The Welfare Costs of Misinformation

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February 6, 2024

Abstract

Social Security (SS) benefits, with an average replacement rate of around 40 percent, serve as an important source of retirement income for older Americans. Yet, the size of lifetime benefits a household receives depend on a myriad of factors, including the age of benefit claim and labor supply decisions. Given the complexity of the associated rules, many households may lack understanding of one or more aspects of the system. In this work, we use a life-cycle model of consumption, savings, labor supply, and Social Security application decisions to study the welfare impact of such misinformation. Our findings indicate significant welfare losses stemming from misinformation, especially when it causes individuals to strongly over-estimate the value of future entitlements. Additionally, we show that the *Social Security Statement* program, a large public information campaign, must inform only 5.5 percent of misinformed individuals in order for aggregate benefits of information to outweigh aggregate costs.

Keywords: Retirement, Social Security, Misinformation, Life-Cycle

JEL Classification Numbers: J14, J26, E21, H55

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1 Introduction

Throughout their lifetimes, individuals are confronted with many intricate financial choices, with retirement planning being one of the most important considerations. Nevertheless, there is a noticeable deficit in financial awareness among the elderly, as only a quarter of those above the age of 65 exhibit proficiency in financial decision-making (Lusardi and Mitchell, 2014). Earlier studies (Lusardi and Mitchell, 2007a,b, 2011; Poterba et al., 2013) have illustrated a connection between the capability to make informed decisions—attributed to either financial acumen or education—and enhanced retirement preparation, leading to increased retirement assets. These assets may be derived from personal savings or the Social Security system.

Over half of the population aged 65 and above primarily rely on Social Security for their income, with nearly a quarter depending on it for more than 90 percent of their income (Dushi et al., 2017). Given the pivotal role these benefits play in the financial planning of households, the well-being of older individuals post-retirement hinges significantly on the magnitude of these benefits. Nonetheless, the intricate regulations of the Social Security program, coupled with prevalent misconceptions about them, can cause individuals to miscalculate their anticipated benefits. Recent studies Bairoliya and McKiernan (2022); Shoven et al. (2017); Liebman and Luttmer (2011) underscore the influence of information (or the lack thereof) pertaining to Social Security rules on retirees' decision-making processes. Yet, there is a lingering question about the repercussions of these misjudgments on the welfare of retirees, especially when considering the heavy dependence of many on Social Security benefits. In our research, we aim to quantify the potential welfare implications arising from such misinformation.

In our study, we focus on three specific provisions of the U.S. Social Security System: the methodology for benefit calculation, the adjustments in benefit amounts based on the age of claim, and the retirement earnings test. Using data from the Understanding America Study, we highlight two findings related to these rules. First, there is a pervasive lack of accurate information regarding these rules. Roughly 90 percent of males have misconceptions about at least one of these. It is essential to note, however, that misconceptions vary among these individuals; having incorrect beliefs does not imply uniformity in misunderstanding. Secondly, we identify a linkage between these rules in terms of misunderstanding. Individuals who misinterpret one provision are often likely to also hold misconceptions about another. Specifically, of those who respond incorrectly to at least one question, more than half get two or more questions wrong.

In order to quantify the welfare impacts of misbeliefs about these program rules, we use a structural model of consumption, savings, labor supply, and Social Security benefit claiming. This work – grounded in the conceptual framework and estimation method developed in Bairoliya and McKiernan (2022) – accounts for a variety of misinformation sources concerning the Social Security program and comprehensively evaluates their effects on savings and labor decisions throughout an individual's life. Specifically, misinformed views of a particular aspect of the program (or a combination of rules) shape behaviors of the economic agents over the life-cycle, and the true nature of these rules are revealed only once workers claim their benefits. Since the benefit claim is an irreversible decision, misinformation may result in mistakes leading households to permanently receive lower pension benefits or have under- or over-saved through their lives. As a result, misinformation driven mistakes are potentially costly for households. Under "complete information" about these rules, workers make optimal decisions about savings, labor supply, and Social Security claiming, resulting in potential welfare gains from any information campaign.

Incorrect interpretations of these program rules can differentially affect household saving behaviors and labor supply choices. For instance, when workers in the model wrongly believe in a 100 percent retirement earnings test – where all retirement benefits are essentially clawed back – they tend to underestimate their prospective Social Security retirement benefits. This group, compared to their fully-informed counterparts, tends to accumulate more assets which result in higher consumption and bequests later in life, albeit at the cost of lower consumption at younger ages. On the other hand, assumptions of retirement benefits acting as a full replacement for average lifetime earnings, despite the actual replacement rate ranging between 15 to 90 percent, lead to inflated anticipations of future retirement benefits. This miscalculation results in lower savings during their working years, leading to reduced consumption and smaller bequests in late-life compared to their fully informed counterparts.

These impacts of misbeliefs on life-cycle savings, consumption, and labor supply decisions translate into significant impacts on welfare. First, when we focus on how misinformation changes life-cycle consumption and leisure decisions, we find welfare costs (measured as CEV) that range between 0.02 percent of consumption and 3.16 percent of consumption. The largest welfare losses arise in scenarios, such as misconceptions surrounding benefit computations, where a misinformed worker's anticipated future benefits starkly contrast with the actual benefits dispensed. Furthermore, given the influence of misinformation on asset accumulation and bequests, we incorporate the utility derived from end-of-life bequests into our welfare considerations. In scenarios where misbeliefs related to program rules induce augmented savings, the resultant elevated bequest levels mitigate the welfare setbacks—or even flip them into gains. Conversely, when misinformation results in diminished savings relative to well-informed counterparts, the associated reductions in assets and bequests exacerbate the welfare losses.

As our structural model allows us to quantify the welfare costs of several forms of misbeliefs related to Social Security rules, we are uniquely positioned to conduct a cost-benefit analysis of an existing program aimed at informing individuals about the true nature of these rules. Starting in 1995, the Social Security Administration (SSA) began sending the Social Security Statement –

a document intended to inform individuals about their personal earnings history, Social Security taxes paid, expected benefits, and additional information related to the Social Security program. Using information from the Justification of Estimate to the Appropriation Committee that is prepared by the SSA, we estimate that the government pays between $1.49 and $4.08 to operate the system as currently set up–to provide the statement online each year until age 60 and paper statements from age 60 until workers claim Social Security benefits. Additionally, it would cost the government between $11.99 and $14.58 to mail a Social Security Statement annually to each worker over age 25. Comparing this with an average welfare gain of 1.1 percent or $268.37 of average annual consumption, indicates that the welfare gains from sending statements far outweigh the costs (either mailed or online). However, this average welfare impact masks heterogeneity in the willingness to pay across different types of misinformation where this number ranges $5.82 to $758.51.

At an individual level, for a majority of agents in the model, the costs of providing information are far lower than the benefits. However, the aggregate analysis assumes that the information program – in this case, the Social Security Statement program – is able to perfectly inform individuals. The aggregate benefits of information are increasing in the share of individuals that go from being misinformed to fully informed. The aggregate costs, however, are nearly stable. Under the assumption that the government is not able to target information based upon beliefs, the cost incurred are a function of only the total population of individuals who have not yet claimed benefits. We find that in order for the aggregate benefits of the Social Security Statement program to exceed the costs to run it, this campaign must be able to inform only between 1.7 and 5.5 percent of misinformed individuals.

Our work contributes to several strands of the existing literature. First, we contribute to the literature using structural life-cycle models of consumption, savings, and retirement to study questions at the intersection of labor economics and public policy. Among these papers are Fan et al. (2022); Jones and Li (2020); Bairoliya (2019); Borella et al. (2019); De Nardi et al. (2010); Imrohoroglu and Kitao (2012); Yu (2022); French and Jones (2011); Hubener et al. (2016); Rust and Phelan (1997); Van der Klaauw and Wolpin (2008); French (2005); Hosseini et al. (2021); Scholz and Seshadri (2011); Bairoliya et al. (2023). We add to this literature by modeling the important role of misbeliefs related to the complicated rules of the Social Security system. By including these misbeliefs in such a model, we also contribute to a large literature studying the well-known retirement-consumption puzzle (Aguiar and Hurst, 2005; Banks et al., 1998; Hurd and Rohwedder, 2003; Haider and Stephens Jr, 2007). We add to this literature by highlighting that misinformed views of the Social Security system can result in non-optimal timing of retirement. Such mistakes in projecting retirement benefits could result in unanticipated, and discontinuous, consumption changes at older ages.

Second, we contribute to the literature highlighting both the issues of financial literacy as well as planning for retirement: both empirically and theoretically. Empirical work, including Ameriks et al. (2003); Lusardi (2003); Lusardi and Mitchell (2007a,b, 2011, 2014); Lusardi et al. (2017); Lusardi and Mitchell (2023); Hurst (2003), have highlighted that not only do many households arrive at retirement without sufficient savings and but also that education and the costs of thinking about retirement may lead to this outcome. Structural work (Bucciol (2011); Hunt et al. (2022); Findley and Caliendo (2009, 2015); Park and Feigenbaum (2018); Feldstein (1985); Docquier (2002)) has used behavioral techniques or limited planning horizon models to understand these household behaviors. We contribute to this literature by identifying that these behaviors may be a result of households who make decisions as a function of incorrect information about the rules of the Social Security system.

Finally, we contribute to an exciting and relatively new literature related to the impact of limited information and expectations on household behavior (Bachmann et al., 2022). Studies on this have ranged from the impact of expectation about inflation (Pilossoph and Ryngaert, 2022; Coibion et al., 2023a,b; Bachmann et al., 2015; Duca-Radu et al., 2021; Burke and Ozdagli, 2021; D'Acunto et al., 2016; Crump et al., 2021; Hajdini et al., 2022; Ryngaert, 2022; Ichiue and Nishiguchi, 2015), future earnings (Caplin et al., 2023; Attanasio and Kaufmann, 2009), mortality (O'Dea and Sturrock, 2018; Bairoliya and McKiernan, 2022), and policies (Gustman and Steinmeier, 2005, 2012; Craig and Slemrod, 2022; Koşar and O'Dea, 2022). We contribute to this literature by focusing on the specifics beliefs about various pension rules and studying their impact on behavior and welfare.

2 Empirical Analysis

In this section we ask the question: do people understand the rules of Social Security? Using the Understanding America Study, we establish the prevalence of misinformation related to three parts of the Social Security system: the benefit calculation, the adjustments made based upon the claiming age, and the retirement earnings test. We show that while there is variation in the share of the population who are misinformed across these three rules, misinformation–to varying degrees–is common. Only slightly over 10 percent of individuals answer all questions correctly. However, there is often variation in what misinformed individuals believe; not all misinformed individuals have the same expectations of how the system works. Finally, we show that there are interactions between misinformation of various rules; among those who answer at least one question incorrectly, almost 60 percent answer two or all three questions incorrectly.

Fact #1: Misinformation is common, but not all misinformation is the same

Benefit Calculation

The United States Social Security system provides a flow of retirement income starting at the time of claiming and continuing until the death of the beneficiary. A worker's benefits are a progressive function of their average indexed monthly earnings–an average of their highest thirty-five years of earnings. Up to a maximum taxable amount, higher income during an individual's working life translates to higher benefits during retirement. However, the progressivity of the formula means that high income individuals receive lower replacement rates on their earnings than lower income workers.

Figure 1: Misinformation about the Social Security Benefit Calculation

Notes: Question asks "Which of the following best describes how a worker's Social Security benefits are calculated? They are based on...". Green bar denotes the correct answer. Additional details in Section A.2

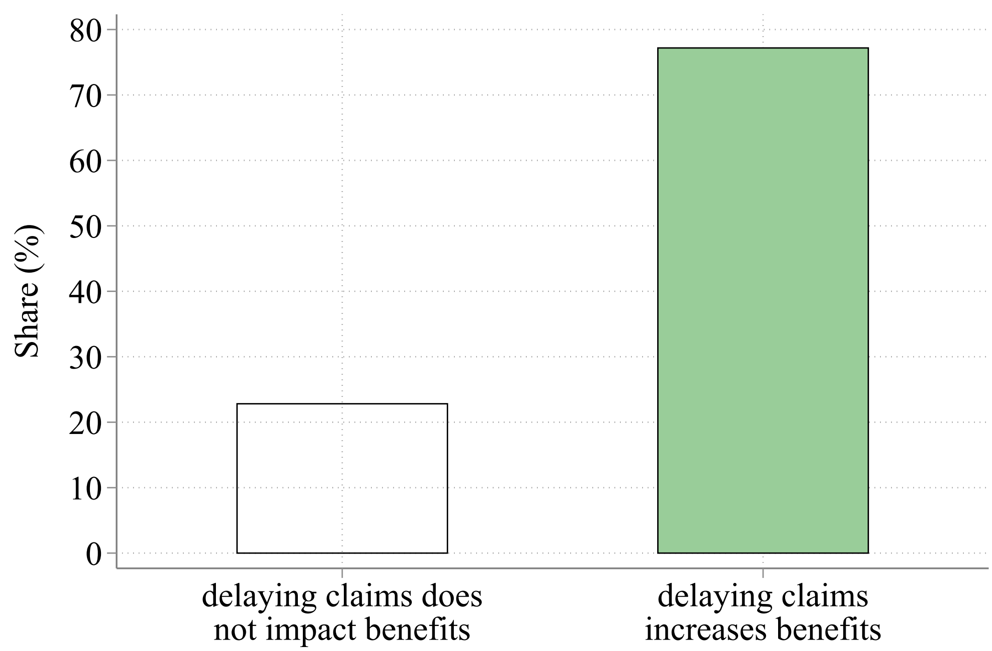
Figure 1 shows the beliefs of workers related to this benefit calculation. When asked what the calculation of SS benefits is based on, slightly more than 30 percent of individuals answered correctly: they are based upon the highest 35 years of earnings. However, nearly 70 percent of workers answered incorrectly. Slightly over 30 percent believe these benefits are a function of their earnings immediately prior to retirement while an additional 30 percent thinks they are a function of the Social Security taxes they have paid throughout their working lives.[1]

[1]Appendix A shows how these shares vary by education, marital status, and age.

Adjustments for Claiming Age

Individuals first become eligible for reduced benefits at the early retirement age (ERA) of 62 and eligible for full benefits at the normal retirement age (NRA). Claiming Social Security benefits before the NRA entails lower pension payments for a longer period of time. Delaying pension claims until beyond the normal retirement age (up until age 70) entitles workers to larger pension payments, albeit for a shorter period of time.

Figure 2: Misinformation about the Adjustment for Claiming Age



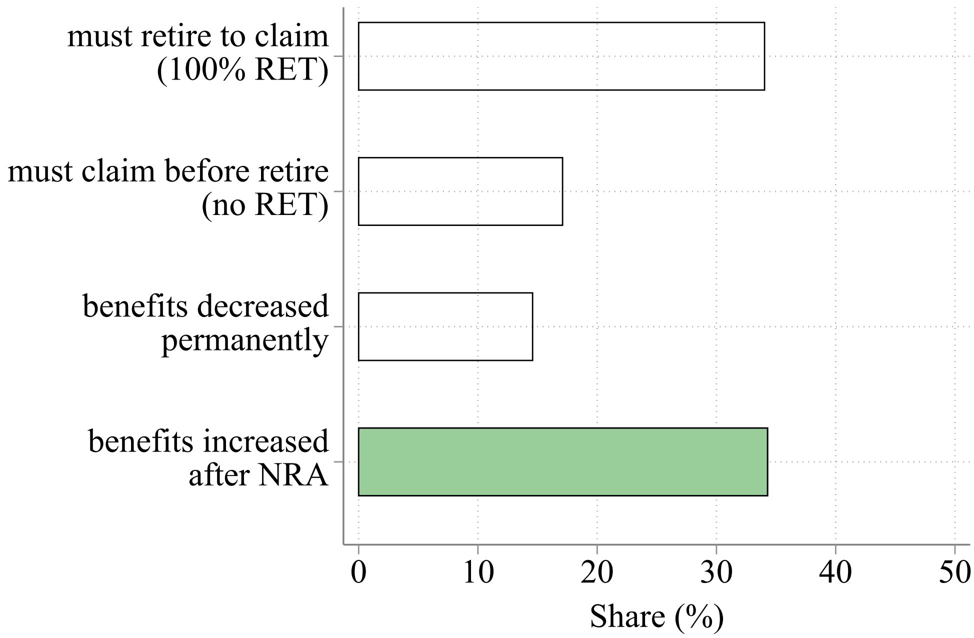
Notes: Question asks ”How much should one expect his monthly benefit to be if he decides to wait to claim at age 64 rather than age 63?” Green bar denotes the correct answer. Additional details in Section A.2

Figure 2 shows how workers respond when asked how the size of benefits received changes if claiming is delayed from age 63 to age 64. While both of these ages are below the normal retirement age and thus entail a penalty, claiming at age 64 is associated with a smaller penalty and benefits that are about 6 percent larger. Those who answer this question are separated into those who do not believe there is any change in benefits (around 20 percent) and those who understand that the size of benefits varies by claiming age (around 80 percent).

Retirement Earnings Test

The United States Social Security system allows workers to continue to work after claiming benefits: retirement and benefit claiming are distinct decisions. However, if a worker continues to earn labor income after claiming SS benefits, the retirement earnings test may apply. If labor earnings exceed a threshold, benefits are withheld. These withheld benefits are returned to the individual through higher benefit payments after he or she reaches the normal retirement age.[2]

Figure 3: Misinformation about the Retirement Earnings Test



Notes: Results are compiled from two questions. The first question asks "Based on Social Security guidelines, what is the relationship between the age at which you stop working and the age at which you can begin claiming benefits?" The second question asks "Which of the following aspects of the Retirement Earnings Test is also true?" Green bar denotes the correct answer. Additional details in Section A.2

Similar to the other rules, misinformation about the retirement earnings test is widespread. Only around 35 percent of workers (shown in Figure 3) understand that while claiming benefits and working may lead to withheld benefits, these benefits are returned in the future as benefits are increased after the NRA. The types of misinformation vary widely. There are those who misunderstand that retirement and claiming are separate decisions; over 30 percent believe one must retire in order to claim while are 15 percent believe one must claim before retiring. Among those who understand the presence of the RET, workers are different based on whether they understand what happens to withheld benefits. Over 10 percent of workers believe these benefits are never returned.

Given the complexity of the rules, it is unsurprising that many individuals answer these questions incorrectly. However, not all individuals who are incorrect have the same beliefs about how

[2]There have been changes to the retirement earnings test over time. Prior to the year 2000, the retirement earnings test applied all the way up until age 70.

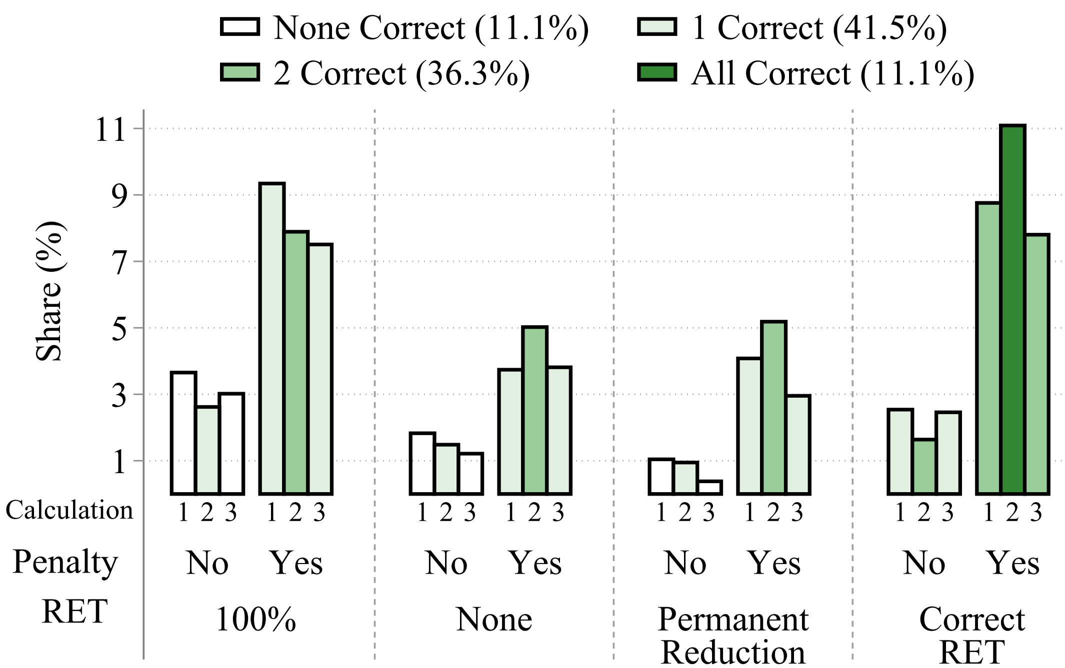
the system calculation benefits or how the retirement earnings test works. Some workers understand that their retirement benefits are based upon their earnings but do not understand that earnings over the life-cycle contribute; Other workers do not understand that their benefits are a function of earnings and believe that the taxes they pay are returned as benefits. Similar lessons appear with the retirement earnings test. Some workers do not understand the existence of the earnings test while others only misunderstand the details of how benefits withheld due to the earnings test are returned to them. In other words, answering these questions incorrectly does not imply unanimity in these incorrect beliefs.

Fact #2: Misinformation of one rule often implies misinformation of another

Our work highlight three key parts of the Social Security rules: benefit calculation, adjustments for claiming age, and the retirement earnings test. Not only do many individuals not understand these rules completely, but those who are incorrect about one rule are often incorrect about another. Figure 4 shows how the population is distributed across these information types with each bar representing a combination of beliefs over these three rules. The highlighting in this figure represents how many of the rules this group understands with a white bar indicating individuals who answered all three rules incorrectly and darker bars representing understanding of additional rules. Only around 11 percent of the population answers all three questions correctly. Additionally, this figure highlights that nearly 90 percent of workers answer at least one question incorrectly while over 50 percent are misinformed about at least two of the rules studied.

Table 1 shows in additional detail how misinformation about one rule is associated with a higher change of being misinformed about another rule. For example, 36 percent of the population are informed about the benefit calculation but this share is only 29 percent and 35 percent among those who also have misbeliefs about the claiming age adjustment and earnings test, respectively. On the other hand, the table also highlights that those who are correct about one rule are slightly more likely to be correct about other rules. Among workers who are informed about the claiming age adjustments or the retirement earnings test, 37 percent of workers are also informed about the benefit calculation–slightly more than the 36 percent who are informed in the overall population.

Figure 4: Distribution across Misinformation Type and Intensity of Misinformation



Notes: Figure shows the share of the population with various combinations of misinformation. Darker green color represents lower intensity of misinformation (being informed along more dimensions). For the categories of benefit calculation: 1. benefits based on earnings 1-5 years prior to retirement, 2. benefits based on the average of earnings in your highest 35 earning years, 3. benefits based on the Social Security taxes paid throughout the working life. Percentage in parentheses on the legend shows the total share of that type.

Table 1: Interactions between Types of Misinformation

		Benefit Calculation			Claiming Age Adjustment		Retirement Earnings Test			
		1-5 years prior	highest 35 earning years	SS taxes paid	No Penalty	Accurate Penalty	100% RET	No RET	Benefits permanently reduced	Future Benefits Increased
Unconditional Share		0.350	0.359	0.291	0.228	0.772	0.340	0.171	0.146	0.343
Conditional Share										
Benefit Calculation	1-5 years prior	1.00	—	—	0.259	0.741	0.372	0.159	0.146	0.323
	highest 35 earning years	—	1.00	—	0.186	0.814	0.293	0.181	0.171	0.355
	SS taxes paid	—	—	1.00	0.243	0.758	0.361	0.172	0.114	0.352
Claiming Age Adjustment	No Penalty	0.397	0.293	0.310	1.00	—	0.407	0.198	0.104	0.291
	Accurate Penalty	0.336	0.378	0.286	—	1.00	0.321	0.163	0.158	0.358
Retirement Earnings Test	100% RET	0.382	0.309	0.309	0.273	0.727	1.00	—	—	—
	No RET	0.326	0.381	0.294	0.265	0.735	—	1.00	—	—
	Benefits permanently reduced	0.351	0.420	0.229	0.162	0.838	—	—	1.00	—
	Future Benefits Increased	0.330	0.371	0.299	0.194	0.807	—	—	—	1.00

Notes: Unconditional shares represent the fraction of the population who hold a given belief. Conditional shares report the fraction of the population who holds a given belief conditional on holding another. For example, the share of the population who believe there is no penalty conditional on already believing that benefits are based upon SS taxes paid.

3 Quantitative Framework

We take the framework developed in (Bairoliya and McKiernan, 2022) to understand the role of several types of misinformation about SS rules in shaping life-cycle behaviors. We choose our baseline to reflect the world of a fully informed individual.[3] In Section 5, we will run counterfactual experiments in which we modify several aspects of the information set of the agents in their decision making process.

3.1 Environment

Individuals' life cycle from ages $t = 25, 26, ..., 99$ is modeled. Individuals are heterogeneous with respect to both permanent and evolving states. Agents are permanently different with respect to their fixed education type (e), and marriage (q). Marriage is summarized by a pair $q = (m, \iota)$ where m is a variable indicating if the agent is single or married and ι denotes the age gap between spouses if the individual is married. Evolving states include stochastic labor productivity (η_t), employment status (λ_t), health status (μ_t), assets (a_t), Social Security wealth (a_t^{ss}) and application status (b_{t-1}^{ss}). Given this vector of states $\left(e, q, \eta_t, \lambda_t, \mu_t, a_t, a_t^{ss}, b_{t-1}^{ss}\right)$, individuals choose optimal labor supply (h_t), consumption (c_t), savings (a_{t+1}) and Social Security benefit application (b_t^{ss}) (if eligible) to maximize the present discounted value of life-time utility. They respond to future uncertainty pertaining to employment, wages, health status, and survival. The dynamic programming model has various components. The following sections describe each model ingredient in detail.

3.2 Preferences

Agents in period t derive utility from consumption c_t and leisure l_t. The within period utility is non-separable between the two and is given as follows.

$$U^{e,m}(c_t, l_t) = \frac{1}{1-\rho}\left(\left(\frac{c_t}{\zeta_t^{e,m}}\right)^{\nu} l_t^{1-\nu}\right)^{1-\rho}$$

Where ρ is the coefficient of relative risk aversion and ν is the weight on consumption. $\zeta_t^{e,m}$ is the equivalent scale in consumption which is permitted to vary by both education (e) and marital status (m). Note that that the utility of married households is also multiplied by two to account for

[3] It is worth noting that an alternative approach could involve constructing a baseline with a combination of misinformed views held by agents in practice. However, this would make it difficult to analyze the role played by each type of misinformation on agent's economic decisions as well as welfare.

spousal utility from consumption and leisure. The total amount of leisure in period t is given by:

$$l_t = \bar{l}^{e,m} - h_t - \phi_P^{e,m}(t)\mathbb{I}\{h_t > 0\} - \phi_H^{e,m}(\mu_t, t) \tag{1}$$

Where $\bar{l}^{e,m}$ is the total endowment of leisure each period, h_t is hours worked, function $\phi_H^{e,m}$ determines the amount of leisure lost due to a bad health shock and $\phi_P^{e,m}$ determines the participation cost incurred if hours worked h_t are positive. We fix the time cost of poor health from Jones and Li (2023) and assume the following functional form for the time costs of working:[4]

$$\phi_P^{e,m} = \frac{\exp(\phi_0^{e,m} + \phi_1^{e,m}t + \phi_2^{e,m}t^2)}{1 + \exp(\phi_0^{e,m} + \phi_1^{e,m}t + \phi_2^{e,m}t^2)} \tag{2}$$

Upon dying, an individual values bequests of any leftover bequeathable wealth, A_t^q, according to the utility function developed by De Nardi (2004):

$$beq^{e,q}(A_t^q) = \frac{\theta_{beq}^{e,m}}{1-\rho}\left(A_t^q + \kappa_{beq}^{e,m}\right)^{(1-\rho)\nu}$$

Bequeathable wealth, A_t^q, is equal to any assets that remain, a_t, and Social Security survivors benefits, if eligible. Eligibility for survivors benefits depends on marriage (marital status and the age gap between spouses), q.[5] The coefficient $\theta_{beq}^{e,m}$ measures the strength of bequest motive and $\kappa_{beq}^{e,m}$ measures the curvature of the bequest function. Increase in $\theta_{beq}^{e,m}$ increases the marginal utility of a unit of bequest and increase in $\kappa_{beq}^{e,m}$ indicate that the bequest is valued more like a luxury good. These parameters are permitted to vary by education level, e, and marital status, m.

3.3 Health and Mortality

In every period, individuals are subject to an exogenous education-specific health shock. Health affects individuals in multiple ways — next period survival probability as well as the total time endowment. The transition probability for health depends on current health status, education level, and age in the next period. Individuals are also subject to mortality shocks in each period. The survival probability for the next period depends on age next period, education level, marital status, and current health status.

[4]The best health state in Jones and Li (2023) corresponds to our first two health states and our worst group directly maps into their fair/poor group. They allow the health costs to vary by education groups same as our. As such we use their age-education specific time cost of poor health for our worst health group. At age 25, this is roughly 15% of time endowment for non-college graduates and 40% for college graduates.

[5]More details on survivors benefits is discussed in Section 3.5.1.

3.4 Employment and Wages

An individual experiences unemployment shocks with probability π^{λ}. Unemployment shocks lower labor productivity and create wage-scarring effects in the model. Hourly wage in every time period is a function of an education and age-specific profile $\omega(e,t)$, unemployment status (λ_t) and an auto-regressive component η_t.

$$\begin{aligned} w_t &= \xi(\lambda_t)\exp(\omega(e,t)+\eta_t) \\ \eta_t &= \rho^w \eta_{t-1} + \epsilon_t^w \\ \epsilon_t^w &\sim N(0,\sigma^2_{\epsilon^w}) \end{aligned} \tag{3}$$

If an individual experiences an unemployment shock $\lambda_t = 1$ then they may immediately re-enter the labor market but will experience a wage penalty ξ. This through persistence in wages generate reasonable wage scarring effects of unemployment spells in the model.

3.5 Social Security

Social Security benefits are computed in several steps. First, the earnings of the 35 highest earning years are averaged into an index – Average Indexed Monthly Earnings (AIME). The AIME increases by working an additional year if earnings in that year are higher than the lowest earnings embedded in it and are also capped at a threshold.

Let a_t^{ss} be Social Security wealth (annualized measure of AIME). The evolution of Social Security wealth is approximated in the model in the following simple way:

$$a_{t+1}^{ss} = \max\{[a_t^{ss} + \max\{0,(w_t h_t - a_t^{ss})/35\}], a^{\max}\} \tag{4}$$

Where $a^{\max}$ is the threshold at which the Social Security wealth is capped and $w_t h_t$ denotes annual earnings for period t. Note that in equation 4, we assume that the high earnings year only replaces an average earnings year, as modeling the actual system would require keeping track of entire earnings history which is computationally infeasible.

Second, AIME is converted to obtain the Primary Insurance Amount (PIA), which determines the Social Security benefits using the following piece-wise linear function:

$$\begin{aligned} pia(a_t^{ss}) = 0.90 \times \min\{a_t^{ss}, b_0\} + 0.32 \times \min\{\max\{a_t^{ss} - b_0, 0\}, b_1 - b_0\} \\ +0.15 \times \max\{a_t^{ss} - b_1, 0\} \end{aligned} \tag{5}$$

Social Security benefits, ssb_t, are a function of the PIA as discussed above and two possible adjustments: a penalty/credit for claiming early/late (Γ_t) and a decrease in benefits for those workers who continue working while also claiming benefits (Υ_t).

$$ssb_t = pia(a_t^{ss}) * \Gamma_t - \Upsilon_t \tag{6}$$

Each of these adjustments is discussed below.

Early Claiming Penalty/Delayed Claiming Credit

SS benefits can be claimed without any penalty at the normal retirement age (t_{NRA}).[6] However, individuals can claim benefits with some penalty starting the Early Retirement Age (t_{ERA}) of age 62. For every year before the NRA that these benefits are claimed, the Social Security amount received is permanently reduced by the early claiming penalty. Individuals can also delay their benefit claim beyond NRA. In that case, future benefits are permanently increased by the delayed claiming credit.

This penalty or credit shows up at a percentage decrease, γ_t^{ss}, for each year prior to the normal retirement age that a worker claims or a percentage increase for each year after the normal retirement age that a worker delays claiming. The penalty or credit for a claiming age of t^{ss} is:

$$\Gamma_t = \begin{cases} 1 - (t_{NRA} - t^{ss}) * \gamma_t^{ss} & \text{if } t^{ss} < t_{NRA} \\ 1 & \text{if } t^{ss} = t_{NRA} \\ 1 + (t^{ss} - t_{NRA}) * \gamma_t^{ss} & \text{if } t^{ss} > t_{NRA} \end{cases} \tag{7}$$

Earnings Test

Social Security earnings test taxes the labor income, above a certain threshold y_t^{ss}, of the Social Security beneficiaries at a rate τ_t^{ss}, until the age of 70. Specifically, for each additional dollar earned above the threshold, Social Security benefits are reduced by τ_t^{ss}, until all benefits are taxed away as shown below:

$$\Upsilon_t = \min\{pia\left(a_t^{ss}\right), \max\{0, w_t h_t - y_t^{et}\}\tau_t^{et}\}$$

Υ_t denotes benefits lost through the earnings test. Taxed benefits are credited back through permanent increases in future benefits, which is implemented in the model through increases in the

[6]The NRA is slightly different for different birth cohorts. For instance, the sample used in this analysis, observed an average NRA of 65. But later cohorts observed an NRA of 66 or 67.

Social Security wealth as shown below:[7]

$$
\begin{aligned}
ssb_{t+1} = pia(a^{ss}_{t+1}) * \left[1 + \left(\frac{\Upsilon_t}{ssb_t}\right)\gamma^{ss}_t\right] \\
a^{ss*}_{t+1} = pia^{-1}(ssb_{t+1})
\end{aligned}
\tag{8}
$$

where γ^{ss}_t is the same reduction/increment factor which is used for determining penalty/credit for early/late benefit application as discussed earlier. The net work incentives provided by the earnings test crucially depends on γ^{ss}_t.[8] As a result, the earnings test combined with the benefit application age structure may provide strong incentives to retire upon reaching the claiming age. Since the Social Security rules have been changing over time, the specific rules pertinent to the sample used in this analysis are taken from SSA.

3.5.1 Marriage Related Benefits

Spousal Benefits

Married households receive additional income through Social Security spousal benefits. Spouses of household heads are entitled to up 50 percent of head's benefits depending upon the age benefits are claimed. We assume that all spouses claim together, and, thus, the size of the spousal benefits received is a function of the head's age at SS claiming, t^{ss}, and the age gap between spouses, ι. Total household Social Security benefits received by a household is given by $\delta^q_t ssb_t$ where δ^q_t is determined as follows:

$$
\delta^q_t = \begin{cases} 1.0 & \text{if single or married and } t^{sp} < t_{ERA} \\ 1.5 * [1 - (t_{NRA} - t^{sp}) * \gamma^{ss}_t)] & \text{if married and } t_{ERA} \leq t^{sp} < t_{NRA} \\ 1.5 & \text{if married and } t^{sp} \geq t_{NRA} \end{cases}
\tag{9}
$$

Where $t^{sp} = t^{ss} - \iota$ is the spousal age. Singles and married individuals whose spouse is not yet eligible for benefits receive no additional spousal benefits. Married individuals for whom the spouse's age is above the normal retirement age, receive the additional 50 percent of benefits. Married individuals whose wives are between 62 and 65 at the time of claiming receive benefits penalized by the early retirement penalty. Spousal benefits do not accrue delayed retirement credits, thus, are maximized at the spouse's normal retirement age.

[7]Note that this is a simplification as in practice, the benefits are typically adjusted upon reaching the NRA.
[8]Note that the earnings test was removed for worker over the NRA starting in 2000.

Survivors Benefits

Married individuals may also leave their Social Security benefits to their spouses when they die. These survivors benefits enter into the bequeathable wealth of individuals, A_t^q, which takes the following form:

$$A_t^q = \begin{cases} a_t + \sum_{j=t-\iota}^{T} \frac{1}{1+r} \pi_{j+1}^s ssb_t & \text{if } m = \text{married}, t^{sp} \geq 62 \\ a_t & \text{otherwise} \end{cases} \tag{10}$$

In addition to any leftover assets, a_t, bequeathable wealth is a function of Social Security wealth if the individual is married and the spouse is over the age of 62. These survivors benefits are calculated as the present value of the stream of benefits a spouse would receive from the time of the death of the household head until the end of her own life. Therefore, this present value is a function of the spouse's age (t^{sp}) at the time of head's death.

3.6 Budget Constraint

The budget constraint is given as follows:

$$c_t + a_{t+1} = a_t + W(y_t, y_{st}, ra_t, \tau) + \delta_t^q ssb_t + tr_t \tag{11}$$

Labor income, $y_t = w_t h_t$, is a function of the hourly wage and work hours chosen by the individual. Spousal income for married households is determined as a function of the head's education, age, health status and labor income, and is given as follows:

$$y_{st} = f(e, t, \mu_t, w_t h_t) \tag{12}$$

There is a standard borrowing constraint on assets given by:

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

and a consumption floor which guarantees a minimum level of consumption (Hubbard et al., 1995).

$$c_t \geq \bar{c} \tag{14}$$

Government transfers, tr_t, bridge the gap between this minimum level of consumption and individual's liquid resources. This is a simple approximation to the federal safety net programs in the U.S. such as Supplemental Nutritional Assistance Program (SNAP), Supplemental Security Income (SSI), Temporary Assistance for Needy Families (TANF), and other programs.

$$tr_t = \min\{0, \underline{c} - (a_t + W_t + \delta_t^q ssb_t)\} \tag{15}$$

Where W_t is the total disposable household income as defined in equation 11.

3.7 Recursive Formulation

Let $z_t = \left(e, q, \eta_t, \lambda_t, \mu_t, a_t, a_t^{ss}, b_{t-1}^{ss}\right)$, be the period t state vector. Then individuals solve a finite-horizon Markovian decision problem where they choose a sequence of consumption $\{c(z_t)\}_{t=1}^{T}$, hours $\{h(z_t)\}_{t=1}^{T}$ and Social Security benefit application $\{b^{ss}(z_t)\}_{t=1}^{T}$ rules to maximize the expected discounted lifetime utility subject to the exogenous processes for health transition, employment shocks, survival, and wage determination, a set of budget, borrowing, and time constraints, government transfer rule, and policies for taxes and Social Security.

The life cycle of an individual between ages 25 and 99 is divided into three distinct phases. The first is the *employment* phase between ages 20 and 61 where individuals make consumption, savings, and employment decisions.The second is the *retirement choice* phase between ages 62 and 69 where individuals also make Social Security application decisions (b_t^{ss}). The final stage is a *retired* phase where individuals make only consumption and savings decisions. The decision problem of a household head with education level e and marital status m for each phase is given below:

3.7.1 Employment phase

$$\begin{aligned}
V_{e,q}(a_t, a_t^{ss}, \eta_t, \lambda_t, \mu_t) = \max_{\{c_t, h_t\}} \Bigg\{ & U^{e,m}(c_t, l_t) \\
& + \beta^{e,m} \pi_{t+1}^{s} \Big[EV_{e,q}(a_{t+1}, a_{t+1}^{ss}, \eta_{t+1}, \lambda_{t+1}, \mu_{t+1}) \Big] \\
& + \beta^{e,m} (1 - \pi_{t+1}^{s}) beq^{e,m}(A_{t+1}^{q}) \Bigg\} \quad s.t.
\end{aligned}$$

$$a_{t+1} = a_t + W(y_t, y_{st}, \bar{r}a_t, \tau) + tr_t - c_t,$$

(1), (4-8), (13), and (14).

where $y_t + y_{st} + ra_t$ is the total pre-tax income and $W(., \tau)$ gives the level of post-tax income with the tax rate τ. Note that the expectation is taken with respect to wage, employment and health uncertainty.

3.7.2 Retirement choice phase

Starting age 62, individuals also make benefit-claiming decisions. Note that this is a one-time decision and benefits are based on the age at which the individuals choose to claim benefits for the first-time. During this phase, if an individual enters a period as a non-claimer, he faces the decision of whether to claim benefits this period or not as shown below:

$$
\begin{aligned}
V_{e,q}(a_t, a_t^{ss}, \eta_t, \lambda_t, \mu_t, b_{t-1}^{ss}) = \max_{\{c_t, h_t, b_t^{ss}\}} \Bigg\{ & U^{e,m}(c_t, l_t) \\
& + \beta^{e,m} \pi_{t+1}^s \Big[EV_{e,q}(a_{t+1}, a_{t+1}^{ss}, \eta_{t+1}, \lambda_{t+1}, \mu_{t+1}, b_t^{ss}) \Big] \\
& + \beta^{e,m}(1 - \pi_{t+1}^s) beq^{e,m}(A_{t+1}^q) \Bigg\} \quad s.t.
\end{aligned}
$$

$$a_{t+1} = a_t + W(y_t, y_{st}, ra_t, \tau) + tr_t + \mathbb{I}\{b_t^{ss} = 1\} \times \delta_t^q ssb_t - c_t,$$

(1), (4-8), (13), and (14).

3.7.3 Retired phase

At age 70, if an individual has still not claimed their benefits, then they automatically start receiving both their own benefits as well as their spousal benefits (if applicable).

$$
\begin{aligned}
V_{e,q}(a_t, a_t^{ss}, \mu_t) = \max_{c_t} \Bigg\{ & U^{e,m}(c_t, l_t) + \beta^{e,m} \pi_{t+1}^s EV_{e,q}(a_{t+1}, a_{t+1}^{ss}, \mu_{t+1}) \\
& + \beta^{e,m}(1 - \pi_{t+1}^s) beq^{e,m}(A_{t+1}^q) \Bigg\} \quad s.t.
\end{aligned}
$$

$$a_{t+1} = a_t + W(y_{st}, ra_t, \tau) + \delta_t^q ssb_t + tr_t - c_t,$$

(1), (5), (13), and (14).

4 Estimation

We estimate our model for male household heads born between 1931 and 1935 using a two-step estimation strategy following Gourinchas and Parker (2002). In the first step, we use several data sets—including the Panel Study of Income Dynamics (PSID), the Health and Retirement Study (HRS) and the Household Component of the Medical Expenditure Panel Study (MEPS) — to estimate processes that can be identified without using the dynamic programming model. In the second step, we use initial conditions drawn from data for the relevant cohort, our structural model, and the parameters from the first step to estimate the preference parameter vector $\{\beta^{e,m}, \theta_{beq}^{e,m}, \kappa_{beq}^{e,m}, \phi_P^{e,m}(t), \bar{l}^{e,m}\}$ using Method of Simulated Moments (MSM). The following sections describe the steps in detail.

4.1 Health and Mortality

We allow health to take take three possible values, $\mu_t = \{\text{excellent}, \text{good}, \text{poor}\}$ in the model. We identify these health states in the Medical Expenditure Panel Survey (MEPS) as well as the Health and Retirement Study data from the self-reported health status variable.[9] Health transitions across these states are then estimated from MEPS by running an ordered probit of self-reported health status on previous year health status, education, and a cubic function of age. We estimate an age-, education-, marital status-, and health-specific survival probabilities from the MEPS data by running an ordered probit model of death indicator on self-reported health status, age cubic, education, and marital status.

4.2 Family Structure

Family structure determines two parameters for married men: the equivalence scale in consumption, $\zeta_t^{e,m}$ and the gap between spouses, ι. In addition to these parameters, married men also receive spousal income.

We assume that the equivalence scale in consumption differs by education and marital status and is constructed based on family statistics calculated in PSID. Single households are assumed to have an equivalence scale of 1. The equivalence scale of married households, however, is based on the presence of a spouse and the average number of children living in the household for each age and education type. Given family size, values for $\zeta_t^{e,m}$ are set based on the OECD equivalence scale.[10]

Additionally for married couples, the age gap between the male household head and their spouse is determined based on the distribution of age gaps for the cohort at hand. We use four age gap options $(0, 1, 4, 8)$ to describe this distribution and assign the mass at each point from PSID

[9] Both surveys asks respondents to self-report their health on a scale of 1 to 5 where 1 is “Excellent,” 2 is “Very Good,” 3 is “Good,” 4 is “Fair,”and 5 is “Poor”. For computational simplicity, the 5-point scale is converted into a 3 point scale by grouping individuals of “Very Good” and “Good” health into the good health category and those in “Fair” and “Poor” into the poor health category.

[10] The OECD equivalence scale gives a weight of 1 to the household head, 0.5 to the spouse and 0.3 to each child.

data. Data indicates that 8.7 percent of married couples have no age gap, 26.2 percent have an age gap of one year, 46.1 percent have an age gap of four years, and 19 percent have an age gap between spouses of eight years.

Spousal income, y_{st}, is estimated from PSID and is assumed to be a function of the age, education level, health, and labor income of the household head.

4.3 Labor productivity

Wages are assumed to be comprised of an age and education-specific profile and a persistent shock. This function of age and education as well as parameters of the AR(1) shock process is estimated from PSID in two steps. First, age-education specific profiles are estimated using Heckman two-step procedure. Second, persistence and standard deviation of the shock process are estimated by fitting an AR(1) process on the wage residuals by using a minimum distance estimator.

4.4 Employment Shock and Wage Scarring

The employment shock is the exogenous probability that a worker is separated from the labor market and is independent of education and marital status. We set this employment shock, λ, to match the separation rate measured in JOLTS and set at $\lambda = 0.1$.

The wage penalty associated with the employments shock, ξ, is modeled as a percentage of income. The penalty is estimated from PSID following the literature on the wage scarring and set to $\xi = 0.86$.[11] To estimate the penalty of a displacement, the log of hourly wages is regressed on dummies representing years since a labor force displacement occur as well as a vector of control variables including a quadratic in age and a quadratic in experience. This penalty is set to be the percentage drop in annual wages that displaced workers experience.

4.5 Social Security

Explicitly modeling the rich detail of the U.S. Social Security System (described in Section 3.5) requires us to define the parameters involved with these modeling choices. Table 2 shows these parameters based on the 1998 rules from the United States Social Security Administration.

The first group of parameters, b_0, b_1, and a^{max}, are related to the calculation of Social Security wealth and benefits. The maximum wealth at which benefits are capped is given by a^{max} and is set at \$68,400. The parameters b_0 and b_1 define the bend points of the Social Security benefits formula,

[11] Papers in this literature include Jacobson et al. (1993), Huff Stevens (1997), and Huckfeldt (2016).

$g(\cdot)$. These points are set to \$5,724 and \$34,500. There is no variation in these parameters based on the claiming age of the worker.

The second group of parameters is based on the earnings test. Before the NRA, earnings above \$9,120 are taxed at a rate of 50 percent. After the normal retirement age, earnings above \$14,500 are taxed at 33 percent.[12]

The final parameter of table 2 defines the penalty for early claiming (or the benefit for delaying claiming). Benefits are decreased by 6.7 percent for each year prior to the NRA the worker claims. After the normal retirement age, benefits are increased by 5.5 percent for each year the worker delays benefit claims.

Table 2: Social Security Benefit Formula

Parameter	Value*	
	before the NRA	after the NRA
a^{max}	68,400	68,400
b_0	5,724	5,724
b_1	34,500	34,500
Earnings Test		
y^{et}	9,120	14,500
τ^{et}	0.50	0.33
γ_t^{ss}	0.067	0.055

*1998 rules from the SSA and those pertaining to the 1931-1935 birth cohort.

4.5.1 Taxes

Individuals in the model pay a proportional payroll tax, τ_t^{ss}, and labor income taxes, $\tau^{e,m}$. The proportional labor income tax τ_t^{ss} includes both the Social Security payroll tax as well as Medicare tax. The Social Security payroll tax is 6.2 percent on income up until the maximum taxable amount, a^{max}, while the Medicate tax is 1.45 percent on total labor income.

Following the literature, we adopt a smooth functional form for the labor income tax that allows for negative tax rates in order to incorporate Earned Income Tax Credit (EITC). We allow the function to vary by education and marital status and estimate the following function from the PSID data:

$$\tau^{e,m} = 1 - \lambda^{e,m} y^{-\xi^{e,m}}.$$

[12]This normal retirement age is dependent on birth cohort. It is age 65 for our benchmark birth cohort (born in 1931-1935).

We allow for the tax function to differ by education type and marital status to capture any differences in family size across these groups.

4.6 Benchmark Model

We estimate the preference parameters by matching age, education and marital status specific moments pertaining to labor supply and wealth evolution. In our benchmark specification, we fix the interest rate, r, to 0.03, consumption weight, ν, to 0.578, and relative risk aversion parameter, ρ, to 3.340 for all groups. Together, these two parameters imply an inter-temporal elasticity of substitution for consumption, $\frac{-1}{\nu(1-\rho)-1}$, which equals 0.425. Table 3 shows our structural parameter estimates for $(\beta^{e,m}, \theta_{beq}^{e,m}, \kappa_{beq}^{e,m}, \bar{l}^{e,m})$. We also estimate the time cost of working using the structural model. Specifically, we estimate the coefficients of the function as described in equation 2 for each education and marital group in the model.

As shown in Bairoliya and McKiernan (2022), this framework provides a benchmark that is consistent with the timing of benefit claiming (see Appendix Figure E.3) for older Americans and several aspects of their life-cycle labor supply and wealth evolution (see Appendix Figures E.1 and E.2). We next use this benchmark model to conduct several counterfactual experiments.

Table 3: Preference Parameters

Parameter	Description	Singles		Married	
		Non-College	College	Non-College	College
Fixed					
ρ	relative risk aversion	3.340	3.340	3.340	3.340
ν	consumption weight	0.578	0.578	0.578	0.578
Group-specific					
β	discount factor	0.904	0.978	0.993	1.007
θ_{beq}	bequest intensity	0.927	0.421	1.198	1.631
κ_{beq} (in 000s)	bequest curvature	1.343	2.525	1.598	1.544
$\bar{l}$	time endowment	7259	5174	6251	4531

5 Counterfactual Experiments

Next, we run several experiments to see how misinformation pertaining to different aspects of the Social Security benefit calculation rules impact labor supply, consumption, savings and SS benefit claiming behavior of individuals over the life cycle.[13] In each case, we compare against a baseline with full information regarding all three rules.

5.1 Benefit Calculation

There are two main sources of misinformation when it comes to how the flow of Social Security benefits that individuals receive upon claiming are calculated. First, while in practice benefits are based on the entire history of earnings (35 highest earnings years), many individuals think that benefits are simply based upon earnings in the year prior to retirement. In order to simulate the effect of this misinformation on the agent's economic decisions, we replace Equation 4 with the following:

$$a_{t+1}^{ss} = \max\{a_t^{ss}, a^{\max}\}$$

Second, individuals may think that there are no bend points in the PIA benefit calculation formula. In other words, they may think that they will get hundred percent of their average indexed monthly earnings as benefits. In the model we implement this by replacing equation 5 by:

$$pia(a_t^{ss}) = a_t^{ss}$$

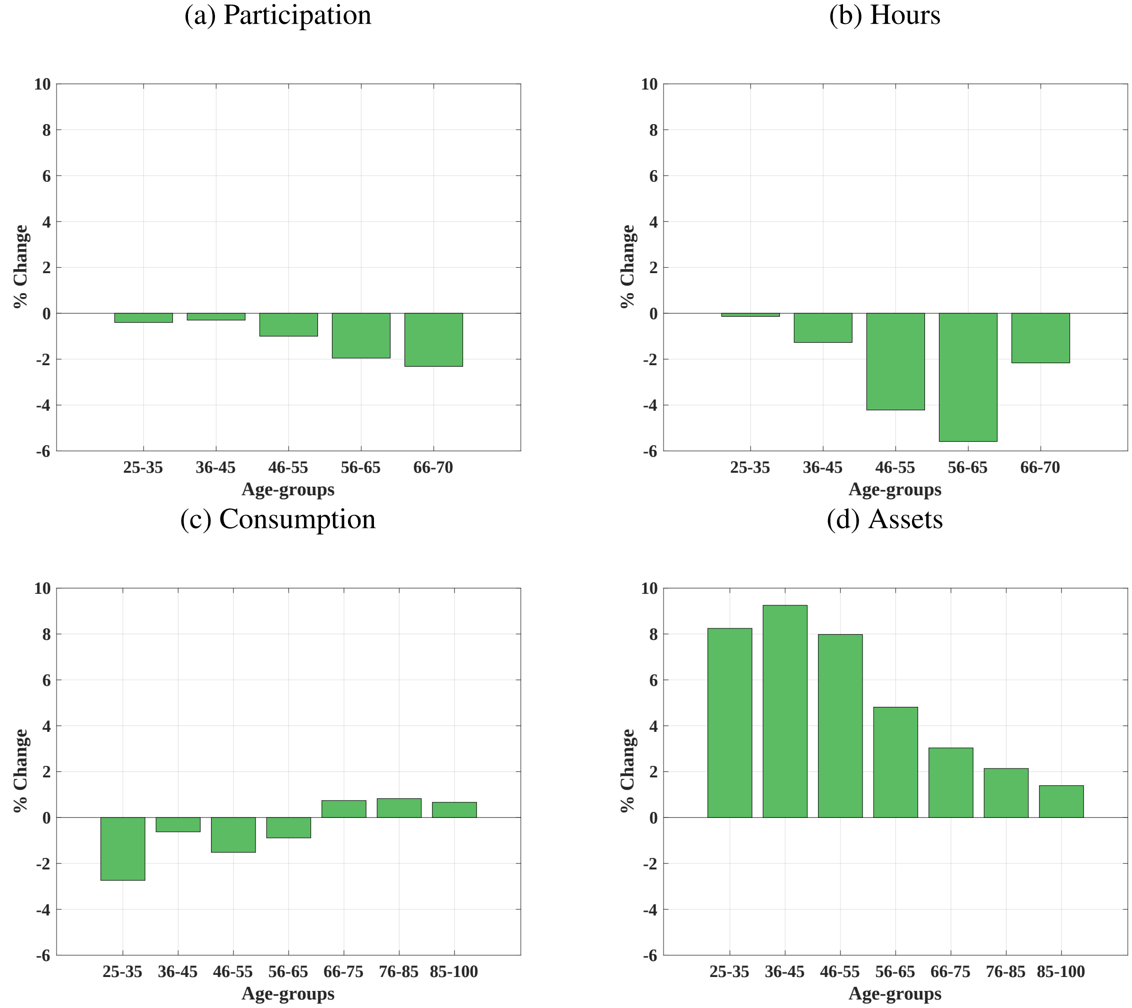
Note that in calculating the actual benefits received for simulated individuals in both cases, we still use Equations 4 and 5 respectively. However, the true nature of benefit calculation is only revealed once misinformed individuals claim their benefits. We present the results pertaining to each of the above type of misinformation below.

5.1.1 No Earnings History

We find large impacts of such a misinformation on life-cycle consumption, labor supply and asset holdings (refer to figures 5a-5d). Note that the dependence of SS benefits on earnings history impacts two important margins in the model. First, it pushes older workers to work longer hours, particularly when labor productivity is higher and also increase labor force participation. Both these forces work towards increasing annual earnings, and as a result life-time social security wealth on which the true benefits are based. Second, having benefits based on past years of

[13] Details on how each type of misinformation shows up in our structural framework is included in Table E.1.

Figure 5: Changes in Consumption, Hours and Assets: Earnings History Misinformation



earnings also insures workers against any sudden losses in labor productivity through health or unemployment shocks. In a scenario where workers are not aware of this rule, and think instead that earnings in the year prior to claiming completely determines the flow of SS benefits, we observe large declines in hours worked and increase in asset holdings over the life-cycle. Agents reduce consumption and accumulate assets to insure against near-retirement labor supply shocks which can wipe away valuable retirement benefits. However, upon claiming, the misinformation is eliminated and individuals receive their actual benefits which are based on life-time earnings. Even though these benefits are somewhat lower than baseline (due to lower hours and labor force participation over the life-cycle), these are higher than those anticipated by the misinformed worker. As a result, consumption goes up after the misinformation is eliminated upon benefit claiming.

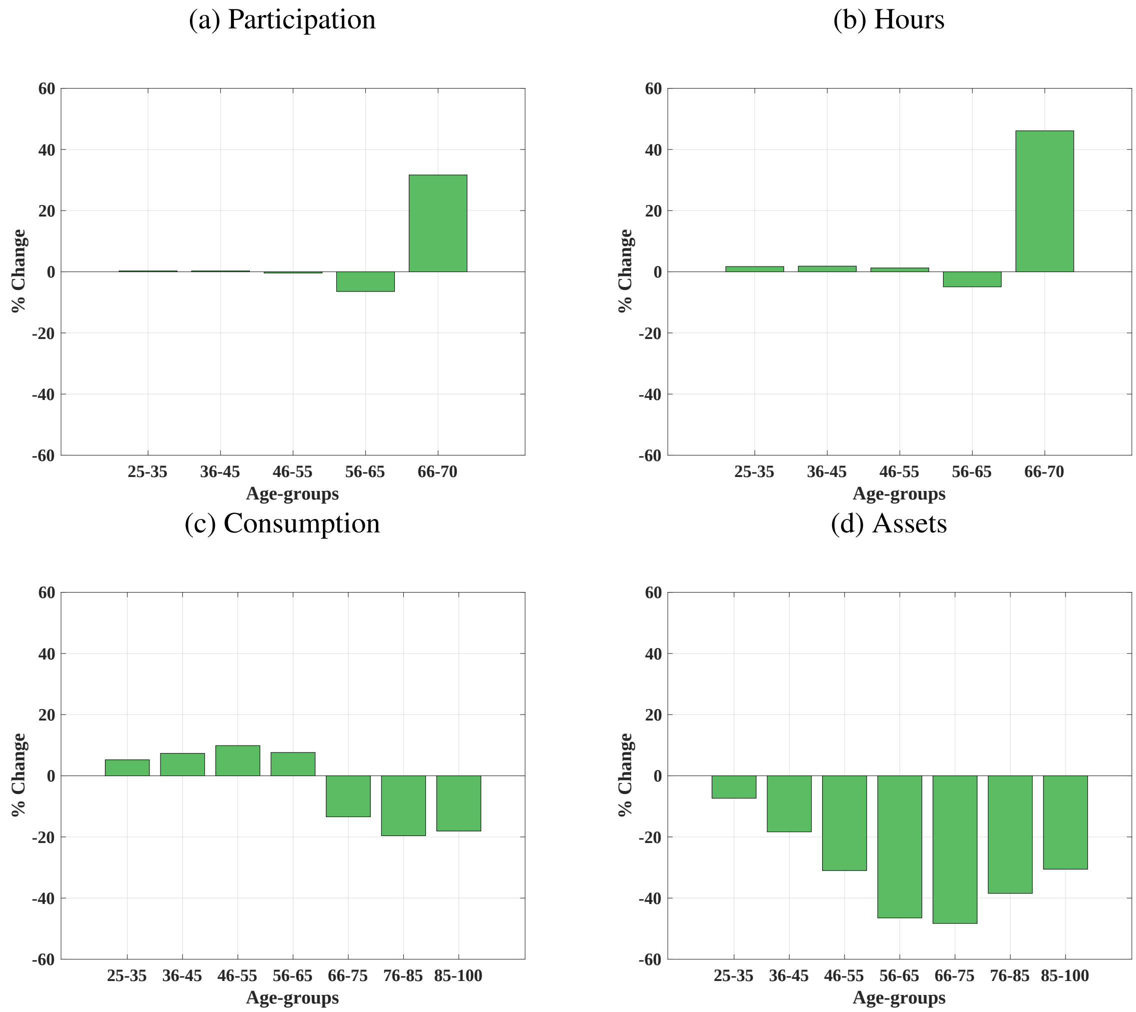
5.1.2 PIA Benefit Calculation

Note that this type of misinformation results in all individuals, particularly high income groups, grossly overestimating the retirement benefits they will receives upon claiming (the replacement rate varies between 15 to 90% but misinformed individuals assume it to be 100%). Figure 6 shows the changes in participation, hours, consumption and asset holdings. Unlike the previous case in which workers are unaware of the dependence of benefits on life-cycle earnings, individuals who do not understand the PIA formula are anticipating much higher future retirement benefits. These workers shift some consumption to the present by reducing their asset holdings. They also exit the labor market early, in anticipation of higher benefits (labor force participation between ages 56 and 65 declines by 6%). However, once the true information is revealed upon benefit claiming, individuals, upon seeing much lower SS benefits than anticipated, respond by increasing both labor supply and hours worked to make up for the lost consumption. This is evident by a roughly 31% increase in participation between ages 66 and 70 (also the age-group where the RET earnings threshold is much more generous). However, consumption stays much lower in retirement compared to the benchmark with informed individuals.

5.2 Benefit Size and Claiming Age

Under this type of misinformation, individuals think that SS benefit size is independent of the claiming age. We implement this in the model by setting $\Gamma_t = 1$ in Equation 7. Note that this misinformation is somewhat similar to the above as individuals here also anticipate receiving a higher benefit flow in retirement than what the rules dictates (assume 100% benefits are available at age 62 instead of 80%). We find that this type of misinformation almost universally results in all benefit claims to shift to age 62 (earliest age of eligibility) as individuals perceive no gains from delaying (refer to Bairoliya and McKiernan (2022) for a detailed discussion on claiming behavior impacts). While there are large shifts in benefit claiming under this type of misinformation, before-retirement effects on labor supply, consumption and assets remain muted (refer to Figure 7). As individuals perceive higher retirement benefits, they shift some consumption to earlier in the life-cycle by saving less. The biggest behavioral response is observed once the true information is revealed upon benefit claiming. Individuals having claimed at sixty two observe a much lower flow of SS benefits and make up for some of the lost old-age consumption by increasing labor supply between the ages 65 and 70 (also the age-group where the RET earnings threshold is much more generous). However, similar to the above case, consumption stays much lower in retirement compared to the benchmark with informed individuals.

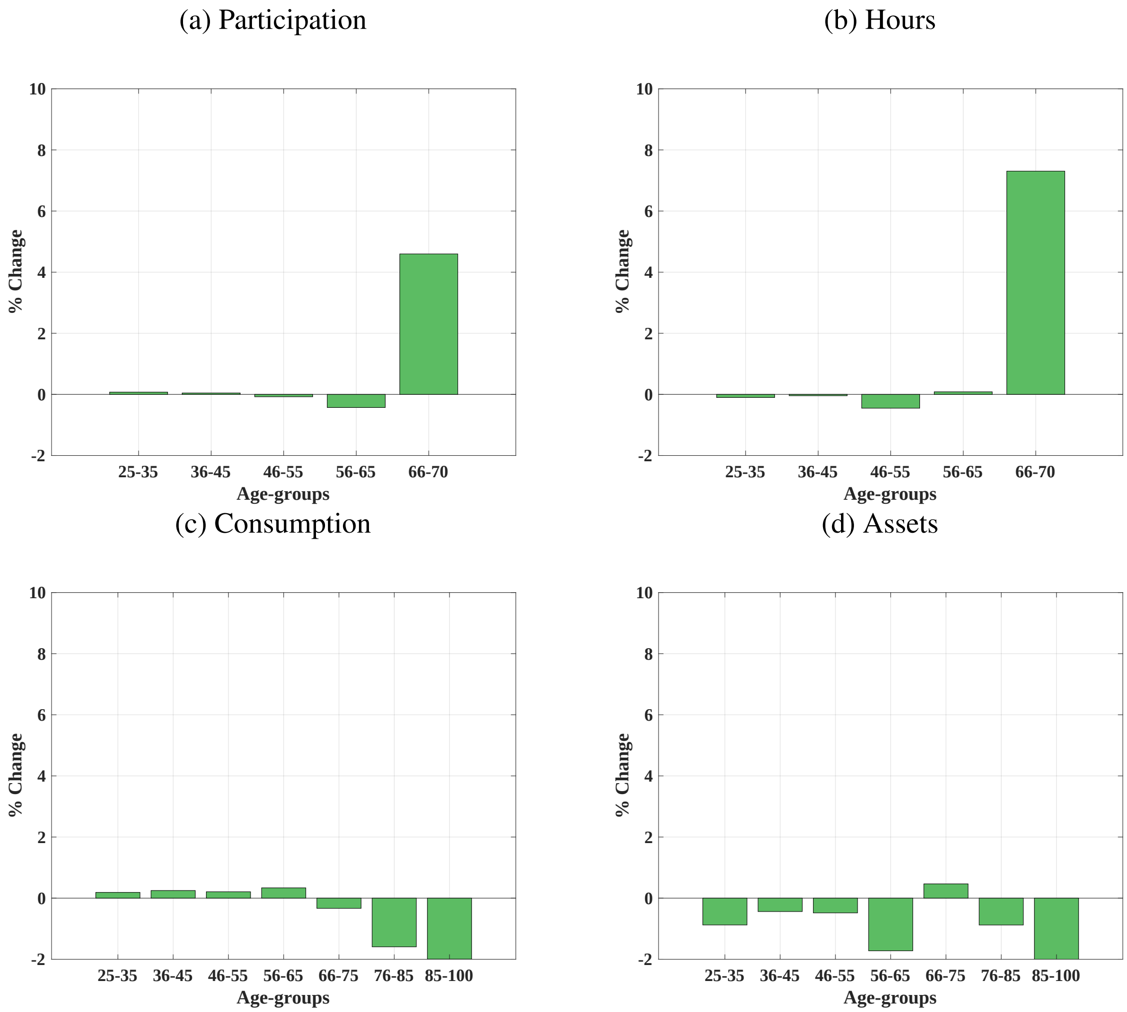
Figure 6: Changes in Consumption, Hours and Assets: PIA Benefit Formula Misinformation



5.3 Retirement Earnings Test

Next, we study how different forms of misinformation related to the Retirement Earnings Test (RET) impact life-cycle decisions. We study three scenarios — 1) individuals assume there is no RET; they believe that they must claim prior to leaving the labor market. We implement this in the model by setting $\Upsilon_t = 0$ (see Equation 6) in the decision process making of the economic agents; 2) individuals assume that RET=100%. In other words, all benefits of older workers (if they have claimed benefits and are working in the labor market) are taxed away, no matter the age. At the same time, individuals also assume that the taxed benefits are not credited back in the future and are permanently lost. We implement this by setting $\Upsilon_t = pia(a_t^{ss}) * \Gamma_t$; 3) individuals assume that benefits that are taxed due to RET are not credited back in the future. Note that the only difference between the second and third experiments is the rate at which benefits are taxed away. While it is 100% in the former, it is the actual age-dependent tax rate for the latter. We present the results

Figure 7: Changes in Consumption, Hours and Assets: Benefit Size and Claiming Age Misinformation

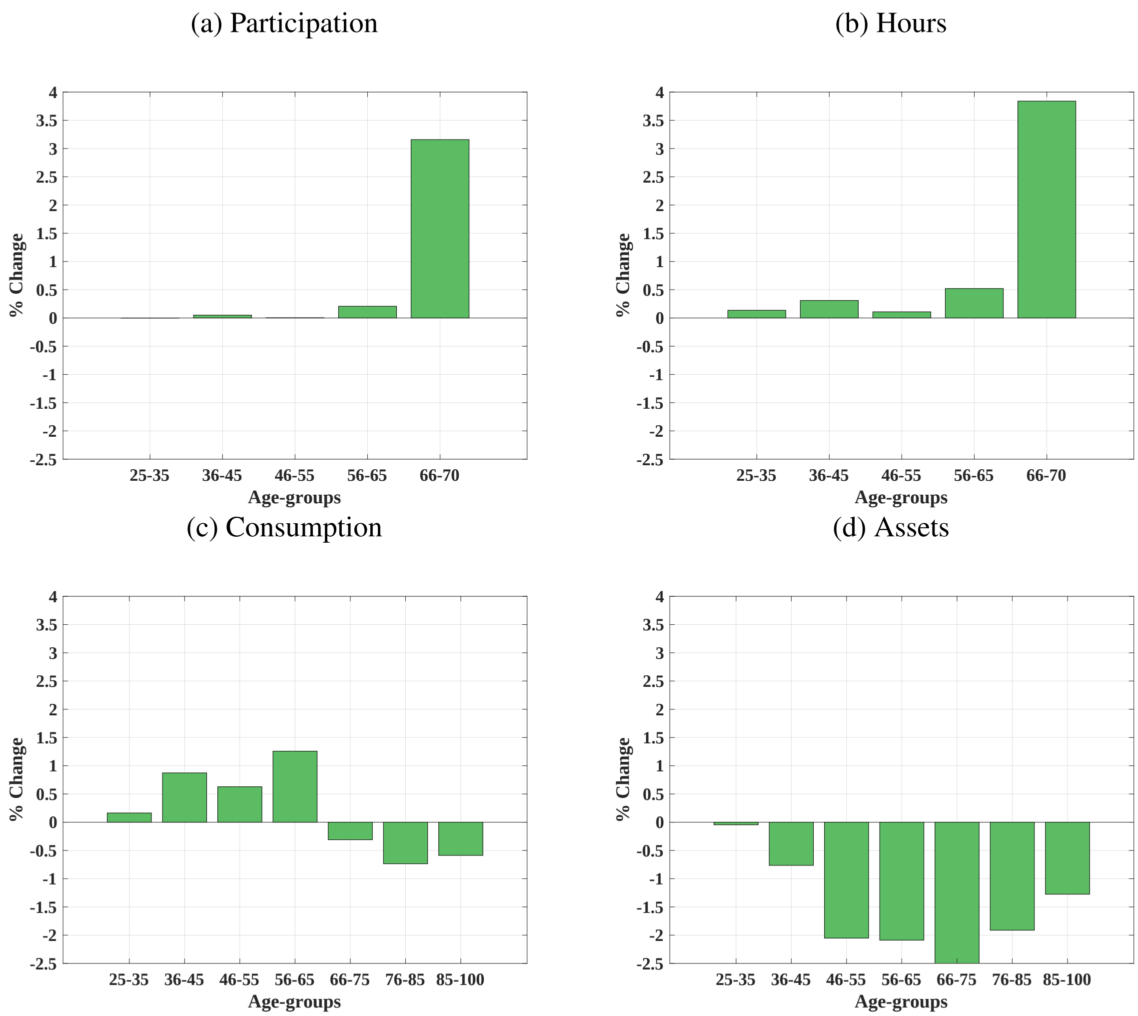


pertaining to each of the above type of misinformation below.

5.3.1 No Earnings Test

Figure 8 shows the changes in participation, hours, consumption and asset holdings, over the life-cycle, between the benchmark and a scenario where individuals assume there is no RET. Note that while the pre-retirement labor supply effects are muted, there are large increases in both hours and participation after retirement, once the misinformation is revealed (refer to Figures 8a and 8b). A stringent earnings test restricts the ability of Social Security beneficiaries to work at older ages and supplement old-age consumption through labor earnings. Misinformed individuals shift some of the old-age consumption to the present as they are counting on the labor income at older ages. As a result, asset holdings for misinformed individuals prior to retirement continue to be lower compared to the informed agents benchmark (refer to Figures 8c and 8d). However, once they claim benefits, the true information is revealed resulting in a significant losses in SS benefits of workers due to RET. The older agents recoup some of the losses in consumption by working longer hours after age 65 when the RET is much more generous. However, old age consumption stays roughly 0.5 to 1% lower compared to the benchmark.

Figure 8: Changes in Consumption, Hours and Assets: No RET Misinformation



5.3.2 Permanent Earnings Test

Here we discuss the last two cases of misinformation pertaining to earnings test together as they impact behavior in very similar ways. Note that both these scenario are the polar opposite of the one discussed above. Individuals assume a drastic earnings test where all or some fraction of Social Security benefits of older workers are permanently taxed away. In order to prepare for retirement, misinformed individuals then increase their hours worked as well as asset holdings (in conjunction with small consumption declines in the event of scenario (2)) over the life-cycle, prior to retirement, due to precautionary motives (refer to Figure 9 and Appendix Figure 10). However, upon retirement, once the true information is revealed, they are able to continue working as they learn about a much less stringent earnings test compared to what they had anticipated. This is evident from the fact that labor force participation between ages 62 and 65 goes up by 1.2% in the event of scenario (2). This, along with higher levels of wealth accumulated prior to retirement, makes older agents quit the labor market somewhat early (labor force participation between ages 66 and 70 goes down by a little over 2% in scenario (2)). Old-age consumption in both scenarios remains higher compared to benchmark.

Figure 9: Changes in Consumption, Hours and Assets: 100% RET Misinformation

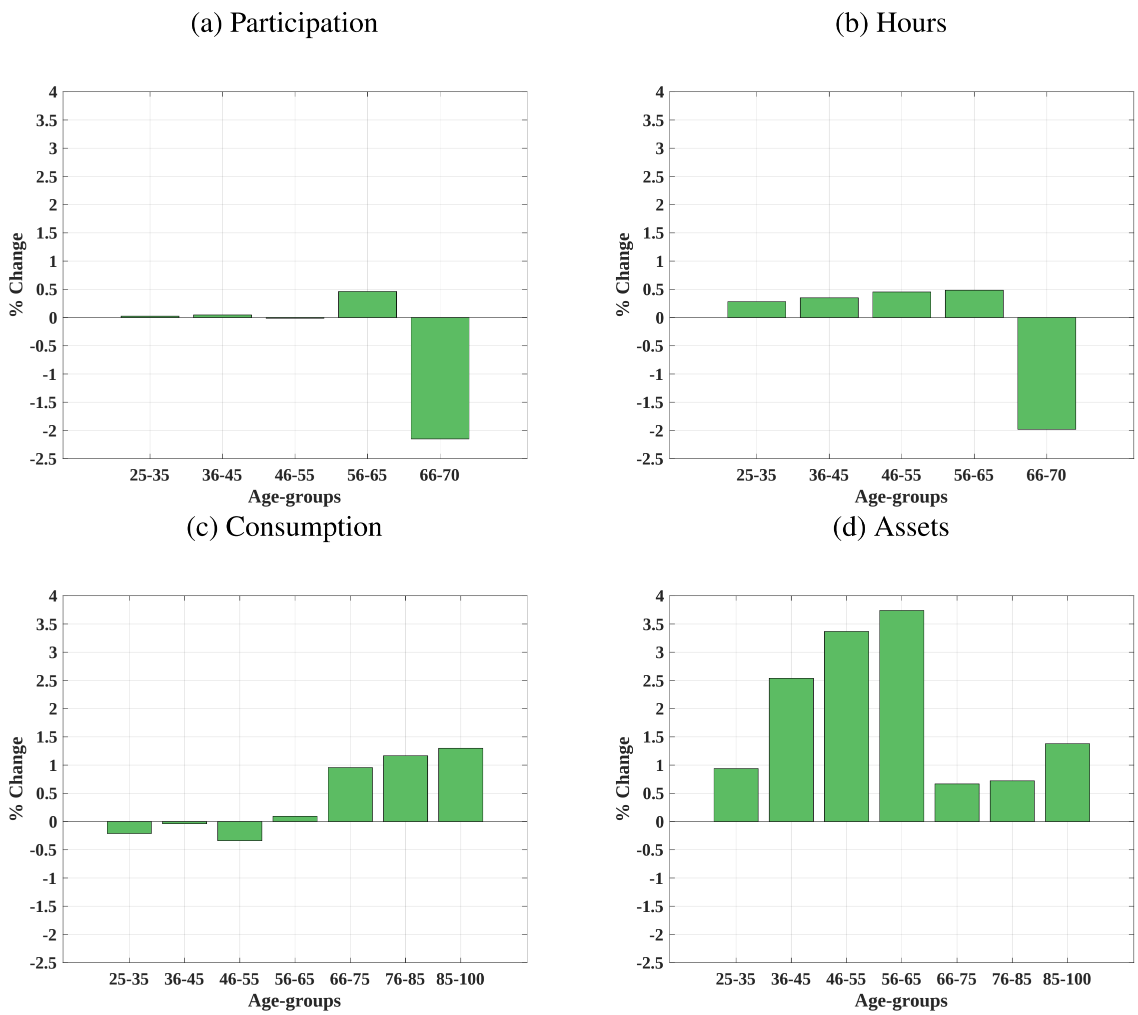
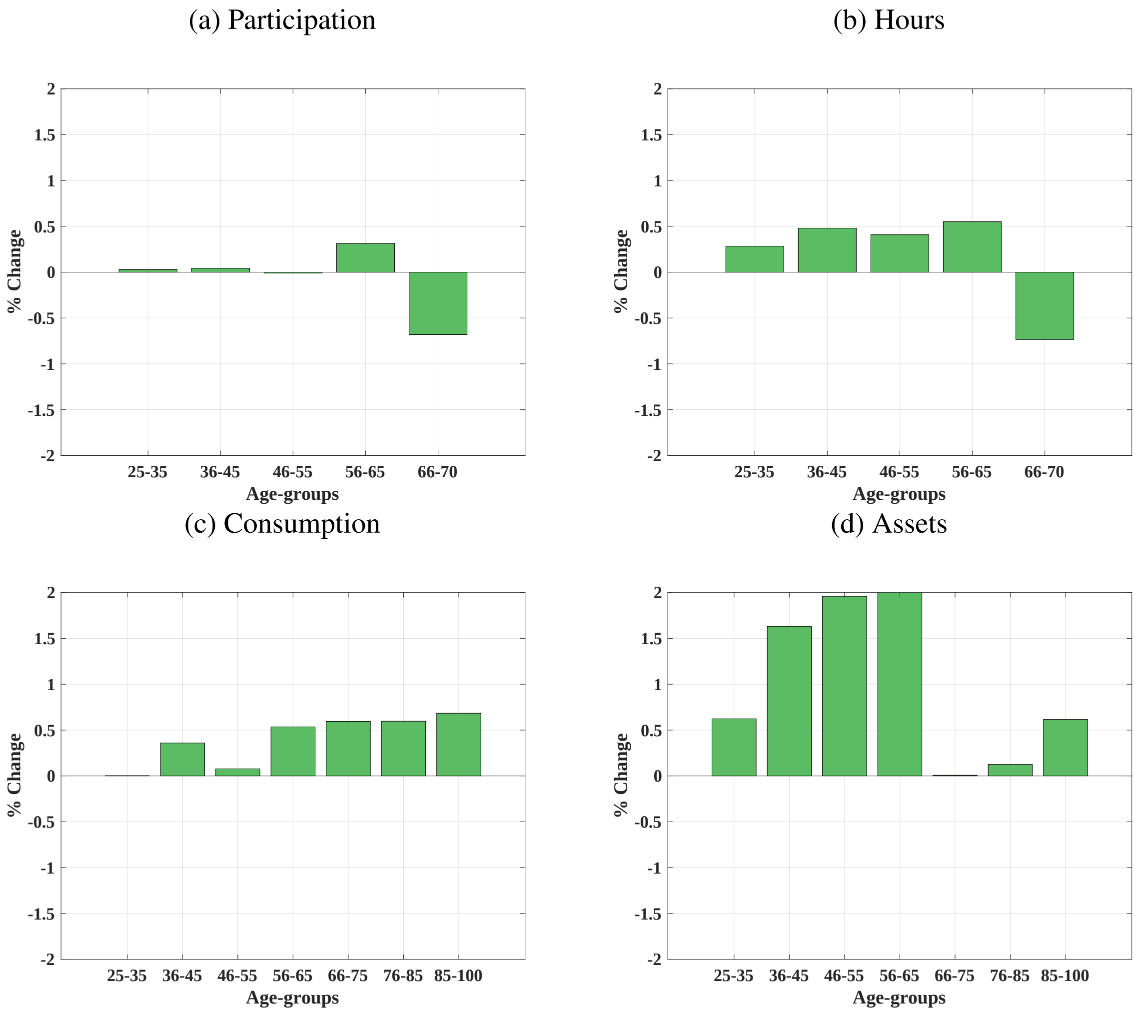


Figure 10: Changes in Consumption, Hours and Assets: Permanent Reduction in Benefits due to RET Misinformation



6 Welfare

When computing welfare, we compare the ex-post realized utility of informed individuals with the ex-post utility of their hypothetical selves in a scenario where they operate under misinformed views about a particular aspect (or aspects) of the Social Security system and become informed only after claiming SS benefits.[14] Note that for misinformed individuals, access to correct information upon benefit claiming is akin to a completely unanticipated shock. Consequently, any attempts to gauge ex-ante welfare based on the acquisition of information become devoid of meaningful interpretation. An ex-post welfare analysis, on the other hand, allows us to analyze the impact of a

[14]In summary, we compare the lifetime utility of an informed individual with a given realization of shocks (health, productivity, employment, survival) with the lifetime utility of a misinformed individuals who receives the same sequence of shock shocks throughout his life. Details on these welfare calculations is discussed in Appendix E

particular shock realization–in this case, the realization of information. This approach aligns with other research which has relied on ex-post welfare measures when examining the significance of shocks (De Nardi et al., 2017).

We compute three ex-post CEV measures: (1) full CEV in which welfare is computed as the percentage reduction in annual consumption that makes the individual's counterfactual lifetime utility including bequests equivalent to the realized lifetime utility including any bequests, (2) a fixed-bequest CEV in which welfare is computed as the percentage reduction in annual consumption that makes the individual's counterfactual lifetime utility, holding bequests at the level realized in the benchmark (informed) case, equivalent to the realized lifetime utility including these bequests, and (3) a life-cycle CEV in which welfare is computed as the percentage reduction in annual consumption that makes the individual's counterfactual lifetime utility excluding the utility impact of bequests, equivalent to the realized lifetime utility also excluding the utility impact of bequests. For each of these calculations, the average welfare impact is computed as the weighted average of the realized welfare impacts for each simulated individual.

In the following sections, we study welfare impacts under two scenarios — 1) when misinformation stems from a single source as discussed above and 2) when agents may be misinformed about several features of the program, resulting in important interaction effects.

6.1 Single Source of Misinformation

Table 4: Welfare Effects of Misinformation

	Benefit Calculation		Benefits & Claim Age	Earnings Test		
	Earnings History	PIA formula		No	Full	Perm.
Overall CEV						
Percent (%)	0.80	-13.61	-1.64	-0.42	0.87	0.47
Nominal (1998 $)	231.97	-3266.89	-461.96	-120.66	254.81	136.73
CEV with Fixed Bequests						
Percent (%)	-0.11	-0.57	0.04	-0.07	-0.07	0.05
Nominal (1998 $)	-31.90	-136.82	11.27	-20.11	-20.50	14.55
Life-cycle CEV						
Percent (%)	-0.21	-3.16	-0.15	-0.10	-0.10	-0.02
Nominal (1998 $)	-60.89	-758.51	-42.25	-28.73	-29.29	-5.82

Welfare impacts for each type of misinformation discussed above are summarize in Table 4.

We present CEV as both the percent change as well as in dollar terms ($1998) as an annual consumption reduction by multiplying by one's average consumption over the lifetime in a given misinformed scenario.

We find that overall CEV shows negative welfare impacts of misinformation about the bend points of the PIA function, the adjustment for claiming age, and the existence of the retirement earnings test. However, we observe welfare gains from misinformation if workers are misinformed about the benefit calculation being a function of earning history or the permanent nature of the RET. The magnitude of these numbers also varies; misinformation about the bend points of the PIA formula entail losses of 13.6 percent (or $3,267) while beliefs about a full earnings test entail welfare gains of 0.9 percent (or $255).

Note that both the magnitude as well as the sign of welfare change are governed by how assets and consumption evolve under benchmark and the misinformed worlds. However, we find that in all these experiments, responses through asset holdings seem to be largely dominating the direction of the overall welfare change. In some cases, the presence of misinformation induces workers to under-save relative to if they were informed; in other cases, misinformation has the opposite impact. When workers are misinformed about the PIA formula, the claiming age adjustments and the presence of the RET, they save less throughout their lives — either because they expect Social Security retirement benefits to be higher than they will be or because they expect to be able to work later in life. Therefore, when the misinformation is corrected, workers do not have the savings available to bolster consumption and leave bequests. This leads to welfare losses from misinformation, driven largely by the impact on bequests. In the other cases (dependence of benefits on earnings history and beliefs that the RET is permanent), misinformed individuals over-save relative to their informed counterparts due to precautionary motives or the expectation of not being able to work at older age due to the severity of the RET. Thus, in these cases, when the misinformation is corrected, individuals have high asset holdings that can be used toward bequests. These higher bequests then lead to welfare gains in these cases.

These results highlight the outsized role of asset holdings and the bequest motive in overall welfare calculations. Therefore, we consider two alternative CEV calculations intended to attenuate this channel. First, we consider a case in which the bequests are held at the level of the informed benchmark. In this calculation, we allow bequests to impact utility but we do not allow this level to change as a result of the misinformation. Second, we do not account for bequests in our calculation of CEV. We find that in both scenarios, welfare impacts are now driven by the direction of change in consumption and leisure over the life cycle. Based on these changes alone, we find that misinformed workers almost always lose in terms of life-time utility as compared to informed agents as they are forced to make consumption, labor, and savings decisions in a world constrained by their incorrect understanding of the Social Security rules. The magnitude of these losses, however, is a function of how large this misinformation is in terms of the expectations of future benefits. For instance, life-cycle CEV is roughly -3.16 percent (or $759) in the case of misinformation about the bend points of the PIA whereas only -0.02 percent (or $6) in the case where they think RET is permanent. This is due to the fact that in the former, workers project benefits to be much higher than they are revealed to be. This leads to retirement consumption which is 20 percent lower than the informed. In comparison, the consumption increases in the latter and leisure drop (due to increase in hours) is relatively small.

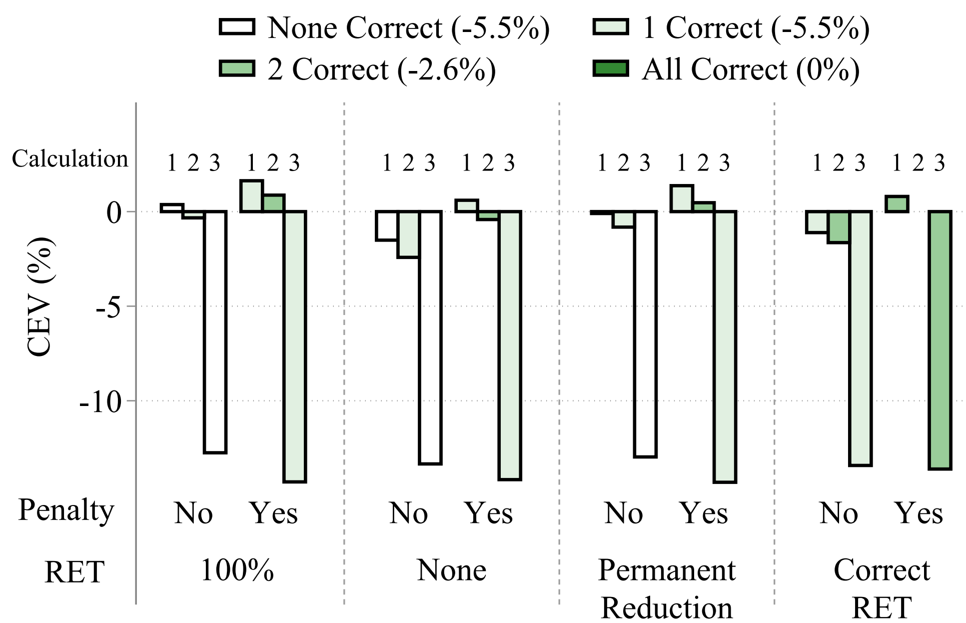
6.2 Multiple Sources of Misinformation

As shown earlier, Figure 4 highlights that workers in practice have multiple sources of misinformation pertaining to SS benefit calculation rules. In order to understand the full extent of observed misinformation in the existing population, Figure 11 shows the welfare impacts of misinformation for each of these cases. Figure 11a shows the full CEV calculation; Figure 11b shows the life-cycle CEV calculation. While the magnitude of welfare change as measured by full CEV is much larger than that of life-cycle CEV (also shown in Table 4 above), we observe similar patterns in how the welfare impact varies for each type of misinformation. The largest welfare impacts occur when an individual has some misbelief related to the Social Security benefit calculation — specifically, when individuals do not understand the bend points in the PIA benefit formula and instead think that their entire SS wealth will be returned to them as benefits. Any scenario which includes misbeliefs about this are around three times larger than the ones with other forms of misinformation. This figure also shows that the welfare impact of misinformation is increasing in how many of the SS rules the individual misunderstands. The full CEV welfare impact of misinformation ranges from -2.6 percent (or $768) for those who answer only one question incorrectly to -5.5 percent (or $1,373) for those who answer all questions incorrectly. The life-cycle CEV impact ranges from -0.8 percent to -1.7 percent (or between $225 and $428) for the same.

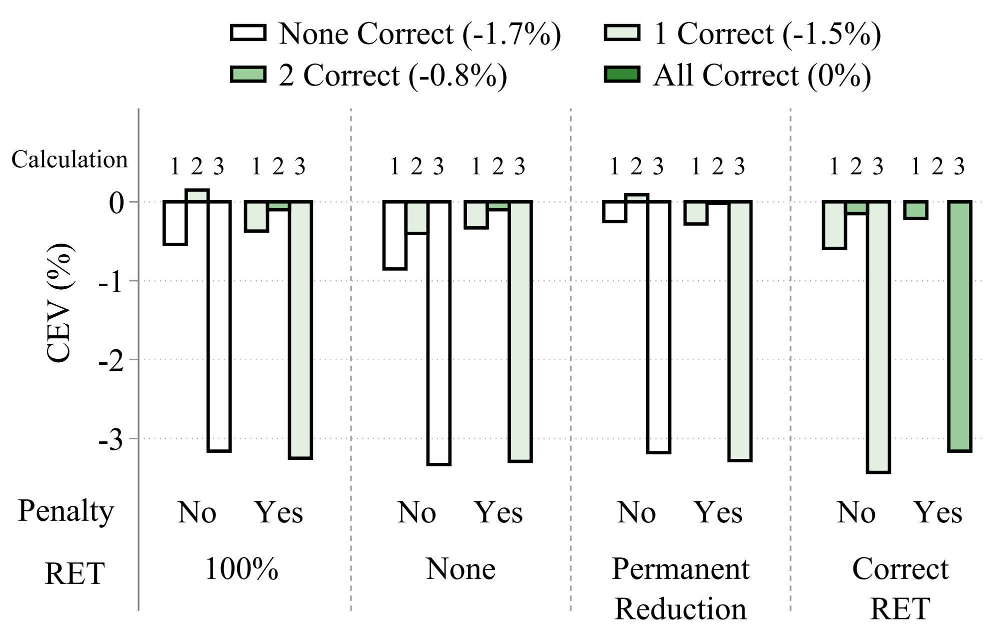
Next, using the distribution of the population across these multiples sources of misinformation, we compute average welfare change due to existing levels of misinformation in the economy. Using the full CEV calculation average welfare loss from misinformation is -3.8 percent (or $3,669) while this average welfare impact is -1.1 percent (or $1,078) when we consider life-cycle CEV calculation.

Figure 11: Welfare Impact by Misinformation Type and Intensity of Misinformation

(a) Overall CEV



(b) Life-cycle CEV



Notes: Figres show the welfare impact for across the misinformation types present in the population. Darker green color represents lower intensity of misinformation (being informed along more dimensions). Panel (a) shows the full CEV welfare calculation; Panel (b) shows the life-cycle CEV calculation. Percentages in parentheses show the average welfare impact for each level of misinformation.

7 Cost-Benefit Analysis

In this section, we perform a cost-benefit analysis of the existing Social Security Statement program which aims to inform workers about several features of the SS benefit calculation.[15] We compare the aggregate cost of informing individuals with the aggregate benefits of this information. Using a hypothetical cohort of 10 million individuals and the shares of various misinformation types (as shown in Figure 4), we calculate the aggregate benefit of information. This aggregated benefit is up to \$7.3 billion for the overall CEV calculation or \$2.3 billion for the life-cycle CEV calculation.

Using the budgetary information from the Social Security Administration, we estimate that the it costs roughly \$0.324 for SSA to mail a Social Security Statement and \$0.024 to provide the statement online.[16] Given these estimated costs, it would costs between \$11.99 and \$14.58 to mail a statement to all workers every year between age 25 and the age at which a worker claims the SS retirement benefits. However, currently, only workers over the age of 60 receive a mailed statement while all other workers have access to this information online. It costs between \$1.49 and \$4.08 to provide the statement to workers online between ages 25 and 60 and mailed from age 60 until claiming. For our cohort of 10 million individuals, and given the distribution of the population over misinformation types, the government would pay an average of \$125.9 million for paper statements and pays around \$20.9 million for the current program including a combination of online and paper statements.

A simple comparison of the benefits and costs as presented above indicates that, on an average, the benefits of providing information to an individual far out-weigh the costs associated with providing Social Security Statements throughout a worker's life. Additionally, at an aggregate level, the potential benefits of this information are much larger than the costs. However, this calculation assumes that 100% of misinformed workers become informed as a result of the policy. Figure 12 shows how the comparison of costs and benefits based upon the share who move from misinformed to informed.[17] The benefit of information is increasing in the share of people who become informed. The costs, however, are roughly constant.[18] This implies the existence of a break-even point at which a sufficient share of workers change from misinformed to informed such that the aggregate cost of providing the information is exactly equal to the benefits. For providing paper statements, this occurs at 5.5 percent of the misinformed population; for a combination online and

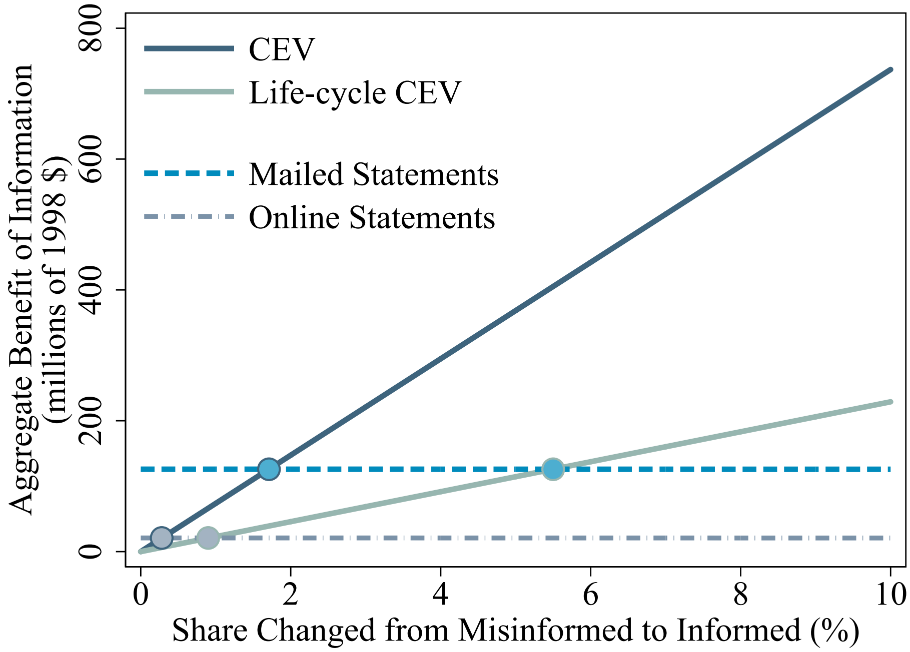
[15] Refer to the Appendix Section B for details on the program history.

[16] For information on this budgetary information and the estimation of the cost to provide the Statement, see Appendix Section C

[17] In this calculation, we assumed that if less than 100% of misinformed workers become informed, those who remain misinformed are equally distributed across misinformation types.

[18] There is small variation in these costs as the average age of claiming varies with information. As claiming ages change, the number of years that the SSA must provide the statement to workers changes.

Figure 12: Cost-Benefit Analysis



Notes: Increasing lines shows the aggregate benefits of information as a function of the share of misinformed workers who become informed using both the full CEV and life-cycle CEV calculations. Horizontal lines represent the costs of providing mailed Social Security Statements to all workers from age 25 to claiming and online statements from 25 to claiming and mailed statements beginning at age 60.

paper statements, this break-even is at only 1.7 percent.[19]

8 Conclusion

In this work, we study the consequences of misinformation regarding the intricate rules of the United States Social Security system. This includes the mechanisms for determining benefits, the variations in benefit size based on the age of claim, and the retirement earnings test. Our empirical analysis reveals that misinformation is pervasive and that individuals exhibit a broad spectrum of misunderstandings, both in terms of the nature and intensity of their misbeliefs. It is common for individuals to have misbeliefs about two or more of the three rules on which we focus.

Using a quantitative model of consumption, labor supply, and retirement, we find that misinformation significantly influences life-cycle behaviors and overall welfare. There are two main

[19]Estimates for the share of individuals who may change decisions as a result of receiving the Social Security Statement ranges between 15 and 50 percent depending on the change made (i.e. increasing savings, changing financial plans, changing intended claiming age etc). More information is discussed in Appendix A.4. Additionally, when asked, over 70 percent of individuals would prefer to receive this information by paper mail.

categories of misbeliefs in terms of their impact on behaviors: those causing workers to underestimate and those causing them to overestimate their future Social Security retirement benefits. Workers who underestimate their benefits, for example by assuming the earnings test leads to a permanent benefit reduction, tend to reduce consumption and increase savings. Upon correction of this misinformation, these workers receive higher benefits than anticipated. In contrast, workers who overestimate their benefits, due to errors like misunderstanding the Primary Insurance Amount (PIA) formula, tend to increase consumption and decrease savings. In our welfare analysis that includes the effect of bequests, the consumption equivalent variation ranges from 0.87 percent (or $255) increase in scenarios where misinformation results in increased savings, to a 13.61 percent ($3,267) decrease where it leads to decreased savings. When we adjust the welfare measure to exclude the impact of these bequests, the welfare impact shifts from a 0.02 percent ($5.82) decrease to a 3.16 percent ($759) decrease due to misinformation.

Finally, we conduct a cost-benefit analysis of the *Social Security Statement* program, a major information campaign by the Social Security Administration. On an individual basis, the welfare gains from information, equivalent to $3,669 (overall CEV) or $1,078 (life-cycle CEV), substantially exceed the program's costs ranging from $11.99 to $14.58 per person. Nonetheless, this does not fully account for the variations in welfare effects across different segments of the population (due to differing misinformation types) and presumes the program's efficacy in altering individual behaviors. Given the large welfare benefits and the program's modest costs, our findings suggest that the program needs to successfully transition between 1.7 and 5.5 percent of the misinformed demographic to an informed status in order to break-even.

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Appendix

A Understanding America Study

The project described in this paper relies on data from survey(s) administered by the Understanding America Study, which is maintained by the Center for Economic and Social Research (CESR) at the University of Southern California. The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of USC or UAS. All data is downloaded from https://uasdata.usc.edu/index.php.

A.1 Sample

The empirical analysis in Section 2 uses a nationally representative sample of men ages 25-69 who are not currently receiving Social Security retirement benefits from UAS94 and UAS231. This sample contains 3,663 observations over the years 2017-2022. 2,777 individuals answered all questions related to misinformation of Social Security rules.

When we consider the impact of the Social Security Statement on retirement and claiming behavior, we use an analogous nationally representative sample of men ages 26-69 who are not currently receiving Social Security benefits. This sample is from UAS16 and covers years 2015-2017. This sample contains 1,538 observations.

Details on this sample selection process are shown in Table A.1.

Table A.1: Understanding America Study Sample Selection

	UAS16	UAS94, UAS231
total observations	5,388	17,520
nationally representative sample	5,107	12,899
ages 25-69	4,415	10,593
male	1,927	4,305
not currently receiving SS retirement benefits	1,538	3,663
answered all misinformation questions	—	2,777

A.2 Survey Questions and Mapping into Misinformation Types

This section contains details on how we map questions from the Understanding America Study into the types of information we consider. These choices are summarized in Table A.2.

Question 1 below is used to classify what individuals understand about the way in which Social Security retirement benefits are calculated. We split individuals into three groups: (1) those who believe benefits are calculated based upon earnings immediately (within five years) prior to

Table A.2: Mapping from Responses to Misinformation Groups

		Response
Benefit Calculation	1-5 years prior	Question 1 a. or d.
	Highest 35 earnings years	Question 1 b.
	SS taxes paid	Question 1 c.
Adjustments for Claiming Age	No Penalty	Question 2 a.
	Accurate Penalty	Question 2 b. or c. or d.
Retirement Earnings Test	100% RET	Question 3. a. or b.
	No RET	Question 3 c.
	Benefits permanently reduced	Question 3 d. and Question 4 a.
	Future benefits increased	Question 3 d. and Question 4 b. or c.

retirement, (2) those who understand that benefits are based upon the average of earnings over their thirty-five highest earnings years, and (3) those who believe that their benefits are based upon the Social Security taxes paid through their lives and the interest earned on these taxes.

Respondent are in group (1) if they respond to Question 1 with either a. or d. Respondents are assumed to understand–placed in group (2)–if they respond with b. Respondents are assumed to be in group (3) if they respond d.

Question 1: Which of the following best describes how a worker's Social Security benefits are calculated? If you are unsure, please give your best guess.

a. They are based on how long the person worked and his or her pay during the last five years.

b. They are based on the average of a person's highest 35 earning years.

c. They are based on the Social Security taxes paid and the interest on those taxes.

d. They are based on a person's income tax bracket when he or she claims benefits.

Responses to Question 2 are used to separate respondents in two group based upon whether or not they know about the link between age at which SS benefits are claimed and the size of the benefits received. If a respondent answers a. to Question 2, he is classified as not understanding there is a penalty for early benefit claims. If the respondent answers b., c., or d. to this question, he is classified as understanding the relationship between claiming age and benefits.

Question 2: Imagine an individual, Mr. Spencer Wills, who is retired from work and turning 63 today. Spencer expects his monthly Social Security retirement benefit to be about $2,000 if he claims now. How much should he expect his monthly benefit to be if he decide to wait another year and claim when he is 64?

a. It would stay the same.

b. Approximately $2120 (6% higher).

c. Approximately $2020 (1% higher).

d. Approximately $2300 (15% higher).

Individuals are separated into groups of information about the Retirement Earnings test based on the answers to Questions 3 and 4 below. These questions allow us to group people into whether they understand the existence of the earnings test (Question 3) and whether they understand the details of the RET (Question 4). First, we use only those observations which give an answer other than e. Don't Know. Worker who respond either a. of b. are classified as believing there is a 100% RET–they believe that workers must be retired in order to claim SS retirement benefits. Those who respond c., on the other hand, are classified as believing there is no RET–they believe benefit claiming must occur prior to retirement. Only those who repsond d. is classified as understanding the existence of the RET.

Question 3: Based on Social Security guidelines, what is the relationship between the age at which you stop working and the age at which you can begin claiming benefits?

a. Both occur at the same age.

b. The age at which you stop working should be first.

c. The Social Security claiming age should be first.

d. Any of these combinations is acceptable.

e. Don't know.

For those who understand that the RET exists–who respond d. to Question 3–we use Question 4 to understand whether they understand the details of the earnings test. If the worker responds a. he believe that the benefits withheld through the RET are never returned. If the respondent answers b. or c., we assume that the worker understands they will receive these benefits back in the future.

Question 4: The Retirement Earnings Test (RET) specifies that Social Security withholds benefits if a person below their Full Retirement Age receives benefits while working, and whose earnings from this work exceed a certain amount. To the best of your knowledge, which of the following aspects of the RET is also true?

a. A person's benefit amount is permanently reduced.

b. Once a person reaches the Full Retirement Age their benefit amount is increased to account for the withheld benefit.

c. The withheld benefit is paid as a lump-sum once the person reaches Full Retirement Age.

A.3 Heterogeneity by Education, Marital Status, and Age

In the main text, we present results for the share of individuals who do not understand the rules of the Social Security system. In this section we show how these shares vary by education, marital status, and age. While we do find some variation in understanding, these differences are small. The share of workers who answers the questions related to the rules of Social Security benefits remains high, even among college-educated and older individuals.

By Education and Marital Status

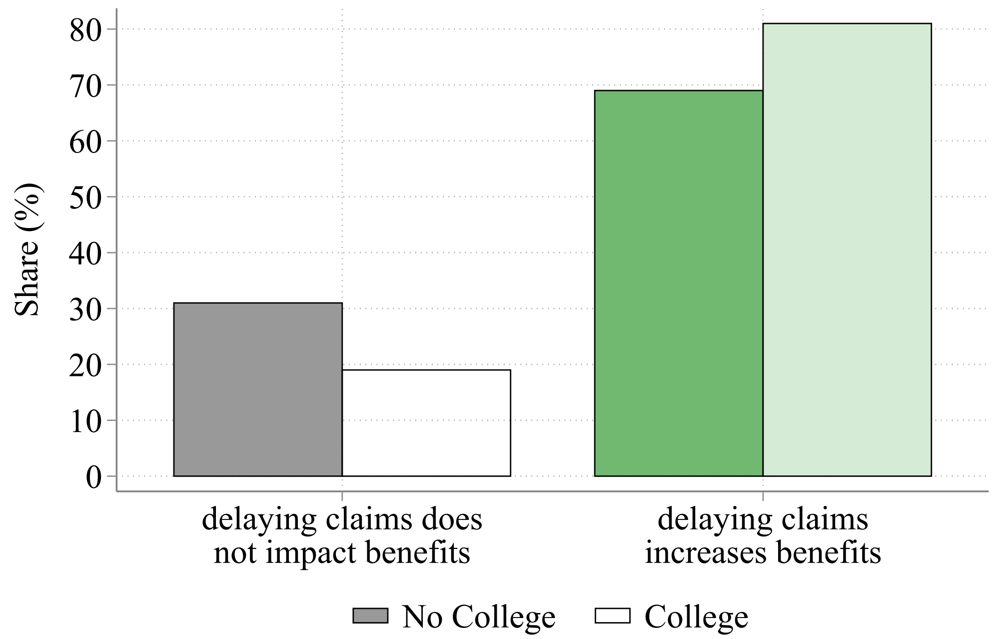
Figures A.1 - A.3 and Figures A.4 - A.6 show how the share of individuals across misinformation groups varies by age and marital status, respectively.

Figure A.1: Misinformation about the Social Security Benefit Calculation by Education

Notes: Question asks "Which of the following best describes how a worker's Social Security benefits are calculated? They are based on...". Green bar denotes the correct answer. Additional details in Section A.2

When we consider this misinformation by education, we look at the same shares from the main text but separate workers by whether or not they have attended college. Consistent with evidence of higher financial literacy among college educated men, we find that the share of college men who answer these questions correctly is higher. However, these differences are minimal. For the benefit calculation, nearly 40 percent of college educated individuals understand that benefits are based on their highest thirty-five years of earnings while this share is slightly over 30 percent for non-college educated men. Additionally, around 80 percent of college men know about the early claiming penalty while 70 percent of non-college men answer this correctly. A bit over 30 percent of college educated men know about the retirement earnings test while slightly under 30 percent

Figure A.2: Misinformation about the Adjustment for Claiming Age by Education



Notes: Question asks ”How much should one expect his monthly benefit to be if he decides to wait to claim at age 64 rather than age 63?” Green bar denotes the correct answer. Additional details in Section A.2

of non-college do.[20]

When we look at variation in these same shares by marital status, we find even smaller differences. Married workers are a bit more likely to be informed, but the gap between single and married individuals is small for all three rules considered.

By Age

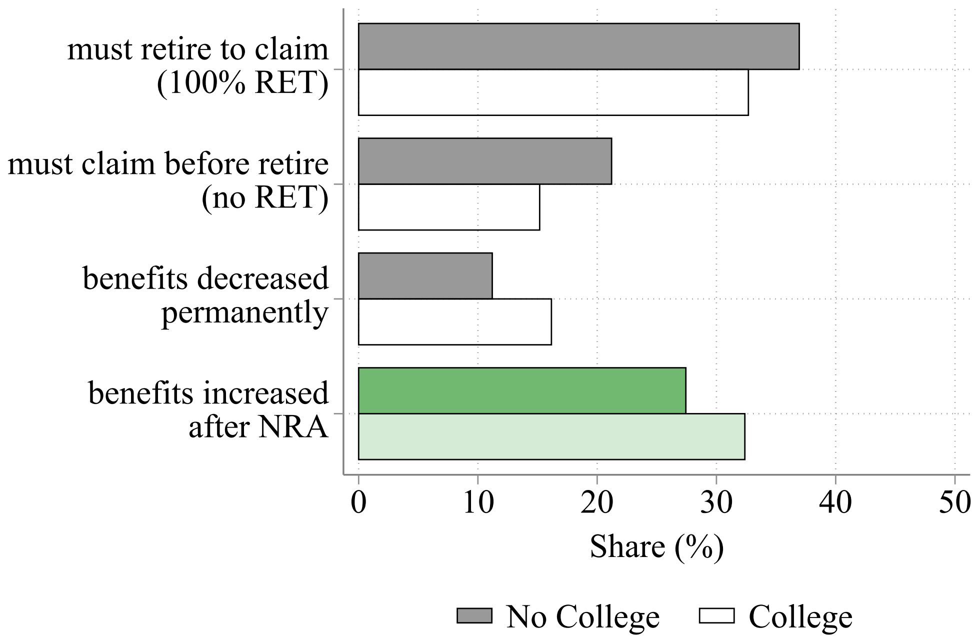
Figures A.7 - A.9 show how these shares evolve by age. This may be of particular interest to see if we find evidence of learning about these rules as workers age and approach retirement. Given the short panel nature of our dataset, we are not able to measure learning of an individual over the life-cycle. However, we are able to look at how the prevalence of misinformation varies across the age distribution for the cross section of our sample.

We do notice some patterns by age. Notably, we see that the share of individuals who are correct about how Social Security benefits are calculated (shown in Figure A.7) is increasing over the age groups. While slightly under 30 percent of 25-34 year old men answer this correctly, nearly 50 percent of those over age 55 do. This increase mirrors a decrease in those who believe their benefits depend upon the Social Security taxes paid throughout their working lives.

We do not see the same increase in informed shares when looking at understanding of claiming age adjustments. Rather, the share who understand the penalty is nearly constant over the life-cycle

[20]One pattern to note is that we do observe that college educated workers are less likely to be uninformed about the existence of the retirement earnings test. However, they are both more likely to be correct about the details of the RET and to be misinformed about how the RET details work.

Figure A.3: Misinformation about the Retirement Earnings Test by Education



Notes: Results are compiled from two questions. The first question asks "Based on Social Security guidelines, what is the relationship between the age at which you stop working and the age at which you can begin claiming benefits?" The second question asks "Which of the following aspects of the Retirement Earnings Test is also true?" Green bar denotes the correct answer. Additional details in Section A.2

(shown in Figure A.8).

As for understanding of the retirement earnings test, shown in Figure A.9, we observe a decrease in those who believe that they must retirement to claim. However, this decrease in misinformation coming from a lower share who believe in a 100% RET is not mirrored by a similar increase in shares who are informed. Rather, while we do observe small increases in the share who are informed, we also see the share who believe in difference types of misinformation rise; the share of those who believe there is no RET or that the RET means benefits are permanently reduced is also increasing.

Overall, while there are some patterns that emerge when we analyze how misinformation varies by age, these patterns are not consistent across rules. We are unable to rule out that workers learn about Social Security rules over time (especially about the benefit calculation), but we do not see strong evidence for consistent learning pattern across individuals and rules.

A.4 Response of Individuals to the Social Security Statement

In UAS16 (covering years 2015-2017), respondents are asked if they remember receiving a Social Security Statement. If they respond yes, respondents are asked a series of questions including whether they carefully read the statement and whether the Statement will motivate them to change various behaviors. Figure A.10 shows the share of individuals who responded yes when asked about these various behaviors. These shares vary by the behavior with over 60 percent of

Figure A.4: Misinformation about the Social Security Benefit Calculation by Marital Status

Notes: Question asks "Which of the following best describes how a worker's Social Security benefits are calculated? They are based on...". Green bar denotes the correct answer. Additional details in Section A.2

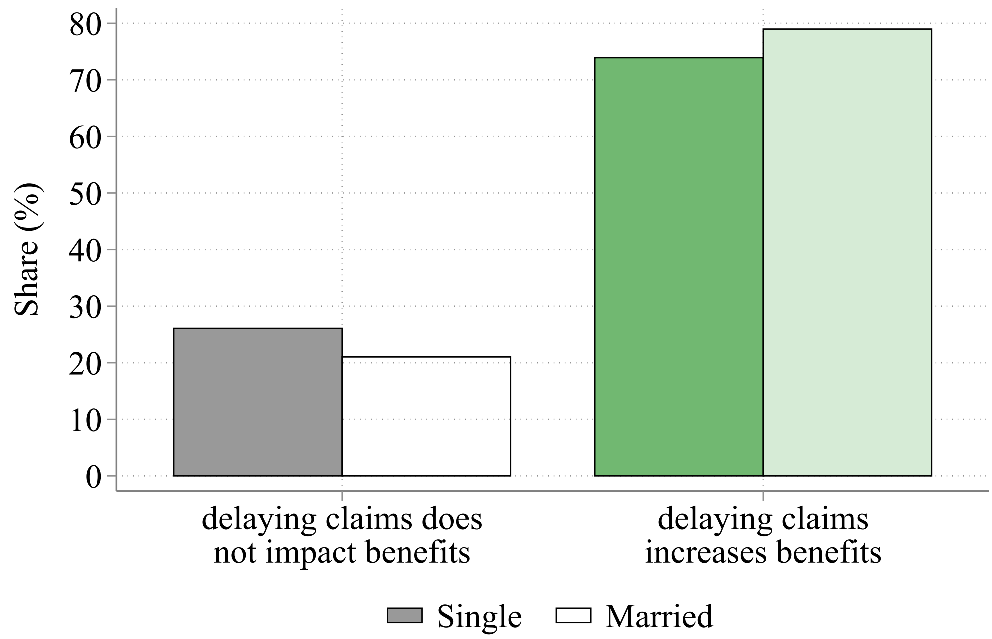
men reporting they will keep the statement with important papers, roughly 50 percent saying they will increase their savings, and under 20 percent responding that they will change their intended claiming age.

B History of Social Security Statement

The prevalence of misinformation throughout the population led the Social Security administration to take steps to improve information about the program. In October 1995, after increased pressure to make benefit calculations more transparent, the administration began sending the Social Security Statement — a document which included information about a worker's personal earnings history, Social Security taxes paid, estimates of expected benefit, and other information related to benefits. While these Statements were initially sent to those close to retirement, the age of first receipt gradually decreased to age 25. The program, however, quickly ran into budgetary issues and the annual mailing of the Social Security statement was suspended in 2011. In 2012, an online version of the Social Security Statement was launched; all workers over the age of 18 were able to view their Social Security statement virtually. In 2014, Social Security announced it would begin sending paper statements to workers every five years — an expensive policy to run.[21] Currently, however, while all workers are able to access their Social Security statement virtually, the

[21] (Smith and Couch, 2014) Beginning in September 2014, SSA began sending paper versions of the Social Security Statement to all workers ages 25, 30, 35, 40, 45, 50, 55, or 60 who had not accessed the online Social Security Statement.

Figure A.5: Misinformation about the Adjustment for Claiming Age by Marital Status



Notes: Question asks "How much should one expect his monthly benefit to be if he decides to wait to claim at age 64 rather than age 63?" Green bar denotes the correct answer. Additional details in Section A.2

statement is only mailed in individuals over age 60.[22]

C Justification of Estimates for Appropriations Committee

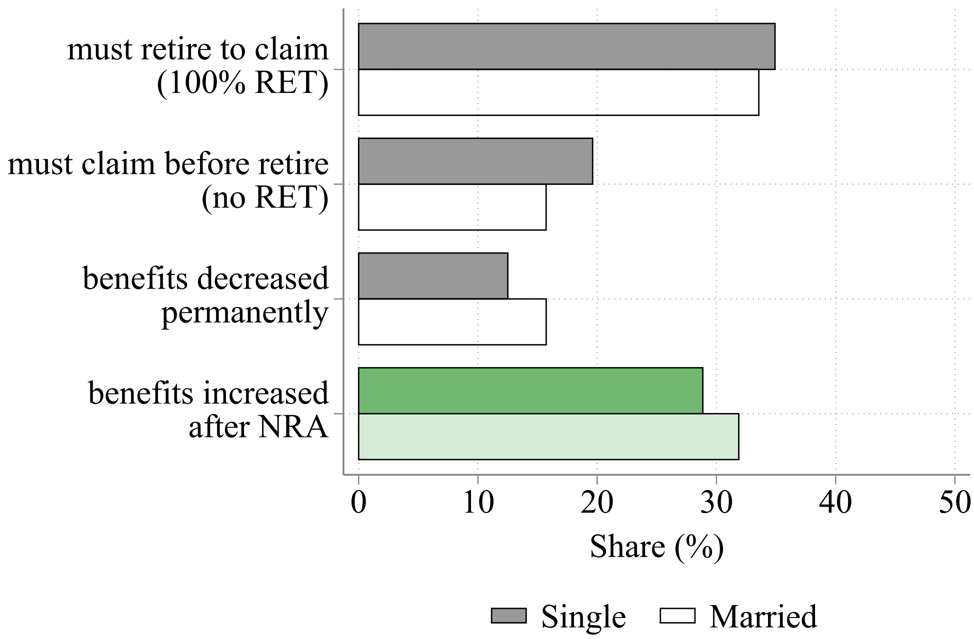
The Justification of Estimates for Appropriations Committee (JEAC) informs members of Congress about the Social Security Administration's funding request including how it will support performance goals and initiatives to improve service. We use these documents for FY2020-FY2024 to estimate the costs of providing information to workers through the Social Security statement and the My Social Security platform. JEAC documents are available for download from the Social Security Administration website (https://www.ssa.gov/budget).

The document for each fiscal year contains information for three years: actual spending estimates for two years prior, estimated spending for one year prior, and budgeted (or requested) funds for that fiscal year. Therefore, we use actual spending information for FY2018-FY2022 in our estimates.

The Limitation on Administrative Expenses (LAE) is the main administrative account of the Social Security Administration and is financed through the Social Security and Medicare trust funds as well as through the General Fund. Throughout FY 2018 - FY 2022 (shown in Table C.1) these expenses have been roughly 8 billion dollars (1998 dollars). In this work, we attempt to

[22] In order to receive the Statement in the mail the worker must also have not signed up through the My Social Security portal.

Figure A.6: Misinformation about the Retirement Earnings Test by Marital Status



Notes: Results are compiled from two questions. The first question asks "Based on Social Security guidelines, what is the relationship between the age at which you stop working and the age at which you can begin claiming benefits?" The second question asks "Which of the following aspects of the Retirement Earnings Test is also true?" Green bar denotes the correct answer. Additional details in Section A.2

identify the portion this spending devoted to the mailed Social Security Statements as well as the spending on the my Social Security platform–the online platform which allows users to access the Statement and its information online.

In the JEAC, the SSA directly reports both the total spending on mailed Social Security Statements as well as the number of statements mailed. These numbers, for FY 2019 to FY 2021 is reported in Table C.2. During these years, the SSA sent between 11 and 19 million statements each year[23] at an aggregate cost of between \$3.7 millions and \$6.1 million. This gives estimates of spending per Social Security Statement between \$0.311 and \$0.339. On average, each mailed Social Security Statement costs the Social Security Administration \$0.324.

The Social Security Administration has made effort in recent years to update online platforms to better provide services to workers and retirees. Part of this investment has been establishing the My Social Security portal and giving access to electronic Social Security Statements to all workers over age 18. As the JEAC does not directly report costs to provide these online information statements, we construct this estimate from the aggregate budget.

Table C.1 shows how the aggregate LAE budget is broken down further into the portion of the budget devoted to information technology, electronic services investments, and the provision on electronic services as well as modernization of the My Social Security platform. Over the years

[23]During these years, Social Security Statements are only mailed to workers over the age of 60 who are not receiving Social Security retirement benefits yet and have not signed up for a My Social Security online account.

Table C.1: Social Security Administration Budget

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Limitation on Administrative Expenses (LAE)	**8,110.151**	**8,210.591**	**8.105.342**	**7,778.901**	**7,443.523**
Information Technology Services (ITS)	1,247.910	1,262.481	1,510.739	1,238.632	1,229.469
(share of LAE)	*(15.4%)*	*(15.4%)*	*(18.6%)*	*(15.9%)*	*(16.5%)*
Electronic Services Investments (ESI)	34.666	46.776	33.099	27.612	28.467
(share of ITS)	*(2.8%)*	*(3.7%)*	*(2.2%)*	*(2.2%)*	*(2.3%)*
Electronic Services	19.669	29.088	20.057	20.874	10.919
(share of ESI)	*(56.7%)*	*(62.2%)*	*(60.6%)*	*(75.6%)*	*(38.4%)*
My Social Security Services	5.933	6.057	5.006	—	—
(share of ESI)	*(17.1%)*	*(12.9%)*	*(15.1%)*	—	—

Source: JEAC FY 2020 - FY 2024

Notes: All values are in millions of 1998 dollars.

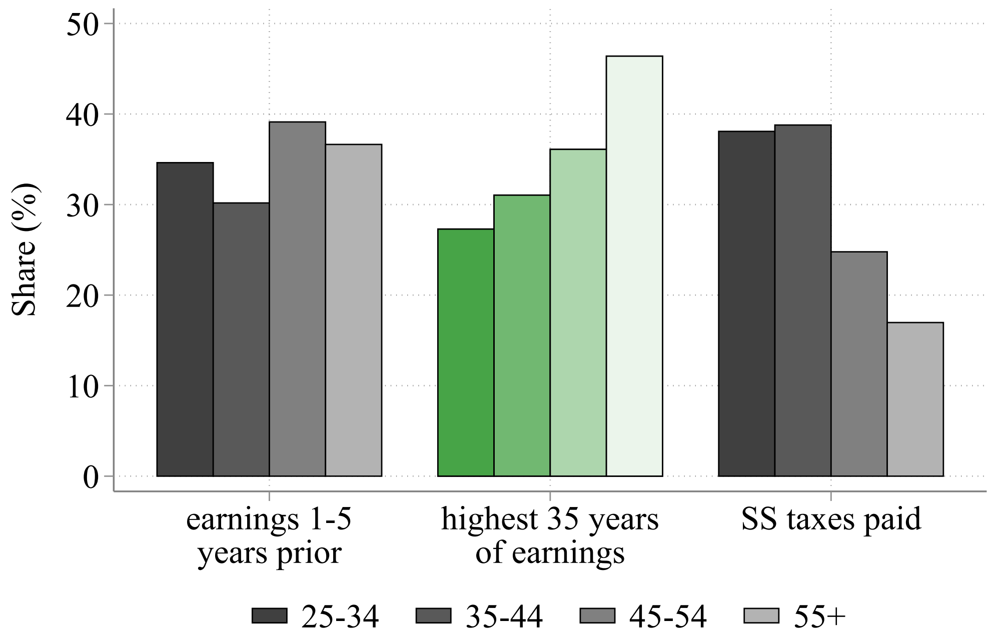
Table C.2: Spending on Mailed Social Security Statements

	FY 2019	FY 2020	FY 2021	Average
Spending on SS Statements (millions of 1998 $)	11	19	12	14
SS Statements Issued (millions)	3.725	6.108	3.732	4.522
Spending per SS Statement Issued (1998 $)	0.339	0.321	0.311	0.324

Source: JEAC FY 2020 - FY 2024

Notes: Aggregate spending values (Spending on SS Statements) are in millions of 1998 dollars. Per SS Statement spending values are in 1998 dollars.

Figure A.7: Misinformation about the Social Security Benefit Calculation by Age



Notes: Question asks "Which of the following best describes how a worker's Social Security benefits are calculated? They are based on...". Green bar denotes the correct answer. Additional details in Section A.2

considered (FY2018 - FY2022), the Social Security Administration spent between around $11 million and $29 million on providing electronic services. Additionally, as part of a electronic services modernization plan, SSA spent over $15 million to improve My Social Security Services. We consider two cases, to estimate the cost of providing information online: (1) an estimate which focuses on only the variable cost of providing electronic services, and (2) an estimate which includes the investment made to modernize the online system.

Table C.3 breaks down the aggregate electronic service spending. Moving from aggregate electronic spending (with or without the My Social Security investment) requires an assumption about the share of electronic services which are focused on providing the public with information about the retirement and Social Security benefits. Table C.3 shows both aggregate and per person spending on these online services for various assumption on this share. For this range of shares (from 10% to 100%), the aggregate spending ranges from $2.01 million to $23.52 million while per-person spending ranges from $0.012 to $0.144. Our preferred estimate for the share of electronic services related to retirement is 19.4%. This number is informed by what number of total electronic services (shown in Table C.4) are related to retirement planning. Under this share, aggregate spending without the My Social Security investment is $3.89 million. This implies a per-person cost of $0.024. If the My Social Security platform investment is included in this estimate, aggregate spending is $4.55 million and per-person spending is $0.028.

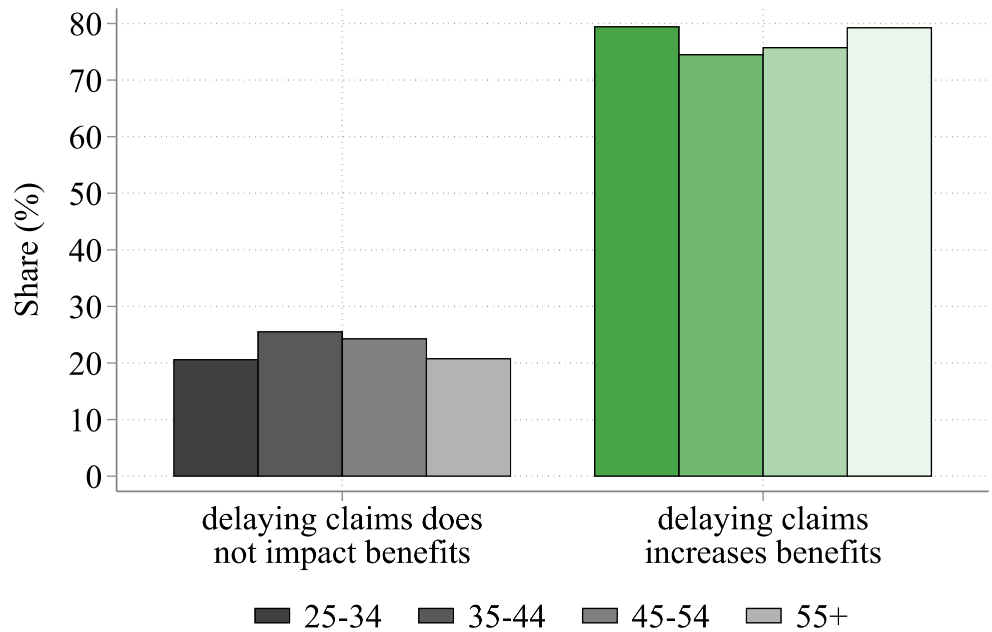
Table C.3: Electronic Services Budget Devoted to Retirement Planning Information

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Average
Electronic Services Spending (millions of 1998 $)	**19.669**	**29.088**	**20.057**	**20.874**	**10.919**	**20.122**
My Social Security Services Spending (millions of 1998 $)	**5.933**	**6.057**	**5.006**	**—**	**—**	**—**
Share devoted to Information	Aggregate Spending on Information (millions of 1998 $)					
10%*	1.97	2.91	2.01	2.09	1.09	2.01
10%**	2.56	3.51	2.51	2.09	1.09	2.35
19.4%*	3.81	5.63	3.88	4.04	2.11	3.89
19.4%**	4.96	6.80	4.85	4.04	2.11	4.55
25%*	4.92	7.27	5.01	5.22	2.73	5.03
25%**	6.40	8.79	6.27	5.22	2.73	5.88
50%*	9.83	14.54	10.03	10.44	5.46	10.06
50%**	12.80	17.57	12.53	10.44	5.46	11.76
75%*	14.75	21.82	15.04	15.66	8.19	15.09
75%**	19.20	26.36	18.80	15.66	8.19	17.64
100%*	19.67	29.09	20.06	20.87	10.92	20.12
100%**	25.60	35.15	25.06	20.87	10.92	23.52
Share devoted to Information	Per person Spending on Information (1998 $)					
10%*	0.012	0.018	0.012	0.013	0.007	0.012
10%**	0.016	0.022	0.015	0.013	0.007	0.014
19.4%*	0.023	0.035	0.024	0.025	0.013	0.024
19.4%**	0.030	0.042	0.030	0.025	0.013	0.028
25%*	0.030	0.045	0.031	0.032	0.017	0.031
25%**	0.039	0.054	0.038	0.032	0.017	0.036
50%*	0.060	0.089	0.062	0.064	0.034	0.062
50%**	0.079	0.108	0.077	0.064	0.034	0.072
75%*	0.091	0.134	0.092	0.096	0.050	0.093
75%**	0.118	0.162	0.115	0.096	0.050	0.108
100%*	0.121	0.179	0.123	0.128	0.067	0.124
100%**	0.157	0.216	0.154	0.128	0.067	0.144

Source: JEAC FY 2020 - FY 2024

Notes: Aggregate spending values (Electronic Services Spending and Aggregate Spending on Information) are in millions of 1998 dollars. Per person spending values are in 1998 dollars. Per-person spending measures are computed using the population age 25-69 who has not claimed SS retirement benefits (162,883,000 workers). The 19.4% share devoted to information is computed as the share of SSA Online Services (shown in Table C.4) which are focused on providing information for retirement, claiming planning. * denotes estimates excluding investments in My Social Security; ** denotes estimates including this investment

Figure A.8: Misinformation about the Adjustment for Claiming Age by Age



Notes: Question asks "How much should one expect his monthly benefit to be if he decides to wait to claim at age 64 rather than age 63?" Green bar denotes the correct answer. Additional details in Section A.2

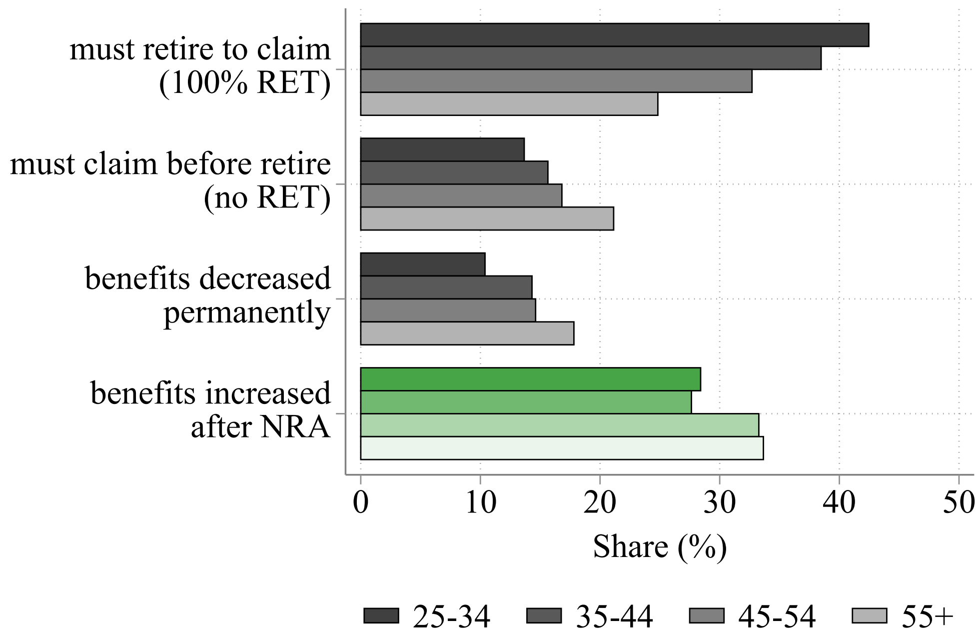
D Data and Estimation Details

The Panel Study of Income Dynamics (PSID) is used to estimates life-cycle profiles of labor force participation, hours, and wealth; the wage process; and the initial conditions. PSID is a nationally representative longitudinal survey in the United States. The original PSID sample was drawn from the nationally representative SRC sample and an oversample of the low-income SEO sample. We use the a sample of individual from the SRC sample who were interviewed twice or more between 1968 and 2017. Our sample consists of only male household heads between the ages of 22 and 74 who were born between 1926 and 1970. Our final sample consists of 103,423 observations for 7,516 individuals. When we consider the wealth profiles, we consider workers up to age 84 and born up until 1990. This sample consists of 149,059 observations for 13,172 individuals.

The Health and Retirement Study (HRS) is a longitudinal study of Americans over the age of 50. 2016 Version 1 is used in this work. Importantly, the survey contains questions related to retirement and Social Security claiming decisions. This data set is used for understanding the distribution of claiming ages as well as for the estimation of the impact of various factors on the probability of claiming early. The estimation sample includes all workers born between 1926 and 1970 who report an age for their Social Security claiming between 62 and 70 (9,255 individuals). Results are predicted for a cohort born between 1931 and 1935 (2,727 individuals).

We use the Household Component of Medical Expenditure Panel Survey (MEPS-HC) to identify health and mortality related parameters. MEPS-HC is a nationally representative survey of the U.S. civilian non-institutionalized population. The sampling frame is drawn from respondents

Figure A.9: Misinformation about the Retirement Earnings Test by Age



Notes: Results are compiled from two questions. The first question asks "Based on Social Security guidelines, what is the relationship between the age at which you stop working and the age at which you can begin claiming benefits?" The second question asks "Which of the following aspects of the Retirement Earnings Test is also true?" Green bar denotes the correct answer. Additional details in Section A.2

to the National Health Interview Survey (NHIS), which is conducted by the National Center for Health Statistics.

We set population shares for these groups based upon population shares at age 25. There are 18, 23, 15 and 43 percent for single-non-college, married-non-college, single-college and married-college groups respectively.

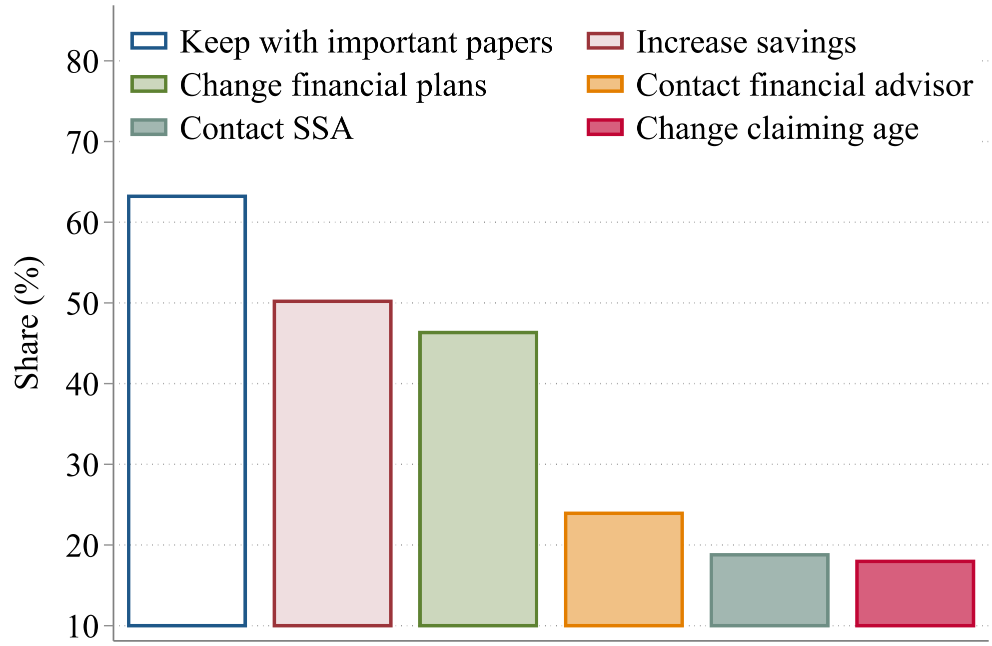
E CEV Calculation

In Section 6 we show three different welfare calculations: overall CEV (τ), life-cycle CEV $(\tilde{\tau})$, and CEV with fixed bequests $(\overline{\tau})$. In this section we discuss the derivation of each of these measures.

Overall CEV: This calculation measures the gains or losses, as a percentage of realized consumption, that an individual i would need in order to deliver the same lifetime utility when informed and misinformed.

Define realized lifetime utility as:

Figure A.10: Response to the Social Security Statement



Notes: Figure shows the share of people who respond they will take the following actions in response to having received the Social Security Statement.

$$V_I^i = \sum_{t=1}^{T_d^i+1} \beta^t \left(u(c_t^*, l_t^*) \times \mathbb{1}_{alive_t} + (1 - \mathbb{1}_{alive_t}) \frac{\theta_{beq}}{1-\rho} \left(a_t^* + \kappa_{beq}\right)^{(1-\rho)\nu} \right)$$

where $\{c_t^*, l_t^*, a_t^*\}_{t=1}^{T_d^i}$ are optimal consumption, leisure and savings decisions, and T_d^i is age at death for agent i (based on simulated health and mortality shocks). $\mathbb{1}_{alive_t}$ is an indicator function that equals one if a person is alive in period t and zero otherwise. We can similarly define the counterfactual lifetime utility of the same person in case of misinformation:

$$V_M^i = \sum_{t=1}^{T_d^i+1} \beta^t \left(u(1 - \tau_c^i)\hat{c}_t^i, \hat{l}_t^i) \times \mathbb{1}_{alive_t} + (1 - \mathbb{1}_{alive_t}) \frac{\theta_{beq}}{1-\rho} \left(\hat{a}_t^i + \kappa_{beq}\right)^{(1-\rho)\nu} \right)$$

where $\{\hat{c}_t^i, \hat{l}_t^i, \hat{a}_t^i\}_{t=1}^{T_d^i}$ are optimal consumption, leisure and savings decisions in the counterfactual scenario. Note that in both scenarios, all exogenous shocks of the individuals remain the same. Therefore, define the consumption equivalent variation (CEV), τ^i, as:

$$\tau^i = \left[\frac{V_M^i}{V_I^i}\right]^{1/\nu(1-\rho)} - 1$$

Life-cycle CEV: This calculation measures the gains or losses, as a percentage of realized consumption, that an individual i would need in order to deliver the same utility when alive.

To focus on the utility individual receives when alive, rewrite these lifetime utilities as:

$$\tilde{V}_I^i = \sum_{t=1}^{T_d^i+1} \beta^t \Big(u(c_t^*, l_t^*) \times \mathbb{1}_{alive_t} \Big)$$

$$\tilde{V}_M^i = \sum_{t=1}^{T_d^i+1} \beta^t \Big(u(1 - \tilde{\tau}_c^i)\hat{c}_t^i, \hat{l}_t^i) \times \mathbb{1}_{alive_t} \Big)$$

Then, define life-cycle CEV as:

$$\tilde{\tau}^i = \left[\frac{\tilde{V}_M^i}{\tilde{V}_I^i} \right]^{1/\nu(1-\rho)} - 1$$

CEV with Fixed Bequests: This calculation measures the gains or losses, as a percentage of realized consumption, that an individual i would need in order to deliver the same lifetime utility when informed and misinformed – holding bequests constant at the informed level in both cases.

Define a lifetime utility in which bequests are held at the baseline (informed level):

$$\overline{V}_M^i = \sum_{t=1}^{T_d^i+1} \beta^t \Big(u(1 - \tau_c^i)\hat{c}_t^i, \hat{l}_t^i) \times \mathbb{1}_{alive_t} + (1 - \mathbb{1}_{alive_t}) \frac{\theta_{beq}}{1-\rho} (a_t^* + \kappa_{beq})^{(1-\rho)\nu} \Big)$$

Then, CEV with fixed bequests is given by

$$\overline{\tau}^i = \left[\frac{\overline{V}_M^i}{V_I^i} \right]^{1/\nu(1-\rho)} - 1$$

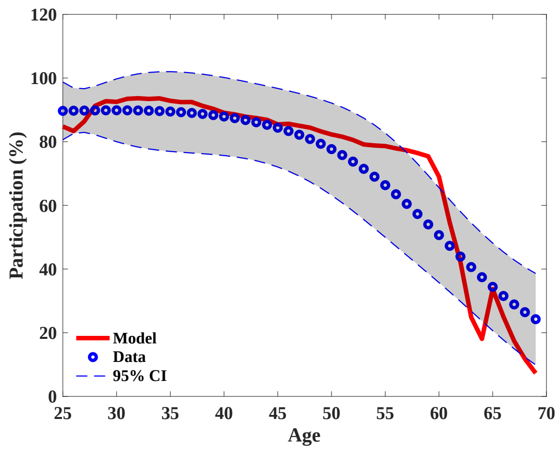
For each of these calculations, average CEV for a population of N individuals is given by:

$$\tau = \sum_{i=1}^{N} \mu^i \tau^i$$

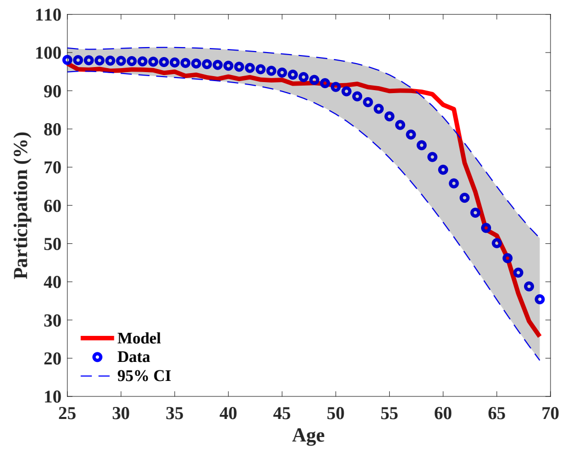
where μ^i is the measure of individual i in the population.

Figure E.1: Model Fit: Labor force participation rates

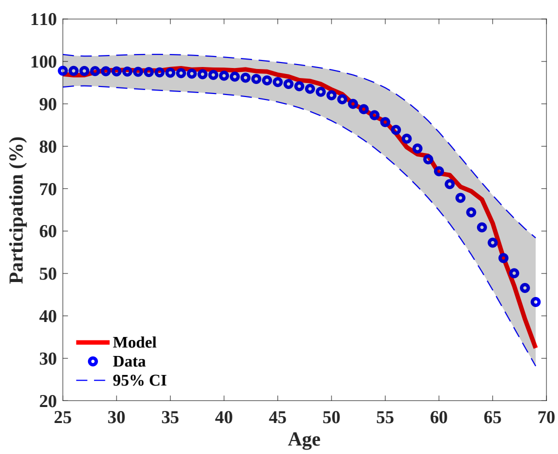
(a) Non-College, Non Married



(b) College, Non Married



(c) Non-College, Married



(d) College, Married

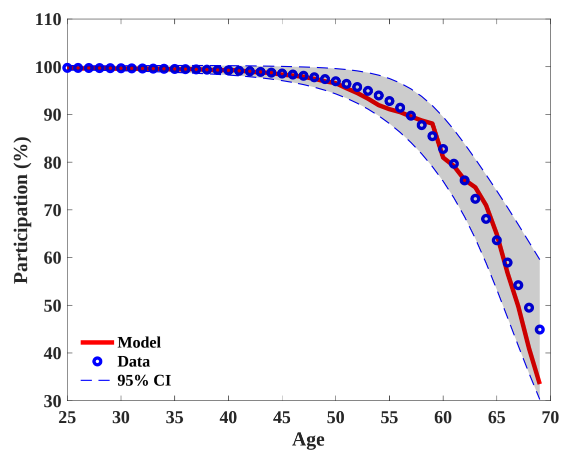


Table C.4: SSA Online Services

Appeals	
	Appeal a recent medical decision
	Continue a medical appeal you already started
	Appeal other non-medical decision
	Check you appeal status
Disability	
	Apply for benefits
	Return to a saved application
	Check your application status
	Apply for help with Medicare prescription drug plan cost
	Pay an overpayment
Medicare	
	Apply for benefits
	Return to a saved application
	Apply for help with medicare prescription drug plan costs
	Check you appication status
	Request a replacement Medicare card
SSI	
	Tell us you want to apply for SSI
	Print proof of benefits
	Pay an overpayment
Accessibility	
	Get help receiving information if you are blind or visually impaired
Retirement	
	Apply for benefits
	Return to a saved application
	Check your application status
✓	Use our online calculators
✓	Estimate retirement benefits
	Pay an overpayment
Estimate Future Benefits	
✓	Find the benefits you qualify for
✓	Find your full retirement age
✓	Estimate retirement benefits
✓	Use our online planners
Social Security Cards	
	Social Security Number and card
	Request a replacement Social Security cards
	Correct or change name

Notes: checkmark (✓) indicates that this online service is related to retirement planning or Social Security claiming information. List of online services can be found here: https://www.ssa.gov/onlineservices/

Table C.5: Mapping from Misinformation Types to Model Features

Benefit Calculation	
1-5 years prior	$a_{t+1}^{ss} = \max\{a_t^{ss}, a^{\max}\}$
	$pia(a_t^{ss}) = 0.90 \times \min\{a_t^{ss}, b_0\} + 0.32 \times \min\{\max\{a_t^{ss} - b_0, 0\}, b_1 - b_0\} + 0.15 \times \max\{a_t^{ss} - b_1, 0\}$
highest 35 earning years	$a_{t+1}^{ss} = \max\{[a_t^{ss} + \max\{0, (w_t h_t - a_t^{ss})/35\}], a^{\max}\}$
	$pia(a_t^{ss}) = 0.90 \times \min\{a_t^{ss}, b_0\} + 0.32 \times \min\{\max\{a_t^{ss} - b_0, 0\}, b_1 - b_0\} + 0.15 \times \max\{a_t^{ss} - b_1, 0\}$
SS taxes paid	$a_{t+1}^{ss} = \max\{[a_t^{ss} + \max\{0, (w_t h_t - a_t^{ss})/35\}], a^{\max}\}$
	$pia(a_t^{ss}) = a_t^{ss}$
Benefit Size and Claiming Age	$ssb_t = pia(a_t^{ss}) * \Gamma_t - \Upsilon_t$
no penalty	$\Gamma_t = 1$
accurate penalty	$\Gamma_t = 1 - (t_{NRA} - t^{ss}) * \gamma_t^{ss}, \gamma_t^{ss} = 0.06$
Retirement Earnings Test	$ssb_t = pia(a_t^{ss}) * \Gamma_t - \Upsilon_t$
100% RET	$\Upsilon_t = pia(a_t^{ss}) * \Gamma_t$
no RET	$\Upsilon_t = 0$
benefits decreased permanently	$ssb_{t+1} = pia(a_{t+1}^{ss})$
	$a_{t+1}^{ss*} = pia^{-1}(ssb_{t+1})$
Correct RET	$ssb_{t+1} = pia(a_{t+1}^{ss}) * \left[1 + \left(\frac{\Upsilon_t}{ssb_t}\right)\gamma_t^{ss}\right]$
	$a_{t+1}^{ss*} = pia^{-1}(ssb_{t+1})$

Figure E.2: Model Fit: Wealth

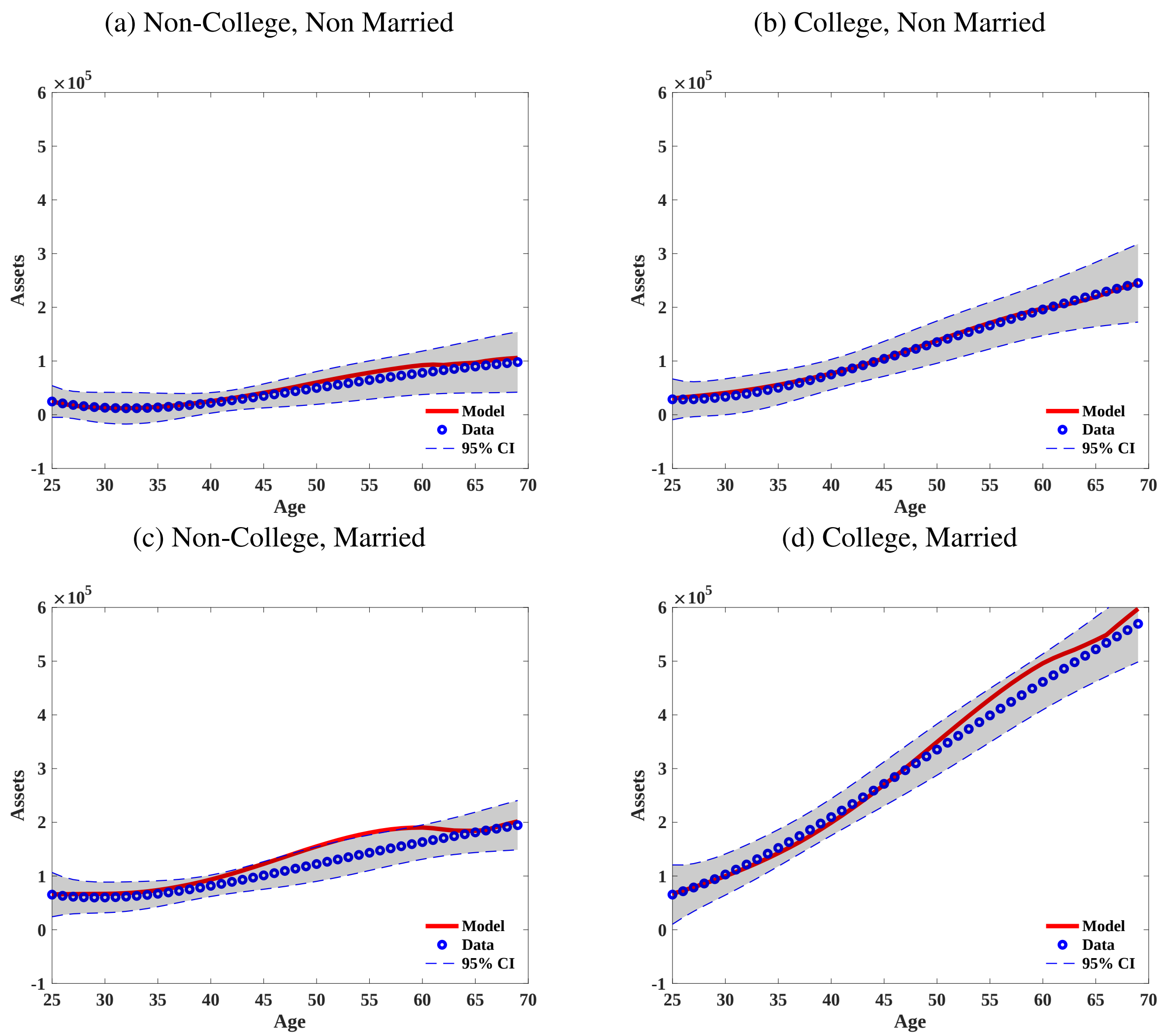


Figure E.3: Model Fit: SS Claiming Behavior

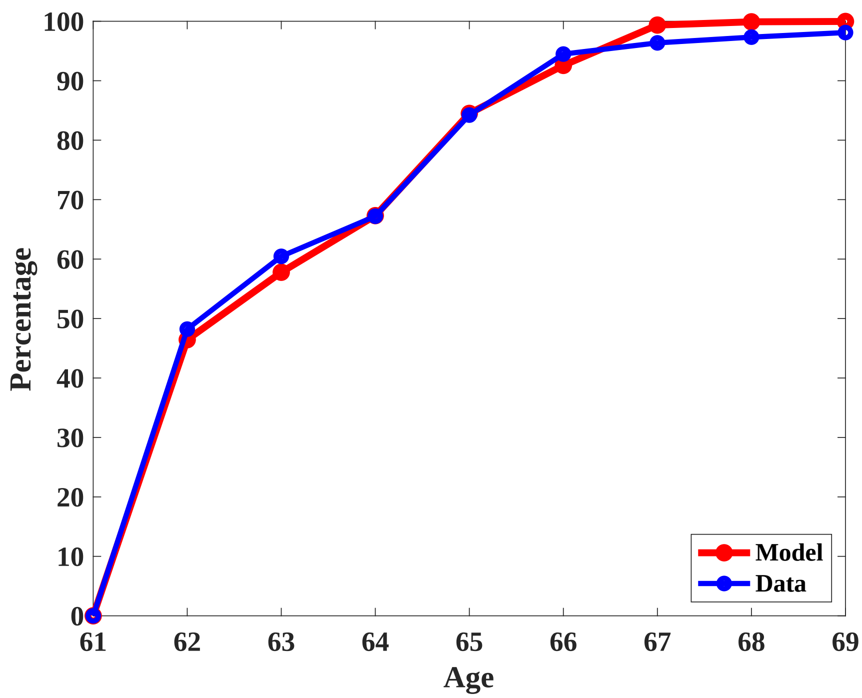


Table E.1: Mapping from Misinformation Types to Model Features

Benefit Calculation	
1-5 years prior	$a_{t+1}^{ss} = \max\{a_t^{ss}, a^{\max}\}$
	$pia(a_t^{ss}) = 0.90 \times \min\{a_t^{ss}, b_0\} + 0.32 \times \min\{\max\{a_t^{ss} - b_0, 0\}, b_1 - b_0\} + 0.15 \times \max\{a_t^{ss} - b_1, 0\}$
highest 35 earning years	$a_{t+1}^{ss} = \max\{[a_t^{ss} + \max\{0, (w_t h_t - a_t^{ss})/35\}], a^{\max}\}$
	$pia(a_t^{ss}) = 0.90 \times \min\{a_t^{ss}, b_0\} + 0.32 \times \min\{\max\{a_t^{ss} - b_0, 0\}, b_1 - b_0\} + 0.15 \times \max\{a_t^{ss} - b_1, 0\}$
SS taxes paid	$a_{t+1}^{ss} = \max\{[a_t^{ss} + \max\{0, (w_t h_t - a_t^{ss})/35\}], a^{\max}\}$
	$pia(a_t^{ss}) = a_t^{ss}$
Benefit Size and Claiming Age	$ssb_t = pia(a_t^{ss}) * \Gamma_t - \Upsilon_t$
no penalty	$\Gamma_t = 1$
accurate penalty	$\Gamma_t = 1 - (t_{NRA} - t^{ss}) * \gamma_t^{ss}, \gamma_t^{ss} = 0.06$
Retirement Earnings Test	$ssb_t = pia(a_t^{ss}) * \Gamma_t - \Upsilon_t$
100% RET	$\Upsilon_t = pia(a_t^{ss}) * \Gamma_t$
no RET	$\Upsilon_t = 0$
benefits decreased permanently	$ssb_{t+1} = pia(a_{t+1}^{ss})$
	$a_{t+1}^{ss*} = pia^{-1}(ssb_{t+1})$
Correct RET	$ssb_{t+1} = pia(a_{t+1}^{ss}) * \left[1 + \left(\frac{\Upsilon_t}{ssb_t}\right)\gamma_t^{ss}\right]$
	$a_{t+1}^{ss*} = pia^{-1}(ssb_{t+1})$

Table E.2: Welfare Impacts of Interactions

	population share	Overall CEV	CEV with Fixed Bequests	Life-Cycle CEV
Fully informed	11.1	—	—	—
Earnings history	8.8	0.8	-0.11	-0.21
PIA formula	7.8	-13.61	-0.57	-3.16
Age adjustments	1.6	-1.64	0.04	-0.15
No RET	5.0	-0.42	-0.07	-0.1
100% RET	7.9	0.87	-0.07	-0.1
Permanent reduction from RET	5.2	0.47	0.05	-0.02
Earnings history + 100% RET	9.3	1.63	-0.09	-0.37
PIA formula + 100% RET	7.5	-14.29	-0.68	-3.25
Earnings history + permanent reduction from RET	4.1	1.37	0.08	-0.28
PIA formula + No RET	3.8	-14.17	-0.48	-3.29
Earnings history + No RET	3.7	0.6	-0.07	-0.33
Earnings history + Age adjustments + 100% RET	3.7	0.37	-0.12	-0.54
PIA formula + Age adjustments + 100% RET	3.0	-12.75	-0.56	-3.16
PIA formula + permanent reduction from RET	3.0	-14.31	-0.63	-3.28
Age adjustments + 100% RET	2.6	-0.33	-0.04	0.15
Earnings history + Age adjustments	2.5	-1.11	-0.18	-0.59
PIA formula + Age adjustments	2.5	-13.42	-0.63	-3.43
Earnings history + Age adjustments + No RET	1.8	-1.51	-0.22	-0.85
Age adjustments + No RET	1.5	-2.42	-0.02	-0.4
PIA formula + Age adjustments + No RET	1.2	-13.34	-0.58	-3.33
Earnings history + Age adjustments + permanent reduction from RET	1.0	-0.1	-0.11	-0.25
Age adjustments + permanent reduction from RET	0.9	-0.82	0.08	0.09
PIA formula + Age adjustments + permanent reduction from RET	0.4	-12.97	-0.62	-3.18