth and efficiency? *Econometrica*, 70(2):481–517, March 2002.

H. Benítez-Silva and F. W. Heiland. Early claiming of social security benefits and labour supply behaviour of older americans. *Applied Economics*, 40(23):2969–2985, 2008.

H. Benítez-Silva and N. Yin. An empirical study of the effects of social security reforms on benefit claiming behavior and receipt using public-use administrative microdata. *Social Security Bulletin*, 69(3), 2009.

D. M. Blau and D. B. Gilleskie. The role of retiree health insurance in the employment behavior of older men. *International Economic Review*, 49(2):475–514, May 2008.

D. M. Blau and R. M. Goodstein. Can social security explain trends in labor force participation of older men in the united states? *The Journal of Human Resources*, 45(2):328–363, Spring 2010.

M. Borella, M. De Nardi, and F. Yang. Are marriage-related taxes and social security benefits holding back female labor supply? *NBER Working Paper no. 26097*, 2019a.

M. Borella, M. De Nardi, and F. Yang. The lost ones: The opportunities and outcomes of white non-college-educated americans born in the 1960s. *NBER Macro Annual*, 2019b.

R. A. Braun, K. A. Kopecky, and T. Koreshkova. Old, sick, alone, and poor: A welfare analysis of old-age social insurance programmes. *Review of Economic Studies*, 84(2):580–612, 2017.

M. Cagetti. Wealth accumulation over the life cycle and precautionary savings. *Journal of Business and Economic Statistics*, 21(3):339–353, 2003.

T. Cajner, J. Fernández-Blanco, and V. S. Marcos. Widening health gap in the U.S. labor force participation at older ages. *BSE Working Paper 1298*, November 2021.

D. Card, N. Maestas, and P. Purcell. Labor market shocks and early social security benefit claiming. *University of Michigan Retirement Research Center (MRRC) Working Paper*, (2014-317), 2014.

M. Casanova. Happy together: A structural model of couples' joint retirement choices. *Working Paper*, November 2010.

C. C. Coile. Working longer in the united states: Trends and explanations. volume Social Security Programs and Retirement around the World: Working Longer. University of Chicago Press, 2019.

M. De Nardi. Wealth inequality and intergenerational links. *Review of Economic Studies*, 71(3): 743–768, 2004.

M. De Nardi, E. French, and J. B. Jones. Why do the elderly save? the role of medical expenses. *Journal of Political Economy*, 118(1):39–75, February 2010.

M. De Nardi, S. Pashchenko, and P. Porapakkarm. The lifetime costs of bad health. *NBER Working Paper no. 23963*, 2018.

M. Duggan, P. Singleton, and J. Song. 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, 2007.

M. Duggan, I. Dushi, S. Jeong, and G. Li. The effects of changes in social security's delayed retirement credit: Evidence from administrative data. *Journal of Public Economics*, 223, 2023.

I. Dushi, H. M. Iams, and B. Trenkamp. The importance of social security benefits to the income of the aged population. *Social Security Bulletin*, 77(2), 2017.

I. Dushi, L. Friedberg, and A. Webb. Is the adjustment of social security benefits actuarially fair, and if so, for whom? *SCEPA working paper series, 2021-04*, 2021.

G. V. Engelhardt and A. Kumar. Taxes and the labor supply of older americans: Recent evidence from the social security earnings test. *National Tax Journal*, 67(2):443–458, 2014.

A. Erosa, L. Fuster, and G. Kambourov. Labor supply and government programs: A cross-country analysis. *Journal of Monetary Economics*, (1):84–107, 2012.

X. Fan, A. Seshadri, and C. Taber. Estimation of a life-cycle model with human capital, labor supply and retirement. *Working Paper*, 2019.

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

E. French and D. Benson. How do sudden large losses in wealth affect labor force participation? *Chicago Fed Letter*, 282, 2011.

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

E. French and J. B. Jones. Public pensions and labor supply over the life cycle. *International Tax and Public Finance*, 19:268–287, 2012.

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

L. Friedberg. The labor supply effects of the social security earnings test. *The Review of Economics and Statistics*, 82(1):48–63, February 2000.

L. Friedberg and A. Webb. Retirement and the evolution of pension structure. *Journal of Human Resources*, 40(2):281–308, 2005.

L. Fuster, A. İmrohoroğlu, and S. İmrohoroğlu. Elimination of social security in a dynastic framework. *Review of Economic Studies*, 74(1):113–145, January 2007.

A. Gelber, D. Jones, D. W. Sacks, and J. Song. The employment effects of the social security earnings test. *Forthcoming, Journal of Human Resources*, 2018.

P. Gourinchas and J. A. Parker. Consumption over the life cycle. *Econometrica*, 70(1):47–89, January 2002.

M. Groneck and J. Wallenius. It sucks to be single! marital status and redistribution of social security. *SSE Working Paper Series in Economics No. 2017:1*, 2017.

J. Gruber and D. Wise. *Introduction to "Social Security Programs and Retirement around the World: Fiscal Implications of Reform"*, volume Social Security Programs and Retirement around the World: Fiscal Implications of Reform. University of Chicago Press, October 2007.

A. L. Gustman and T. L. Steinmeier. Effects of pensions on savings: analysis with data from the health and retirement study. *Carnegie-Rochester Conference Series on Public Policy*, 50: 271–324, June 1999.

A. L. Gustman and T. L. Steinmeier. Effects of social security policies on benefit claiming, retirement and saving. *Journal of Public Economics*, 129:51–62, 2015.

A. L. Gustman, A. A. Mitchell, Olivia S.and Samwick, and T. L. Steinmeier. *Forecasting Retirement Needs and Retirement Wealth*, volume Evaluating Pension Entitlements. University of Pennsylvania Press, 2000.

P. Haan and V. Prowse. Longevity, life-cycle behavior and pension reform. *Journal of Econometrics*, 178:582–601, 2014.

J. Heathcote, K. Storesletten, and G. L. Violante. Optimal progressivity with age-dependent taxation. *Journal of Public Economics*, 189, September 2020.

F. W. Heiland and N. Yin. Have we finally achieved actuarial fairness of social security retirement benefits and will it last? *University of Michigan Retirement Research Center (MRRC) Working Paper 2014-307*, 2014.

R. Hosseini, K. A. Kopecky, and K. Zhao. The evolution of health over the life cycle. *Review of Economic Dynamics*, forthcoming.

R. G. Hubbard, J. Skinner, and S. P. Zeldes. Precautionary saving and social insurance. *Journal of Political Economy*, 103(2):360–399, April 1995.

S. Imrohoroğlu and S. Kitao. Social security reforms: Benefit claiming, labor force participation, and long-run sustainability. *AMERICAN ECONOMIC JOURNAL: MACROECONOMICS*, 4(3): 96–127, July 2012.

R. A. Ippolito. *Pension Plans and Employee Performance*. University of Chicago Press, 1997.

L. Jacobs and S. Piyapromdee. Labor force transitions at older ages: Burnout, recovery, and reverse retirement. *Finance and Economics Discussion Series*, (2016 - 053), 2016.

J. B. Jones and Y. Li. The effects of collecting income taxes on social security benefits. *Journal of Public Economics*, 159:128–145, March 2018.

J. A. Kahn. Social security, liquidity, and early retirement. *Journal of Public Economics*, 35(1): 97–117, February 1988.

M. P. Keane. Life-cycle labour supply with human capital: Econometric and behavioural implications. *The Economic Journal*, 126(592):546–577, May 2016.

M. P. Keane and S. Imai. Intertemporal labor supply and human capital accumulation. *International Economic Review*, 45(2):601–641, May 2004.

M. P. Keane and N. Wasi. Labour supply: The roles of human capital and the extensive margin get access arrow. *The Economic Journal*, 126(592):578–617, May 2016.

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

K. A. Kopecky and T. Koreshkova. The impact of medical and nursing home expenses on savings. *American Economic Journal: Macroeconomics*, 6:29–72, 2014.

L. J. Kotlikoff and D. A. Wise. Pension backloading, wage taxes, and work disincentives. *Tax policy and the economy*, 2:161–196, 1988.

T. Laun and J. Wallenius. Social insurance and retirement: A cross-country perspective. *Review of Economic Dynamics*, 22:72–92, October 2016.

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

Z. Li. Social security: Adjustment factors for early or delayed benefit claiming. *Congressional Research Service, Report R47151*, June 2022.

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

R. L. Lumsdaine and O. Mitchell. New developments in the economic analysis of retirement. In O. Ashenfelter and D. Card, editors, *Handbook of Labor Economics*, volume 3, Part C, chapter 49, pages 3261–3307. Elsevier, 1999.

N. Maestas and J. Zissimopoulos. How longer work lives ease the crunch of population aging. *Journal of Economic Perspectives*, 24(1):139–160, Winter 2010.

N. Maestas, K. J. Mullen, and A. Strand. Does disability insurance receipt discourage work? using examiner assignment to estimate causal effects of ssdi receipt. *AMERICAN ECONOMIC REVIEW*, 103(5):1797–1829, AUGUST 2013.

I. Merkurieva. Late career job loss and the decision to retire. *International Economic Review*, 60 (1), 2019.

A. Michaud and D. Wiczer. The disability option: Labor market dynamics with economic and health risks. *Working Paper*, 2019.

A. H. Munnell and A. Chen. Are social security's actuarial adjustments still correct? Center for Retirement Research, No. 19-18, November 2019.

S. Park. A structural explanation of recent changes in life-cycle labor supply and fertility behavior of married women in the united states. *European Economic Review*, 102:129–168, 2018.

S. Pashchenko and P. Porapakkarm. Reducing medical spending of the publicly insured: The case for a cash-out option. *AMERICAN ECONOMIC JOURNAL: ECONOMIC POLICY*, 11(3): 390–426, AUGUST 2019.

S. Pashchenko and P. Porapakkarm. Accounting for social security claiming behavior. HCEO Working Paper 2019-068, 2020.

R. Rogerson and J. Wallenius. Fixed costs, retirement and the elasticity of labor supply. *Journal of Economic Theory*, 144(6):2277–2292, November 2009.

R. Rogerson and J. Wallenius. Secular changes in employment of older individuals. *NBER Macroeconomics Annual*, 36, 2021.

J. Rust and C. Phelan. How social security and medicare affect retirement behavior in a world of incomplete markets. *Econometrica*, 65(4):781–831, July 1997.

M. S. Rutledge and N. B. Coe. Great recession-induced early claimers: Who are they? how much do they lose? *Center for Retirement Research at Boston College Working Paper*, (2012-12), 2012.

T. Schirle. Why have the labor force participation rates of older men increased since the mid-1990s? *Journal of Labor Economics*, 26(4):549–594, October 2008.

Social Security Administration. The 2019 annual report of the board of trustees of the federal old-age and survivors insurance and federal disability insurance trust funds. Technical report, 2019.

H. Waldron. Heterogeneity in health and mortality risk among early retiree men. ORES Working Paper No. 105, May 2004.

B. Zhao. Too poor to retire? housing prices and retirement. *Review of Economic Dynamics*, 27, 2018.

Appendix A. Health Measures

The bulk of my model estimation is based on the 1968 to 2015 waves of the Panel Study of Income Dynamics (PSID). I also use data from the Medical Expenditure Panel Survey (MEPS) for medical spending analysis.

In MEPS, health status is measured based on self-perceived health rank, which ranges from 1 to 5, following Pashchenko and Porapakkarm (2019). The MEPS survey has three waves in each year t, and in each wave respondents rank their health as (1) *excellent,* (2) *very good,* (3) *good,* (4) *fair, or* (5) *poor*. Individuals whose health rank falls in the first three categories in all three waves are referred to people in good health ($h_t = 0$); individuals with health rank falls in the last category in any wave are referred to as disabled people ($h_t = 2$); and the rest are referred to as people in bad health ($h_t = 1$).

While the PSID has included survey questions on self-reported health rank since 1984, this measure cannot be adopted in this paper because I focus on the health dynamics for the 1930s cohort over the entire life cycle. Consequently, using the PSID survey questions on health would not be feasible. In the PSID, health and disability status is measured based on the self-reported work limitation questions from the PSID (consistent with previous literature, e.g., Low and Pistaferri (2015)). Respondents in year t report (1) *Do you have any physical or nervous condition that limits the type of work or the amount of work that you can do*? (2) *Does this condition keep you from doing some types of work*? (3) *For work you can do, how much does it limit the amount of work you can do – a lot, somewhat, or just a little*?

The possible answers to the first question are (1) Yes or (2) No; the possible answers to the second question are (1) Yes, (2) No, or (3) Can do nothing; the possible answers to the third question (after 1976) are (1) Not at all, (2) Somewhat, (3) Just a little, or (4) A lot; and the possible answers to the third question (before 1976) are (1) I can't work, (2) It limits me a lot, (3) Some, not much, or (4) Limitation, but not on work. Since the second question became available from 1986, before that, I define the health status only based on the first and third questions.

I define those who are in good health ($h_t = 0$) as anyone who reports "No" to the first question or "Not at all" to the third question; those who are in bad health ($h_t = 1$) as anyone who reports "Yes" to the first question and "Somewhat" or "Just a little" to the third question; and those who are in a disabled state ($h_t = 2$) as anyone who reports "Yes" to the first question, "Can do nothing" to the second questions, and "A lot" to the third question, which intends to meet the SSA criterion on disability insurance qualification.

The table below compares two health measures and demonstrates their consistency.

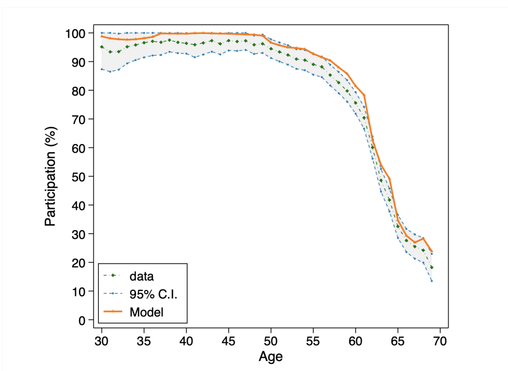
Table A.1: Health Measures Over Ages, Comparing Two Datasets

Health Measures	Ages 50-60 MEPS (%)	Ages 50-60 PSID (%)	Ages 60-70 MEPS (%)	Ages 60-70 PSID (%)	Ages 70 and older MEPS (%)	Ages 70 and older PSID (%)
Disabled	10	8.9	11.7	12.1	15	13.6
Bad health	21	9.4	23.6	14.2	28.7	11.9
Good health	69	81.7	64.7	73.7	56.3	74.5

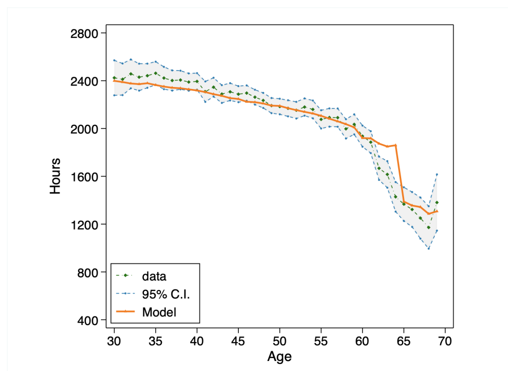
Source: Panel Study of Income Dynamics, Medical Expenditure Panel Survey, author'scalculations.

Appendix B. Supplemental Figures

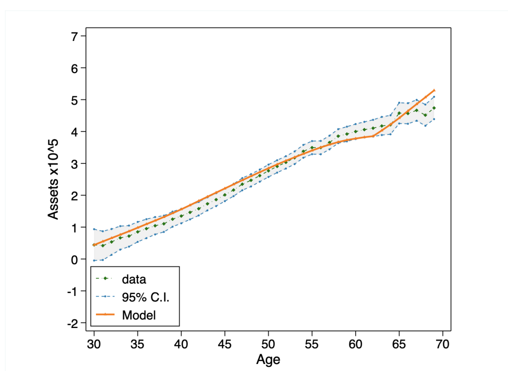
B.1. Additional Moments



(a) Labor Force Participation



(b) Hours Worked by Workers



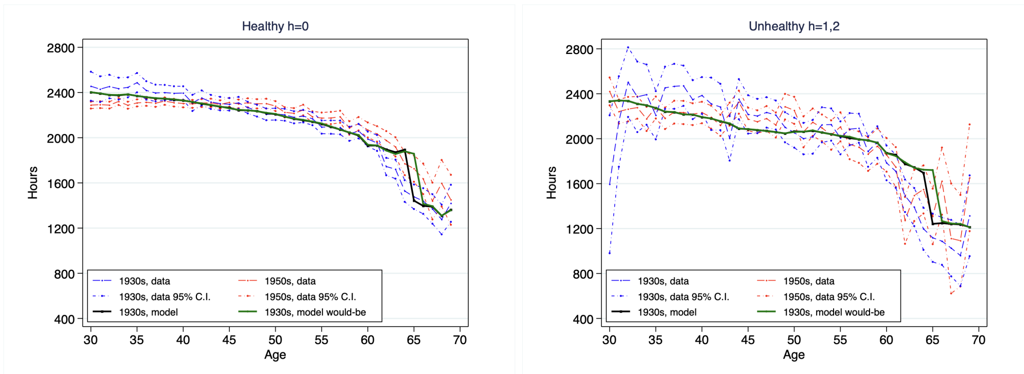
(c) Non-Pension Assets

Fig. B.1. Model v.s. Data Profiles: Additional Moments

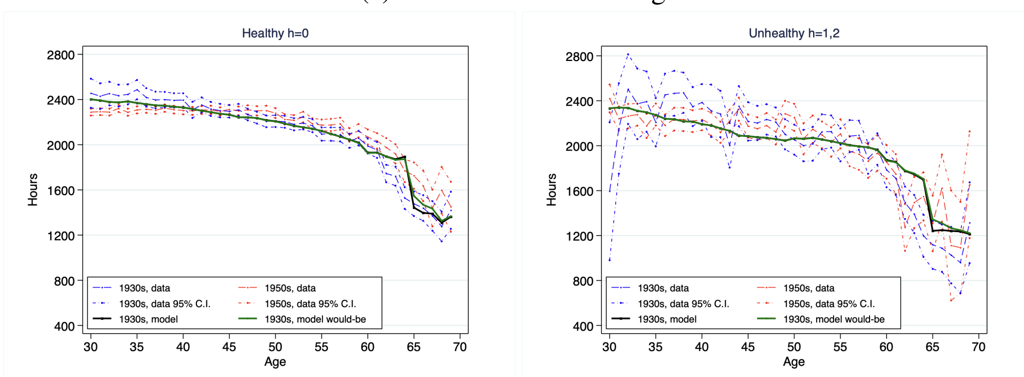
Notes: Model fit for the average profiles of labor force participation (panel a), hours worked conditional on participation (panel b), and non-pension assets (panel c). Model-generated profiles are represented by the orange lines. Data profiles with 95% confidence intervals are represented by the shaded area. Monetary values are expressed in 2016 dollars.

Data Source: Panel Study of Income Dynamics, author's calculations.

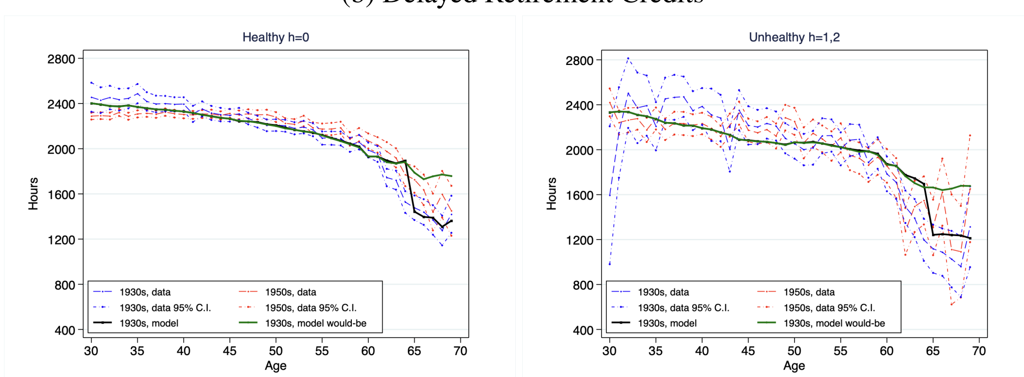
B.2. Effects of Social Security Reforms on Labor Supply



(a) Normal Retirement Age



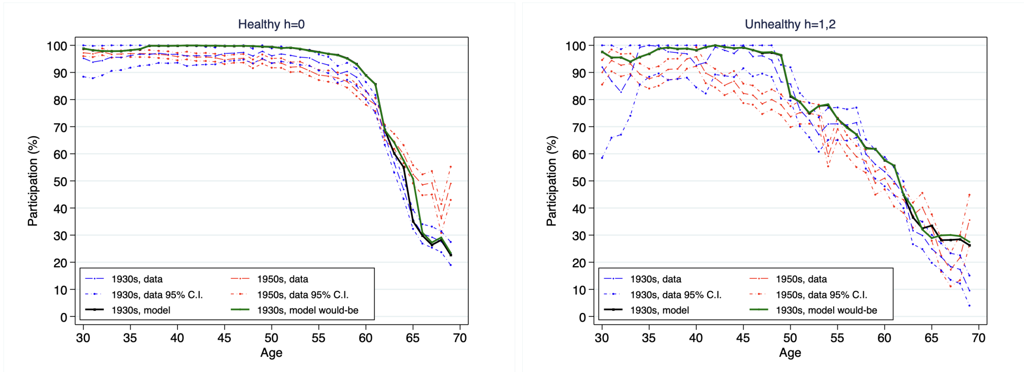
(b) Delayed Retirement Credits



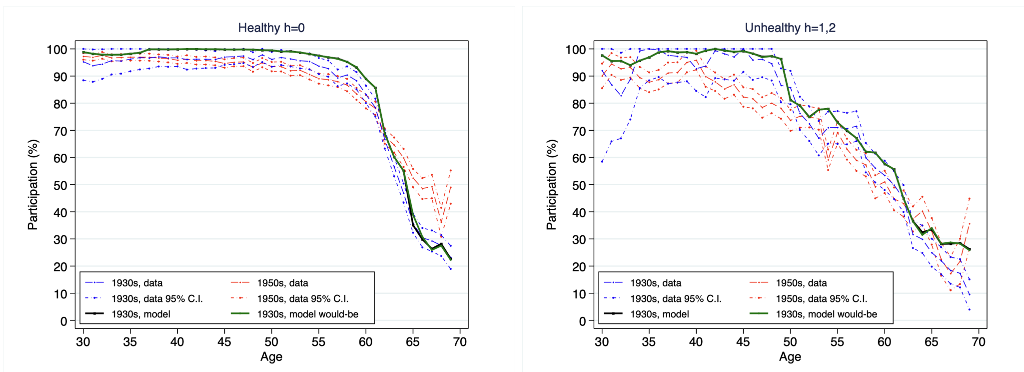
(c) Retirement Earnings Test

Fig. B.2. Model v.s. Data Profiles: Effects of Changing Social Security Rules on Hours Worked by Health Status

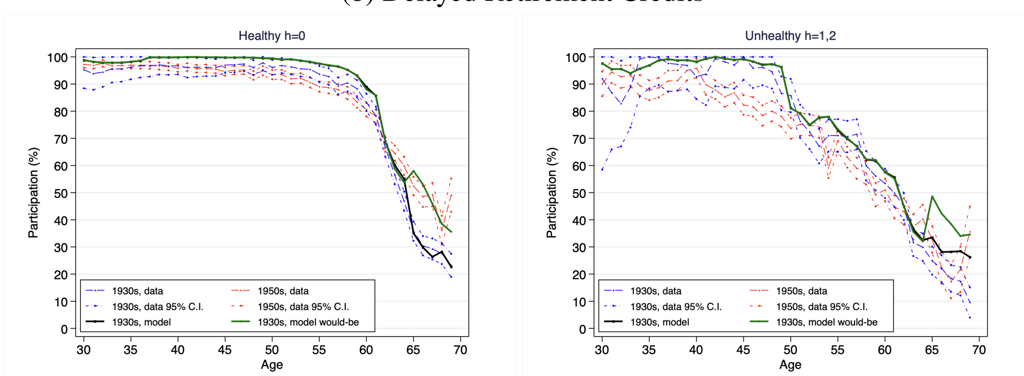
Notes: Effects of the corresponding policy changes on hours worked for healthy workers (left panels) and unhealthy workers (right panels). The black (green) lines represent the model-simulated profiles for the 1930s cohort before (after) implementing policy changes. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.
Policy Experiments: increasing the NRA from 65 to 66 (panel a); increasing the DRC from 4.5% to 8% (panel b); removing the RET from 70 to 65 (panel c).
Data Source: Panel Study of Income Dynamics, author's calculations.



(a) Normal Retirement Age



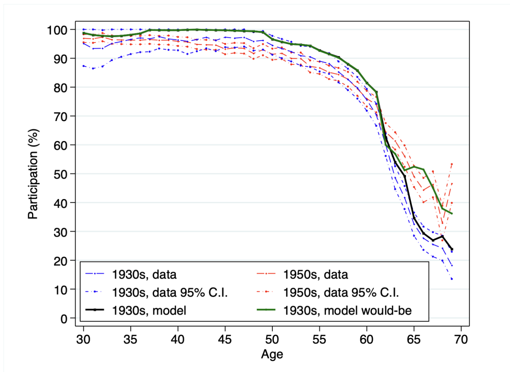
(b) Delayed Retirement Credits



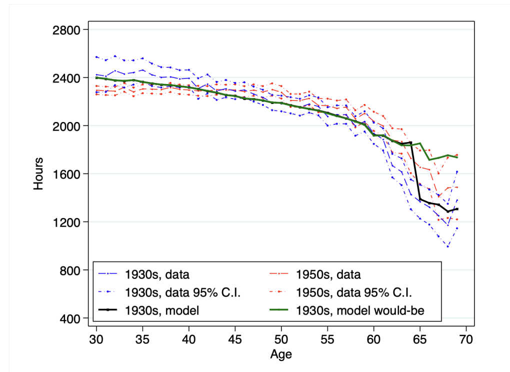
(c) Retirement Earnings Test

Fig. B.3. Model v.s. Data Profiles: Effects of Changing Social Security Rules on Labor Force Participation by Health Status

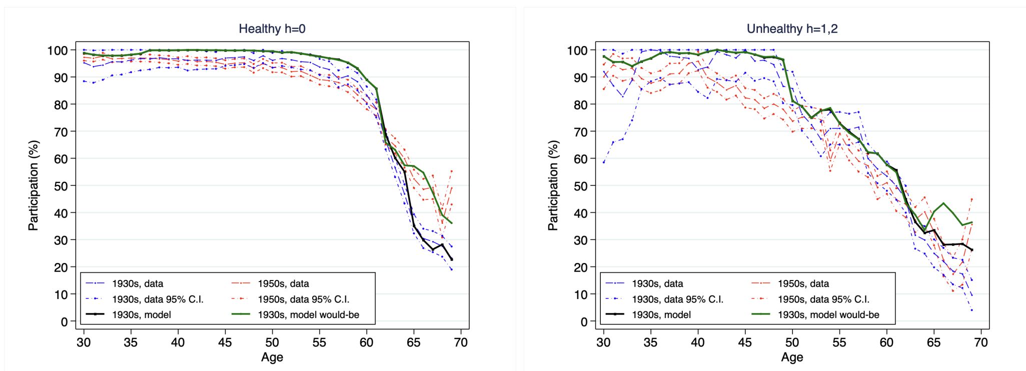
Notes: Effects of the corresponding policy changes on labor force participation for healthy workers (left panels) and unhealthy workers (right panels). The black (green) lines represent the model-simulated profiles for the 1930s cohort before (after) implementing policy changes. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.
Policy Experiments: increasing the NRA from 65 to 66 (panel a); increasing the DRC from 4.5% to 8% (panel b); removing the RET from 70 to 65 (panel c).
Data Source: Panel Study of Income Dynamics, author's calculations.



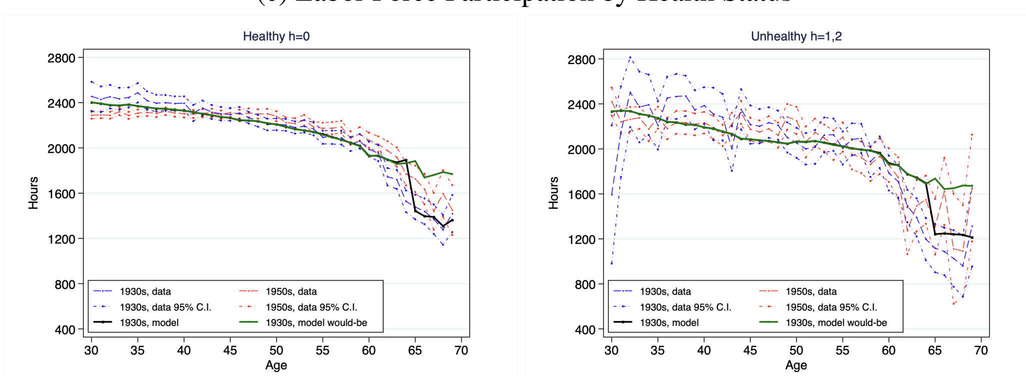
(a) Labor Force Participation



(b) Hours Worked by Workers



(c) Labor Force Participation by Health Status



(d) Hours Worked by Health Status

Fig. B.4. Model v.s. Data Profiles: Effects of Changing Three Social Security Rules

Notes: Panel a and panel b show the effects on the labor behaviors at the average level. Panel c and panel d show the effects by health status. The black (green) lines represent the model-simulated profiles for the 1930s cohort before (after) implementing policy changes. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.

Data Source: Panel Study of Income Dynamics, author's calculations.

Appendix C. Supplemental Tables

Table C.1: Social Security Rules for People Born in 1920-1960

Year of Birth	NRA (1)	DRC (%) (2)	RET (3)
1920 - 1924	65	3	70
1925 - 1926	65	3.5	70
1927 - 1928	65	4	70
1929 - 1930	65	4.5	70
1931 - 1932	65	5	70
1933 - 1934	65	5.5	70
1935 - 1936	65	6	NRA
1937	65	6.5	NRA
1938	65 and 2 months	6.5	NRA
1939	65 and 4 months	7	NRA
1940	65 and 6 months	7	NRA
1941	65 and 8 months	7.5	NRA
1942	65 and 10 months	7.5	NRA
1943 - 1954	66	8	NRA
1955	66 and 2 months	8	NRA
1956	66 and 4 months	8	NRA
1957	66 and 6 months	8	NRA
1958	66 and 8 months	8	NRA
1959	66 and 10 months	8	NRA
1960 or Later	67	8	NRA

[1] Abbreviation: NRA = Normal Retirement Age; DRC = Delayed Retirement Credit (%); RET = Retirement Earnings Test.

[2] Notes: Columns 1 and 2 report the normal retirement age and delayed retirement credits faced by individuals in each birth cohort. Column 3 reports the age that the retirement earnings test is removed.

[3] Source: Social Security Administration.

Table C.2: Changes in Disability Benefit Program Across Cohorts

	Income Threshold		Disability Rolls		Moral Hazard			
	Overall y_{db}		Disabled $\pi^{db}_{h=2}$		Healthy $\pi^{db}_{h=0}$		Bad Health $\pi^{db}_{h=1}$	
Age	40-50 (1)	50-65 (2)	40-50 (3)	50-65 (4)	40-50 (5)	50-65 (6)	40-50 (7)	50-65 (8)
1930s	0	3600	0	0.63	0	0.014	0	0.16
1950s	4125	4125	0.33	0.58	0.003	0.013	0.09	0.15

Data Source: Panel Study of Income Dynamics, author's calculations; Social Security Administration.

Appendix D. Effects of Non-Social-Security Changes

D.1. Effects of Reducing Mortality Ratess

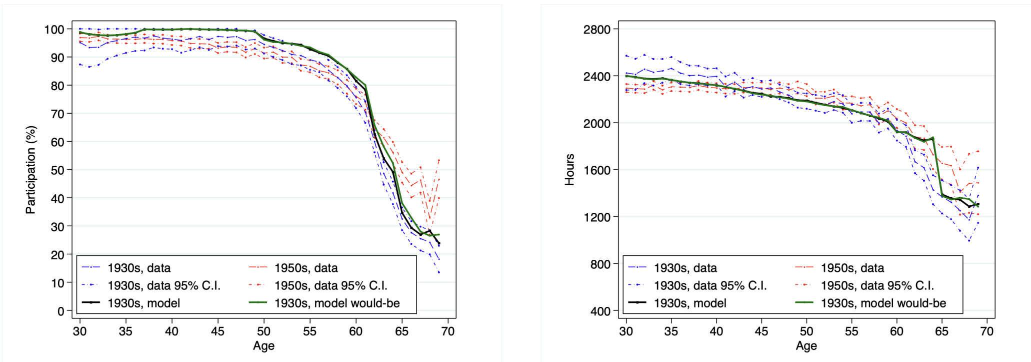


Fig. D.1. Model v.s. Data Profiles: Effects of Decreasing Morality Rates

Notes: The effects reducing mortality rates on labor force participation and hours worked by workers at the average level. The black (green) lines represent the model-simulated profiles for the 1930s cohort before (after) reducing mortality rates by 25% for 50+. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.

Data Source: Panel Study of Income Dynamics, author's calculations.

D.2. Effects of Changing Health Dynamics

Health dynamics change across cohorts. Figure D.2 (left panel) shows the age-specific probabilities of transitioning from good health $Pr(h_t|h_{t-1} = 0)$ to good health, bad health, or disability status for individuals born in the 1930s (solid lines) and the 1950s (dashed lines). Compared to the older cohort, individuals born in the 1950s have higher probabilities of staying in good health and lower probabilities of transitioning to bad health or disability over the life cycle. As a result, relative to the 1930s cohort, the fraction of individuals in good health is higher, and the fraction of people with disability is lower in the 1950s cohort, as seen in Figure D.2 (right panel).

Figure D.3 compares the model-simulated changes in labor force participation and hours per worker over the life cycle with the actual data profiles across the 1930s and 1950s cohorts. The improvement in health dynamics leads to increases in labor participation at prime working ages and hours worked at older ages. On average, it increases the participation rates and hours worked of workers ages 60-69 by a 0.7 p.p. and 2.4%, respectively.

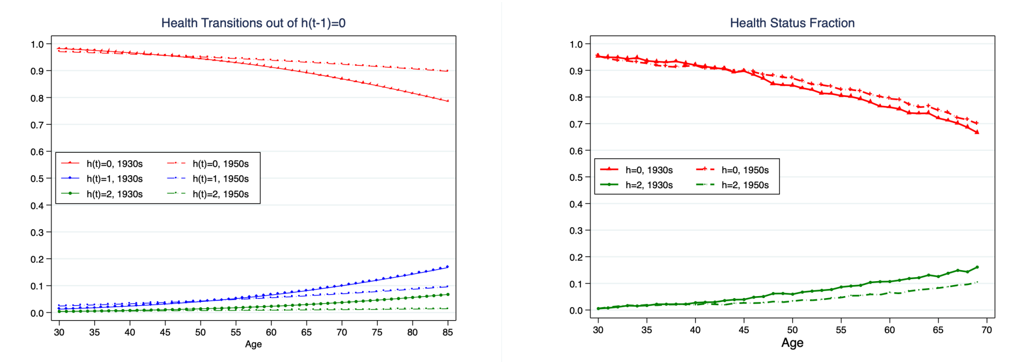


Fig. D.2. Health Dynamics Across Cohorts

Notes: The solid lines (dashed lines) indicate probabilities/fraction for the 1930s (1950s) cohort. Left panel: The red line shows the transition probabilities from good health to good health. The blue line shows the transition probabilities from good health to bad health. The green lines show the transition probabilities from good health to disabled state. Right panel: The red (green) lines show the fraction of individuals in good health (disabled state).

Source: Panel Study of Income Dynamics, author's calculations.

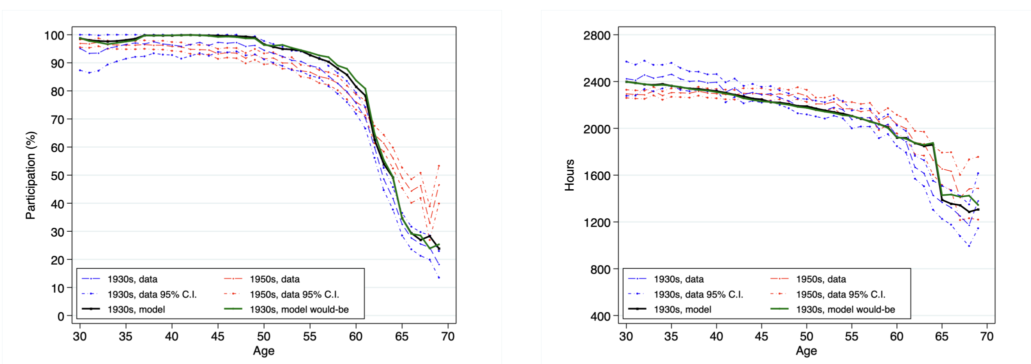


Fig. D.3. Model v.s. Data Profiles: Effects of Changing Health Dynamics

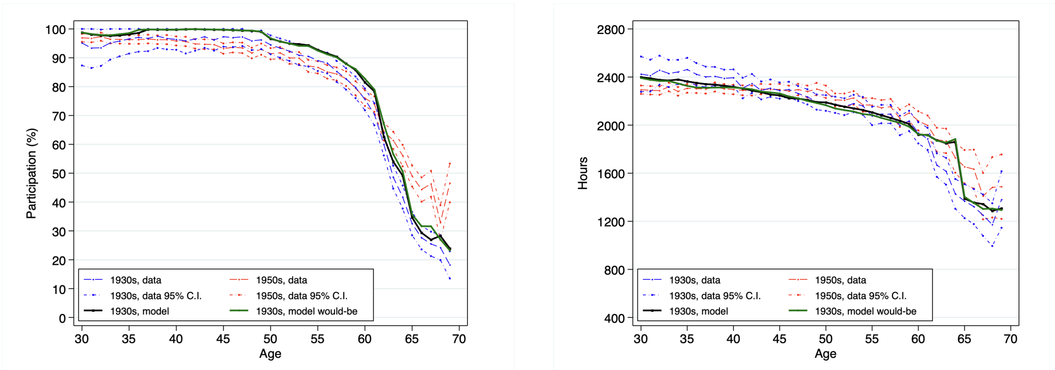
Notes: The effects on the labor force participation and hours per worker at the average level. The black (green) lines represent the model-simulated profiles for the 1930s cohort before (after) implementing new health dynamics. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.

Data Source: Panel Study of Income Dynamics, author's calculations.

D.3. Effects of Changing Marginal Taxes

The progressive income tax system changes over time for a specific age group, resulting in variations in the marginal tax rates faced by different cohorts. Using estimated tax rates from Borella et al. (2019a), I replace the income tax rates of the 1930s cohort with those of the 1950s cohort, and I simulate their impact on labor behaviors for the 1930s cohort when facing tax changes.

Figure D.4 illustrates the effects of changing income tax rates on labor force participation and hours worked throughout the life cycle. The results show that the impact of changing marginal income tax rates is not significant, with a 1.65 p.p. increase in participation rates and a 0.03% increase in annual hours worked for workers aged 60-69.



(a) Labor Force Participation

(b) Hours Worked by Workers

Fig. D.4. Model v.s. Data Profiles: Effects of Changing Marginal Tax Rates

Notes: The effects on the labor behaviors at the average level. The black (green) lines represent the model-simulated profiles for the 1930s cohort before (after) implementing new marginal tax rates on income. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.

Data Source: Panel Study of Income Dynamics, author's calculations.

D.4. Effects of Changing National Wage Index

According to Social Security Advisory Board, when calculating the retirement benefits, an individual's earnings up to two years before eligibility (currently age 60) are indexed to average wage growth, using national wage growth index (NWG). That is to ensure the benefits reflect the general rise in the standard of living that occurred during the working years.

When modeling Social Security benefits, the AIME has already been adjusted for inflation using the personal consumption expenditure index (PCE) through wages. However, differences exist in the national wage growth index experienced by 1930s and 1950s cohorts. Figure D.5 displays the ratios of NWG over PCE across cohorts and revealing that, compared to PCE, NWG is higher at younger ages and for the older cohort. For example, at age 60 (the base year of the index adjustment), the NWG-adjusted labor income at age 30 is 1.5 times higher than the PCE-adjusted income, but for the 1950s cohort, it is 1.3 times higher.

I use the model to estimate the effects of different NWG-PCE gaps between the two cohorts on the labor dynamics. First, I simulate my model with the AIME adjusted using the NWG-PCE ratio to reflect the NWG adjustment on retirement benefits for the 1930s cohort. Then, I replace the ratio with the one faced by the 1950s cohort and simulate the model to get the labor responses.

The results are presented in Figure D.6. Due to lower NWG-PCE ratio at younger ages, the 1950s cohort accumulates lower AIME compared to the 1930s cohort, leading them to work more on the participation margin. Specifically, it increases the participation rates and hours worked of workers at ages 60-69 by 3 p.p. and 0.69%, respectively.

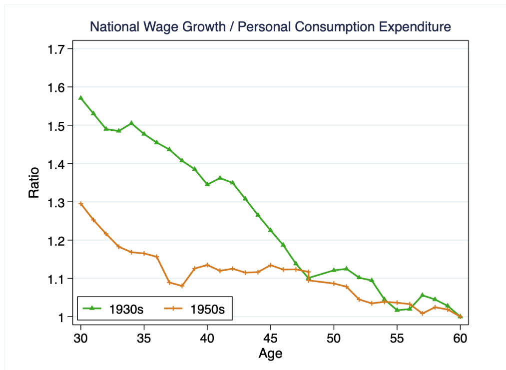
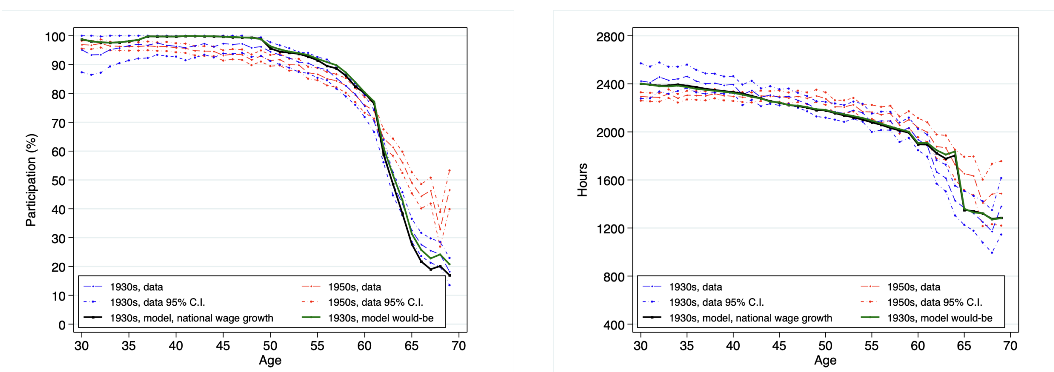


Fig. D.5. Ratio of National Wage Growth Index over Personal Consumption Expenditure Price Index Across Cohorts

Notes: The green (orange) line indicates the corresponding ratio for the 1930s (1950s) cohort.
Source: Personal Consumption Expenditure Price Index are from FRED Federal Reserve Economic Data; National Wage Growth Index are from Social Security Administration



(a) Labor Force Participation

(b) Hours Worked by Workers

Fig. D.6. Model v.s. Data Profiles: Effects of Changing National Wage Growth Index

Notes: The effects on the labor behaviors at the average level. The black (green) lines represent the model-simulated profiles for the 1930s cohort after adjusting Social Security wealth using the ratio for the 1930s (1950s) cohort. The blue (red) dashed lines represent the data profiles with 95% confidence intervals for the 1930s (1950s) cohort.
Data Source: Panel Study of Income Dynamics, author's calculations.