Bequest Motives and the Social Security Notch *

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Abstract

Bequests may be a key driver of late life savings behavior and, more broadly, a determinant of intergenerational inequality. However, distinguishing bequest motives from precautionary savings is challenging. Using the Health and Retirement Study, we exploit an unanticipated change in Social Security benefits, commonly called the Social Security Notch, as an instrument to identify the effect of benefits on bequests. We show that an increase in benefits leads to a sizeable increase in bequest amounts. We combine our instrumental variable estimates with a model of late life savings behavior that accounts for mortality risk and unobserved expenditure shocks to identify bequest motives. The model is used to analyze two counterfactuals. The first demonstrates the importance of bequest motives as a driver of late life savings by comparing asset profiles with and without utility from bequests. We find that roughly two-fifths of accumulated assets and bequests are attributable to bequest motives among retirees. Our second counterfactual features a more progressive Social Security benefits schedule that reduces benefits for the richest retirees. We show that wealth declines, acting as a cushion against benefit reduction so that consumption remains largely unchanged.

Key words: bequests, late life savings, assets, social security
JEL codes: D3, D91, H55, J14

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1 Introduction

Given that retirees are nearing the end of their life-cycle, they seem to be saving “too much” under standard models of consumption and savings. Two major reasons that can explain this phenomenon are precautionary savings and bequest motives. Precautionary savings are driven by various risks to consumption that retirees face, while bequest motives are driven by warm glow from leaving bequests. However, since accumulated assets can serve both purposes, bequest motives are notoriously difficult to distinguish from precautionary savings (De Nardi et al., 2016b; Dynan et al., 2004).

This paper proposes a novel solution by exploiting a plausibly exogenous change in Social Security benefits, known as the Social Security Notch, to identify bequest motives. This change in benefits arose from an error in the calculation of benefits in the 1970s and led to higher benefits for retirees born between 1911-1916 relative to cohorts before and after. Using the policy change as an instrument for benefits, we estimate positive and large effects of benefits on bequests to show that bequest motives are important. We then incorporate the instrumental variable estimates with a model of post-retirement savings behavior to decompose assets and bequests by bequest motives versus precautionary savings.

The Social Security Notch has a unique advantage for identifying bequest motives. Social Security benefits are effectively a source of annuity income and serve as insurance against mortality risk. Therefore, a difference in benefits would mean a difference in the incentive to save for precautionary reasons. However, benefit levels are closely tied to lifetime earnings and hence correlated with initial wealth at retirement. Since initial wealth levels are in turn correlated with both bequest motives and precautionary motives, we cannot recover bequest motives. Using the Social Security Notch as an instrument circumvents this problem so that we can estimate the effect of benefits on bequests and identify bequest motives. It is important to note that an alternate instrument that generates a one-time wealth or income change would be insufficient for our purposes. The one-time windfall in wealth can be saved for either precautionary reasons or bequest motives and cannot separate the two.
Using the Health and Retirement Study, Asset and Health Dynamics among the Oldest Old (HRS AHEAD), we estimate the effect of annual benefits on bequests. We also estimate the effect of Social Security wealth on bequests to recover the intergenerational “pass-through” rate for an increase in late-life wealth. Our estimates show that a $1,000 increase (1993 dollars) in annual Social Security benefits leads to an $18,000 increase in bequests and a 6 percentage point increase in the probability of leaving any bequests. The corresponding pass-through rate for this increase is approximately 50%. The large bequest response of retirees to an increase in benefits suggest that bequest motives are in fact important.

We also provide evidence that bequests are a luxury good by looking at heterogeneity in the benefit effect by wealth levels (as captured at first observation). We find that the effect is larger for higher quantiles of wealth. In particular, the pass-through rate is roughly 20% for most of the wealth distribution but rises sharply past the 90th percentile, reaching 100% for the top 1% of our sample.

While informative, these estimates are insufficient to uncover the role of bequests in savings behavior relative to precautionary savings. To address this, we construct a model of post-retirement savings behavior for single retirees. The model includes mortality risk as an incentive for precautionary savings, yearly expenditure shocks that flexibly depend on permanent income, and bequest motives. Using indirect inference, we identify and estimate the model by matching the instrumental variable estimates above in addition to median asset profiles by cohort. While asset profiles reflect both the bequest motive and precautionary savings, the additional variation from the Notch separately identifies preference parameters that govern the strength of bequest motives. The model is used to decompose bequests into voluntary bequests (due to the bequest motive) and accidental bequests (due to precautionary savings). The model is also used to analyze the savings behavior of retirees when faced with counterfactual Social Security benefits.

Our estimates of the preference parameters governing bequest motives show that they
are influential in determining savings for retirees. As suggested in the heterogeneity of the instrumental variable estimates by asset levels, we find that bequests are a luxury good. To quantify the importance of bequest motives, we simulate asset profiles under the assumption that bequests yield no utility while keeping all other estimated parameters fixed. Without bequest motives, asset profiles decline much more sharply. At age 84, ten years after the start of our counterfactual simulation, we find that counterfactual assets are 40% lower than baseline. Counterfactual bequests, now purely accidental, are roughly 60% of our baseline model simulations. Furthermore, the fraction of bequests that are driven by bequest motives seem to be fairly steady over the bequest distribution.

Given that bequests are an important part of savings behavior, we expect that savings set aside for bequests act as a cushion for cuts in Social Security benefits for the rich. We implement a more progressive benefit schedule which would reduce the cost of Social Security as an insurance program by capping benefits at the 80th percentile. Our counterfactual simulations indicate that median consumption levels are largely unchanged. Instead, the richer retirees elect to draw down on their assets, and by implication, reduce their bequest amounts.

Our findings speak to a long literature on bequests, at least since the debate between Kotlikoff and Summers (1981) and Modigliani (1988) regarding the portion of wealth stemming from intergenerational transfers. Gale and Scholz (1994) argue that intergenerational transfers account for at least 50% of accumulated wealth. If most wealth is not earned but inherited, then understanding why wealth is left behind is important for any kind of policy targeted at reducing intergenerational wealth inequality by changing bequest behavior.

In addition, the fact that retirees are using savings to insure themselves against risk indicate that annuity markets are too expensive for most retirees due to adverse selection (Lockwood, 2012). The relative strength of bequest motives and precautionary savings inform us about the degree of market failure. Our finding that precautionary savings explain 60% of accumulated assets can serve as a justification for Social Security as an effective
government intervention to insure retirees against mortality risk.

Furthermore, without an understanding of the motives underlying the savings behavior of retirees, it would be difficult to evaluate the distributional and welfare effects of changes to Social Security benefits. With the looming costs of Social Security in the United States and other countries, it is important to understand the consequences of reductions in such benefits. Our results show that although Social Security benefits insure retirees against mortality risk, at the higher end of the benefit distribution, benefits are bequeathed rather than consumed.

Prior papers have attempted to disentangle bequest motives from precautionary savings (see De Nardi et al. (2016b) for a comprehensive review). One approach is to include data that pertains to different sources of risk such as medical costs and long-term care to capture major drivers of precautionary savings (De Nardi et al., 2010; Lockwood, 2012). The residual is left to bequest motives. Other papers elicit bequest motives from respondents directly (Ameriks et al., 2011).

Our paper departs from the literature by adopting an instrumental variable approach. The two major threats to existing approaches of identification are omitted sources of risk, and other types of unobserved heterogeneity that are correlated with both precautionary savings incentives and bequest motives.\textsuperscript{1} Our instrument, the Social Security Notch, addresses both of these concerns. Identification hinges on the fact that retirees in the 1911-1916 cohorts received higher payouts for the rest of their life than retirees from earlier and later cohorts, and that this windfall was unanticipated pre-retirement.

Our model is considerably simpler than previous efforts to disentangle bequest motives and precautionary savings since we side-step the need for explicitly modelling multiple sources of expenditure risk by relying on the Notch as an instrument. Instead, our model allows for expenditure risks to be correlated with income in a flexible way and identifies them

\textsuperscript{1}These include initial wealth levels at retirement, unobserved expenditure shocks due to emergencies, transfers to and from friends or family, and heterogeneity in rates of return to savings from portfolio composition.
through the wedge in savings and bequests behavior between the Windfall and non-Windfall cohorts. These unobserved shocks in the model capture the unobserved heterogeneity that may be correlated with Social Security benefits and bequests that the instrument addresses.

Our paper therefore contributes to the literature by proposing a new identification strategy to estimate bequest motives. Although many papers have analyzed late-life savings behavior, the literature remains divided on the relative importance of bequest motives and precautionary savings. On one hand, some argue that bequests are largely accidental, and assets are driven mainly by precautionary savings. Hurd (1987) is an early paper arguing that bequest motives are weak by comparing the savings behaviors of retirees with children against childless retirees, hypothesizing that childless retirees would have a weak bequest motive. Finding that both groups of retirees dissave at similar rates, he concludes that most retirees have economically insignificant bequest motives. Hurd (1989) complements the earlier finding with a model of savings behavior and estimates a small marginal utility of bequests. De Nardi et al. (2010) estimate a model of late-life savings behavior explicitly accounting for mortality risk and medical cost, and finds that bequest motives are only important for a tiny fraction of the wealthiest households while most savings are generated for precautionary reasons. Ameriks et al. (2011) relies on survey responses that reveal bequest motives by asking respondents about trade-offs between future consumption and bequests under hypothetical scenarios (see also Ameriks et al. (2015a,b)).

On the other hand, David and Menchik (1985) is an early precursor to our paper finding evidence that bequests matter for explaining the response of retirees to Social Security. Bernheim (1991) shows that most retirees would choose to retain a portion of their wealth in bequeathable form rather than annuitize it as insurance against mortality risk, even if insurance markets were perfect. This suggests the presence of a bequest motive for the majority of households. Lockwood (2012) brings this intuition to a model of annuity choice and provides evidence that annuity markets are priced such that people with bequest motives do not take up annuities at all. Without bequest motives, the low participation in annuity
markets would be hard to explain. Another line of research looks at the response of inter vivos gifts to either bequest taxes or estate taxes (Bernheim et al., 2004; Joulfaian, 2000; Page, 2003). Since the elderly choose to pass more wealth through inter vivos gifts when bequest or estate taxes rise, then the bequest motive is likely to be operative. Our paper supports the claim that bequest motives are important.

To our knowledge, our paper is also the first to use the Social Security Notch as a way to identify bequest motives. The Notch has been used by many others as an instrument for income and wealth, starting from Krueger and Pischke (1992) who analyzed retirement decisions in response to changes in post-retirement income (other more recent papers include Gelber et al. (2016); Moulton and Stevens (2015)). However, prior papers do not capitalize on the nature of benefits as a source of annuity income which leads to a reduction in the incentive to save against mortality risk.

Another related literature examines the propensity to bequeath or save in response to changes in earnings or wealth. A number of papers provide evidence that bequests are luxury goods (Altonji and Villanueva, 2007; Hurd and Smith, 2002; Menchik and David, 1983). Our estimates for the effect of Social Security wealth on bequests are larger than previous estimates.

Finally, we add to a literature that studies the effects of changes in Social Security benefits on the savings behavior of retirees. Our counterfactual analysis sheds light on the way retirees trade off bequests for consumption when faced with lower benefits. Other studies have examined the potential effects of benefit cuts to retirees but have thus far focused on income (Goodman and Liebman, 2008). In particular, the Social Security Administration bases much of its analysis on a simulation model known as Modeling Income in the Near Term (MINT) (Olsen, 2008; Smith and Favreault, 2014). Weinzierl (2014) is a notable exception, providing an analysis of a reduction in benefits with regard to retiree consumption. However,

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2 Other outcomes include mortality (Snyder and Evans, 2006), co-residence (Engelhardt et al., 2005), home-ownership (Engelhardt, 2008), long-term care utilization (Goda et al., 2011), healthcare expenditure (Moran and Simon, 2006; Tsai, 2016), and child’s wealth (Edwards et al., 2016; Moulton, 2014).
the focus is on the comparison of back-loaded benefits versus front-loaded benefits.

The rest of the paper is as follows: the first half of the paper lays out the institutional
details of our instrument (Section 2), and describes how it is used to identify the bequest
response of retirees when Social Security benefits are exogenously changed (Section 3). The
second half proposes a model of post-retirement savings behavior (Section 4). We use this
model in conjunction with the instrument to estimate and identify underlying preferences for
bequests (Section 5). We show our results in Section 6 and decompose the savings of retirees
and consider policy counterfactuals where benefit levels are reduced. Section 7 concludes.

2 Social Security Notch

The Social Security Notch arose from a change in the way Social Security benefits were cal-
culated in the early 1970s. Before 1972, benefits were determined by computing a Principal
Insured Amount (PIA) based on Average Monthly Earnings (AME) over the retiree’s career.
The PIA was linked to benefit levels via a table. However, in order to account for creeping
inflation, Congress would increase benefit levels associated with one’s PIA on an ad hoc
basis.

In 1972, Congress passed amendments that were aimed at removing the need to period-
ically alter benefits, to be implemented in 1975. The new formula double-counted inflation
by accounting for inflation in the computation of the PIA based on (nominal) AME, and by
allowing for automatic Cost of Living Adjustments (COLA) each year based on prevailing
prices. This is commonly referred to as the double-indexation issue. As a result, benefits
would become overly generous during periods of high inflation and high wage growth. This
windfall affected cohorts born between 1911-1916 retiring at the normal retirement age of
65 or later (henceforth referred to as the Windfall cohort). Earlier cohorts did not benefit

\[\text{\footnotesize 3} \text{Refer to the Congressional Budget Office report on the Notch issue for a detailed history of the legislation surrounding the Notch (Kollmann, 2003).}\]

\[\text{\footnotesize 4} \text{We include 1911-1912 cohorts even though retirees who retired before age 65 would not benefit from the windfall. Instead, they benefited from a large ad hoc 20% increase in benefit levels implemented in}\]
from the higher nominal wages that the Windfall cohorts received.

However, the Social Security Administration quickly realized that the new formula would lead to a severe lack of funds by the 1980s. Congress therefore passed the 1977 amendments which provided a corrected formula that separately accounted for inflation over the working life of retirees and COLA. The corrected formula computed the retirees’ PIA based on Average Indexed Monthly Earnings (AIME) and was implemented in 1979. Importantly, the correction was only applied to retirees born in 1917 and after, regardless of retirement age. Retirees who were born in the Windfall cohorts retained the PIA computed using the flawed formula and therefore were entitled to higher benefits than subsequent cohorts for the rest of their post-retirement lives. This decrease in benefits due to the correction is commonly referred to as the “Notch”. Figure 1 shows what a retiree earning average wages throughout her career would receive given her birth year. The Notch is represented by the dip in benefits associated with a retiree from the 1917-1921 cohort retiring at 65.

These changes provide the variation we need for identifying bequest motives. The new formula was implemented in 1975, affecting cohorts born between 1911-1916 and retiring at 65. Earlier cohorts (1905-1910) and later cohorts (1917-1921) did not receive the windfall from double-indexation that the flawed formula in combination with high wage growth and inflation provided.

3 Benefits and Bequests

In this section, we describe how we make use of the Notch to estimate the effect of benefits on bequests. We employ an instrumental variables (IV) approach and discuss the data we use, the identification strategy and the validity of the instrument, and present results.

September 1972 because Congress thought it was necessary to act against rising inflation before the full implementation of the 1972 amendments.
Figure 1: Payout for Average Worker by Birth Year

Chart 6: Retirement at 65

Notes: Sourced from Kollmann (2003). Social security payout for workers who had average earnings every year of their working life in 1994 dollars.
3.1 Data

To exploit the instrument, we require a sample of retirees whose birth years fall in the relevant period. The Health and Retirement Study, Assets and Health Dynamics of the Oldest Old (HRS AHEAD)\(^5\), has two features that make it ideal for our purposes. First, it includes retirees who were affected by our instrument. Second, it contains data on bequests and Social Security benefits. The HRS AHEAD surveyed retirees in 1993, 1995, 1998, and biannually henceforth to 2012. Information about assets, Social Security income, bequests, and mortality was elicited. Our sample consists of retirees born between 1905-1921. We focus on singles to avoid dealing with joint household decisions.\(^6\) We restrict our sample to whites since non-whites account for a small fraction of our sample, and the mortality risks for non-whites are considerably different. Retirees must have non-missing Social Security benefits and assets in 1995.\(^7\) Finally, we construct bequest data from the exit interviews after death (typically with next-of-kin). We include bequests to spouses, children, siblings, relatives, friends, charities, and others.\(^8\) To maximize sample size, we also impute assets in the year prior to death if bequest amounts are unknown.\(^9\) Assets refer to non-annuitized sources of wealth, including housing, stocks, savings and checking accounts, and bonds. This yields a final sample of 1638 observations.

3.2 Identification

Our identification strategy is to compare retirees who were affected by different benefit rules based on birth year. For the cohorts born between 1911-1916, benefits were exceptionally high, deviating from the general trend of benefits over time. As can be seen in Figure 1, there

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\(^5\)All core variables are from the RAND version of the HRS data.

\(^6\)This includes never married retirees, as well as divorcees, widows, and widowers. Roughly 80% of the sample consists of widows and widowers.

\(^7\)We use assets in 1995 instead of 1993 because of a well-known problem in the asset data from 1993 (Rohwedder et al., 2006).

\(^8\)The survey includes information on either the dollar amount or the percentage of the estate with the total estate amount. We use both types of information.

\(^9\)In practice, the estimates with and without the imputed observations do not differ, although standard errors are larger.
were substantial differences in benefits by birth year. Other researchers have chosen different birth years to designate as Windfall cohorts but the deviation from the trend is clear.\textsuperscript{10} To capture deviations from the general increase in benefit levels over time, we include linear cohort trends.\textsuperscript{11}

The key assumption required for the instrument to be valid is that any observed difference in bequests across the Windfall and non-Windfall cohorts is driven by the institutional changes determining benefit levels. If the windfall were anticipated by retirees from the Windfall cohort, they may have saved less pre-retirement\textsuperscript{12}, which would yield an underestimate of the effect of benefits on bequests. However, the windfall was unanticipated even by Congress and the Social Security Administration, who did not expect it to exhaust the program’s funds. It is therefore plausible that retirees from the Windfall cohorts did not act in anticipation of the windfall by saving less pre-retirement.

A related concern is that the later cohorts (1917-1921) may have anticipated benefit formulas received by the Windfall cohort and thus planned to retire at earlier ages or dissaved at faster rates. Since early retirement lowers benefits as well as reduces assets, this would violate the assumption that the instrument is uncorrelated with bequests except through benefits. This would upward-bias our estimates since a portion of our “control group” would have started off retirement with lower assets relative to the Windfall cohort, and hence have lower bequest amounts.

However, if retirees from the Notch cohort in fact anticipated benefit levels that were as high as the Windfall cohort’s received benefits, we would see a nearly immediate reaction against the 1977 amendments from them the moment they began collecting benefits that were significantly smaller. However, the Notch remained unnoticed by the media until September 1983, when a column from Dear Abby\textsuperscript{13} coined the term “Notch babies” for the retirees in

\textsuperscript{10}In our instrumental variable estimates, we check that alternate specifications of the Windfall cohort do not affect our results. The results are in Appendix A.
\textsuperscript{11}Unfortunately, the sample sizes in the HRS are not large enough to facilitate an analysis based on a tight bandwidth around the 1916-1917 discontinuity.
\textsuperscript{12}By “retirement”, we mean the year when Social Security benefits are first received.
\textsuperscript{13}A well known columnist.
the later cohort. She was a Notch baby herself, and the first to raise the issue to public attention, urging retirees to take political action. Without the column, the Notch issue might have entirely disappeared without notice. Instead, the Social Security Administration responded both in newspapers and by commissioning a study to examine the costs and benefits of compensating the Notch babies.\(^\text{14}\)

We argue that the circumstances surrounding the change in benefits were such that retirees from all three cohorts (pre-Windfall, Windfall, and Notch) were unaware of the changes in benefits pre-retirement until they received their first month’s benefit. Therefore, differences in assets post-retirement across the cohorts can be attributed to the disparities in benefits, conditional on general cohort trends. Unfortunately we do not directly observe pre-retirement assets and are unable to directly test for differences. Instead, we first check for comparability of pre-retirement characteristics across the Windfall and non-Windfall cohorts. Table 1 shows regressions of pre-retirement characteristics on an indicator for belonging to the Windfall cohort (conditional on linear cohort trends and gender). Pre-retirement characteristics include education, number of children, gender, pension benefits, and retirement age.

The results are reassuring, suggesting that retirees across the cohorts are similar. Of particular importance is the test for differences in retirement age. This is the major endogenous choice that one may expect would be affected by a change in benefits. We find little difference in age of retirement, in line with prior literature studying the labor force participation effects of the Notch (Krueger and Pischke, 1992).

### 3.3 Results

For the instrument to be useful, benefits must be sufficiently different across the Windfall and non-Windfall cohorts. Our first stage regresses annual Social Security benefits on an\(^\text{14}\) See U.S. General Accounting Office (1988) for more detail.
Table 1: Balancing Tests on Pre-retirement Characteristics

<table>
<thead>
<tr>
<th></th>
<th>coef.</th>
<th>s.e.</th>
<th>p-val.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>0.010</td>
<td>(0.155)</td>
<td>0.950</td>
</tr>
<tr>
<td>Number of kids</td>
<td>-0.032</td>
<td>(0.096)</td>
<td>0.735</td>
</tr>
<tr>
<td>Female</td>
<td>0.002</td>
<td>(0.022)</td>
<td>0.941</td>
</tr>
<tr>
<td>Pension benefits</td>
<td>-0.036</td>
<td>(0.281)</td>
<td>0.897</td>
</tr>
<tr>
<td>Retirement age</td>
<td>-0.271</td>
<td>(0.307)</td>
<td>0.377</td>
</tr>
</tbody>
</table>

Notes: Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Retirement refers to receipt of Social Security benefits. “Retirement age” is imputed as 62 if recorded as less than 62.

indicator for being born in the Windfall cohort (1911-1916), linear cohort trends, and gender:

$$SSB_i = \alpha_0 + \alpha_1 Wind_i + \alpha_2 Birthyr_i + \alpha_3 Fem_i + \nu_i^{SSB}$$ (1)

where $SSB$ refers to Social Security benefits, $Wind$ refers to an indicator for belonging to the Windfall cohort, $Birthyr$ refers to birth year, and $Fem$ refers to a gender dummy. Our first stage regression is represented by the difference in mean Social Security benefits between the Windfall cohort and the non-Windfall cohorts as seen in Figure 2.

Our second stage regresses three bequest-related outcomes on predicted benefits:

$$Beq_i = \omega_{0}^{beq} + \omega_{1}^{beq} \hat{SSB}_i + \omega_{2}^{beq} Birthyr_i + \omega_{3}^{beq} Fem_i + \nu_i^{beq}$$ (2)

The first outcome is bequests (in thousands of 1993 dollars), the second is bequests conditional on positive bequests, and the third is an indicator for positive bequests (linear probability model). The regression results are presented in Table 2, along with estimates from a corresponding Ordinary Least Squares (OLS) regression. We also report the OLS estimates alongside the IV estimates for comparison. The results show that a $1,000 increase
Figure 2: Social Security Benefits by Birth Year

Notes: Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993 (3% discount rate).
in yearly annuity income leads to a roughly $18,000 increase in bequests and a 6 percentage point increase in the probability of leaving one. As a robustness, we run the same regressions with additional controls including education, an indicator for having children, and being born during World War 1. The estimates are very similar. We also use alternate discount rates (6% and 9%) and obtain qualitatively similar results, although the magnitude of the coefficient is slightly lower ($15,000 and $12,000 respectively).15

Our IV estimates have two main implications. First, they suggest that bequest motives are in fact important since bequests are responsive to a change in benefits. Both bequest amounts and the probability of leaving non-zero bequests increase significantly with an increase in benefits. Second, the disparity between the OLS and IV estimates suggest that unobserved heterogeneity that is correlated with benefits and bequests are important.

### 3.4 Marginal Propensity to Save

An alternate regression examines the effect of Social Security wealth rather than annual benefits on bequests. This effectively captures the pass-through rate of the windfall – how much of the additional income was left behind rather than consumed. We compute Social Security wealth by summing Social Security benefits from retirement to death, discounted to 1993 (3%). Retirees are responding to changes in their annuitized wealth in the form of Social Security benefits over a horizon of roughly 25 years – the span of time between retirement and death. The estimated pass-through rate can be interpreted as the (local) average marginal propensity to save in the (very) long run.

The results in Table 3 show that on average, retirees passed roughly 50% of their increase in Social Security wealth through bequests. This finding is in stark contrast to Altonji and Villanueva (2007) who find a pass-through of only 3% in bequests to adult children, similar to our OLS estimates. An important difference is that we consider all bequests, not only to adult children. However, the main implication is that retirees consume less of an extra

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15See Appendix Tables A.1 and A.2 for robustness checks.
Table 2: The Effect of Annual Social Security Benefits on Bequests

<table>
<thead>
<tr>
<th></th>
<th>Bequests</th>
<th>Non-zero bequests</th>
<th>Any bequests</th>
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<tbody>
<tr>
<td><strong>First Stage</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Windfall</td>
<td>coef.</td>
<td>0.924</td>
<td>1.087</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.242)</td>
<td>(0.319)</td>
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<tr>
<td></td>
<td>p-val.</td>
<td><strong>0.000</strong></td>
<td><strong>0.001</strong></td>
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<tr>
<td>Weak identification test</td>
<td>F stat.</td>
<td>14.559</td>
<td>10.826</td>
</tr>
<tr>
<td><strong>Second stage</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Social Security payout</td>
<td>coef.</td>
<td>18.199</td>
<td>16.407</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(8.369)</td>
<td>(10.182)</td>
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<tr>
<td></td>
<td>p-val.</td>
<td><strong>0.030</strong></td>
<td>0.107</td>
</tr>
<tr>
<td><strong>OLS</strong></td>
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<tr>
<td>Social Security payout</td>
<td>coef.</td>
<td>4.108</td>
<td>4.550</td>
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<td></td>
<td>s.e.</td>
<td>(0.706)</td>
<td>(1.024)</td>
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<td></td>
<td>p-val.</td>
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<tr>
<td>Sample</td>
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<td>1638</td>
<td>1013</td>
</tr>
</tbody>
</table>

Notes: “Non-zero bequests” refers to results based on the sample restriction of retirees with positive bequests. Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993 (3% discount rate).
### Table 3: The Effect of Lifetime Social Security Wealth on Bequests

<table>
<thead>
<tr>
<th></th>
<th>Bequests</th>
<th>Non-zero bequests</th>
<th>Any bequests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Stage</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Windfall</td>
<td>coef.</td>
<td>24.351</td>
<td>32.949</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(7.436)</td>
<td>(9.406)</td>
</tr>
<tr>
<td></td>
<td>p-val.</td>
<td><strong>0.001</strong></td>
<td><strong>0.000</strong></td>
</tr>
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<td>Weak identification test</td>
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<td><strong>Second stage</strong></td>
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<td></td>
</tr>
<tr>
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<td>0.521</td>
<td>0.460</td>
</tr>
<tr>
<td></td>
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<td>(0.263)</td>
<td>(0.309)</td>
</tr>
<tr>
<td></td>
<td>p-val.</td>
<td><strong>0.047</strong></td>
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<td><strong>OLS</strong></td>
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<tr>
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<td>0.107</td>
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<tr>
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<td>(0.035)</td>
</tr>
<tr>
<td></td>
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<td><strong>0.002</strong></td>
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<tr>
<td>Sample</td>
<td></td>
<td>1638</td>
<td>1013</td>
</tr>
</tbody>
</table>

Notes: “Non-zero bequests” refers to results based on the sample restriction of retirees with positive bequests. Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993 (3% discount rate).
dollar of wealth than what we would expect based on prior estimates.

To investigate heterogeneity in the pass-through rate by wealth levels, we allow for an interaction effect between assets at first observation and Social Security benefits:

\[
SSW_i = \alpha_0^{xa} + \alpha_1^{xa} Wind_i + \alpha_2^{xa} Wind_i \times A_i + \alpha_3^{xa} Birthyr_i + \alpha_4^{xa} Fem_i + \nu_{1,i}^{xa} \quad (3)
\]

\[
SSW_i \times A_i = \beta_0^{xa} + \beta_1^{xa} Wind_i + \beta_2^{xa} Wind_i \times A_i + \beta_3^{xa} Birthyr_i + \beta_4^{xa} Fem_i + \nu_{2,i}^{xa} \quad (4)
\]

\[
Beq_i = \omega_0^{xa} + \omega_1^{xa} SSW_i + \omega_2^{xa} SSW_i \times A_i + \omega_3^{xa} Birthyr_i + \omega_4^{xa} Fem_i + \nu_{3,i}^{xa} \quad (5)
\]

where \(SSW\) refers to Social Security wealth and \(A\) refers to assets.

The total effect of benefits is given by:

\[
Total\ Effect_i = \omega_1^{xa} + \omega_2^{xa} SSW_i \times A_i \quad (6)
\]

We plot the total effect against asset percentile in Figure 3.\(^{16}\) The interaction effect \(\omega_2^{xa}\) is positive, indicating an increasing pass-through rate or marginal propensity to save along the wealth distribution.

This is in line with the hypothesis that bequests are luxury goods: retirees only leave bequests if their consumption levels exceed a certain threshold. The propensity to save for bequests instead of consume is therefore higher if the retiree is already wealthy and consuming at a level where the marginal utility of consumption is considerably lower than the marginal utility of additional bequests. As a result, the wealthiest retirees (roughly the top 3\%) allocate all of the increase in benefits to bequests. In Section 4, we introduce our model of savings behavior and choose a utility function for bequests that can capture these data facts.

\(^{16}\)The estimated coefficients can be found in Table A.3 of the Appendix.
Figure 3: The Effect of Social Security Benefits on Bequests by Asset Percentile

Notes: Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993 (3% discount rate).
Late-Life Savings Behavior

While the IV estimates are informative of the magnitude and existence of bequest motives, they are insufficient for providing a quantitative decomposition of the role of bequests in explaining the savings behavior of retirees. In particular, the IV estimates are an average effect over retirees with different realizations of mortality and expenditure risks. Furthermore, our interest in exploring the response of savings behavior to changes in Social Security benefits are only partially addressed by the reduced-form specification since we would want to consider the savings behavior of retirees across ages over time. To achieve this, we build a model of savings behavior that captures the role of bequests, mortality risks, and other unobserved expenditure shocks that may be correlated to income.

4.1 Model

Retirees begin with initial assets and known Social Security benefits. They maximize lifetime expected utility by choosing their consumption each period (year), saving the rest for future periods. The optimization problem is as follows:

\[
V_t(A_t, \psi_{t-1}, y, Fem, SSB) = \max_{c_t} \{ u(c_t) + \beta [(1 - \delta_t(y, Fem, SSB))v(A_{t+1}) \\
+ \delta_t(y, Fem, SSB)EV_{t+1}(A_{t+1}, \psi_{t}, y, Fem, SSB)] \} 
\]

\[
c_t + \frac{A_{t+1}}{1+r} = A_t + SSB + \xi_t(Fem, y, \psi_{t-1}) + g_t
\]

where the state space consists of assets \(A\), a persistent component of expenditure shocks \(\psi\), gender \(Fem\), permanent income \(y\), and Social Security benefits \(SSB\). Assets, persistent shocks, and benefits enter the budget constraint, whereas gender affects mortality risk captured by \(\delta_t\). \(c\) refers to consumption, \(\xi\) refers to expenditure shocks, \(b\) refers to
bequests, $\beta$ refers to the discount factor, and $r$ refers to the interest rate. $g_t$ represents a consumption floor guaranteed by government or societal transfers (Hubbard et al., 1995):

$$g_t = \max\{0, c - (A_t + SSB + \xi_t)\}$$  \hspace{1cm} (9)

Utility for consumption is specified with constant relative risk aversion:

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$  \hspace{1cm} (10)

where $\sigma$ refers to risk aversion with regard to inter-temporal consumption subject to mortality risk and shocks to the budget constraint. Utility from bequests also follows a constant relative risk aversion form:

$$v(b) = \left(\frac{\phi}{1 - \phi}\right)^{\alpha} \left(\frac{\phi c_b + b}{1 - \sigma}\right)$$  \hspace{1cm} if $\phi \in (0, 1)$, \hspace{1cm} (11)

where $\phi$ refers to altruism and $c_b$ refers to a consumption threshold. Both these parameters have intuitive interpretations. $\phi$ can be interpreted as the marginal propensity to leave bequests out of a dollar in the last period of life. That is, for an extra dollar in the case where there are no precautionary savings incentives, $\phi$ is the portion left as bequests (conditional on leaving a non-zero bequest).\(^{17}\) $c_b$ acts as a shifter that allows for bequests to be non-homothetic to consumption. The higher $c_b$ is, the more bequests are a luxury good. It is a consumption threshold such that in the case where there are no precautionary savings incentives, bequests are only left if retiree consumption exceeds $c_b$.\(^{18}\)

---

\(^{17}\)See Section 5.4 for a further discussion on the parameterization of the bequest motive.

\(^{18}\)To see this, observe that $u'(c_b) = v'(0) = c_b^{-\sigma}$.
4.2 Expenditure Shocks

So far, our model follows other recent models in the literature that incorporate medical expenditure and/or long-term care insurance (De Nardi et al., 2010; Lockwood, 2016). However, instead of including multiple sources of risks that drive precautionary savings based on observable data, we rely on $\xi_t$ to capture all expenditure risk, both observable and unobservable.

To give some intuition for the role of $\xi$, we draw an analogy with the control function approach of interpreting IV regressions. The residual from the first stage captures the component of the endogenous variable (in this case, $SSB$) that does not depend on the instrument (in this case the Notch). Including the residual from the first stage in the second stage regression along with the endogenous variable of interest produces the IV coefficient for the endogenous variable by controlling for the component of $SSB$ that is uncorrelated with the Notch but may be correlated with unobserved heterogeneity and $SSB$. Consider Equation (1) and rewrite Equation (2) as:

$$SSB_i = \alpha_0 + \alpha_1 Wind_i + \upsilon_i^{SSB}$$

$$Beq_i = \pi_0 + \pi_1 SSBO_i + \pi_2 \hat{\upsilon}_i^{SSB} + \nu_i$$

Then $\pi_1$ is identical to $\omega_1$ from Equation (2). Our model of savings behavior is clearly non-linear but the motivation is similar: we allow the unobserved expenditure risks in our model to depend on permanent income quintiles that are unaffected by the Notch, so that $\xi_t$ (in the model) takes on the role of $\hat{\upsilon}_i^{SSB}$ in the instrumental variable regression. Indeed, it is $\xi_t$ that will allow our model’s simulated data to replicate the instrumental variable estimates in the true data.
We allow $\xi_t$ to depend on income in the following way:

$$\xi_t(Fem,y,\psi_{t-1}) = m_t(Fem,y) + \sigma_{\xi_t}(Fem,y) \times (\psi_t + \eta_t), \quad \eta_t \sim N(0,\sigma_\eta^2)$$

$$\psi_t = \rho\psi_{t-1} + \epsilon_t, \quad \epsilon_t \sim N(0,\sigma_\epsilon^2)$$

The permanent income quintile is represented by $y = 1, \ldots, 5$.\(^{19}\) We allow unobserved expenditures to have a first order autoregressive component and a white noise component. This specification is based on French and Jones (2004), who show that it is able to fit medical costs well.\(^{20}\) The idea is for the autoregressive component to capture persistent costs such as long-term care. The specification also allows for the expenditure shocks to increase in variance by age and income, as we may expect from previous findings in the literature with regard to medical costs (De Nardi et al., 2010). Further, we allow the mean and variance of unobserved expenditures to depend on a linear function with quartic age, gender, and income quintile.

Our approach differs from prior attempts to separate bequest motives from precautionary savings by explicitly modelling various sources of expenditure risk such as medical expenditure or long-term care. While this is a substantial improvement to a model with no expenditure risk, there remain the potential for other unobserved expenditure risks that retirees face. We instead exploit the plausibly exogenous variation in Social Security benefits to avoid the pitfall of unobserved expenditure risk, and hence provide an alternate source of identification for bequest motives which does not require us to take a stand on how retirees make insurance choices. That is not to say that modelling other expenditure risks explicitly is not fruitful – we think that it is important to understand these other sources of risk. However, we believe that our approach focuses on distinguishing bequest motives and precautionary savings with fewer assumptions.

\(^{19}\)We describe the construction of the permanent income quintiles in Section 5.

\(^{20}\)There are alternative specifications that could be adopted. We are working on checking the robustness of our estimated preference parameters under different specifications.
5 Estimation

We estimate the model in two stages. The first stage takes mortality data from the HRS AHEAD to recover the parameters that govern mortality risk, $\delta$. The second stage uses indirect inference to recover the rest of the parameters in the model:

$$\theta = (\phi, c_b, \sigma, c, \sigma_c, \sigma, \rho, m_t, \sigma_{\xi_t}).$$

The vector of 27 parameters include two bequest preference parameters, the coefficient of relative risk aversion, minimum consumption floor, standard deviation of the white noise and autoregressive components of expenditure risk, the first order autoregressive coefficient, and mean and variance coefficients for expenditure risk.

5.1 Data

The data for estimating the model of savings behavior is the same HRS AHEAD sample described in Section 3. Aside from data on assets, bequests, and Social Security benefits, we also construct permanent income quintiles. Quintiles are based on both pension income and Social Security benefits, which serve as proxies for permanent income since both depend on earnings over the career of retirees. However, since Social Security benefits are subject to the changes from the Notch, quintiles are birth year specific, so that the Notch does not affect the computation of the quintiles. Finally, we also use death dates to estimate mortality risk.

5.2 Mortality Risk

We assume that mortality risk is exogenous to the model. To predict the probability of death given state variables in the model, we run a logistic regression with the log-odds of survival as the dependent. We include quadratic age effects, effects of each income quintile, and the interaction between income quintile and age. We also include gender and Social
Security benefits. The predicted mortality rates fit the data well, as shown in Figure D.1 of the Appendix.

5.3 Indirect Inference

The model is solved backwards from period $T = 110$. We take expectations over expenditure risks $\xi_t$ that have an autoregressive component, as well as expectations over mortality risk.\(^{21}\)

The estimation procedure starts with an initial guess of $\theta$ and initial state variables (assets, Social Security benefits, income quintile, and gender) from the HRS AHEAD sample. We simulate shocks $\xi_{it}$ and combine that with our model solution and the first stage estimates of mortality risk to obtain asset profiles and hence bequests.\(^{22}\) We generate a sample of 25,000 simulated retirees to capture the distribution of simulated shocks. We then generate a selected set of data moments ($\hat{M}$) using the simulated data and compare them with their counterparts ($M$) in the true data from the HRS AHEAD sample. The estimator therefore minimizes the distance between the data moments from the simulated data and the true data, weighted by the precision of the data moments computed from the true data ($W$):\(^{23}\)

$$\hat{\theta} = \text{argmin} (M - \hat{M}(\theta))^\prime W (M - \hat{M}(\theta))$$ (13)

The entire process is summarized below:

- Simulate behavior from data observations of initial assets, Social Security benefits, age, gender, and income quintile given $\theta$
- Compute $\hat{M}$
- Update $\theta$ to minimize $(M - \hat{M}(\theta))^\prime W (M - \hat{M}(\theta))$

---

\(^{21}\)See Appendix B for more detail on the model solution.

\(^{22}\)While we do rely on estimated mortality probabilities $\delta$ to calculate continuation values, our simulated retirees have the same death age as observed in the data, with the exception of those who were alive at last observation. This is similar to the approach taken by De Nardi et al. (2010).

\(^{23}\)Following Pischke (1995) and Altonji and Segal (1996), we take the inverse of the standard error of the estimated data moments as the weight.
Indirect inference is suitable for two reasons: first, the solution for the model is not analytic and using Maximum Likelihood would increase the computational burden. Second, the OLS and IV estimates from Section 3 can be readily included in the set of data moments that we choose to match. Indirect inference allows us to incorporate them into our estimates of our savings behavior model in a natural way. On top of the OLS and IV estimates for the effect of income on bequests, our set of matched moments also include asset profiles of each cohort within the sample – pre-Windfall (1905-1910), Windfall (1911-1916), and Notch (1917-1921). In particular, we match median assets and asset variances by income quintile, age, and cohort. Given that we incorporate gender heterogeneity in our unobserved expenditure risk $\xi$, we match median assets and asset variances for females by age as well.

Loosely speaking, matching the IV estimates from Section 3 helps us recover $\phi$ and $c_b$. $\sigma$ and $\xi$ are reflected in the asset profiles while the parameters that govern $xi$ are reflected in the wedge between the OLS and IV estimates, as well as the difference in the asset profiles of the Windfall versus the non-Windfall cohorts.

5.4 Identification

To see how the instrument helps in the identification of our model, consider a simplified version of our model where $T = 1$, $r = 0$, and $\beta = 1$ with no expenditure risks and no mortality risk. This is a special case of the full model presented above. The only decision is the allocation of resources to consumption and bequests. Equating the marginal utility of consumption and bequests (based on Equation (10) and (11)), and substituting in the budget constraint (Equation (8)):

$$u'(c) = v'(b)$$

$$(A_1 + SSB - b)^{-\sigma} = (c_b + \frac{1-\phi}{\phi}b)^{-\sigma}$$
we obtain:

\[ b^* = \max(0, \phi SSB + \phi A_1 - \phi c_b) \]

Note that if \( SSB + A_1 < c_b \), no bequests are left behind. \( c_b \) has a natural interpretation as the minimum consumption needed, under no uncertainty, for non-zero bequests. For retirees whose initial assets are low, an increase in \( SSB \) means higher consumption and no increase in savings. They consume the entire increase. However, some of them may “tip over” into leaving some bequests behind. Our IV estimates of the effect of \( SSB \) on the probability of leaving bequests therefore speaks to the magnitude of \( c_b \).

Further, the altruism parameter \( \phi \) is precisely the effect of wealth or benefits on bequests. Under the assumption that there is no unobserved heterogeneity correlated with benefits/wealth and bequests, and under the naive model with no risks, OLS estimates are indicative of bequest motives. However, since there are many potential unobservables that threaten the identification of \( \phi \), our instrument serves as a means to address this. As argued before, this is a qualitatively different approach from the previous literature which relied on observable expenditures.

To distinguish between precautionary savings and bequest motives, we again consider a simple case of our main model. This time we take a two period model \( T = 2 \), again with \( r = 0 \) and \( \beta = 1 \). In this version, there is no other expenditure risk aside from the consumption associated with the ‘risk’ of living in the second period. Consider a retiree who is wealthy enough to consume so that:

\[
[A_2] : \frac{(A_1 - A_2 + SSB)^{-\sigma}}{\text{MU of } c_1} = (1 - \delta)(A_2 + SSB - b)^{-\sigma} + \delta \left( \frac{\phi}{1 - \phi} \right)^\sigma \left( \frac{\phi}{1 - \phi} c_b + A_2 \right)^{-\sigma}
\]

The key observation is that our instrument shifts \( SSB \) in both periods, essentially providing additional insurance against mortality risk. If our instrument only shifts \( A_1 \), i.e. a one time wealth shock in period 1, the left hand side (marginal utility of \( c_1 \)) will fall. \( A_2 \) will have to
increase in response to offset the lower marginal utility of $c_1$ until the first order condition is satisfied again. That is, retirees who are given a positive one-time wealth shock would save more for precautionary reasons even if there were no bequest motives. Hence the change in savings behavior can be explained by either precautionary savings or bequest motives and the two motives are not distinguishable.

On the other hand, if there were no bequest motives (marginal utility of bequest is zero) and $SSB$ was increased in both periods, then $A_2$ would decline. Since consumption is higher in period 1 than period 2 before the shift in $SSB$ (given risk averse retirees), then an increase in $SSB$ across both periods would mean that the marginal utility of $c_1$ declines to a smaller extent than the decline in the marginal utility of $c_2$ (holding $A_2$ fixed). This in turn implies that consumption in period 1 needs to increase ($A_2$ needs to decrease) to fulfil the first order condition after the change in benefits. Therefore, if retirees respond to the increase in benefits by saving more ($A_2$ increases), this must indicate the presence of a bequest motive that overwhelms the incentive to save less for precautionary reasons. The extent to which they save more identifies the strength of the bequest motive. Note that the argument carries through if we extend the number of periods or introduce other expenditure risks, as long as $SSB$ is received in all states of the world (except death).

Suppose now that our retiree is not wealthy enough to fulfil the first order condition. Instead,

$$ [A_2] : \left( \frac{A_1 - A_2 + SSB}{\text{MU of } c_1} \right)^{-\sigma} > (1 - \delta) \left( \frac{A_2 + SSB - b}{\text{MU of } c_2} \right)^{-\sigma} + \delta \left( \frac{\phi}{1 - \phi} \right)^{-\sigma} \left( \frac{\phi}{1 - \phi} c_b + A_2 \right)^{-\sigma} $$

even when $A_2 = 0$. Here, the ‘risk’ is mortality risk but we can also incorporate other expenditure risks such as large medical shocks. Our retiree is unable to insure herself against expenditure risks with savings and has to rely on government transfers since her incentive to save (marginal utility of $c_2$) is swamped by the marginal utility of current consumption and she consumes all her assets in period 1. One possibility is that the increase in $SSB$ is
too small to change savings behavior and she still consumes all assets as well as the increase in $SSB$. On the other hand, her assets may be sufficiently large such that even though she is unable to fulfil the first order condition before the $SSB$ increase, she is able to do so if she receives the Windfall. In this case, the increase in savings may reflect not just the bequest motive but also precautionary motives. It would reflect only precautionary motives if $c_b$ is sufficiently large so that her consumption does not exceed the threshold required for bequests to become important.

Both vignettes serve to illustrate the role of the instrument in identifying bequest motives – first by dealing with unobserved heterogeneity and second by providing variation in the incentive to save for precautionary reasons. In our model, unobserved heterogeneity comes in the form of unobserved expenditure risks $\xi$. The variation in $SSB$ appears in the budget constraint and the fact that we analyze the asset profiles of both Windfall and non-Windfall retirees makes use of the exogenous variation in precautionary incentives.

6 Results

Given the IV and asset moments, as well as initial conditions and the estimated survival probabilities from the HRS AHEAD data, we estimate our model. We take $\beta = 0.97$ and $r = 0.03$ from the literature. The estimated parameters are shown in Table 4.\footnote{Confidence intervals are computed via bootstrap. Details are in Appendix C.}

Our estimates confirm that bequests are a luxury good since $c_b > 0$, although the consumption threshold for leaving bequests under no risk is moderate ($14,067). Further, we find that $\phi$ is large (note that $\phi$ is between 0 and 1). These results are consistent with the fact that a significant portion of retirees increased bequests in response to an increase in benefits, and that the pass-through rate was large. If only a small number of wealthy retirees had changed their savings behavior in response, then the consumption threshold $c_b$ would have been higher. If the pass-through rate had been lower, then $\phi$ would have been lower.
Table 4: Estimated Model Parameters

<table>
<thead>
<tr>
<th>Preferences</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$c_{\eta}$</th>
<th>$c$</th>
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<tbody>
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<td></td>
<td>2.68</td>
<td>0.91</td>
<td>14067</td>
<td>6093</td>
</tr>
<tr>
<td></td>
<td>(2.34,3.03)</td>
<td>(0.87,0.95)</td>
<td>(11706,16430)</td>
<td>(4852,7334)</td>
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<table>
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<td>(-0.02,0.01)</td>
</tr>
<tr>
<td>Age$^2$</td>
<td>0.07</td>
<td>(0.06,0.07)</td>
</tr>
<tr>
<td>Age$^3$</td>
<td>0.06</td>
<td>(0.06,0.07)</td>
</tr>
<tr>
<td>Age$^4$</td>
<td>-0.27</td>
<td>(-0.4,-0.14)</td>
</tr>
<tr>
<td>Female</td>
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<td>(-85.42,-45.44)</td>
</tr>
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<td>Income Quintile 1</td>
<td>23.25</td>
<td>(10.03,36.48)</td>
</tr>
<tr>
<td>Income Quintile 2</td>
<td>-58.34</td>
<td>(-72.15,-44.54)</td>
</tr>
<tr>
<td>Income Quintile 3</td>
<td>20.96</td>
<td>(12.51,29.42)</td>
</tr>
<tr>
<td>Income Quintile 4</td>
<td>-49.92</td>
<td>(-69.82,-30.02)</td>
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<tr>
<td>Income Quintile 5</td>
<td>143.62</td>
<td>(140.11,147.12)</td>
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</tbody>
</table>

$\rho$ 0.98 (0.79,1.18)
$\sigma_\epsilon$ 116.28 (10.13,222.44)
$\sigma_\eta$ 254.69 (161.21,348.18)

Notes: 95% confidence intervals are in parantheses, and are calculated using bootstrap.

Utility Functions: $u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}$, $v(b) = \left( \frac{\phi}{1-\phi} \right)^{\sigma} \frac{(1-\sigma)(\phi+c_{\phi}+b)^{1-\sigma}}{1-\sigma}$
Our estimated parameters produce an acceptable fit of the asset moments. The data moments and the simulated moments are shown in Figure 4. We present the median asset profiles for the 2nd and 4th income quintiles.25

**Figure 4:** Median Asset Profiles: 2nd and 4th Income Quintiles

Notes: Lines with crosses indicate the true data. Lines without are simulated data based on the estimated model. Median asset profiles in 1993 dollars, discounted to 1993 (3% interest rate). Model fit for remaining quintiles are in the Appendix.

In comparison to the literature, our estimate for $c_b$ is moderate while our estimate for $\phi$ is large. Recent estimates range from $3,500 to $25,000 and 0.5 to 0.9 respectively. Our estimate for $\sigma$ is also moderate, with the literature ranging from 2.5 to 5.85, showing that retirees are fairly risk averse.26

25See Appendix D for the model fit of the other three quintiles.
26See for example, Ameriks et al. (2015a,b, 2011); De Nardi et al. (2010, 2016a); Lockwood (2016).
6.1 Bequest Motives and the Notch

We present estimates for two additional versions of our model that demonstrate the role of the Notch and the role of bequest motives in our model. The first version (labelled “no IV”) ignores moments related to the Notch instrument. We therefore match median asset profiles and variances by income quintile across all cohorts rather than separately for the Windfall and non-Windfall cohorts. Furthermore, we do not match the IV estimates but only the OLS estimates. Our results in Table 5 show that without exploiting the instrument, bequest motives are underestimated, with $\phi = 0.74$ and $c_b$ close to $23,000$. As such, risk aversion has to compensate to explain high levels of savings and is estimated to be 5.30.

Table 5: Comparing Parameter Estimates: “no IV”

<table>
<thead>
<tr>
<th>Preferences</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$c_b$</th>
<th>$c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
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<td>0.91</td>
<td>14067</td>
<td>6093</td>
</tr>
<tr>
<td>No &quot;IV&quot;</td>
<td>5.30</td>
<td>0.74</td>
<td>22700</td>
<td>6364</td>
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</tbody>
</table>

<table>
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<th>Non-zero bequests</th>
<th>Any bequests</th>
</tr>
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<td>Data moment</td>
<td>17.90</td>
<td>16.10</td>
<td>0.063</td>
</tr>
<tr>
<td></td>
<td>(8.26)</td>
<td>(10.46)</td>
<td>(0.29)</td>
</tr>
<tr>
<td>Baseline</td>
<td>14.14</td>
<td>13.25</td>
<td>0.026</td>
</tr>
<tr>
<td>No &quot;IV&quot;</td>
<td>4.35</td>
<td>4.93</td>
<td>0.006</td>
</tr>
</tbody>
</table>

The second version of the model is similar to the baseline, except that $\phi$ is constrained to be 0. This means that retirees receive no utility from bequests. Our estimates in Table 6 show that to compensate for the lack of a bequest motive, risk aversion has to increase dramatically, with $\sigma = 5.08$. Model fit declines significantly, and is driven by the inability to match Notch-related moments. Our results are in line with Lockwood (2016) who finds...
that bequest motives are important for explaining annuity choices as well as asset profiles.

Table 6: Comparing Parameter Estimates: No Bequest Motives

<table>
<thead>
<tr>
<th>Preferences</th>
<th>$\sigma$</th>
<th>$\phi$</th>
<th>$c_b$</th>
<th>$c$</th>
<th>Criterion Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>2.68</td>
<td>0.91</td>
<td>14067</td>
<td>6093</td>
<td>295</td>
</tr>
<tr>
<td>No bequests</td>
<td>5.08</td>
<td>-</td>
<td>-</td>
<td>7012</td>
<td>395</td>
</tr>
</tbody>
</table>

6.2 Decomposing Bequests, Expenditure Risk, and Mortality Risk

We also use our baseline model to decompose bequests and assets. We wish to uncover the proportion of left bequests that are attributable to voluntary bequest motives or accidental bequests arising from precautionary savings. To do this, we simulate our baseline model under the restriction that bequests yield no utility ($\phi = 0$). All savings under this regime stem from precautionary reasons. On top of that, we simulate the model under the additional restriction that the variance of expenditure shocks $\xi_t$ is zero ($\sigma^2_{\eta} = \sigma^2_{\epsilon} = 0$). Under this regime, savings are precautionary, hedging specifically against mortality risk.

Due to the non-linearities in the model, the order of the counterfactuals matter for the decomposition result. We chose this order since we believe that most models of late life savings behavior would begin with some notion of mortality risk, and the question we are trying to address is whether the addition of bequest motives and expenditure risks would be important for explaining asset accumulation.

The bequest distributions under the baseline, the model with no utility from bequests, and the model with neither expenditure risk nor utility from bequests are presented in Figure 5. Our counterfactuals show that roughly 40% of bequests are voluntary, about $40,000 per retiree. Of the remaining 60%, a further third can be explained by precautionary savings against expenditure risks. The remainder is due to mortality risk. The proportion of retirees who leave non-zero bequests also declines from 59% to 54% and 37%.
Figure 5: Decomposing Bequests

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Prop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>92.57</td>
<td>0.59</td>
</tr>
<tr>
<td>No Bequest Motive</td>
<td>55.91</td>
<td>0.54</td>
</tr>
<tr>
<td>No Expenditure Risk</td>
<td>36.19</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Notes: Densities of bequests under the counterfactual of no bequest motives, and neither bequest motives nor expenditure shocks. Densities are conditional on non-zero bequests. The Epanechnikov kernel is used.
We also document that bequest motives explains roughly 40% of bequests across most of the non-zero bequest distribution. In Figure 6 we plot the mean counterfactual bequest to mean baseline bequest within 4 percent quantiles of baseline bequests under the two counterfactuals described. We find that the gap from the 45 degree line is present across the bequest distribution, implying that bequest motives are important for most retirees.

**Figure 6: Counterfactual Bequests versus Baseline Bequests**

![Figure 6](image)

Notes: Bequests under the counterfactual of no bequest motives, and neither bequest motives nor expenditure shocks are plotted against non-zero baseline bequests. The 45 degree line reflect counterfactual bequests if bequest motives and expenditure shocks do not play a role in determining bequest amounts. Each point is the average counterfactual bequest within a 4 percent quantile of baseline bequests.

Another way to see the role of bequest motives is to examine median asset profiles. The median asset profiles show an even more dramatic decline for the 2nd and 4th income quintiles are shown in Figure 7.
Figure 7: Decomposing Assets: 2nd and 4th Income Quintiles

Notes: Assets under the counterfactual of no bequest motives. The solid line shows baseline assets. The dashed line shows counterfactual assets.
An important caveat in our sample is that it does not include significant numbers of the wealthiest retirees, for whom the role of voluntary bequests may be different. However, this indicates that even among more moderately wealthy retirees, the bequest motive is important.

### 6.3 Policy Counterfactual: Benefit Cuts

Thus far we have used the estimated model to understand the role of bequest motives in driving the savings behavior of retirees. One advantage of this is to generate counterfactual behavior under different policy environments. A wide variety of policies have been proposed to reduce the anticipated budget deficits that the Social Security program faces. The major proposals include increasing the minimum and full retirement ages, raising the wage caps used to calculate Social Security payroll taxes, and reducing benefits (see for example 114th Congress (2015); Congressional Budget Office (2014)). Our model is particularly suitable for exploring the effects of policies that reduce benefits for current retirees.\(^{27}\)

One major policy proposal that would lead to immediate reductions in benefits is to switch an alternate measure of inflation when calculating cost of living adjustments for benefits from year to year. In 1996, the Boskin Commission (Boskin et al., 1996) found that the Consumer Price Index (CPI) overstated inflation by about 1.1%. This resulted in the creation of the Chained Consumer Price Index by the Bureau of Labor Statistics in 2002. Inflation measured by the Chained CPI is roughly 0.3 percentage points lower than CPI, and as such would effectively lead to a reduction in benefits as retirees. In fact, as part of the negotiations surrounding the fiscal cliff faced by the United States in 2013, President Obama repeatedly proposed the application of the Chained CPI with low-income protections (Office of Management and Budget, 2013).

Instead of replicating particular policies proposed, we summarize potential policies for

---

\(^{27}\)Changes in retirement age and wage caps for taxes could induce large changes in savings and labor force participation before retirees claim benefits (see Scholz et al. (2006), for example), and our model is silent on those choices.
benefit reduction as a cap on benefits at the 80th percentile of our sample (roughly $16,000 a year). We argue that most of the policies proposed, including the switch to the Chained CPI, would be progressive in nature, and would likely be accompanied by exemption based on means-tests. We simulate the savings behavior of retirees from the top quintile of benefits but instead assign them $16,000 a year in benefits. We plot their median assets and median consumption profiles in Figure 8. We also plot the ratio of counterfactual consumption over baseline consumption against baseline consumption (see Figure 9). A ratio equal to 1 means that consumption did not change in response to the benefit cuts.

We find that retirees in the top benefits quintile respond by reducing savings, while consumption levels virtually do not change. In other words, the loss in welfare comes from a reduction in bequests. Given our estimates that bequests are a luxury good, this is not unexpected. We find that while for the most part, the consumption ratio is very close to 1, a small fraction of retirees (less than 5%) at the lower end of the consumption distribution are adversely affected by the benefit cuts. These were retirees among the top 20% of benefits who had lower assets and larger negative expenditure shocks. Policy changes in benefits may wish to put in place exemptions for those retirees.

Our findings imply that a reduction of benefits for the highest income retirees will not substantially reduce welfare derived from consumption but instead reduces bequests. To the extent that Social Security benefits are meant as an insurance against consumption risk arising from lifespan uncertainty, this may serve as a powerful justification for a more progressive benefit schedule, particularly in light of the solvency issues faced by Social Security.

In addition, such cuts may also alleviate intergenerational wealth inequality. Retirees in the highest benefits quintile are likely to also have children who are high income, given the strength of the intergenerational earnings correlation found in the literature. While we do not observe the income of children for our sample of retirees, we do observe education. We find that children of retirees in the top quintile of benefits have 10 more months of education on average.
Notes: Assets and consumption of retirees in the top quintile of Social Security benefits. The solid line shows baseline savings and consumption. The dashed line shows counterfactual behavior when a cap of $16,000 per annum is imposed.
Figure 9: Consumption and Asset Ratios by Baseline Asset Quantile at Age 84

Notes: Consumption and assets of retirees in the top quintile of Social Security benefits. Scatterplot reflects the ratio of counterfactual consumption/ assets (under the benefits cap) and baseline consumption/assets by baseline asset quantile. A ratio of 1 indicates no change when benefits are capped.
We acknowledge a number of important caveats. First, our model does not allow for retirees to adjust non-benefit income through earnings or other sources. Second, our model is estimated using a sample of singles born from specific cohorts, and may not apply to non-single retirees.\footnote{We are currently working on a version of the model that incorporates the preferences of couples based on \textit{De Nardi et al.} (2015).} However, our approach can pave the way for future work to address these issues if the model is suitably enriched.

7 Conclusions

Our paper has provided strong evidence for the presence of economically significant bequest motives by exploiting a novel instrument in the form of the Social Security Notch. We find that bequests increase by $18,000 in response to an increase in yearly benefits by $1,000.

In addition, we combine our instrumental variable estimates with a model of post-retirement savings behavior to recover estimates of preference parameters governing bequests and precautionary savings. We show that without our instrument as a source of identification, bequest motives are underestimated. We use the model to decompose savings into precautionary versus bequest motives and find that bequest motives explain 40\% of left bequests.

Finally we investigate the consequences of a moderate reduction in Social Security benefits in the form of a benefits cap for retirees in the top quintile of benefits. We find that retirees respond by reducing savings (and hence bequests) rather than cutting back on consumption. This suggests that such policies can both alleviate the costs faced by Social Security as well as reduce intergenerational wealth inequality.
References


Appendix

A Supplemental Regressions

In this section, we show that our instrumental variable estimates are not sensitive to a number of robustness checks. First, we show that the estimates are similar if we choose a different discount rate for calculating bequests in 1993 dollars (see Table A.1). Table A.2 reports results for our other robustness checks. We show that the estimates are qualitatively similar conditional on pre-retirement characteristics, including education, an indicator for having children, and being born during World War 1. “Windfall 1913-1916” shows that our results are robust to using an alternate definition of the Windfall cohort, namely 1913-1916 instead of 1911-1916. This is motivated by the fact that the 1913 cohort is the earliest cohort of retirees who were definitely affected by the 1972 amendments. “Windfall 1906-1911” is a placebo test where the Windfall cohort is defined as 1906-1911 instead of the true Windfall cohort and we find that the estimated coefficient is both small and statistically insignificant. This remains true when we restrict the sample to the 1900-1911 cohorts for the placebo test. Finally, “Sample 1911-1921” shows that our results are robust to restricting the sample only to retirees born after 1910. This addresses the fact that some of the cohorts in our control group who were born prior to 1911 may have been affected by the treatment and received the Windfall. Finally, we report the regression results investigating heterogeneity in the bequest response of retirees (see Table A.3). In particular, we show that the interaction between initial observed assets and benefits is statistically significant.
Table A.1: The Effect of Social Security Benefits with Different Discount Rates

<table>
<thead>
<tr>
<th></th>
<th>Bequests</th>
<th>Non-zero bequests</th>
<th>Any bequests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main results</td>
<td>18.199</td>
<td>16.407</td>
<td>0.061</td>
</tr>
<tr>
<td></td>
<td>(8.369)</td>
<td>(10.182)</td>
<td>(0.029)</td>
</tr>
<tr>
<td></td>
<td><strong>0.030</strong></td>
<td>0.107</td>
<td><strong>0.036</strong></td>
</tr>
<tr>
<td>6% discount</td>
<td>14.767</td>
<td>13.311</td>
<td>0.061</td>
</tr>
<tr>
<td></td>
<td>(6.782)</td>
<td>(8.586)</td>
<td>(0.029)</td>
</tr>
<tr>
<td></td>
<td><strong>0.029</strong></td>
<td>0.121</td>
<td><strong>0.036</strong></td>
</tr>
<tr>
<td>9% discount</td>
<td>12.419</td>
<td>11.205</td>
<td>0.061</td>
</tr>
<tr>
<td></td>
<td>(5.763)</td>
<td>(7.317)</td>
<td>(0.029)</td>
</tr>
<tr>
<td></td>
<td><strong>0.031</strong></td>
<td>0.126</td>
<td><strong>0.036</strong></td>
</tr>
</tbody>
</table>

Notes: “Non-zero bequests” refers to results based on the sample restriction of retirees with positive bequests. Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993.
Table A.2: The Effect of Social Security Benefits (Robustness Checks)

<table>
<thead>
<tr>
<th></th>
<th>Bequests</th>
<th>Non-zero bequests</th>
<th>Any bequests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full controls</td>
<td>21.677</td>
<td>19.516</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(12.149)</td>
<td>(12.584)</td>
<td>(0.041)</td>
</tr>
<tr>
<td></td>
<td>0.074</td>
<td>0.121</td>
<td>0.119</td>
</tr>
<tr>
<td>Windfall 1913-1916</td>
<td>16.256</td>
<td>14.088</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(9.596)</td>
<td>(11.702)</td>
<td>(0.034)</td>
</tr>
<tr>
<td></td>
<td>0.090</td>
<td>0.229</td>
<td>0.099</td>
</tr>
<tr>
<td>Windfall 1906-1911</td>
<td>-0.613</td>
<td>8.864</td>
<td>-0.158</td>
</tr>
<tr>
<td></td>
<td>(32.550)</td>
<td>(17.599)</td>
<td>(0.222)</td>
</tr>
<tr>
<td></td>
<td>0.985</td>
<td>0.614</td>
<td>0.476</td>
</tr>
<tr>
<td>Windfall 1906-1911</td>
<td>1.731</td>
<td>9.689</td>
<td>-0.018</td>
</tr>
<tr>
<td>Sample 1900-1911</td>
<td>(18.053)</td>
<td>(48.011)</td>
<td>(0.066)</td>
</tr>
<tr>
<td></td>
<td>0.924</td>
<td>0.840</td>
<td>0.786</td>
</tr>
<tr>
<td>Sample 1911-1921</td>
<td>19.259</td>
<td>17.764</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>(11.199)</td>
<td>(11.102)</td>
<td>(0.034)</td>
</tr>
<tr>
<td></td>
<td>0.085</td>
<td>0.110</td>
<td>0.366</td>
</tr>
</tbody>
</table>

Notes: “Non-zero bequests” refers to results based on the sample restriction of retirees with positive bequests. Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993 (3% discount rate).
Table A.3: The Effect of Social Security Payouts Interacted with Assets

<table>
<thead>
<tr>
<th></th>
<th>Annual Benefits</th>
<th>Total Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Security payout</td>
<td>coef. 3.837</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>s.e. (8.987)</td>
<td>(0.322)</td>
</tr>
<tr>
<td></td>
<td>p-val. 0.669</td>
<td>0.653</td>
</tr>
<tr>
<td>BenefitsXAssets</td>
<td>coef. 0.018</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>s.e. (0.003)</td>
<td>(0.000)</td>
</tr>
<tr>
<td></td>
<td>p-val. 0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Weak identification test</td>
<td>F stat. 4.892</td>
<td>4.06</td>
</tr>
<tr>
<td>Stock-Yogo maximal IV size</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>Sample</td>
<td>1436</td>
<td>1436</td>
</tr>
</tbody>
</table>

Notes: Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in 1993 dollars, and bequests are discounted to 1993 (3% discount rate).

B Model Solution

In this section we describe how we solve our model. In order to reduce the dimensionality of our state space, we define cash on hand \( x_t \), where

\[
    x_t = A_t + \xi_t + SSB \tag{B.14}
\]

\[
    A_{t+1} = (1 + r)(x_t - c_t) \tag{B.15}
\]

\[
    x_{t+1} = (1 + r)(x_t - c_t) + \xi_{t+1} + SSB \tag{B.16}
\]

\[
    c \leq c_t \leq x_t \tag{B.17}
\]

To take expectations over the persistent component of unobserved expenditure risk \( \psi_t \), we first compute a transition matrix for \( \psi_t \) to \( \psi_{t+1} \) using the Rouwenhorst method (Rouwenhorst, 1995). Next, to compute the continuation value \( EV \) (see Equation 7), we discretize \( \psi_{t+1} \) and \( \eta_{t+1} \). Given \( c_t \), each combination of \( \psi_{t+1} \) and \( \eta_{t+1} \) will give the value of \( x_{t+1} \). Looping over
ψ_{t+1} and η_{t+1}, we multiply the probability of each ψ_{t+1} (calculated using Rouwenhorst) and η_{t+1} (Gaussian quadrature) being realized with the value of next period V(x_{t+1}). If x_{t+1} does not correspond to the x_t grid, we use linear interpolation to calculate V(x_{t+1}). This enables us to solve the model.
C Bootstrap

Let the true data be denoted $\chi$. As in Section 5, let the moments computed from the true data be denoted $M$, and the accompanying weights used in estimation be denoted $W$. Let the estimated parameters based on $\chi, M, W$ be denoted $\hat{\theta}$. To obtain confidence intervals for the estimates in our model of savings behavior, we perform the following algorithm for each $s \in S$ where $S = 1, \ldots, 100$:

- Take a random draw (with replacement) of the initial state variables from the HRS sample ($\chi_s$)
- Compute all moments that are targeted for matching based on the drawn sample ($M_s$)
- Compute weights for the moments from the drawn sample ($W_s$)
- Estimate the model using the drawn sample by matching $M_s$ weighted by $W_s$
- Record estimated parameters $\hat{\theta}_s$

This generates a distribution of $\hat{\theta}$. The 5th and 95th percentiles of the distribution are our 95% confidence intervals.
D Supplemental Tables and Figures

This section contains additional figures showing model fit.

Figure D.1: Survival Probabilities

Notes: Regression results are based on the HRS AHEAD data. Sample consists of single, white, male and female retirees.
Figure D.2: Median Asset Profiles

Notes: Lines with crosses indicate the true data. Lines without are simulated data based on the estimated model. Median asset profiles in 1993 dollars, discounted to 1993 (3% interest rate).