Dying to Retire:
Adverse Selection and Welfare in Social Security*

Andrew Beauchamp
Boston College

Mathis Wagner
Boston College

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Abstract

Despite facing some of the same challenges as private insurance markets, little is known about the role of adverse selection in Old-Age Social Security. Using data from the Health and Retirement Study we find robust evidence that people who live longer both choose larger annuities - by delaying the age they first claim benefits - and are more costly to insure, evidence of adverse selection. To quantify welfare consequences we develop and estimate a model of claiming decisions, finding that adverse selection increases costs to the system and reduces social welfare by 1-3 percent. Our results are robust to extending the choice set to include disability insurance, observed and unobserved heterogeneity in Social Security annuity valuations, and the endogeneity of longevity expectations. The estimates imply that increasing the pension accrual rate, by decreasing the adjustment factor for early retirement, would yield substantial costs savings and by encouraging more efficient sorting, slightly increasing social welfare. In contrast, the cost savings from increasing the full retirement age are accompanied by significant reductions in social welfare. A mandate eliminating the choice to claim early, while resulting in large cost reductions, is even less desirable: it would entail large social welfare losses and a 50 percent increase in the number of people claiming disability insurance.

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"We can never insure one hundred percent of the population against one hundred percent of the hazards and vicissitudes of life, but we have tried to frame a law which will give some measure of protection to the average citizen and to his family against the loss of a job and against poverty-ridden old age." - Franklin Roosevelt's Statement on Signing the Social Security Act (August 14 , 1935).

1 Introduction

Old-Age Social Security (OASS) was established in 1935 by the Social Security Act as insurance against poverty-ridden old age. The massive scale of the program (in 2011 retirement benefits accounted for around 17 percent of federal spending)[1] has given rise to an extensive literature exploring its various aspects, with much focus on labor supply and savings. However, we know little about the efficiency of OASS as an insurance mechanism (Chetty and Finkelstein, 2012). The fundamental challenges to efficiently functioning insurance systems are adverse selection and moral hazard. OASS provides an annuity insuring against outliving ones' assets. Individuals can choose their level of insurance because delayed claiming is equivalent to the purchase of a larger annuity (Coile, Diamond, Gruber and Jousten, 2002). If people self-select their Social Security claiming ages based on their expected longevity, then an individual's demand for more insurance (the claiming of benefits later) is likely positively correlated with the individual's risk profile (their life expectancy). Since the Social Security system does not incorporate this when pricing benefits, it would give rise to adverse selection. Whether it does and to what degree this selection affects the solvency of the system and the attractiveness of various reform proposals is the focus of this paper. Drawing data from the Health and Retirement Study (HRS) we identify the existence of adverse selection in OASS, quantify its welfare consequences, and analyze the effect of alternative policy reforms.

The standard test for asymmetric information is to determine whether people with higher expected claims buy more insurance.[2] Our approach differs from the standard test since in the case of Social Security the HRS contains two direct measures of underlying risk: actual longevity (for the subset of individuals who are observed to have died in the sample), and a subjective longevity measure.[3] We provide clear evidence that life expectancy is correlated with both annuity choice and the cost to the insurer. Based on actual death ages we find that living one year longer was correlated with claiming three-quarters of a month later and roughly a \$10,000 additional cost to the Social Security Trust Fund. Taken together the results provide clear evidence of asymmetric information being an important determinant in the timing and associated costs of claiming retirement benefits. These correlations are robust to the inclusion of a large set of covariates, and to instrumenting the subjective death age measure using father's death age. Thus we find evidence that individuals' private information about longevity generates an inefficiency

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[1] In fiscal year 2011, the federal government spent \$3.6 trillion of which \$604 billion went to the Old-Age and Survivors Insurance program, and \$132 billion to the Disability Insurance program.

[2] See Chiappori and Salanie (2000). Cohen and Siegelman (2010) and Einav, Finkelstein and Levin (2010) provide a recent survey of evidence from a variety of markets.

[3] Finkelstein and Poterba (2006) describe such variables as "unused observables."

in the overall system.

To quantify the welfare consequences of the adverse selection present in Social Security, we develop a discrete choice model of claiming Social Security benefits. This approach allows us to estimate preferences for when to claim Social Security benefits, accounting for various sources of heterogeneity, and to then evaluate how various policy changes interact with adverse selection to change costs and social welfare. In our baseline model we use a non-linear transformation of the raw correlation between death and claiming ages to identify the inter-temporal elasticity of substitution. Guided by the literature we include in the estimation a large set of covariates that influence claiming decisions to better approximate the complexity of the choice problem. We also extend our baseline model on three important dimensions: (i) using an instrumented subjective longevity measure as a plausibly exogenous measure of life expectancy, (ii) extending the individuals' choice set to include claiming disability benefits, and (iii) allowing for (observed and unobserved) heterogeneity in valuations of the annuity provided by Social Security.

We find robust evidence that a large fraction of individuals claim old-age Social Security benefits at a socially inefficient age (at a minimum 7.3 percent of claimants). The associated social welfare losses are of the order of 0.05 to 3.2 percent,[4] which is in the range of estimated welfare costs of asymmetric information in other markets.[5] Adverse selection also increases the costs of operating the Social Security system by 1.1 to 3.2 percent of current outlays, which is 7 to 20 percent of the current projected deficit of the Social Security Trust Fund.

We estimate the model in order to study how adverse selection interacts with two key features of the annuity contracts offered by Social Security: the adjustment factor (or "early retirement penalty"), and a changing of the full retirement age (FRA) while keeping accrual rates constant (the policy implemented in the 1983 reforms to Social Security).[6] We also simulate the effect of a mandate that eliminates the option to claim benefits early, and examine substitution toward claiming Social Security Disability Insurance (SSDI).

The results show that Social Security claiming decisions respond to financial incentives, and that heterogeneity plays a key role in determining whether policies improve or reduce welfare. The socially optimal accrual rate, achieved by decreasing the adjustment factor at age 62 to 0.71 (rather than the 0.80 penalty our sample faced) would allow the system to cut costs by 7.2 percent, but without decreasing social welfare.[7] The fraction of early claimants under this policy would fall from 0.70 in our sample to around 0.64 with optimal accrual rates, leading to the large cost reductions. Raising accrual rates reduces the marginal incentives of individuals to claim early and would induce some of the most

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[4] Willingness-to-pay, and hence welfare, are estimated as relative to claiming benefits at age 65.

[5] Notably, in the UK annuity market Einav, Finkelstein and Schrimpf (2010) find welfare losses of about 2 percent of annuitized wealth. In health insurance markets studies find welfare losses due to adverse selection of between 1 and 4 percent (Cutler and Reber, 1998; Einav, Finkelstein and Cullen, 2010; and Bundorf, Levin and Mahoney, 2011). Hackman, Kolstad and Kowalski (2013) find somewhat larger welfare gains from reductions in adverse selection due to the Massachusetts health reform of 2006.

[6] Existing empirical work on adverse selection has focused on inefficiencies arising from the mispricing of existing contracts and the effect of mandates (Einav, Finkelstein and Levin, 2010). In contrast, in this paper we consider the effects of changes in the types of contracts available, as these are the focus of policy debates regarding the solvency of Social Security.

[7] 7.2 percent is roughly 45 percent of the projected shortfall in the Social Security Trust Fund.

costly early claimants toward later retirement, allowing for cost reductions and welfare gains. Our results suggest only a small fraction of individuals (0.6 percent of OASS claimants in our sample) would switch to SSDI, not enough to substantively affect any of our conclusions.

In contrast, simulations suggest that raising the FRA to 66, while reducing the age 62 benefit to 0.75 of the FRA benefit, reduces costs by roughly 6 percent but also reduces social welfare by a similar magnitude.[8] Increasing the FRA is equivalent to cutting benefits, which unlike changing the accrual rate does not induce more socially efficient sorting (it makes matters slightly worse), and hence is accompanied by large decreases in social welfare. In contrast to much of the existing evidence we find evidence of sizable wealth effects.[9] Our simulations suggest that the reduction in Social Security wealth from an increase in the FRA to age 66 results in an around 5 percentage point reduction in people claiming benefits early (and 0.7 percent would switch to SSDI).

Mandating that everyone claim benefits at age 65 yields the largest costs-savings of any reform, around 11 percent of current costs or $13,000 per claimant. However, the average estimated value of claiming benefits early among those who choose to exercise that option (70 percent of our sample) is over $60,000. The option to receive benefits early is very valuable to early claimants, and the welfare losses from a mandate eliminating early retirement would far outweigh the cost savings. Among our simulated policy reforms, such a mandate would result in a substantial rise in the number of people claiming disability (by around 50 percent).

The current debate surrounding the solvency of OASS often involves suggestions of raising the full retirement age.[10] However, our estimates here present evidence that there are still inefficiencies in the system, and fairly straightforward ways to reduce outlays without broadly reducing social welfare. Namely, policies which increase accrual rates offer the hope of inducing more socially efficient selection of individuals into claiming ages, reducing the costs to the system while mitigating welfare losses. Meanwhile, cutting benefits by raising the FRA, as in the 1983 Amendments, leaves the adverse selection problem un-addressed, and may exacerbate it.

The remainder of the paper proceeds as follows. Section 2 outlines the OASS system and describes the data. We discuss our strategy for identifying adverse selection in Social Security claiming choices and present our estimates in Section 3. In Section 4 we develop an empirical model for quantifying the welfare consequences of adverse selection, present our results for a baseline model and its three main extensions: heterogeneous annuity valuations, accounting for the option to claim disability benefits, and using an instrumented

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[8] The 1983 Amendments to the Social Security Act progressively makes this adjustment for cohorts born after 1937 (for our sample the full retirement age is 65). For birth cohorts after 1955 it was progressively increased to age 67 (in two month increments for each ensuing year of birth)

[9] While the existence of price effects due to changes in accrual rates is well established, see for example Gruber and Wise (2004, 2007); Krueger and Pischke (1992) and subsequent work have tended to find small wealth effects.

[10] AARP (2012), Congressional Budget Office (2010), Diamond and Orszag (2005), Urban Institute (2009), and National Co mmission on Fiscal Responsibility and Reform (2010). Increasing payroll taxes (or raising the cap) and reducing the annual adjustments to the level of benefits (COLA) are other common proposals. Adjusting the COLA, like raising the FRA, is an effective cut in benefits, with probably similar welfare consequences.

subjective longevity measure. Section 5 develops the implications of two important policy reforms changing the contracts available to claimants: changing the benefit accrual rate and the full retirement age; as well as the effect of a mandate eliminating early retirement. Section 6 offers some concluding thoughts.

2 Data

2.1 Social Security Retirement Benefits[11]

An individual's OASS benefits depend on the average indexed monthly earnings (AIME), the pension coefficient, and the age at which the individual retires.[12] Nearly everyone in our data is eligible for Social Security. The ability to choose the age at which to claim Social Security was introduced in 1956 for women and 1961 for men.

The earliest benefits are available is at age 62. Full retirement benefits depend on a retiree's year of birth. The full retirement age for those born 1937 and prior is 65, which covers nearly everyone in our sample.[13] A worker who starts benefits before full retirement age has their benefit reduced based on the number of months before full retirement age they start benefits. This reduction is 5/9 percentage points for each month up to 36 and then 5/12 percentage points for each additional month. This formula gives an 80 percent benefit at age 62 for a worker with a full retirement age of 65. One can also defer claiming Social Security beyond their full retirement age, increasing the benefit. Finally, one can continue working while claiming benefits, but an earnings test taxes away earnings beyond of cohort specific cap among the early claimants in our sample. In the data, there is a strong positive correlation between the decision to stop working and claim Social Security benefits. For the birth cohorts we examine (1916-40) only one in four individuals continue working after claiming benefits.

Social Security is primarily funded through a dedicated payroll tax, known as a pay-as-you go system, so current workers taxes pay current claimant benefits. Thus although one contributes through taxation to the system, contributions are not a price paid for receipt of benefits. Rather contributing is both legally binding for most, and entitles one to participate in the system upon retirement, receiving whatever benefits the law

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[11] The Social Security Administration documents all features of the system on its website: www.socialsecurity.gov.

[12] The AIME is constructed by averaging an individual's 35 highest earning years (up to the social security earnings cap) adjusted by the national average wage index. The pension coefficient is a piecewise linear function, the primary insurance amount (PIA) is 90 percent of the AIME up to the first (low) bend point, and 32 percent of the excess of AIME over the first bend point but not in excess of the second (high) bend point, plus 15 percent of the AIME in excess of the second bend point. This PIA is then adjusted by automatic cost-of-living adjustments (COLA) annually starting with the year the worker turns 62.

[13] The FRA increases by two months for each ensuing year of birth until 1943, when it reaches 66 and stays at 66 until the 1955 cohort. Thereafter it increases again by two months for each year until the 1960 cohort when the FRA is 67 and remains there for all individuals born thereafter. For every year that benefits are deferred beyond the FRA, benefits are increased, up until age 70, where the amount of the bonus is dependent on the person's birth date, ranging from 3 percent per year for birth cohorts 1917-24 to 8 percent per year for those born 1943 and later.

proscribes.[14] According to *The 2012 Old-Age and Survivors Insurance and Disability Insurance (OASDI) Trustees Report* under current projections, the annual cost of Social Security benefits expressed as a share of workers' taxable earnings will grow rapidly from 11.3 percent in 2007, the last pre-recession year, to roughly 17.4 percent in 2035, and will then decline slightly before slowly increasing after 2050. The projected 75-year actuarial deficit for the combined OASDI Trust Funds is 2.67 percent of taxable payroll. This deficit amounts to 20 percent of program non-interest income or 16 percent of program cost.

2.2 Health and Retirement Study

The University of Michigan Health and Retirement Study (HRS) is a longitudinal panel study that surveys a representative sample of more than 26,000 Americans 51 years and older, with surveys conducted over the period 1992 to 2010.[15] The survey is representative of the cross-section of older Americans at any given point in time, but is not representative of the longitudinal experience of any one particular cohort.

The HRS contains a comprehensive set of variables that are likely important for an individual's Social Security claiming decision. The data provides detailed information in a number of domains: health, demographics, wealth and spousal characteristics. The available health information relates to the top four causes of death among those aged 65 and above: heart disease, cancer, chronic lower respiratory disease, and stroke, as well as diabetes, accounted for 68.4 percent of deaths in 2008.[16,17] The demographic information includes years of schooling, whether the person has been or is married, whether they belong to an ethnic minority (Black, Hispanic and other groups) and year of birth.[18] For a subsample of the data there are numerous measures of financials at the time of retirement: including: the capital income of the household, their total wealth (including housing), and income from employer provided pensions.[19] We also use information from the HRS on the spouses Social Security benefits, their years of education and spousal death age (if the spouse died before the primary respondent), mean subjective longevity of the

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[14] Luttmer and Samwick (2012) examine the welfare costs from uncertainty regarding the level of benefits claimants will actually receive.

[15] The current version of the HRS was created in 1998 when the original HRS, which surveyed people born 1931-41, was merged with the Asset and Health Dynamics Among the Oldest Old (AHEAD), for cohorts born before 1924, study, as well as with two new cohorts: the Children of the Depression Era (CODA), born in 1924-30 and War Babies (WB), born in 1942-47.

[16] See Heron (2008). The other main causes of death are Alzheimer's disease, influenza and pneumonia, unintentional injuries, and nephritis, which are not causes of death that people are likely to anticipate when making their Social Security retirement decision.

[17] Health histories (with the exception of diabetes) are frequently incomplete because of both the phrasing of questions, and the timing of interviews (some respondents were interviewed only after age 62). We include three different indicators for each health condition: never had, ever had before age 62, and censored by the survey design.

[18] Minorities (Black and Hispanic) are overrepresented in the HRS (15.5 percent of the sample). Correcting for the sampling methodology has no impact on the correlation test in Section 3 below. Since we do not use weights in the structural estimation we present unweighted results throughout.

[19] We use indicators of these and other variables for individuals from earlier cohorts who were not surveyed until after age 62.

spouse, and spouse age. Finally, we construct from the panel of social security income reports the individuals' AIME, which given an individual's payment is a deterministic function of year of birth, year of claiming, and age of claiming.[20]

The HRS contains two measures of longevity. An objective measure of life expectancy: the actual death age for those individuals in the sample who are observed to have died during the sampling period.[21] We also construct a mean subjective longevity measure created from questions on the probability of living to various ages administered over the course of the panel.[22] Our main sample is those 1807 individuals whose death age we observe, and who did not claim disability benefits or SSI. Restricting our main sample to those who have died means that we do not have a representative sample of individuals in a cohort (but rather those who died early). In principle, though we have a representative sample of the cross-section of older Americans. We also provide estimates for those 5772 individuals for who we have a subjective longevity measure, and who did not claim disability benefits or SSI. In an extension to our basic model, see Section 4, we also incorporate those individuals who claim disability benefits and die during the sample period.

Table 1 provides descriptive statistics for our main sample. Around 50 percent of the sample claim benefits at the age of first eligibility (age 62) and only about 29 percent claim at or after the full retirement age of 65. The average death age is increasing in the age at which individuals first claim Social Security, 72.5 years for those claiming at age 62 as compared to 74.8 years for those claiming at age 65. Individuals who claim benefits earlier are also in poorer health at age 62. They are more likely to have had heart disease, cancer, stroke, diabetes, lung disease, arthritis and to have smoked. No such clear relationship exists in terms of years of education, marital status, minority status, or spousal death age, though the age gap and spousal age-62 benefit levels both increase with respondent claiming age. Those who claim benefits at age 62 are also poorer than those who claim at age 65 or thereafter. They have lower Social Security benefits, less capital income, total wealth, private pension income, and lower earnings at the time they claimed benefits.

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[20] Because the panel of reports showed some irregularities (if for instance benefits are withheld due to work or reduced because of part-year claiming), we take the second order statistic (the second highest benefit reported) from the sequence of individual reported social security income between 1992 and 2010 (or the year of death).

[21] The HRS typically learns of the death of a respondent when an interviewer attempts to reach the respondent for an interview during the main data collection period. The respondent's spouse or another close family member or friend is asked to provide a final interview on behalf of the respondent (the exit interview), the response rate has ranged between 84 and 92 percent.

[22] To construct the mean of the subjective longevity distribution we use at least two measurements of the probability of living to age 75, 85, or 90 (which of these we observe for an individual in a given wave depends on the birth cohort). We construct the mean as the weighted average using the mid-points within each interval, combined with the assumption that no positive probability is placed on living past age 95. Thus $\theta_i^{subj} = .5 * (A_{wave_{obs}} + 75) * P(\theta_i < 75) + 80 * (P(\theta_i \in [75, 85]) + 90 * P(\theta_i > 85)$. For a few individuals, only observed in the data past age 75, we perform a similar procedure with the probability of living to age 80, 85 and 90.

3 Testing for Adverse Selection

3.1 The Positive Correlation Test

A standard feature of models of insurance markets with asymmetric information is that in equilibrium those choosing more insurance are more likely to experience the insured risk (Philipson and Cawley, 1999; Chiappori and Salanie, 2000; Chiappori, Jullien, Salanie and Salanie, 2006). The standard test for asymmetric information (either adverse selection or moral hazard) is to determine whether people with higher expected claims buy more insurance. There is an extensive empirical literature on adverse selection in insurance markets, which argues that the magnitude and even sign of the correlation between preferences for insurance and expected claims is not the same across markets.[23] However, we know of no evidence on the role of adverse selection in public pensions. Moreoever, Finkelstein and McGarry (2006) and Cutler, Finkelstein and McGarry (2008) argue that the magnitude and even sign of the correlation between preferences for insurance and expected claims is not the same across markets. This suggests that evidence from other insurance markets, for example private annuity markets, is unlikely to be very informative with regard to understanding the scope of adverse selection in Social Security.

The issue of whether asymmetric information is present in OASS annuity choices has to our knowledge not been previously investigated. The expected cost to the Social Security Administration (SSA) of providing this insurance depends both on the level of benefits and the length of the period over which they pay benefits, which in turn depends on longevity. Adverse selection in Social Security would arise if those with a greater longevity (more risky individuals) systematically obtained more insurance (a higher annuity) by claiming Social Security benefits later. Moral hazard would arise if obtaining a higher annuity by claiming later, for reasons unrelated to longevity, resulted in greater life expectancy (for example, through greater investment in health related inputs). Moral hazard though is arguably less important in the context of Social Security than for other forms of insurance.[24]

In the absence of information on the underlying source of risk (longevity) the canonical positive correlation test involves two reduced-form estimating equations: one for insurance coverage and the other for risk of loss. The set of conditioning variables are exclusively those observable characteristics that are used in pricing the insurance policy. Unlike private life insurance companies Social Security does not sell annuities, but rather is funded through dedicated payroll taxes. It charges all eligible individuals an identical price equal to zero for claiming benefits, and consequently does not use any observable characteristics to price the annuities it provides.[25] A statistically significant positive correlation between the residuals of the two equations yields a rejection of the null hypothesis of symmetric information.

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[23] See Cohen and Siegelman (2010) and Einav, Finkelstein and Levin (2010) for recent overviews of the literature. Hackman, Kolstad and Kowalski (2012) present evidence of adverse selection in health care.

[24] Finkelstein and Poterba (2004, 2006) and Einav, Finkelstein and Schrimpf (2010) also make that argument for the private UK annuity market.

[25] Penalties for early claiming and the opportunity costs of waiting to retire both make early claiming less attractive all else equal, but they are not prices. Penalties enter lifetime utility non-linearly for risk averse agents, and opportunity costs vary across the population.

The HRS contains many observed characteristics which are plausibly correlated with the underlying risk measure, and thus potentially with both insurance coverage and costs. Finkelstein and Poterba (2006) describe such variables as "unused observables," whereby it makes no conceptual difference whether these variables are truly not observable to the insurer but are to the individual, or whether for some reason those characteristics are not used in pricing. The SSA is of course by law not allowed to use any observables for pricing their annuities, and hence there are plausibly a large number of unused observables.[26] In particular, the HRS contains two direct measures of underlying risk: actual longevity for the subset of individuals who are observed to have died in the sample, and a subjective longevity measure.

A straightforward way to implement the positive correlation test for Social Security is to test whether individuals' choice of annuity, as measured by the age at which they first claim (A), is correlated with underlying risk, as measured by life expectancy (θ). In addition, we need to establish that our measure of risk is correlated with the costs to the insurer (C).[27] The estimating equation are:

$$\begin{aligned} A_i &= \mu\theta_i + \varepsilon_i, \qquad (1) \\ C_i &= \gamma\theta_i + \upsilon_i. \qquad (2) \end{aligned}$$

Statistically significant positive estimates of μ and γ imply the presence of adverse selection or moral hazard (a statistically significant correlations of opposite signs would suggest advantageous selection). It is worth emphasizing that the positive correlation test relies on identifying an equilibrium relationship between longevity and annuity choice and costs. It does not require that our longevity measure be exogenous.

3.2 A Graphical Illustration

To provide intuition for why the positive correlation test identifies adverse selection in Social Security consider a simplified situation in which individuals choose to either claim a large annuity at the full retirement age (age 65) or claim a lower annuity at the age of first eligibility (age 62). Also, for illustrative purposes, assume that individuals are identical except for life expectancy θ. Denote the the incremental willingness-to-pay for claiming benefits early for an individual of type θ as $\Delta V(\theta)$; and the relative expected monetary costs to the Social Security Trust Fund as $\Delta C(\theta)$.

If both μ and γ, from equations (1) and (2), are positive then $\frac{d\Delta V(\theta)}{d\theta} < 0$ and $\frac{d\Delta C(\theta)}{d\theta} < 0$. This situation is illustrated in Figure 1 with individuals' longevity θ on the x-axis and dollars on the y-axis. The key feature of adverse selection is that the individuals who have the highest willingness-to-pay are those who, on average, have the highest expected costs. The corresponding aggregate demand and cost curves are plotted in Figure 2, with the relative price (or cost) of claiming benefits early on the y-axis, and the share

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[26] The unused observables approach is particularly attractive for understanding adverse selection in highly regulated insurance markets, since in such markets legislation provides clear reasons for why certain observables are not used in pricing contracts.

[27] Our estimate of costs combines observed benefit levels and longevity, giving the discounted value of payments. This understates true costs which are increased by spousal benefits.

of individuals claiming benefits early on the x-axis.[28] Adverse selection is represented in the figures by drawing a downward sloping marginal cost (MC) curve. As the price falls, the marginal individuals who claim early have lower expected cost than infra-marginal individuals, lowering average costs.

In this simplified case, it is possible to achieve an efficient allocation by setting a payment p^* for claiming benefits early. The consequences of adverse selection in a competitive market with free entry and exit result from private annuity providers pricing early benefits where average cost is equal to demand. This would result in too few early claimants, Q^{eqm} in Figure 2, as some people for whom willingness-to-pay is above marginal cost are priced out of the market, $Q^{eqm} - Q^*$. Social Security sets the price of claiming benefits early equal to zero, $p^{ss} = 0$ which corresponds to a cut-off θ^{ss} and Q^{SS} people claim benefits early. Note that in Figure 2 we have depicted an actuarially fair system, which Social Security approximates (Feldstein, 2005), where a price equal to zero corresponds to the average cost of providing benefits early if everyone claimed early, so that $AC(Q^{\max}) = 0$. The current system may have too many $\left(Q^{SS} > Q^*\right)$ or too few $\left(Q^{SS} < Q^*\right)$ people claiming benefits early, either way there will be an inefficiency arising due to adverse selection. This is because any heterogeneity which influences costs and valuations (such as longevity) would need to be conditioned on in p^* in order to maintain the efficient equilibrium; as we argue above p^{ss} is unconditionally zero for all claimants.

3.3 Sources of Adverse Selection and Causation

The positive correlation test relies on identifying an equilibrium relationship between longevity annuity choice and costs, and does not require that our longevity measure be exogenous. However, interpreting a canonical positive correlation is difficult mainly for two reasons. Firstly, it does not distinguish adverse selection from moral hazard. Secondly, it does not identify the underlying source of asymmetric information, and hence a causal relationship. For example, insurance demand is determined not only by private information about risk type but also by, for example, heterogeneity in risk aversion. More risk averse individuals are likely to demand more life insurance, and risk aversion is also likely positively correlated with the risk of living a long time. The fact that the HRS provides, for a subsample of individuals, good measures of underlying risk allows us to address these shortcomings.

The correlation test based on unused observables, described by equations (1) and (2) takes an explicit stance on the source of asymmetric information. The disadvantage is that it requires a good measure of the underlying risk (longevity). A poor measure of underlying risk may fail to detect adverse selection or moral hazard even though it is present. A first advantage is that we can include a number of covariates in equation (1) that can be considered predetermined when people first become eligible for OASS benefits (age 62). Equation (1) describes the selection of individuals into different Social Security annuities based on a measure of the underlying longevity risk. The degree to which this correlation is attenuated (or strengthened) by the inclusion of such covariates is informa-

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[28] Figure 2 draws on the graphical depictions of adverse selection in Einav, Finkelstein and Cullen (2010) and Einav and Finkelstein (2011).

tive about how much of the selection can be unambiguously attributed to predetermined characteristics, and hence to adverse selection. The estimating equation is:

$$A_i = \mu\theta_i + \beta X_i + \varepsilon_i, \tag{3}$$

where X_i is a set of predetermined individual characteristics. We apply recent work by Gelbach (2009) which attributes to each group of covariates the degree to which they reduce (or increase) the raw correlation between the retirement and death ages. The description of the methodology is in the Appendix.

A second advantage of the unused observables approach is that it is possible to instrument for the measure of underlying risk. An instrumental variables strategy provides evidence on whether the observed correlation should be considered causal. It also helps deal with measurement error problems that are may arise as any measures of underlying risk are likely imperfect. The HRS contains information on parental death ages, which are determined by factors that are plausibly orthogonal to the unobserved factors that determine claiming decisions (we discuss these extensively in Section 4.2 below). In practice, mother's and father's death age turn out to be sufficiently highly correlated that we use only use father's death age as an instrument for longevity. Early parental death may of course have substantial effects on individuals that may also affect retirement decisions (and not be fully captured by covariates), as well as being less informative about their children's longevity.[29] Consequently, we also include a spline to estimate a separate slope if the father's death age is less than 70, so that identification comes from variation in paternal death age post-70.

3.4 Results

We present the results of the basic positive correlation test in Table 2. Each column presents results for a different dependent variable. In the first three columns we show results for different measures of annuity choice, equation (1): the age at which the person first claim Social Security, whether they claim after the age of first eligibility (age 62), and whether they claim at the full retirement age (age 65) or later. Column four shows the correlation with the present discounted value of costs to the Social Security system (in thousands of US dollars), equation (2). Panel A uses our objective longevity measure and Panel B our subjective longevity measure as the independent variable. We include cohort fixed effects in all regressions to help account for the fact that we do not have a representative sample of all deaths in a cohort.

The results provide clear evidence that life expectancy is correlated with annuity choice: those who live longer (both on objective and subjective measures) claim benefits later.[30] Based on actual death ages we find that living one year longer is correlated with claiming three-quarters of a month later, a 1.3 percentage point lower likelihood of claiming at first eligibility, a 1.5 percentage point higher likelihood of claiming at 65,

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[29] For example, Gertler, Levine and Ames (2004), and Case and Ardington (2006).

[30] Coile, Diamond, Gruber and Jousten (2002) find that men with longer life expectancies (based on living to age 70) have longer delays in claiming benefits; and Hurd, Smith and Zissimopoulos (2004) find those with higher life subjective life expectancies claim later. Neither paper connects their findings to the presence of adverse selection.

and \$10,958 in additional costs to the Social Security Trust Fund. Taken together the results provide clear evidence of asymmetric information being important in determining the timing of claims. Using the subjective longevity measure the results are still all significant, but of a smaller magnitude.

Table 3 reports results for equation (3), the correlation between longevity (using the objective and subjective measures) and annuity choice as we include covariates. In each column we sequentially add an additional set of covariates. Using the objective measure the inclusion of covariates somewhat reduces the correlation between longevity and the age an individual claims. The correlation between the age of retirement and longevity goes from 0.062 to 0.039 with the full set of covariates. Similarly, the correlation between annuity choice and the subjective longevity measure is attenuated by the inclusion of covariates (decreasing by more than half) though it too remains significant.

Table 4 presents the decomposition of the correlation between longevity and annuity choice. We find that spousal characteristics explain about one-third of the positive correlation and that occupation dummies also reduce the positive correlation. Conditioning on the level of Social Security benefits actually decreases the correlation between age of death and claiming benefits, thus people who have a history of higher earnings claim benefits earlier, but die later. This suggest that people with high benefit levels both live longer and claim benefits earlier which reduces program costs and is thus a source of advantageous selection. Column two shows the decomposition for the subjective longevity measure. Here the explained portion of the correlation is driven by the health and occupation indicators, as well as demographics. As with the objective measure, including the level of Social Security benefits decreases the correlation. A lack of power in the first column likely prevents us from drawing conclusions about many of the variable groups.[31]

In Table 5 we present instrumental variable estimates using the subjective longevity measure. We are unable to obtain significant first stages using the objective longevity measure, plausibly since we have only about one-third the number of observations. The first two columns of Table 5 report the OLS estimates using the objective and subjective longevity measures, the third column reports the IV results for the subjective longevity measure. The first-stages are highly significant, and the coefficients suggest that a person's subjective life expectancy increases by somewhat more than a month for every additional year, above age 70, their father lives. The IV estimates of the correlation between death age and annuity choice using the subjective longevity measure are nearly identical to the correlations using the objective measure, though no longer significant once we include the full set of covariates. One interpretation is that the subjective longevity measure is a noisy measure of actual life expectancy resulting in attenuation bias in the OLS estimates. Instrumenting for the subjective measure uncovers the true causal relationship. The fact that it is identical to the OLS estimate using the objective measure is suggestive evidence that the objective longevity measure is actually exogenous with respect to the age at which people claim Social Security. This also suggests that the correlation is driven primarily by adverse selection, since with moral hazard the causation runs from annuity choice to longevity.[32]

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[31] Identification for each covariate-group comes from how each group influences the death-retirement correlation conditional on all other sets of covariates.

[32] Moral hazard would require the age at which people claim benefits (annuity choice) to affect longevity.

4 Quantifying the Effects of Adverse Selection

4.1 Model

In this section we outline a multinonomial discrete choice model that allows us to estimate preferences for when to claim Social Security benefits. The literature on Social Security has focused on the distortions created by the system for economic behavior, primarily savings and labor supply decisions. Dynamic (life-cycle) models are a natural choice for understanding the long-term dynamic costs of these distortions (for example, Stock and Wise, 1990; Rust and Phelan, 1997; French, 2005); and the trade-off with the benefits provided to myopic individuals (Feldstein, 1985), or by insurance against wage shocks (Huggett and Parra, 2010). The focus of this paper is on the annuity choice that individuals face once they have reached the age of first eligibility, and how this choice responds to longevity expectations. Effectively the structure of the data prevent one from analyzing the dynamics of expectations: actual longevity is observed once, and our instrument for subjective expectations (paternal mortality) sees little time-variation over the sample window.[33] As a consequence we use a static framework to recover valuations for claiming at different ages. The data also prohibit analysis of claiming and labor supply jointly: for too many individuals in our sample of deceased respondents we see no labor market information except their long-term wage average.[34]

To deal with these short-comings we use a flexibly specified discrete choice model, including a large vector of covariates, correlation between unobserved utility and random coefficients on the annuity valuation. Thus we can recover the distribution of consumer contract valuations in a fairly flexible manner, conditioning on the exogenous variables that drive the full set of life-cycle decisions. The drawback is that our results provide guidance for understanding our set of counterfactuals - the effect of changes in the accrual rate and the full retirement age on the timing of claims, the welfare losses due to adverse selection, and the costs of the system - conditional on assumptions made regarding the labor market and savings.[35]

4.1.1 Claiming Choice

We allow individuals to differ in their privately known forecast of life expectancy θ, as well as additional dimensions of consumer heterogeneity, the vector ζ. We denote the

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Coe and Lindeboom (2008) find no negative effects of early retirement on health. Insler (2012) finds that the retirement effect on health is beneficial; with additional leisure time, many retirees invest in their health via healthy habits. This effect would mitigate against finding a positive correlation between longevity and the age at which people claim benefits.

[33] Health shocks, which clearly move expectations in unanticipated ways, also affect the utility from claiming directly.

[34] The same is true for joint claiming with a spouse: for only a small fraction of our deceased respondents do we also see spousal longevity.

[35] Eivan, Finklestein and Levin (2010) discuss the trade-offs between different approaches in the empirical analysis of insurance markets. Effectively we can only simulate unannounced or short-run policy changes, an important drawback. Our simulations suppress any explicit longer-term labor supply or savings responses to policy changes; some of these responses are captured implicitly in the vector of observables.

value for an individual of type (θ, ζ) of claiming benefits at age A as $V(A|\theta,\zeta)$; and $\Delta V(A|\theta,\zeta) = V(A|\theta,\zeta) - V(A = 65|\theta,\zeta)$ as the relative willingness-to-pay for claiming benefits at age A as compared to age 65.[36] Individuals choose the age at which they claim benefits based on a latent index, and the observed age of claiming for individual i is:

$$A_i^* = \arg \max_{A \in [62,66]} \quad \{\Delta V(A|\theta_i, \zeta_i)\}, \tag{4}$$

In our baseline model the utility of claiming at a certain age (relative to claiming at age 65) is given by:

$$\Delta V(A|\theta_i,\zeta_i) = \left[\sum_{t=A}^{\theta-1} \beta^t u(\delta_A B_i) - \sum_{t=3}^{\theta-1} \beta^t u(B_i)\right] + \left[\sum_{t=1}^{A} \beta^t u(w_i^\tau) - \sum_{t=0}^{3} \beta^t u(w_i^\tau)\right] + X_i\gamma_A + v_{Ai}, \tag{5}$$

where B is the full retirement age benefit level, δ_A is the adjustment factor to Social Security payments associated with claiming at age A, and X_i is a large set of individual characteristics the relative importance of which we allow to vary with claiming age. We begin the decision problem at age 6 (so $t = 0$ correspond to age 62). We follow the literature in assuming that the per period utility function exhibits constant relative risk aversion (CRRA), $u(x) = \frac{(x)^{1-\rho}}{1-\rho}$, governed by an elasticity of inter-temporal substitution parameter $1/\rho$ (ρ is the coefficient of relative risk aversion). We also include a term capturing the after-tax income from working, assuming that individuals could obtain employment at their permanent wage average (w_i^τ).

The log-likelihood of a given Social Security claiming age A being observed for individual i is simply:

$$\ell(d_i = A) = \log\left(P\left\{V(A|\theta_i,\zeta_i) > V(A'|\theta_i,\zeta_i)\right\}, \forall A \neq A'\right)$$

We estimate this "non-linear-in-parameters" probit using simulated maximum likelihood (SMLE) to obtain estimates of the coefficient of relative risk aversion ρ, the age-specific parameters γ_A, and Σ the covariance matrix of v.[37]

4.1.2 Costs to the Social Security Trust Fund

The cost function is given by the design of the Social Security system and depends on a person's longevity and the benefit level at the full retirement age. The expected present

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[36] In our model we discretize the continuous claiming age problem, agents can claim at ages 62, 63, 64, 65 or 66; where for sample size reasons we assume that everyone who claims after age 65 claims at age 66.

[37] To smooth the likelihood we employ a logit-smoothed kernel for the choice probability, for the r-th simulation, we calculate:

$$P(d_i = A|\theta_i,\zeta_i) = \frac{e^{(V^r(A|\theta_i,\zeta_i) - \max_{\tilde{A}\in S}\{V^r(\tilde{A}|\theta_i,\zeta_i)\})/\tau}}{\sum_{A'} e^{(V^r(A'|\theta_i,\zeta_i) - \max_{\tilde{A}\in S}\{V^r(\tilde{A}|\theta_i,\zeta_i)\})/\tau}},$$

where S is the choice set. We then average over the $R = 200$ draws and set $\tau = 5$.

discounted value of lifetime payments to a claimant choosing age A is:

$$C_i\left(A|\theta_i,\zeta_i\right)=\sum_{t=A}^{\theta-1}\phi^t\delta_A B_i-\sum_{t=0}^{A-1}\phi^t w_i\tau_i,$$

where $\phi=\left(\frac{1}{1+r}\right)^3$ and $r>0$ is the annual interest rate, and we deduct the present discounted value revenue raised from social security taxes τ_i on the individual's income w_i earned for up to the four years where they do not claim benefits. The relative cost to the system of an individual claiming benefits at age A as compared to age 65 ($A=3$) is given by:

$$\Delta C_i\left(A|\theta_i,\zeta_i\right)=\left[\sum_{t=A}^{\theta-1}\phi^t\delta_A B_i-\sum_{t=3}^{\theta-1}\phi^t B_i\right]-\sum_{t=0}^{A-1}\phi^t w_i\tau_i+\sum_{t=0}^{3}\phi^t w_i\tau_i.$$

Social Security does have provisions for both spousal benefits and survivor benefits, making spouse characteristics an important part of the total costs to the system. However, due to data limitations (for only one-eighth of households do we observe death ages for both spouses) we do not allow for any spouse characteristics in the cost functions.[38] Note that it is essential for calculating costs to observe actual longevity; for specifications below using subjective longevity expectations, costs (and therefore adverse selection) are calculated for the sub-sample for whom we observe actual longevity.

4.1.3 Welfare

The welfare implications of adverse selection in our model with multiple sources of heterogeneity are most easily illustrated in the simplified scenario where individuals face a binary choice between claiming at ages 62 or 65. This situation is depicted in Figure 3. The shaded area represents the distribution of willingness-to-pay for individuals $\Delta V\left(\theta,\zeta\right)$. For any θ there now exists a marginal distribution of willingness-to-pay, $\Delta\tilde{V}\left(\zeta|\theta=\theta_0\right)$. For simplicity of exposition in this figure we assume that costs are solely a function of longevity, $\Delta C\left(\theta\right)$. The current system sets the price (uniformly) at zero so welfare losses can arise from inefficient sorting.

An individual of type-(θ,ζ) claims benefits inefficiently early if their willingness-to-pay is greater than zero, but below the relative cost to the system. Formally:

$$\Delta C\left(\theta,\zeta\right)\geq\Delta V\left(\theta,\zeta\right)\geq 0.$$

Similarly, there will be those who claim full benefits even though the relative cost of is higher than their willingness-to-pay. An individual of type-(θ,ζ) claims benefits inefficiently late if

$$\Delta C\left(\theta,\zeta\right)\leq\Delta V\left(\theta,\zeta\right)\leq 0.$$

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[38] See Shoven and Slavov (2012) for a detailed description of those rules. This likely understates true costs since they are increased by spousal benefits. Our formulation of the cost function also assumes that if they do not claim people would be employed and contributing to the Social Security Trust Fund.

Thus total welfare losses are:

$$\begin{aligned} WL &= \int (\Delta V(\theta,\zeta) - \Delta C(\theta,\zeta))[1(\Delta C(\theta,\zeta) \geq \Delta V(\theta,\zeta) \geq 0) \\ &\quad +1(\Delta C(\theta,\zeta) \leq \Delta V(\theta,\zeta) \leq 0)]dF(\theta,\zeta), \end{aligned}$$

where $F(\theta,\zeta)$ is the joint distribution of types-(θ,ζ). The degree of inefficiency depends on the distribution of characteristics, and the cost structure of the Social Security system.

In the multinomial choice setting we are considering the welfare loss, conditional on the observed choices of when individuals claim A^*, is:

$$WL = \int \max\{\Delta C(A^*|\theta,\zeta) - \Delta V(A^*|\theta,\zeta), 0\} dF(\theta,\zeta),$$

which is the sum of social surplus across types where social surplus is negative, i.e. costs are greater than willingness-to-pay.

Inefficient choices also generate an additional financial burden on the Social Security Trust Fund. For those who retire inefficiently early the relative cost to the program of early retirement are positive, $\Delta C(\theta,\zeta) \geq 0$. It would be both social welfare increasing and less costly if they were to claim benefits at the full retirement age. Similarly, for those who retire inefficiently late the relative cost to the system of early retirement are negative, $\Delta C(\theta,\zeta) \leq 0$, i.e. for those individuals it would be both social welfare increasing and less costly if they were to claim benefits early.

With individuals who differ on multiple dimensions self-selection in when to claim benefits can result in adverse selection for some individuals, and advantageous selection for others. The more standard case of adverse selection, discussed above, is more likely to arise since those with a lower life expectancy are likely to have both a higher willingness-to-pay and higher relative costs of claiming benefits early. Advantageous selection arises when costs are higher for the marginal individual than the infra-marginal individuals, i.e. cost curves are upward sloping. Empirically we allow either form of selection to occur.

4.2 Identification and Discussion

The key elements needed to quantify to the extent of adverse selection, and the associated welfare losses, are the SSA cost function for providing old-age pensions, and the distribution of claimant preferences as a function of the potential annuity streams and non-pecuniary utility associated with each claiming age. We use a discounted sum of annuity payments for the individuals' lifespan in calculating the costs of the government. However, the demand for different claiming ages has a number of challenges we address.

4.2.1 Baseline Model

In our baseline discrete choice model longevity enters the value function as the limit of the discounted sum of utility from future benefit payments. The value to individuals of receiving an annuity from Social Security depends on how long they expect to live, the level of benefits and their degree of (constant) risk aversion. In this model identification, conditional on covariates, of the inter-temporal elasticity of substitution comes from three sources: (i) the death-age claiming-age correlation, (ii) constraining the correlation to be the same across the different claiming ages, and (iii) from non-linearities in the benefit formula.[39] The full set of covariates which enter utility linearly include (when available) information at age 62 on health histories, financials, demographics, spousal characteristics, birth year and permanent income as measured by the Social Security AIME; each set of covariates is allowed to impact the utility from each claiming choice separately. The baseline model with all covariates has 172 parameters: the inter-temporal elasticity of substitution, 42 parameters for each of the four (relative) claiming choices, and 3 covariance parameters governing unobserved utility shocks.[40] Utility is relative to age-65 claiming.

We assume that people form an expectation of how long they will live past age 62 (longevity θ) and that they expect to receive a constant (in real terms) stream of benefits from this annuity until their expected death age.[41] An implicit assumption is that people do not save their benefits (it is illegal to borrow against future Social Security benefits), which given the existing evidence seems an innocuous assumption.[42] We could have alternatively assumed that individuals form an expectation over the full set of probabilities of surviving to a certain age using the fact that mortality rates follow a Gompertz distribution.[43] We take our approach since we are estimating a static model and the measures of longevity available in the HRS are informative about people's life expectancy, but less informative about their full expected hazard rate into death.

Estimating people's willingness-to-pay for claiming at different ages requires us, unlike the positive correlation test, to take a stance on the determinants of claiming decisions. In particular, conditional on controls, identification of our key parameters requires that our longevity measure is exogenous with respect to claiming decisions. The extensive literature on publicly provided pensions provides us with a guide to the large set of factors that may be both correlated with longevity and claiming decisions, and thus should be accounted for in our estimation. In our discrete choice approach these concerns are reflected in the inclusion of the vector of covariates.

There is a particularly large literature on the distortions to labor supply due to the

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[39] We observe the old-age benefit from Social Security, the year of first claiming, the age of first claiming and the birth year. This information allows us calculate the wage average individuals had at claiming, the AIME. Thus differences between the observed benefit and the AIME serve to aid identification.

[40] In principle 9 covariance parameters are identified in a 5 choice model, however these parameters are often difficult to estimate, especially when we subsequently include random coefficients. Rather than change specifications at that point, we only estimate three correlation parameters on the discrete choice shocks, and include more unobserved-covariance parameters when we estimate random coefficients below. To reduce the number of covariances to be estimated we impose a uniform correlation structure across alternatives that are one year, two years and three years apart.

[41] Our results are robust to also including longevity linearly as a covariate, allowing it to directly affect retirement choices.

[42] See Attanasio and Emmerson (2005) and De Nardi, French and Jones (2010) for recent work on this issue.

[43] See Gavrilov and Gavrilov (2011). Einav, Finkelstein and Schrimpf (2010) use a baseline hazard rate that follows a Gompertz distribution and make a distributional assumption about the underlying heterogeneity among individuals. Mitchell et. al. (1999) use lifetables to calculate mortality rates at different ages.

incentives inherent in the Social Security system.[44] First, the Social Security earnings test taxes labour income for Social Security beneficiaries at a very high rate, creating incentives to claim Social Security and stop working at the same time. The rules are cohort and age-specific and thus are, at least on average, captured by the inclusion of cohort fixed effects and separate intercepts at each claiming age.[45] Second, the dedicated payroll taxes funding Social Security, and the degree to which your AIME increases with additional years of work, distort labor supply decisions.[46] There is though little reason to believe they systematically do so differentially between ages 62 and 66, and thus are unlikely to affect our estimation. Third, claiming decisions have been found to be responsive to the accrual rate, the main incentive our model is designed to capture.[47]

A person's health, and that of their spouse, has important implications for the incentives to claim Social Security benefits through channels other than life expectancy. Health affects the disutility of labor, the marginal benefits of health insurance (Medicare is only available beginning at age 65), the cost associated with liquidity constraints, and the ability to work.[48] Health shocks are a main reason why the insurance provided by Social Security is valuable to people: individuals may have insufficient precautionary savings to insure against experiencing positive longevity shocks late in life. To capture an individual's health at age 62 we include in our main specification a large set of health indicators (related to around 70 percent of the causes of death), an indicator for whether the person has employer provided health insurance, and whether the insurance continues after retirement (both for the individual and their spouse). In addition, in an extension to our baseline model, see below, we allow the value of the annuity payments to vary with an individual's health status at age 62, thus allowing the insurance value of the annuity provide by Social Security to be dependent on a person's health.[49]

People with low labor-force attachment, for reasons possibly correlated with longevity, are more likely to claim benefits early. First, liquidity constraints and low precautionary savings may result in benefits being important for financing current consumption.[50] Second, the distortionary effects of the Social Security earnings test are unimportant for these individuals. We include age 62 earnings (and a dummy for zero) and various wealth measures as proxies for low labor market attachment and liquidity constraints.[51]

Social Security also acts as a compulsory savings scheme which is valuable to myopic

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[44] French and Jones (2012) provide a recent overview.

[45] These also capture changing norms about when to claim benefits, see for example Lumsdaine, Stock, and Wise (1995) and Iyengar and Mastrobuoni (2008).

[46] Feldstein and Samwick (1992) point out distortionary effect of marginal Social Security taxes on labor supply; see also French (2005), Liebman, Luttmer and Seif (2009).

[47] Krueger and Pischke (1992) study wealth effects from changes in the benefit level; Manoli, Mullen and Wagner (2011) study the effect of both substitution and wealth effects using policy reforms. Huggett and Parra (2010) analyze the trade-off between the disincentive effect and insurance against labor income risk. See Gruber and Wise (1999, 2004, 2007) for a summary of the evidence from a number of countries.

[48] Rust and Phelan (1997) highlight the importance of Medicare coverage in explaining the spike in claims at age 65; an issue revisited by French and Jones (2012).

[49] There may also be heterogeneity in discount rates (Gustman and Steinmeier, 2005), which are plausibly correlated with longevity.

[50] Rust and Phelan (1997) emphasize the importance of borrowing constraints in explaining the peak in claiming at age 62.

[51] We do not have data on labor supply decisions for most of sample.

individuals, but otherwise distorts private savings decisions.[52] The view that Social Security is an insurance and compulsory savings scheme are not incompatible. However, there is a tension between these two perspectives since the feature which makes Social Security attractive as an insurance scheme against longevity - it pays out more to individuals who live longer - makes it unattractive as a compulsory savings scheme - those who live longer have higher rates of return.[53] After 35 years in the labor market the AIME is only adjusted upward if current earnings are greater than earnings in a previous year. Hence, it seems unlikely that the longevity induced differential rates of return to additional work plays an important role in people's choice when to claim benefits. Adverse selection in the timing of Social Security retirement though may off-set some of the inefficiencies that arise from the forced savings aspect of Social Security. The fact that people with low life expectancy can choose to claim early may ameliorate the inefficiencies generated by the low rate of return to their Social Security contributions. The potential interaction between these two sources of inefficiency is not something we account for in our analysis.

With recent years having seen a rapid rise in the number of individuals claiming disability and transiting directly into Old-Age Social Security at age 65, it is potentially important to account for possible interactions between Old-Age and Disability Insurance.[54] In particular, when considering policy counterfactuals understanding the degree to which individuals substitute between these two programs is likely important. While our main sample excludes those who ever claim disability, below we extend the analysis to incorporate disability insurance by expanding individuals' choice sets.

Finally, spouses tend to coordinate the timing of retirement from the labor force and when they claim benefits.[55] In principle, one could extend our analysis to allow for an explicit model of the household. However, only for around one-eighth of households in our data do we observe both death ages, making our main identification strategy infeasible for households. Instead we include a large set of spouse characteristics which alter the age-specific valuations.

4.2.2 Extensions

We extend our baseline model on three important dimensions: (i) using our instrumented subjective longevity measure as an exogenous measure of life expectancy, (ii) extending individuals' choice sets to include retiring on disability benefits, and (iii) allowing for heterogeneity in people's valuation of the annuity provided by Social Security.

Using actual longevity as our measure of people's expectations of their longevity is tantamount to assuming that people have perfect foresight. One alternative assumption is that objective longevity is not observed by decision makers, but rather serves as an error laden measure of an individual's longevity forecast at the time they made their claiming

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[52] Feldstein (1985) argues that "the primary cost of providing social security benefits is the welfare loss that results from reductions in private saving" (p. 303). See also Feldstein and Liebman (2002) for an overview.

[53] Moreover, Social Security is a highly illiquid form of savings, which further diminishes its usefulness in insuring against anything other than longevity risk.

[54] See Autor and Duggan (2006), and Duggan, Singleton and Song (2007).

[55] See Blau (1998) and Gustman and Steinmeier (2000)

decisions, with shocks to the true forecast by construction being orthogonal to the information set at age 62. Simulation with shocks under reasonable variance assumptions show the bias introduced by the assumption of perfect foresight to be modest.[56] Alternatively, we use our subjective longevity measure as a proxy for people's life expectancy. However, the subjective longevity measure is likely prone to substantial measurement error, and may (like the objective measure) not satisfy the conditional exogeneity assumption. Hence, we instrument our subjective longevity measure using father's death age (see the discussion in Section 3.2 above).

To allow for potentially important interactions between the OASS and SSDI programs we extend individuals' choice set to include the choice to claim disability insurance. The choice to claim disability benefits (at any age after 55) is modeled using our full set of covariates with a choice specific vector of parameters.[57] This extension is important when considering counterfactual policies, as any changes to the old-age program may also affect the likelihood a person retires by claiming disability benefits.

The baseline model assumes all decision makers have the same parameters governing substitution between claiming choices, which may generate unrealistic substitution patterns in counterfactual policy simulations. For a wide-range of reasons, discussed above, people will have heterogeneous valuation of the same annuity. To address this we extend the basic model to allow for both heterogeneous and random coefficients in the parameters governing the choice model. We allow for heterogeneity in people's valuation of the annuity provided by Social Security by allowing heterogeneous parameters on the annuity term based on lifetime income (an indicator whether their AIME is above or below the median), health (the sum of indicators for heart disease, cancer stroke, diabetes, and lung disease), and wealth (an indicator whether they have positive wealth). In addition, we include random coefficients in people's valuation of the annuity drawn from income, health and wealth specific distribution normal distributions, allowing for additional flexibility in substitution patterns.[58] Additionally when we include heterogeneous valuations we add another vector of parameters (the means and variances of the random coefficients) to be estimated. The utility function for the heterogeneous model takes the form:

$$\Delta V\left(A|\theta_i,\zeta_i\right)=\alpha_i\left[\sum_{t=A}^{\theta-1}\beta^t u\left(\delta_A B_i\right)-\sum_{t=3}^{\theta-1}\beta^t u\left(B_i\right)\right]+\left[\sum_{t=1}^{A}\beta^t u\left(w_i^{\tau}\right)-\sum_{t=0}^{3}\beta^t u\left(w_i^{\tau}\right)\right]+X_i\gamma_A+v_{Ai}, \tag{6}$$

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[56] The measurement error enters the model non-linearly, which as Griliches and Ringstad (1970) showed means the bias cannot be signed in general. Results for simulations available from the authors.

[57] On account of the range of ages at which people can claim disability we do not include the discounted Social Security annuity value associated with claiming SSDI as part of the utility associated with that choice. Individuals claiming SSDI before 55 are not included. Disability rules are more strict for earlier DI claimants, lessening the capacity for this system to function as de facto early retirement.

[58] We could alternatively allow for heterogeneity in the degree of risk aversion (ρ). However, random coefficients are difficult to estimate in a non-linear structure, and the interpretation of the results and identification are less straightforward. Hoderlein, Nesheim and Simoni (2012) discuss non-parametric identification of a general class or random coefficients models.

where

$$\alpha_i = \sum_{k=1}^{K} Z'_{ik}\mu_k + \varepsilon_{ik} \quad \text{with} \quad \varepsilon_{ik} \sim N(0, \sigma_k), \tag{7}$$

captures heterogeneous valuations.

4.3 Estimates and Welfare Consequences

4.3.1 Baseline Model

The strategy outlined above allows us to quantify willingness-to-pay, costs, the amount of adverse selection and social welfare using our estimates of $\Delta V_i\left(A\right)$ and $\Delta C_i\left(A\right)$. Table 6 presents the baseline model estimates using people's actual death age as our measure of life expectancy.[59] In the first column we only include cohort fixed effects and the AIME. The second and third columns include health and demographic variables. The fourth column includes the full set of individual characteristics as covariates, but does not include spouse characteristics; these are included in the specification in column five.

Our estimates for the coefficient of relative risk aversion are in the range 1.66 to 1.76, depending on the set of covariates we include. These estimates are close to Hurd (1989) who studies the bequest motives of the elderly. However, recent work on annuity markets, see Einav, Finkelstein and Schrimpf (2010) in the UK annuity market, assumes a coefficient of relative risk aversion equal to 3. Bundorf, Levin and Mahoney (2011) in estimating health plan choices choose a constant absolute risk aversion specification with a parameter which is equivalent to $\rho = 4$, which is near the top end of estimates in the literature (Cohen and Einav, 2007).[60]

In our sample nearly all the adverse selection is among people who inefficiently choose to claim benefits before age 65 ($\Delta C_i\left(A^*\right) \geq \Delta V_i\left(A^*\right) \geq 0$) . In the specification with the full set of covariates we estimate that 8.7 percent of all claimants adversely select their claiming age. The social welfare loss associated with adverse selection are considerably smaller than the number adversely selecting. Most adversely selecting individuals are near the margin of whether they should claim benefits early or not, and for those individuals the difference between their willingness-to-pay and costs tends to be small. Meanwhile, there are individuals who place a very high value on the option of claiming benefits early, the benefits that accrue to those individuals are far larger than welfare costs of adverse selection. We find that adverse selection in Social Security decreases social welfare by a modest 1.1 percent, though that number is as high as 2.4 percent when we only include cohort fixed effects and the AIME.[61] While the exact welfare estimates vary across

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[59] We use a government real discount rate of 3 percent, which is in the mid-range of those used by the *The 2012 Old-Age and Survivors Insurance and Disability Insurance (OASDI) Trustees Report*; and an individual discount rate of 5 percent, typical in the economics literature. Our qualitative results are insensentive to the choice of either parameter, and even quantitively the results are highly robust.

[60] Einav, Finkelstein, Pascu and Cullen (2012) argue that there is a both a domain-specific and a common component to risk aversion. Nevertheless our results suggest that the coefficients of relative risk aversion currently used in the literature may be too high.

[61] Recall that our measure of welfare is relative to claiming at age 65, so total surplus is relative to a world in which everyone were forced to claim benefits at the full retirement age of 65.

specifications, our broad finding of adverse selection in Social Security benefit choice and large welfare gains among those claiming benefits early are robust to whether we include specific covariates or not.

Our results are similar to the estimated welfare costs of asymmetric information in other markets. In the UK annuity market Einav, Finkelstein and Schrimpf (2010) find that asymmetric information reduces welfare relative to a first-best symmetric information benchmark by about 2 percent of annuitized wealth. There are numerous studies relying on data from employer provided health insurance who consistently find welfare losses due to adverse selection of between 1 and 4 percent (Cutler and Reber, 1998; Einav, Finkelstein and Cullen, 2010; and Bundorf, Levin and Mahoney, 2011). Hackmann, Kolstad and Kowalski (2012) find somewhat larger welfare gains from reductions in adverse selection due to the Massachusetts health reform of 2006.

Adverse selection also increases the costs of operating the Social Security system. We estimate that assigning each individual to their socially optimal Social Security retirement age would save the system 1.4 percent of current outlays (in the full specification). For comparison, if we were to randomly assign individuals to retirement ages (keeping the current proportions intact) costs would fall by around 1 percent. To put these numbers into context, the current projected deficit of the Social Security Trust Fund is 16 percent of program cost. According to our estimates adverse selection imposes costs which are around 9 percent of that shortfall. In comparison, the Report of the National Commission on Fiscal Responsibility and Reform (2010), i.e. "The Simpson-Bowles Commission," found that adjusting the cost-of-living formula to reflect a chained CPI would reduce the deficit by 26 percent, indexing the retirement age to life expectancy would decrease it by 21 percent, and raising the payroll tax cap to cover 90 percent of all earnings would decrease the deficit by 35 percent.

The ability to claim benefits at age 62 (as compared to age 65) is very valuable to those individuals who actually do so, \$60,295 for the median early claimant (in the specification with all covariates); compared to -\$35,536 for the median late claimant. Moreover, there is clear evidence of adverse selection: those who have the highest willingness-to-pay for claiming benefits early are also those for who it is most expensive to provide those benefits. The relative cost of providing benefits early (as opposed to at age 65) to the median early claimant is around \$14,232, while the relative (counterfactual) cost of providing benefits early to the median person who retires at age 65 would be around \$12,694.

4.3.2 Extensions

In Table 7 we show results for our alternative model specifications, where all specifications include a full set of covariates. For comparison the first column reports the estimates from our baseline model (the fifth column of Table 6). The second column shows results using our instrumented subjective longevity measure. In the third column we include claiming disability benefits as one of the options available to individuals. The results in the fourth column corresponds to the model where we allow for heterogeneity in individuals' valuation of the annuity, and in column five we have extended this heterogeneity to include random coefficients.

Using our instrumented subjective longevity measure to identify individuals' demand for claiming benefits yields a lower estimate of the coefficient of relative risk aversion ($\rho = 1.58$), and considerably higher estimates of the fraction of individuals claiming at a socially inefficient age (14.4 percent) and associated welfare losses (3.2 percent). While the sample we use is larger than in the baseline model, the results do suggest that any concerns with regards to our assumptions about individuals' longevity expectations and the conditional exogeneity of that variable in the baseline model may lead to an underestimation of the degree of adverse selection in claiming choices.

Reassuringly, the results are highly robust to the inclusion of the option to claim disability (and those individuals who claim it). It has little effect on the estimates of ρ, the number of adverse selectors in old-age Social Security or the associated welfare costs. Note that while including the option to claim disability does not significantly affect our estimates of the current system, it may nevertheless matter when evaluating possible counterfactual policies.

Allowing for heterogeneous annuity valuations results in somewhat lower estimates of the fraction of individuals first claiming Social Security at a socially inefficient age (7.3 percent). The further inclusion of random coefficients makes little difference to our estimates. We find that the annuity provided by Social Security is less important for poorer people - those with an AIME below the median and non-positive wealth - when making their claiming decision, and by implication other considerations matter more. That also means they will be less responsive to reforms in the Social Security system. In contrast, for those in poorer health the annuity is more important in influencing the age at which they claim benefits, and they will be more responsive to any changes in the system.

The model fit is presented in Table 8 for the model with observable heterogeneity and random coefficients in the valuation of the annuity.[62] The table compares simulated choices for each of the five claiming ages, averaging over 100 simulations. Each column shows results for a different claiming age, and each row for a different sub-sample in the data. Overall the model fits the data closely. It slightly over-predict the fraction claiming at age 62, 48.6 percent instead of the true 47.8 percent. Importantly, the model fits equally well for those individuals above and below the median longevity. The estimated male claiming age profile fits the observed data well, but we slightly over-predicts the fraction of women claiming at age 62 and slightly under-predict the fraction claiming at other ages. The model also slightly over-predict the fraction of people with below median AIMEs claiming at age 62, and those with above median AIMEs claiming at age 65.

5 The Impact of Policy Reforms

We study the effects of changing two key features of the annuity contracts offered by Social Security: the adjustment factor δ, the penalties reducing benefits for having retired before the full retirement age, and the full retirement age (while keeping the accrual rate constant). We also consider the effect of a mandate that eliminates the option to claim benefits early.

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[62] The model fit for the other models is very similar.

Current work has considered inefficiencies arising from the mispricing of existing contracts, focusing on how market prices or various pricing interventions efficiently sort consumers into a fixed set of coverage options. For example, Bundorf, Levin and Mahoney (2012) consider the potential welfare gains associated with optimal uniform pricing and individualized pricing using only observable information on risk.[63] We do not know of work that has analyzed the welfare effects of changes in coverage options.[64] It is unlikely that Social Security would consider implementing uniform pricing for claiming benefits early (i.e. a lump-sum transfer on retiring early), much less optimal risk-related price based on a person's longevity. Policymakers are, however, willing to consider changes to the types of annuity contracts available to individuals; making our estimates particularly informative for current debates about reforming Social Security.

5.1 Optimal Adjustment Factors and Modeling Policy Reforms

The problem of how to optimally design annuity contracts in the presence of adverse selection presents particular challenges. Analyzing the effect of price changes is simplified by the fact that it is reasonable to assume that both the willingness-to-pay (demand) function and the cost (supply) function are unaffected (provided that we can assume that income effects are small). In contrast, changing the adjustment factor will result in shifts of both $\Delta V(\theta, \zeta)$ and $\Delta C(\theta, \zeta)$ for all types-(θ, ζ). A lower adjustment factor, i.e. a higher penalty for claiming early, will in general both decrease the willingness-to-pay for early Social Security retirement and decrease the relative cost of providing benefits early. An adjustment factor that is too high will result in some people claiming benefits inefficiently early, while an adjustment factor that is too low will induce some to claim benefits inefficiently late. The optimal choice of adjustment factor is found by maximizing the total social surplus derived from the option of claiming benefits early, and is given by

$$\delta^* = \arg\max \int \left(\Delta V(\theta, \zeta; \delta) - \Delta c(\theta, \zeta; \delta)\right) 1\left(\Delta V(\theta, \zeta; \delta) \geq 0\right) dF(\theta, \zeta)$$

which minimizes the welfare losses due to adverse selection.

The 1983 Amendments to the Social Security Act progressively increased the FRA to age 66 for birth cohorts after 1937 (by two months for each ensuing year of birth until 1943), while keeping the accrual rate basically unchanged.[65] This reform is equivalent to simply cutting the level of benefits available to individuals at every claiming age, on average by 6.2 percent in our sample.[66] We model its impact by moving the FRA benefit to age 66 and reducing all other benefits accordingly.

Mandates, eliminating any contract choice, are the canonical solution to adverse selection in insurance markets (Akerlof, 1970). While mandates do resolve the adverse

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[63] Since their model, like ours, allows for multiple sources of individual heterogeneity risk-rated pricing can not entirely eliminate welfare losses due to selection.

[64] A point made by Einav, Finkelstein and Levin (2010).

[65] The affected birth cohorts are only slightly older than the bulk of our sample and so arguably highly comparable. For birth cohorts after 1955 the FRA was progressively increased to age 67 (in two month increments for each ensuing year of birth).

[66] In evaluating the reform we do not account for the possibility that the reform also changed social norms about when to claim benefits.

selection problem they, as emphasized by Feldstein (2005), are not necessarily welfare improving when individuals differ in their preferences. Instead, they involve a trade-off between reducing the allocative inefficiency produced by adverse selection and increasing allocative inefficiency by eliminating self-selection. In the context of our discrete choice model it is straightforward to estimate the impact of mandating that everyone receive benefits at a given age, whereby we focus on age 65 since it is the FRA for people in our sample.[67]

5.2 Results

We illustrate the relationship between the adjustment factor and the estimated change in the fraction of individuals adversely claiming benefits early and late as a function of the adjustment factor in Figure 4. Notice that under an adjustment factor of 80 percent, which is the actual adjustment factor for people in our sample, nearly all adverse selection is on account of individuals claiming benefits inefficiently early. At lower adjustment factors the fraction claiming inefficiently early declines, and an increasing number of individuals start claiming inefficiently late. Figure 5 depicts the estimated welfare costs of adverse selection and the total cost to the program as a function of the adjustment factor. The costs to the Social Security Trust Fund decline monotonically with the adjustment factor. However, there is a u-shaped relationship between social welfare and the adjustment factor. The welfare maximizing adjustment factor at age 62 is 0.72. Further lowering the adjustment factor would continue to decrease costs to Social Security, but also social welfare.

Tables 9a, 9b and 9c each report the impact of four policy reforms: adopting the optimal linear and non-linear adjustment factors (and those adjustment factors), changing the full retirement age to 66, and mandating that everyone claim benefits at age 65. They do so for three models: baseline, heterogeneous annuity valuations, and including disability respectively.[68] For comparison the first column of each table reports results based on the system relevant for our sample. Columns two to five report counterfactual outcomes under the optimal linear accrual rate, the optimal non-linear accrual rate, raising the full retirement age to 66, and mandating everyone claim benefits at age 65, respectively.

The social welfare maximizing linear accrual rate in the baseline model, Table 9a, implies a benefit penalty of 28.2 percent for claiming benefits at age 62; the actual penalty for the cohorts we analyze is 20 percent. We estimate that the fraction of individuals who claim benefits inefficiently would fall to 6.5 percent. The decrease in the adjustment factor would result in a 5.7 percent reduction in costs. Nevertheless social welfare, i.e. the social surplus derived from individuals' ability to claim at an age other than 65, increases slightly by 1.3 percent; 0.5 percentage points of which are due to a reduction in welfare losses associated with adverse selection. In the presence of individual heterogeneity on multiple dimensions the social welfare gains of such a policy change would be small but non-negative, and the additional savings would reduce the Social Security Trust Fund deficit by around one-third. Allowing for non-linear accrual rates would further increase welfare and reduce costs only slightly. Our results suggest that implementing such a schedule

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[67] Very similar results were obtained when mandating retirement at other ages.

[68] We do not include results for the model using instrumented subjective longevity, since it is based on a different sample of individuals and it is less obvious how to calculate costs in that model.

would decrease the fraction adversely claiming benefits early to 7 percent, increase social welfare by 1.7 percent, and reduce costs by 6.4 percent (or 40 percent of the current shortfall). Social Security claiming decisions respond strongly to financial incentives. The large cost reductions associated with implementing the socially optimal accrual rate are achieved by discouraging individuals from claiming benefits early. The fraction who claim before the FRA is 70 percent in our baseline, and we estimate it would fall to 64.3 and 63.1 percent with the optimal linear and non-linear accrual rate respectively.

Increasing the full retirement age to 66, thereby cutting benefits by 6.2 percent at all ages, results in a fall in costs to the Social Security system by that amount (see column four of Table 9a). However, social welfare falls by an even greater amount, 12.6 percent.[69] We find that claimants respond strongly to wealth effects, the 6.2 percent fall in benefit levels results in 6.5 percentage point drop in the number of people claiming benefits before age 65. Our results are consistent with the idea that increasing the full retirement age cuts benefits, reducing people's permanent income, which results in them decreasing their leisure by working longer and claiming benefits later.[70]

The reason across the board cuts in benefits from increasing the full retirement age are detrimental to welfare is because on average people value their marginal benefits more than it costs to provide them. Social Security is very valuable to individuals and, at least from a static perspective, generates substantial social surplus. In contrast, increasing the accrual rate by reducing the annuity early claimants receive can generate cost savings with little change in social surplus. This is because it allows individuals to sort more efficiently to take advantage of the higher accrual rate. Those who highly value the annuity can claim at the FRA (or later) and avoid any reduction in benefits, while those who value claiming early highly continue to do so. The policy changes incentives mostly for individuals near the margin of early versus late retirement, where much of the inefficiency occurs. These claimants valuations for early versus later retirement are quite similar, but their costs to the insurer of each annuity are very different.

The fifth column of Table 9a presents the effects of mandating that everyone start receiving Social Security benefits at age 65. We estimate that the cost reductions of such a mandate are large: 11.4 percent of total costs, equivalent to three-quarters of the current Social Security deficit, and about $13,000 per claimant. However, the welfare losses of such a mandate would be substantially larger than any cost reductions, on average about $60,000 per claimant. People are willing to forego substantial amounts of money to claim benefits early (which is why so many do) and eliminating that option would correspondingly decrease social welfare. As a comparison, Einav, Finkelstein and Schrimpf (2010) consider the consequences of government mandates that each individual purchases the same guarantee length in the UK annuity market, eliminating any contract choice. They find that mandates have ambiguous welfare consequences in an annuity

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[69] If changing the full retirement age also changes people's preferences about when to retire, then our estimate is an upper-bound on the welfare losses.

[70] While it is reasonably well established that people respond to changes in accrual rates, see for example Gruber and Wise (2004, 2007); there is clear less evidence for wealth effects. Krueger and Pischke (1992) and subsequent work have tended to find small wealth effects. In contrast, French (2005) finds wealth effects to be important. Manoli, Mullen and Wagner (2011) provide recent evidence on large accrual rate and small wealth effects in Austria.

market with risk and preference heterogeneity. We find that in Social Security there is no such ambiguity: the welfare benefits of allowing individuals to choose the age at which they claim benefits are substantial.

Allowing for heterogeneous annuity valuations, Table 9b, yields somewhat lower estimates for the fraction of individuals making socially inefficient choices. It also results in slightly lower estimates of the welfare gains that can be obtained from introducing optimal linear and non-linear accrual rates. The cost savings obtained from the reforms are very similar to those in our baseline. The results suggest that, as in the baseline, large cost reductions can be obtained from increasing the accrual rate, by reducing the age 62 adjustment factor to 0.71, without reducing social welfare. Additional gains from non-linear accrual rates are small. Increasing the FRA reduces costs - by 5.4 percent as compared to 6.1 percent for the optimal linear accrual rate - but leads to even larger social welfare losses of 11.6 percent. Mandating that everyone claim benefits at age 65 yields the largest costs-savings, 11.4 percent, but also very large welfare losses.

The effect of counterfactual polices in the model where we include claiming disability as one of the choices are summarized in Table 9c. Our results suggest that changes to the accrual rate and the level of benefits (by changing the full retirement age) have little effect on the number of people claiming disability (from 17.9 percent in our baseline to at most 18.5 percent as the level of benefits is cut).[71] Consequently, the effect of adopting optimal accrual rates and changing the FRA to age 66 is very similar to that in our baseline model. The introduction of a mandate would, however, have substantially larger effects. If OASS were only available at age 65 we estimate that the fraction of people claiming disability would rise by around 50 percent (to 26.6 percent of our sample). Consequently, the estimated fall in costs in the Old-Age system would be even larger than in the baseline: 20 percent of total costs and thus more than the current shortfall. However, a large part of that burden would simply be shifted to the SSDI (and then eventually back to the OASS as people reach the FRA) and so does not represent savings to the overall Social Security system.[72]

5.3 Who Adversely Selects?

Adjusting the accrual rates in Social Security will have an impact on who claims benefits, both efficiently and inefficiently. Table 10 describes the characteristics of the people in our sample who claim benefits inefficiently early (before age 65).[73] It does so for our three main models, and for the baseline system, with the optimal linear accrual rates, and when raising the full retirement age to 66. Table 1 provides descriptive statistics for people claiming at ages 62 to 66, we do not repeat these here.

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[71] The reason the fraction of people claiming disability is so high in our sample is that we are conditioning on people who have died, and those who claim disability have a considerably lower life expectancy than those who do not.

[72] To calculate the impact on the total costs of the Social Security system (and not just Old-Age) we would need to know at what age people, who formerly claimed OASS, would claim disability after the policy reform. That analysis, while in principle feasible, is beyond the scope of this paper.

[73] There is only a small number of individuals who claim inefficiently late (age 65 or later), which is why we do not provide descriptive statistics for that group.

The descriptive statistics for those people who claim benefits adversely early in the system are in the first column for each model. These individuals have a lower life expectancy (9.1 - 9.3 years after age 65), a below average full retirement benefit level ($11,800 - $12,800), lower capital income, are in poor health (a health index of 0.39 - 0.42), and women and minorities are somewhat over-represented.

Introducing an optimal linear accrual rate reduces the number of adverse selectors, and changes the composition toward less costly demographics. By inducing those individuals with characteristics more like the average individual in the sample to claim later costs fall. As a result, this further skews the characteristics of those who claim benefits inefficiently early: the average longevity falls to 7.1 - 7.3 years, their health is worse (an index of 0.45 - 0.49), and they have lower full retirement benefits and capital income.[74] The group of claimants making socially inefficient choices now claim on average lower benefits and for fewer years.[75] In contrast, changing the FRA slightly increases the number of people claiming benefits inefficiently early, and the demographics among the inefficient group do not change appreciably. The fact that changing the full retirement age fails to induce more efficient sorting of individuals explains why it also does not have the positive welfare effects associated with increasing the accrual rate.

6 Conclusions

Old-Age Social Security was established as insurance against poverty in old age. While there is an extensive literature exploring its various consequences, primarily for labor supply and savings, we know little about the efficiency of the insurance aspect of the OASS system. This paper contributes both to the literature on Social Security and potential policy reforms, and a growing literature on detecting adverse selection in insurance markets, quantifying its implications for welfare and considering the implications of counterfactual policy reforms. Our methodology can be applied to other public pensions and, more generally, in insurance markets where adverse selection is based on observed characteristics of insurance buyers that for various reasons are not used in setting insurance prices.

We find clear evidence of adverse selection when people first claim OASS benefits. Both costs and annuity choice are correlated with measures (objective and subjective) of the underlying longevity risk against which Social Security provides insurance. The social welfare consequences of this adverse selection are comparable to those found in private annuity and health insurance markets.

Unlike previous work, which has primarily focused on adverse selection in private insurance markets and the consequences of more efficient pricing, we study the effect to reforms of the contract terms offered to individuals. We find that increasing the pension accrual rate, by decreasing the adjustment factor for early retirement, would yield substantial costs savings, while decreasing the amount of adverse selection, and slightly increasing social welfare. In contrast the cost savings from increasing the FRA, as was done in the 1983 Amendments to the Social Security Act, are accompanied by

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[74] Results for the optimal non-linear accrual rate are very similar.

[75] This comes at the cost (shown in Figure 4) of more adverse selection among late claimants, though nonetheless overall costs fall under this policy.

significant reductions in social welfare. Social Security generates substantial social surplus at the margin, making policies which only cut benefits, like raising the FRA, particularly undesirable. In contrast, changes to the adjustment factors can induce efficient sorting, generating reductions in costs without losses in social welfare. A mandate eliminating the choice to claim early, while resulting in large cost reductions, leads to even larger welfare losses.

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Appendix: Decomposition Method

To understand which factors account for adverse selection in our sample of Social Security beneficiaries, we apply recent work by Gelbach (2009) which allows us to attribute to what degree each group of covariates affects the correlation between the retirement and death ages. Our baseline model has the form:

$$R_i = \alpha_0^B + \alpha_d^B DeathAge_i + \alpha_1^B X_{i1} + \varepsilon_i^B, \tag{8}$$

where the superscript "B" denotes baseline. In a full regression we then include a large set of regressors: social security benefits (X_{i2}), a health history (X_{i3}), demographic information (X_{i4}), 2-digit occupation fixed effects (X_{i5}), financial information (X_{i6}) and spousal characteristics (X_{i7}). That is we run:

$$\begin{aligned} R_i = \; & \alpha_0^F + \alpha_d^F DeathAge_i + \alpha_1^F X_{i1} + \alpha_2^F X_{i2} + \alpha_3^F X_{i3} + \alpha_4^F X_{i4} \\ & + \alpha_5^F X_{i5} + \alpha_6^F X_{i6} + \alpha_7^F X_{i7} + \varepsilon_i^F \end{aligned} \tag{9}$$

where the superscript "F" denotes what we refer to as our full specification with all controls.

We use a method developed by Gelbach (2009) which nests the well known Oaxaca-Blinder decomposition. Gelbach points out that from the perspective of Equation (9) being the complete model, Equation (8) is just a model with the variables $X_{i2}, X_{i3}, X_{i4}, X_{i5}, X_{i6}, X_{i7}$ omitted. Thinking about Equation (8) in this way the well known omitted variable bias formula applies. That is, the relationship between α_d^B and α_d^F is:

$$\begin{aligned} \alpha_d^B = \; & \alpha_d^F + \left[\sum_{j=1}^{N_2} \theta_{2j}\alpha_{2j}^F\right] + \left[\sum_{j=1}^{N_3} \theta_{3j}\alpha_{3j}^F\right] + \left[\sum_{j=1}^{N_4} \theta_{4j}\alpha_{4j}^F\right] + \left[\sum_{j=1}^{N_5} \theta_{5j}\alpha_{5j}^F\right] + ... \\ & + \left[\sum_{j=1}^{N_6} \theta_{6j}\alpha_{6j}^F\right] + \left[\sum_{j=1}^{N_7} \theta_{7j}\alpha_{7j}^F\right], \end{aligned} \tag{10}$$

where the α_{kj}^F for $k = 1, ..., 7$ are defined in Equation (9) and there are N_k covariates in each of the k-groups. The θ_{kj} are the k elements in each θ_j vector defined by the auxiliary regression:

$$DeathAge_i = \theta_0 + \theta_1 X_{i1} + \theta_2 X_{i2} + \theta_3 X_{i3} + \theta_4 X_{i4} + \theta_5 X_{i5} + \theta_6 X_{i6} + \theta_7 X_{i7} + \eta_i. \tag{11}$$

Rearranging terms, a decomposition of how much each set of factors contribute to explaining the gap in outcomes is:

$$\begin{aligned} (\alpha_d^B - \alpha_d^F) = \; & \left[\sum_{j=1}^{N_2} \theta_{2j}\alpha_{2j}^F\right] + \left[\sum_{j=1}^{N_3} \theta_{3j}\alpha_{3j}^F\right] + \left[\sum_{j=1}^{N_4} \theta_{4j}\alpha_{4j}^F\right] + \left[\sum_{j=1}^{N_5} \theta_{5j}\alpha_{5j}^F\right] + ... \\ & + \left[\sum_{j=1}^{N_6} \theta_{6j}\alpha_{6j}^F\right] + \left[\sum_{j=1}^{N_7} \theta_{7j}\alpha_{7j}^F\right], \end{aligned} \tag{12}$$

where each term in the brackets is that part of the correlation explained by sum of the respective covariates.

Figure 1: Note: Claiming Benefits Early and Longevity: The Case of No Heterogeneity and Uniform Pricing

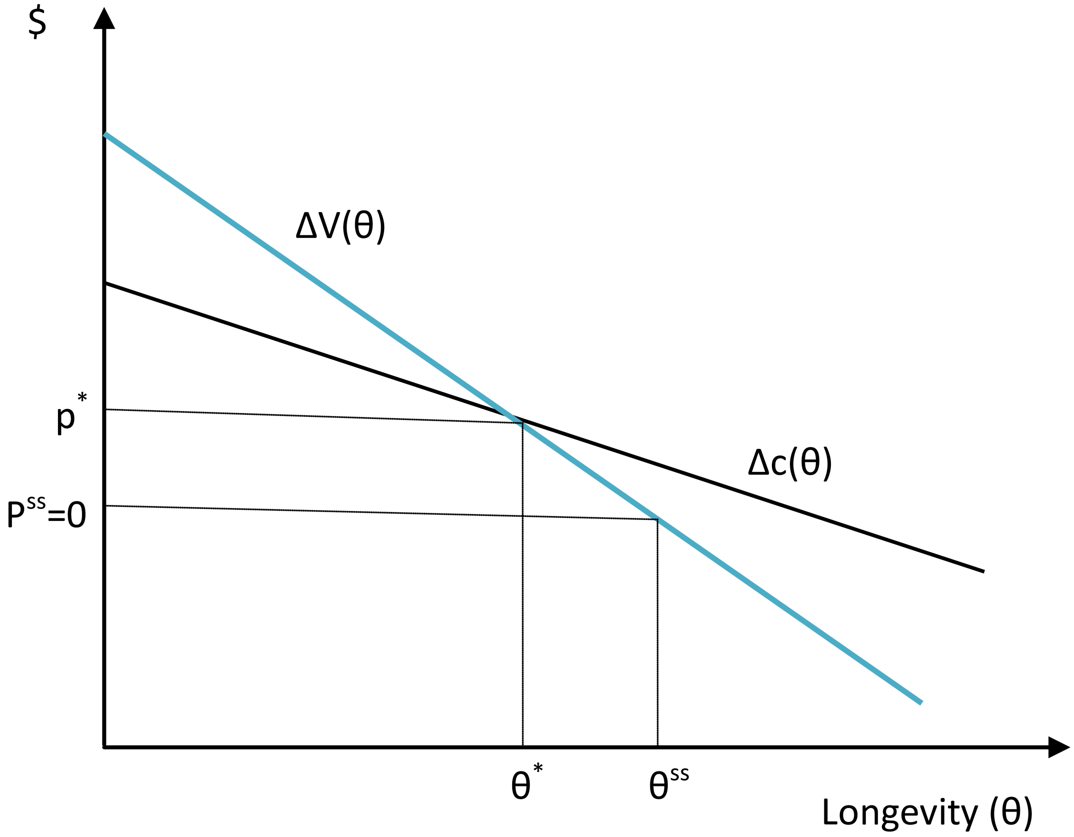
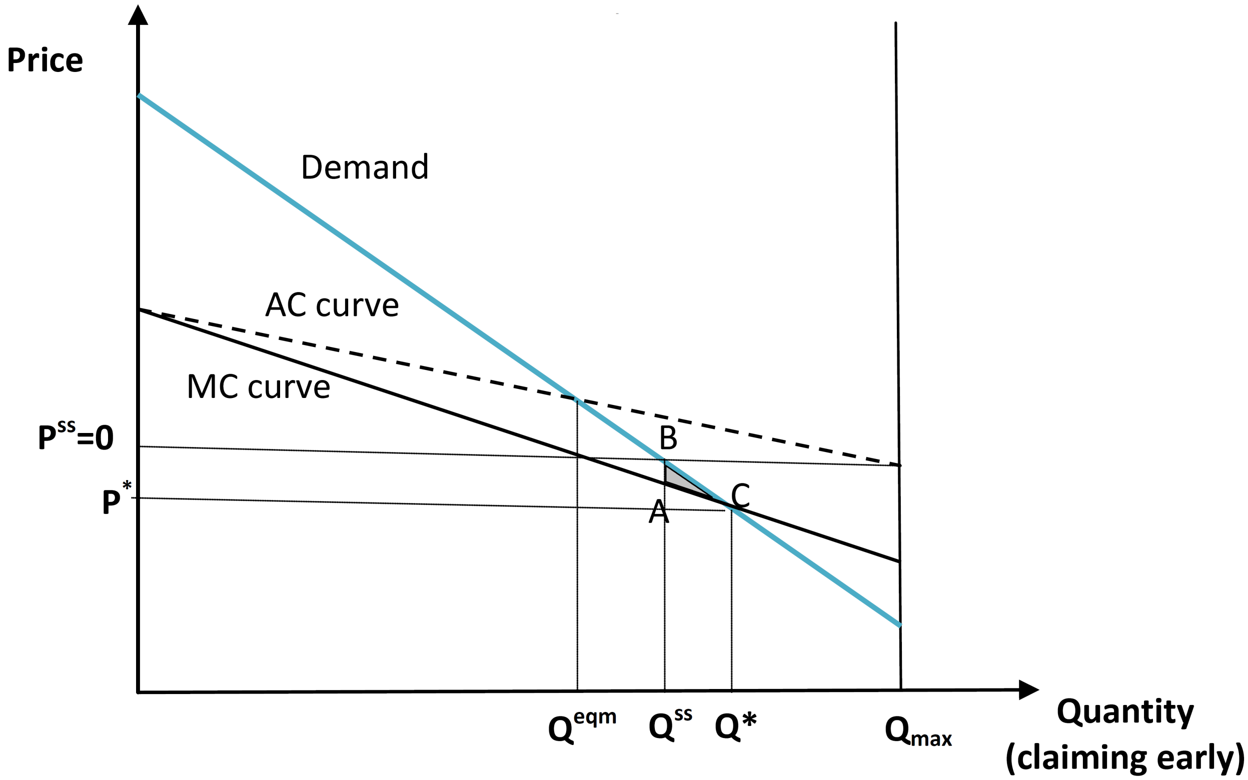


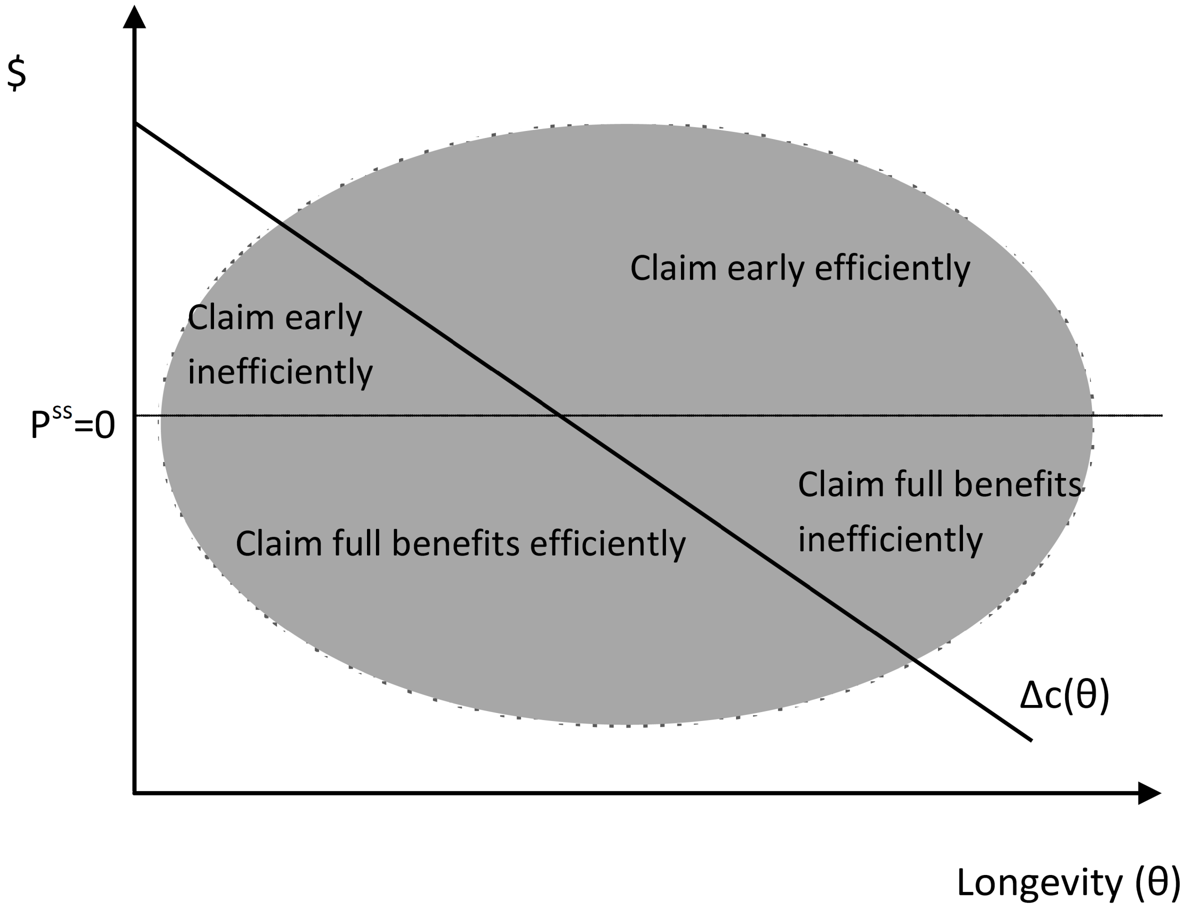
Figure shows a special case where there is no heterogeneity among individuals other than in life expectancy (θ). $\Delta V(\theta)$ describes the relationship between the incremental willingness-to-pay for claiming benefits early and longevity; $\Delta C(\theta)$ the incremental cost to the SSA of claiming benefits early and longevity. The positive correlation test checks whether in practice $\Delta V(\theta)$ and $\Delta C(\theta)$ are both downward sloping. p^* is the uniform premium that efficiently allocates individuals across Social Security annuity choices; $P^{ss} = 0$ is the premium actually charged by the SSA.

Figure 2: Efficiency Costs of Adverse Selection in Social Security



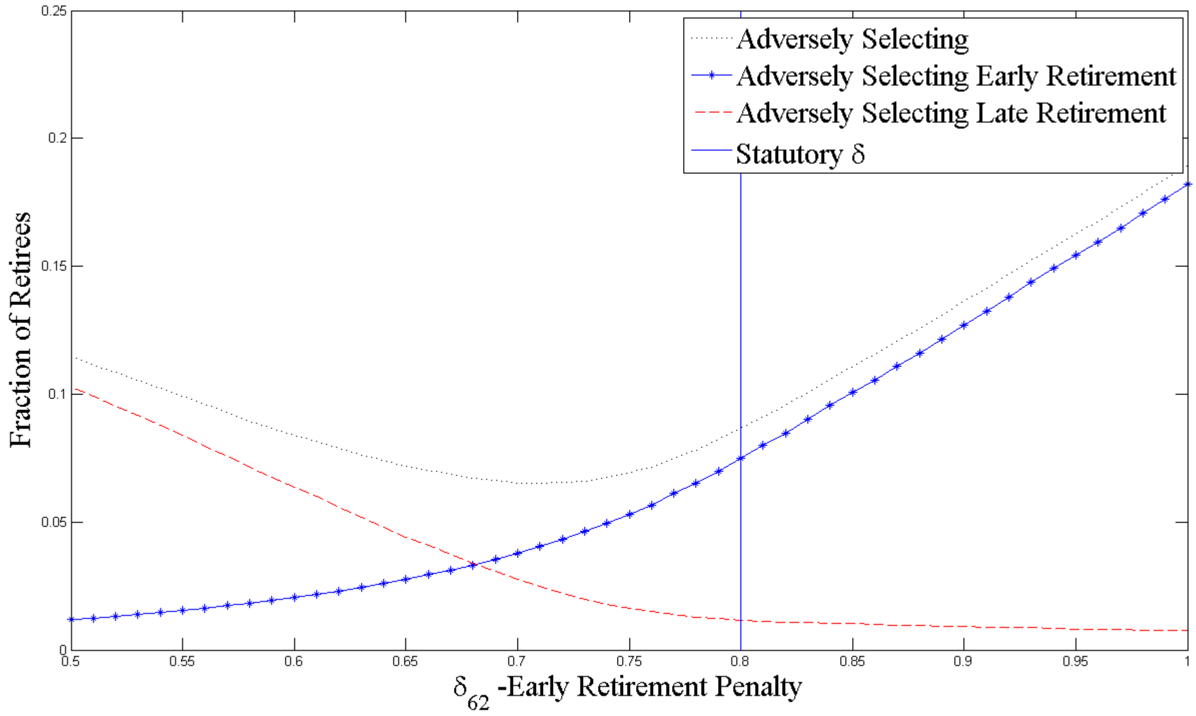
Note: Figure represents the theoretical efficiency cost of adverse selection. It depicts a situation reflecting the positive correlation between $\Delta V(\theta)$ and $\Delta C(\theta)$ depicted in Figure 1. The marginal cost curve is decreasing in quantity, indicating that the people who have the highest willingness to pay for claiming benefits early also have the highest expected cost to the insurer, generating adverse selection. p^* is the uniform premium that efficiently allocates individuals across Social Security annuity choices; $P^{ss} = 0$ is the premium actually charged by the SSA. Q and Q^{ss} are the corresponding fraction of individuals claiming benefits early. The triangle ABC is the welfare cost from inefficient choice of Social Security annuity due to adverse selection.

Figure 3: Claiming Benefits Early and Longevity: the Case With Heterogeneity and Uniform pricing



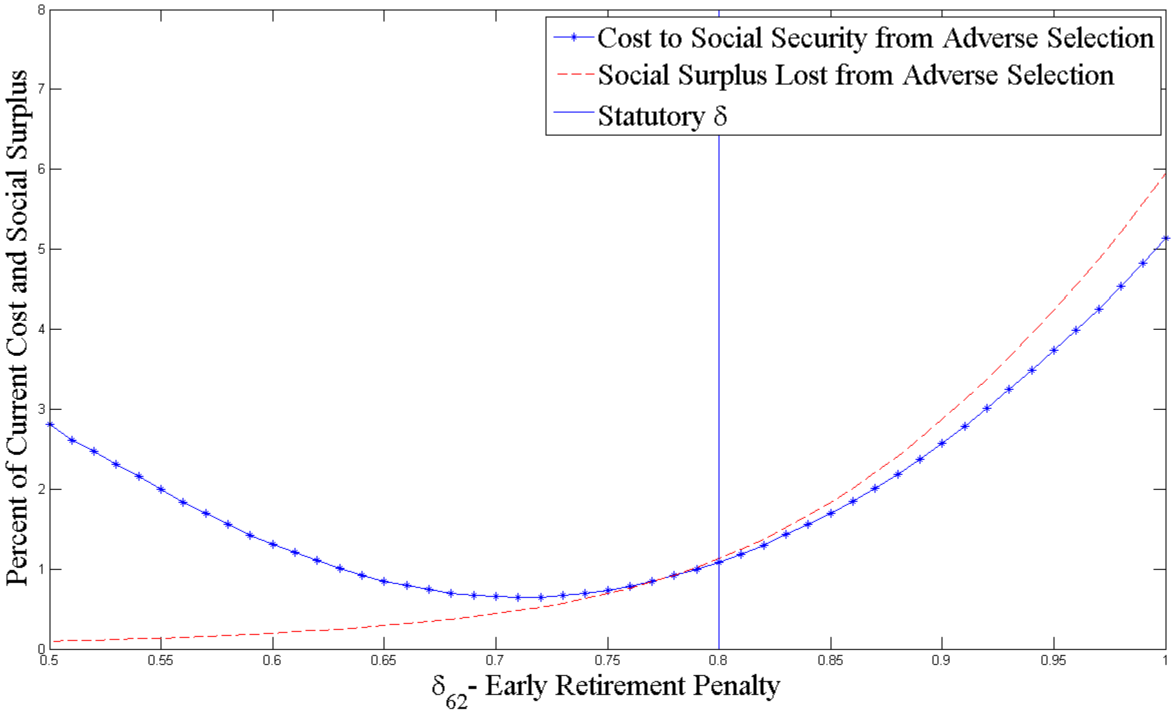
Note: Figure shows mis-allocation from uniform pricing with heterogeneous preferences. The shaded region shows the distribution of $\Delta V\left(\theta,\zeta\right)$. For these individuals, the y-axis value is the incremental willingness-to-pay for claiming benefits early and the x-axis value is longevity (θ). The line $\Delta C\left(\theta,\zeta\right)$ shows the relationship between incremental cost to Social Security and longevity. $P^{ss}=0$ is the current lump-sum premium charged by Social Security for claiming benefits early that allocates individuals in Social Security retirement ages.

Figure 4: Adverse Selection Under Different Early Retirement Penalties



Note: Simulations using the baseline model of the affect of changing the adjustment factor δ and maintaining a linear accrual rate. Each point is averaged over 100 draws. Curves represent the fraction of all retirees adversely selecting, followed by splitting this group into its two components: those adversely selecting early and late retirements.

Figure 5: Net Costs from Adverse Selection



Note: Simulations using the baseline model of the affect of changing the adjustment factor δ and maintaining a linear accrual rate. Each point is averaged over 100 draws. The upper curve represents the total social surplus under each δ-policy expressed as a percent of the baseline social surplus. The lower curve the total costs to the government under each δ-policy expressed as a percent of the baseline costs.

Table 1: Descriptive Means

	Social Security Claiming Age				
	62	63	64	65	Above 65
Fraction of Sample	0.493	0.126	0.082	0.179	0.120
Death Age	72.51	73.18	73.62	74.99	77.12
Subjective Longevity	79.16	78.66	78.79	79.88	81.96
Cost of Retirement ($1000s)	105.40	107.60	111.71	123.06	113.55
Health Conditions at Age 62					
Had Heart Disease	0.089	0.066	0.087	0.034	0.028
Had Cancer	0.058	0.039	0.047	0.046	0.014
Had Stroke	0.037	0.031	0.013	0.028	0.009
Had Diabetes	0.110	0.136	0.081	0.096	0.046
Had Lung Disease	0.128	0.149	0.121	0.099	0.065
Had Arthritis	0.461	0.535	0.456	0.418	0.389
Ever Smoke	0.750	0.816	0.705	0.734	0.694
Demographics at Age 62					
Education (years)	11.65	11.41	11.32	11.62	11.50
Ever Married	0.965	0.974	0.980	0.947	0.972
Minority	0.168	0.197	0.168	0.183	0.171
Mean Birth Year	1930.19	1929.48	1929.44	1928.37	1926.07
Financials at Retirement (in $1000s)					
Social Security Age 62 Benefit ($)	11.50	11.36	11.53	12.28	11.47
Capital Income ($)	10.93	11.31	11.91	13.69	20.98
Housing Wealth ($)	87.47	93.25	103.96	109.98	111.62
Non-housing Wealth ($)	150.01	146.48	196.21	163.69	214.57
No Positive Wealth	0.053	0.022	0.027	0.009	0.014
Private Pension Income ($)	5.35	5.58	5.07	5.50	5.21
Earnings at Retirement ($)	22.09	25.99	24.77	25.05	26.32
Zero Private Pension	0.350	0.307	0.369	0.269	0.231
Missing Financials	0.590	0.640	0.577	0.656	0.741
Spouse Characteristics					
Spouse OASS-Age 62 Benefit ($1000s)	8.34	8.34	9.17	9.10	9.93
No Spousal Social Security Benefit	0.524	0.566	0.477	0.520	0.486
Spouse Death Age	72.45	72.77	72.55	72.61	73.13
Spouse Death Age Missing	0.779	0.750	0.765	0.780	0.764
Age Gap (Male - Female)	2.77	2.79	3.17	3.35	4.19
N	891	228	149	323	216

Note: Sample is restricted to men and women who did not claim Social Security Disability Benefits prior to age 62, did claim old-age retirement benefits, with a known death age. Sample includes those born after 1915 and before 1941. Sample size is 1807 claimants.

Table 2: Correlation Test

	Claiming Age	Claim at Age 62	Claim at Age $\geq$65	Costs
	Panel A:Objective Longevity Measure			
Death Age	0.062***	-0.013***	0.015***	10.958***
	(0.012)	(0.004)	(0.003)	(0.382)
N	1807	1807	1807	1807
R^2/Pseudo R^2	0.133	0.051	0.087	0.467
	Panel B: Subjective Longevity Measure			
Death Age	0.019***	-0.005***	0.005***	0.873**
	(0.004)	(0.001)	(0.001)	(0.370)
N	5772	5772	5772	1062
R^2/Pseudo R^2	0.074	0.020	0.044	0.257

Note: Objective longevity measure is observed mortality; subjective measure is the mean of the individual distribution of subjective expectations of mortality. Costs are the discounted lifetime value of the observed retiree benefit. The first column is OLS of linear claiming age, column two and three are probit regressions, and column four is the linear regression of costs denominated in $1000s of 2010 dollars. *,** and *** denote significance at the 10%, 5%, and 1% levels respectively.

Table 3: Correlation Test with Covariates

	Continuous Retirement Age						
Objective Longevity	0.062***	0.063***	0.059***	0.060***	0.057***	0.054***	0.039***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
N	1807	1807	1807	1807	1807	1807	1807
R^2	0.133	0.135	0.145	0.147	0.156	0.197	0.211
Subjective Longevity	0.019***	0.019***	0.014***	0.010**	0.009**	0.009**	0.008**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
N	5772	5772	5772	5772	5772	5772	5772
R^2	0.074	0.075	0.082	0.096	0.107	0.167	0.18
Controls							
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AIME	No	Yes	Yes	Yes	Yes	Yes	Yes
Health History	No	No	Yes	Yes	Yes	Yes	Yes
Demographics	No	No	No	Yes	Yes	Yes	Yes
Occupation	No	No	No	No	Yes	Yes	Yes
Financial Information	No	No	No	No	No	Yes	Yes
Spousal Characteristics	No	No	No	No	No	No	Yes

Note: Objective longevity measure is observed mortality; subjective measure is the mean of the individual distribution of subjective expectations of mortality. *,** and *** denote significance at the 10%, 5%, and 1% levels respectively.

Table 4: Correlation Decomposition

	Linear Retirement Age-Correlation	
Death-Age Coefficient:	Objective Longevity	Subjective Longevity
Baseline Model	0.062***	0.0191***
	(0.012)	(0.006)
Full Model	0.039**	0.008**
	(0.013)	(0.004)
Fraction of Difference Explained by:		
AIME	-0.130**	-0.058**
Health History	0.065	0.212***
Demographics	-0.030	0.120**
Occupation	0.071**	0.155 ***
Financial Information I	0.035	0.095***
Financial Information II	-0.021	0.038
Spousal Characteristics	0.351***	0.061
Female	-0.072	-0.086***
Insurance	0.018	0.058
N	1807	5772

Note: Objective longevity measure is observed mortality; subjective measure is the mean of the individual distribution of subjective expectations of mortality. *,** and *** denote significance at the 10%, 5%, and 1% levels respectively.

Table 5: Correlation Endogeneity

	Objective	Subjective	IV-Subjective
	Without Controls		
Death Age	0.062***	0.019***	0.072**
	(0.012)	(0.004)	(0.033)
First-Stage Excluded Instrument			
Dad Death Age × 1{Dad Death Age >70}			0.081***
			(0.008)
N	1807	5772	5772
R^2	0.133	0.074	0.050
	With All Controls		
Death Age	0.039***	0.008**	0.040
	(0.013)	(0.004)	(0.035)
First-Stage Excluded Instrument			
Dad Death Age × 1{ Dad Death Age > 70}			0.071***
			(0.008)
N	1807	5772	5772
R^2	0.205	0.141	0.173

Note: Objective longevity measure is observed mortality; subjective measure is the mean of the individual distribution of subjective expectations of mortality. *,** and *** denote significance at the 10%, 5%, and 1% levels respectively.

Table 6: Model Estimates

$\hat{\rho}$	1.668***	1.670***	1.660***	1.667***	1.761***
	(0.075)	(0.121)	(0.085)	(0.150)	(0.104)
Adverse Selection and Welfare					
Fraction Adversely Selecting	0.120	0.112	0.109	0.103	0.087
Welfare Loss/Current Surplus	0.024	0.021	0.020	0.018	0.011
Welfare Loss per Beneficiary ($)	975	903	889	845	670
Average Costs ($):					
Optimal	114,376	114,092	114,264	114,168	114,993
Random Assignment	115,624	115,624	115,624	115,624	115,624
Baseline	116,566	116,600	116,576	116,543	116,617
Median Early Retiree ($)					
Willingness to Pay	44,452	46,528	47,795	49,144	60,295
Relative Costs	14,105	14,111	14,111	14,134	14,232
Median Late Retiree ($)					
Willingness to Pay	-28,412	-21,647	-25,289	-21,116	-35,536
Relative Costs	12,800	12,706	12,731	12,772	12,694
Controls					
Cohort Trend	Yes	Yes	Yes	Yes	Yes
AIME	Yes	Yes	Yes	Yes	Yes
Health History	No	Yes	Yes	Yes	Yes
Demographics	No	No	Yes	Yes	Yes
Financial Information	No	No	No	Yes	Yes
Spousal Characteristics	No	No	No	No	Yes

Note: *,** and *** denote significance at the 10%, 5%, and 1% levels respectively. Willingness to pay and relative costs are for claiming benefits at age 62. Sample size for all columns is 1719 which includes only individuals who died after age 65.

Table 7: Alternative Model Estimates

				Heterogeneity	
	Baseline	With Disability	IV-Subjective	No Random Coefficients	Random Coefficients
$\hat{\rho}$	1.761***	1.720***	1.583***	1.806***	1.793***
	(0.104)	(0.181)	(0.060)	(0.179)	(0.158)
Adverse Selection and Welfare					
% Adversley Selecting	8.648	8.6873	14.41	7.30	7.36
Welfare Loss/Surplus	0.011	0.005	0.032	0.007	0.008
Welfare Loss per Claimant($)	671	818	1,368	557	559
Average Costs ($):					
Optimal	114,992	114,797	99,160	115,287	115,160
Random Assignment	115,642	114,923	100,577	115,624	115,624
Baseline	116,617	116,281	102,415	116,597	116,638
Heterogeneity Mean (μ)					
Below Median AIME				-0.688***	-0.577*
				(0.012)	(0.297)
Health Index				0.272***	0.397
				(0.063)	(0.517)
1(No Positive Wealth)				-4.164***	-3.935
				(0.028)	(2.684)
Heterogeneity Standard Deviation (σ)					
Below Median AIME				-	0.371*
					(0.227)
Health Index				-	1.424**
					(0.549)
1(No Positive Wealth)				-	0.000
					(0.036)
Controls					
Longevity	Observed	Observed	Predicted Subjective	Observed	Observed
N	1719	2093	5772	1719	1719

Note: *,** and *** denote significance at the 10%, 5%, and 1% levels respectively. All regressions include a full set of controls. Welfare losses are measured relative to baseline social surplus among Old-Age claimants.

Table 8: Random Coefficient Model With Heterogeneous Annuity Valuation: Model Fit by Claiming Ages

	Age 62		Age 63		Age 64		Age 65		> Age 65	
Fraction	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed
Overall	0.486	0.478	0.119	0.122	0.084	0.087	0.186	0.188	0.125	0.126
θ_i Below Median	0.563	0.557	0.123	0.130	0.089	0.091	0.154	0.156	0.070	0.066
θ_i Above Median	0.416	0.405	0.115	0.115	0.079	0.083	0.214	0.217	0.176	0.181
Male	0.477	0.471	0.109	0.110	0.085	0.089	0.205	0.204	0.125	0.127
Female	0.501	0.488	0.137	0.143	0.082	0.084	0.154	0.161	0.125	0.124
AIME Below Median	0.492	0.467	0.121	0.113	0.085	0.087	0.169	0.187	0.134	0.146
AIME Above Median	0.481	0.488	0.117	0.131	0.083	0.086	0.202	0.188	0.116	0.106

Note: Based on 100 simulation draws for the random coefficients and utility shocks; each row reports results for a different sub-sample of the data

Table 9a: Counterfactual Policy Simulations, Baseline Model

	Baseline	Optimal Linear Accrual Rates	Optimal Non-Linear Accrual Rates	Raise FRA to 66, Cut Accrual Rates	Mandated Age 65 Retirement
% of Baseline Costs	100.00	94.30	93.55	93.83	88.64
% of Baseline Social Surplus	100.00	101.27	101.66	87.37	-
% Adversely Selecting	8.648	6.514	7.017	8.672	0
Welfare Losses/Social Surplus	0.011	0.006	0.007	0.010	0
Fraction Claiming before FRA	0.701	0.643	0.631	0.635	0
Per Claimant (in $1000s)					
Change in Social Surplus	-	783	1027	-7789	-
Change in Total Costs	-	-6641	-7528	-7199	-13243
Adjustment Factors					
δ_{62}	0.800	0.718	0.728	0.750	0.800
δ_{63}	0.867	0.812	0.770	0.813	-
δ_{64}	0.933	0.906	0.812	0.875	-
δ_{65}	-	-	-	0.938	-

Note: Each column is based on 100 simulation draws.

Table 9b: Counterfactual Policy Simulations, Random Coefficient Model

	Baseline	Optimal Linear Accrual Rates	Optimal Non-Linear Accrual Rates	Raise FRA to 66, Cut Accrual Rates	Mandated Age 65 Retirement
% of Baseline Costs	100.00	93.90	92.75	94.62	88.63
% of Baseline Social Surplus	100.00	100.26	100.49	88.37	-
% Adversely Selecting	7.394	5.505	5.789	7.800	0
Welfare Losses/Social Surplus	0.008	0.005	0.005	0.008	0
Fraction Claiming before FRA	0.696	0.653	0.641	0.658	0
Per Claimant (in $'s)					
Change in Social Surplus	-	189	360	-8510	-
Change in Total Costs	-	-7,115	-8,454	-6,280	-13,262
Adjustment Factors					
δ_{62}	0.800	0.711	0.711	0.750	0.800
δ_{63}	0.867	0.807	0.773	0.813	-
δ_{64}	0.933	0.904	0.819	0.875	-
δ_{65}	-	-	-	0.938	-

Note: Each column is based on 100 simulation draws.

Table 9c: Counterfactual Policy Simulations, Including Disability

	Baseline	Optimal Linear Accrual Rates	Optimal Non-Linear Accrual Rates	Raise FRA to 66, Cut Accrual Rates	Mandated Age 65 Retirement
% of Baseline Costs	100.00	94.97	94.24	93.41	79.91
% of Baseline Social Surplus	100.00	100.34	100.40	93.85	-
% Adversely Selecting	8.687	6.334	6.431	8.113	0
Welfare Losses/Social Surplus	0.007	0.003	0.003	0.007	0
Fraction Claiming before FRA	0.564	0.544	0.544	0.531	0
Fraction Retiring on Disability	0.179	0.183	0.184	0.185	0.266
Per Claimant (in $'s)					
Change in Social Surplus	-	479	551	-7793	-
Change in Total Costs	-	-4804	-5503	-6289	-19185
Adjustment Factors					
δ_{62}	0.800	0.723	0.739	0.750	0.800
δ_{63}	0.867	0.821	0.771	0.813	-
δ_{64}	0.933	0.911	0.864	0.875	-
δ_{65}	-	-	-	0.938	-

Note: Each column is based on 100 simulation draws. Costs are calculated only among those choosing Old-Age Social Security benefits.

Table 10: Who Adversely Selects

	Model								
	Baseline			Heterogeneity B			With Disability		
	Policy			Policy			Policy		
		Optimal			Optimal			Optimal	
Claim Early Adversely:	Current	Linear	FRA 66	Current	Linear	FRA 66	Current	Linear	FRA 66
Fraction of OASS Claimants	0.075	0.043	0.077	0.064	0.034	0.066	0.085	0.048	0.085
Longevity	9.14	7.17	9.30	9.13	7.09	9.73	9.33	7.30	9.32
FRA Benefit ($1000s)	12.05	11.40	12.20	11.80	11.13	12.27	12.81	12.39	12.92
Capital Income ($1000s)	11.18	10.49	11.08	11.27	10.66	11.19	11.22	10.38	10.94
Health Index	0.419	0.481	0.421	0.389	0.450	0.357	0.419	0.486	0.431
Married	0.723	0.736	0.731	0.736	0.758	0.743	0.740	0.750	0.747
Female	0.406	0.407	0.412	0.398	0.401	0.398	0.388	0.392	0.401
Minority	0.186	0.194	0.188	0.180	0.187	0.183	0.183	0.192	0.181
Fraction Claiming Early	0.689	0.643	0.635	0.696	0.653	0.648	0.707	0.656	0.647
Fraction Claiming Disability Insurance							0.179	0.183	0.185
Fraction Claiming FRA or Later	0.311	0.357	0.365	0.304	0.347	0.353	0.290	0.339	0.346

Note: Numbers are averages from 100 simulations under each policy-model combination.