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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 data from 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 sizable 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 one-third 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 although wealth declines, consumption remains largely unchanged since wealth generated by bequest motives acts as a cushion against benefit reduction.

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

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1 Introduction

Although standard life-cycle models predict that it is optimal for individuals to run down their assets towards the end of their lives, many elderly still hold on to large amounts of assets. 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 utility gained from leaving bequests.[1] 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., 2002).

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

[1] Utility from bequests can be modeled in different ways such as warm glow, altruistic motives, or strategic motives. In this paper we deal with warm glow bequest motives as this is the most common way of modeling bequest motives and thus facilitates comparison of our results with the literature.

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 effect of benefits 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.

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 35% lower than baseline. Counterfactual bequests, now purely accidental, are roughly 65% of our baseline model simulations.

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.

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. This allows our model to be considerably simpler than previous efforts to disentangle bequest motives and precautionary savings since we side-step the need for explicitly modeling 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 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 small 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 bequest motives are 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.[2] 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 significantly larger than previous estimates.

Finally, we add to the literature that studies the effects of changes in Social Security benefits on the savings behavior of retirees. Our counterfactual analysis sheds light on the

[2]More recent papers include Moulton and Stevens (2015) and Gelber et al. (2016). Other outcomes that have been examined using the Notch 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, 2018), and child's wealth (Edwards et al., 2016; Moulton, 2014).

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, 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 The Social Security Notch

The Social Security Notch arose from a change in the way Social Security benefits were calculated in the early 1970s.[3] 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 periodically update the benefits table, to be implemented in 1975. However, 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).[4] Earlier cohorts

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

[4] 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 September 1972 because Congress thought it was necessary to act against rising inflation before the full implementation of the 1972 amendments.

also had high nominal wage growth, but did not benefit from the flawed formula due to retiring before the 1972 change.

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 The Effect of Benefits on Bequests

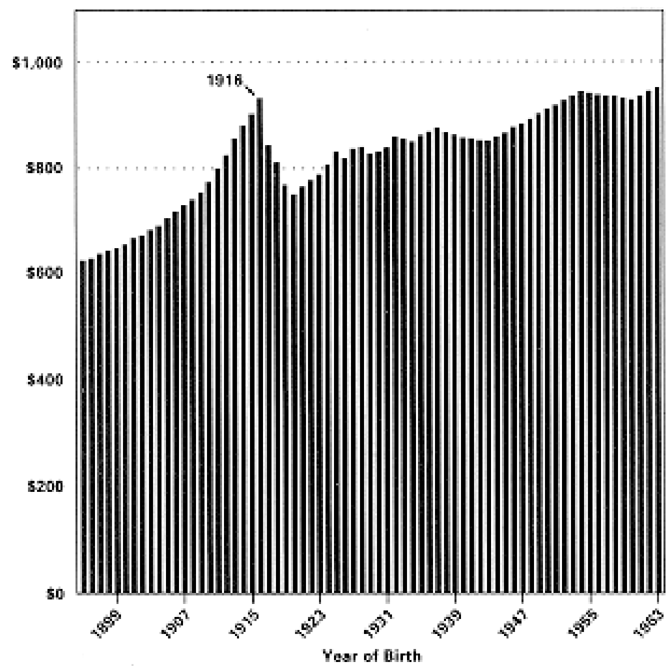
In this section, we describe how we make use of the Notch to estimate the effect of benefits on bequests. We employ an instrumental variables (IV) approach and discuss the data we use, the identification strategy and the validity of the instrument, and present results.

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 assets, Social Security benefits, mortality, and bequests. The HRS AHEAD surveyed retirees in 1993, 1995, 1998, and biannually henceforth. We use all available survey waves up to 2012.

[5]All variables from the AHEAD Core survey are from the RAND version of the HRS data.

Figure 1: Monthly Social Security Payout for An Average Worker by Birth Year



Notes: Monthly Social Security payout in 1994 dollars for workers who claimed benefits at age 65 and had average earnings every year of their working life. Source: Kollmann (2003).

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 HRS Exit interviews which include information on how each respondent's assets were distributed after death (typically by interviewing 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 1,638 respondents.

3.2 Identification

Our identification strategy is to compare retirees who were affected by different benefit rules based on birth year. As seen in Figure 1, benefits were exceptionally high for the Windfall cohort (born between 1911-1916), deviating from the general trend of benefits over time.[10] To capture deviations from the general increase in benefit levels over time, we include linear cohort trends.[11]

The key assumption required for the instrument to be valid is that any observed differences in bequests across the Windfall and non-Windfall cohorts are 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[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 to exhaust the program's funds. It is therefore plausible that retirees from the Windfall cohort did not

[6] This includes never married retirees, as well as divorcees, widows, and widowers. Roughly 80% of our sample consists of widows and widowers.

[7] We use assets in 1995 instead of 1993 because of a well-known under-reporting 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 significantly, although standard errors are larger when we use only non-imputed observations.

[10] Although the birth years chosen to designate as the Windfall cohort vary across studies, the deviation from the general trend is clear. In our instrumental variable estimates, we check that alternate specifications of the Windfall cohort do not affect our results. These results are presented in Table A.3 of Appendix A.

[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.

[12] Throughout this paper, "retirement" refers to the first year of receiving Social Security benefits.

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[13] coined the term "Notch babies" for the retirees in 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. Subsequently, the Social Security Administration responded both in newspapers and by commissioning a study to examine the costs and benefits of compensating the Notch babies.[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).

[13] A well-known columnist.

[14] See U.S. General Accounting Office (1988) for more detail.

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

$$SSB_i = \alpha_0 + \alpha_1 Wind_i + \alpha_2 Birthyr_i + \alpha_3 Fem_i + \upsilon_i^{SSB} \tag{1}$$

where SSB refers to Social Security benefits, $Wind$ refers to an indicator for belonging to the Windfall cohort, $Birthyr$ referes 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:

$$Beq_i = \omega_0^{beq} + \omega_1^{beq}\widehat{SSB_i} + \omega_2^{beq} Birthyr_i + \omega_3^{beq} Fem_i + \upsilon_i^{beq} \tag{2}$$

The first outcome is bequests (in thousands of 1993 dollars), and the second 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 for comparison. The results show that a $1,000 increase 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 (see Appendix Table A.2). We also use alternate discount rates (6% and 9%) and present qualitatively similar results in Appendix Table A.1, although the magnitude of the coefficient is slightly lower ($15,000 and $12,000 respectively).

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. This result is consistent with papers that have documented higher levels of intergenerational transfers associated with higher Social Security benefits (Moulton, 2014; Mukherjee, 2018). Second, the disparity between the OLS and IV estimates suggest that unobserved heterogeneity that is positively correlated with benefits/income and negatively correlated with bequests are important. A prominent example of such a source of heterogeneity would be medical costs (see De Nardi et al. (2010)).

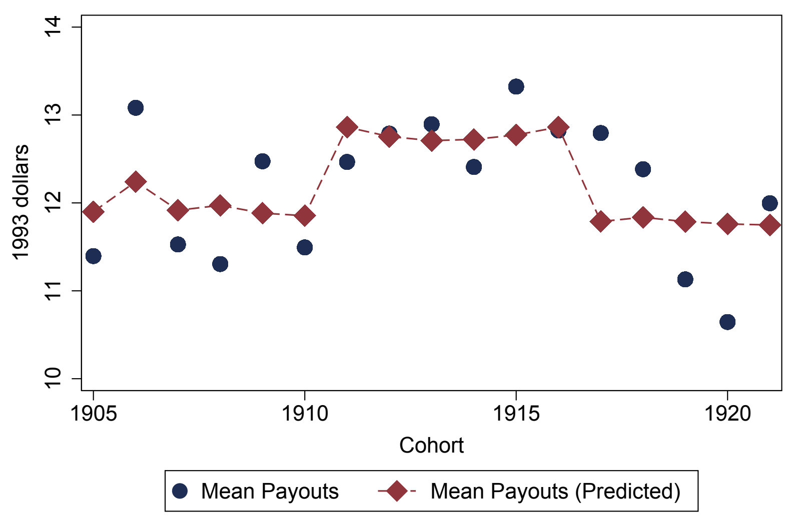
Our results may be threatened if the increase in benefits not only lowered the need for precautionary savings by raising insurance payouts but also affected bequests through

Table 1: Balancing Tests on Pre-retirement Characteristics

	Coefficient	Std. Err.	p-value
Years of education	0.010	(0.155)	0.950
Number of kids	-0.032	(0.096)	0.735
Female	0.002	(0.022)	0.941
Pension benefits	-0.036	(0.281)	0.897
Retirement age	-0.271	(0.307)	0.377

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

Figure 2: Annual Social Security Benefits by Birth Year



Notes: Sample consists of single, white, male and female retirees in the HRS AHEAD data. Benefits are measured in thousands of 1993 dollars.

other channels. One potential reason is if the increase in benefits led to shorter lifespan, as documented by Snyder and Evans (2006), then the estimated increase in bequests could be due to higher accidental bequests from earlier deaths rather than a response driven by the bequest motive. We deal with this in two ways. First, the specific issue of longevity is explicitly addressed in our model for post-retirement savings behavior and we account for the possibility that mortality is affected by changes in benefits. Second, we add lifespan as a control and find that our results are robust (see Table A.2 in the Appendix).

We also compile estimated effects of the Notch on various post-retirement outcomes from the literature (see Table D.5 of the Appendix). Most of these outcomes deal with health expenditure and can be viewed as mediators rather than threats to our interpretation of our estimated effects, but regardless, we argue that the reported effects are not sizeable enough to account for our estimates. Cohabitation is another outcome that is negatively affected by benefits (Engelhardt et al., 2005), which suggests that the increase in bequest amounts may be due to frictions in housing as an asset. Higher benefits allow the elderly to maintain homes rather than downsizing, leading to higher bequest amounts. However, Engelhardt et al. (2005) find that most of the effect is concentrated among the less educated, whereas our estimates seem to be driven by the wealthier retirees, as we show below in Figure 3.

Another concern arising from a recent paper by Gelber et al. (2016) is that retirees may be adjusting their post-retirement earnings (i.e., earnings after claiming SS benefits) in response to differences in Social Security benefits. This should dampen the effect of the Notch on bequests, and they find that the affected cohorts delayed leaving the work force by 0.16 years on average. While it is statistically significant, in our view two things explain the seeming disparity. First, the sample in Gelber et al. (2016) is the population as they are using administrative data, whereas our sample is selected on survival to 1992. It is likely that our sample had higher wealth and income than the general population. Given that bequests seem to be luxury goods, we would expect that our sample would be less susceptible to the adjustments of post-retirement earnings that they find. Second, similar to the previous issue regarding housing assets complicating the analysis, it is likely that our estimates are driven by wealthier retirees whereas their findings seem to be driven by lower income retirees. [15] As an additional check, we perform the same instrumental variable regression controlling for the year of labor force exit and find that our results are robust (see Table A.2 in the Appendix).

[15] Gelber et al. (2016) find that the point estimate for below-median income retirees is larger (although not statistically significantly larger) than for above-median income retirees.

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 considerably less of an extra 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 (A_i) and Social Security benefits:

$$SSW_i = \alpha_0^{xa} + \alpha_1^{xa} Wind_i + \alpha_2^{xa} Wind_i \times A_i + \alpha_3^{xa} Birthyr_i + \alpha_4^{xa} Fem_i + \upsilon_{1,i}^{xa} \tag{3}$$

$$SSW_i \times A_i = \beta_0^{xa} + \beta_1^{xa} Wind_i + \beta_2^{xa} Wind_i \times A_i + \beta_3^{xa} Birthyr_i + \beta_4^{xa} Fem_i + \upsilon_{2,i}^{xa} \tag{4}$$

$$Beq_i = \omega_0^{xa} + \omega_1^{xa} SSW_i + \omega_2^{xa} SSW_i \times A_i + \omega_3^{xa} Birthyr_i + \omega_4^{xa} Fem_i + \upsilon_{3,i}^{xa} \tag{5}$$

where SSW refers to Social Security wealth and A refers to assets.

The total effect of benefits is given by:

$$\textit{Total Effect}_i = \omega_1^{xa} + \omega_2^{xa} \times A_i \tag{6}$$

We plot the total effect against asset percentile in Figure 3.[16] The interaction effect ω_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

[16]The estimated coefficients can be found in Table A.4 of the Appendix.

Table 2: The Effect of Annual Social Security Benefits on Bequests

Panel A: First stage	**Social Security benefits ($1,000)**	
Windfall	**0.924**	
	(0.242)	
Weak identification test (F stat.)	14.559	
Panel B: Second stage	**Bequests ($1,000)**	**Any bequests**†
Annual Social Security benefits	**18.199**	**0.061**
($1,000)	(8.369)	(0.029)
Panel C: OLS	**Bequests ($1,000)**	**Any bequests**†
Annual Social Security benefits	**4.108**	**0.010**
($1,000)	(0.706)	(0.002)
Observations	1,638	1,638

Notes: Panels A and B report IV regression results while Panel C reports results from OLS regressions. Sample consists of single, white, male and female retirees in the HRS AHEAD data. Benefits and bequests are measured in thousands of 1993 dollars, and bequests are discounted to 1993 (3% discount rate). Standard errors in parentheses.

† "Any bequests" refers to an indicator for leaving positive bequests.

Table 3: The Effect of Lifetime Social Security Wealth on Bequests

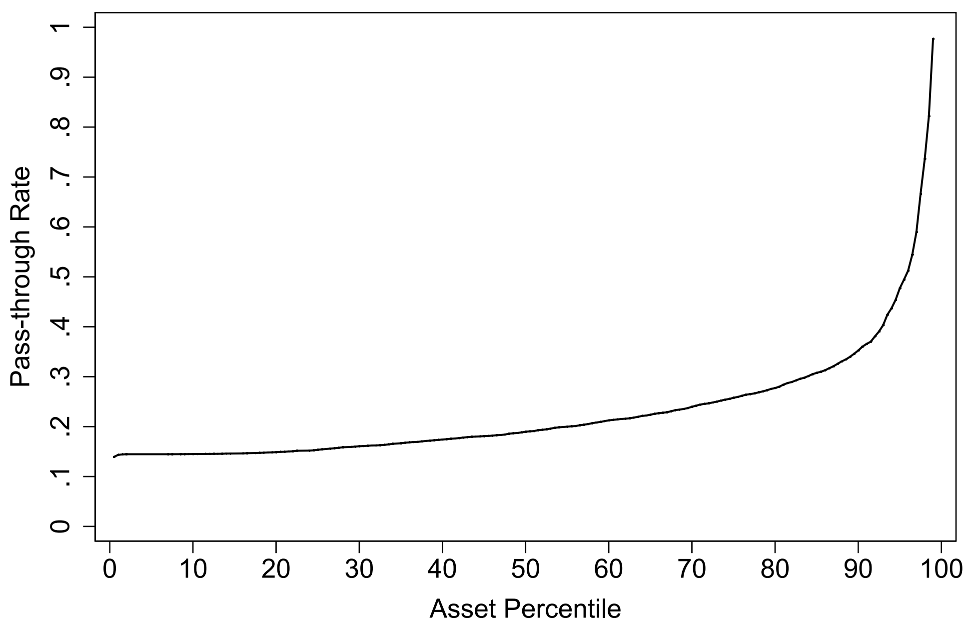
Panel A: First Stage	**Social Security wealth ($1,000)**	
Windfall	**24.351**	
	(7.436)	
Weak identification test (F stat.)	17.074	
Panel B: Second stage	**Bequests ($1,000)**	**Any bequests**†
Social Security wealth	**0.521**	**0.002**
($1,000)	(0.263)	(0.001)
Panel C: OLS	**Bequests ($1,000)**	**Any bequests** $(\times 10^{-3})^{\dagger,\ddagger}$
Social Security wealth	**0.072**	0.040
($1,000)	(0.023)	(0.080)
Observations	1,638	1,638

Notes: Panels A and B report IV regression results while Panel C reports results from OLS regressions. Sample consists of single, white, male and female retirees in the HRS AHEAD data. Social Security wealth and bequests are measured in thousands of 1993 dollars. Bequests are discounted to 1993 (3% discount rate). Standard errors in parentheses.

† "Any bequests" refers to an indicator for leaving positive bequests.

‡ For simplicity, the OLS estimate and standard error for the effect of Social Security wealth on leaving positive bequests are expressed in 10^{-3}.

Figure 3: The Effect of Lifetime Social Security Wealth on Bequests by Asset Percentile



Notes: Sample consists of single, white, male and female retirees in the HRS AHEAD data. Social Security wealth and bequests are measured in thousands of 1993 dollars. Bequests are discounted to 1993 (3% discount rate). Asset percentiles are calculated based on assets at first observation.

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.

4 Model

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. 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.

Preferences – Utility for consumption is specified with constant relative risk aversion:

$$u(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma} \tag{7}$$

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

$$v(b) = \left(\frac{\phi}{1-\phi}\right)^{\sigma} \frac{\left(\frac{\phi}{1-\phi}c_b + b\right)^{1-\sigma}}{1-\sigma} \quad \text{if } \phi \in (0,\, 1), \tag{8}$$

where ϕ refers to altruism and c_b refers to a consumption threshold. Both these parameters have intuitive interpretations. ϕ 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, ϕ 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

[17] See Section 5.3.1 for a further discussion on the parameterization of the bequest motive.

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]

Budget Constraints – Preferences are subject to a budget constraint each period:

$$c_t + \frac{A_{t+1}}{1+r} = A_t + SSB + \xi_t(Fem, y, \psi_t) + g_t \tag{9}$$

where A refers to assets, c refers to consumption, SSB refers to Social Security benefits, ξ refers to expenditure shocks, b refers to bequests, and r refers to the interest rate. We assume that there is no borrowing, partly due to the fact that borrowing against Social Security benefits and means-tested programs is illegal:

$$A_t \geq 0, \quad \forall t \tag{10}$$

Lastly, g_t represents a consumption floor guaranteed by government or societal transfers (Hubbard et al., 1995):

$$g_t = \max\{0,\ \underline{c} - (A_t + SSB + \xi_t)\} \tag{11}$$

Furthermore, we impose the consumption floor $\underline{c}$ by imposing the following.

$$c_t \geq \underline{c}, \quad \forall t \tag{12}$$

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, 2018). However, instead of including multiple sources of risks that drive precautionary savings based on observable data, we rely on ξ_t to capture all expenditure risk, both observable and unobservable.

Expenditure Shocks – We allow expenditure shocks, ξ_t, to depend on income in the following way:

$$\begin{aligned} \xi_t(Fem, y, \psi_t) = m_t(Fem, y) + \sigma_{\xi_t}(Fem, y) \times (\psi_t + \eta_t), \qquad \eta_t \sim N(0, \sigma_\eta^2) \\ \psi_t = \rho\psi_{t-1} + \epsilon_t, \qquad \epsilon_t \sim N(0, \sigma_\epsilon^2) \end{aligned} \tag{13}$$

The permanent income quintile is represented by $y = 1, ..., 5$.[19] We allow unobserved expen-

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

[19] We describe the construction of the permanent income quintiles in Section 5.1.

ditures to have a first order autoregressive component and a white noise component.[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). We allow the mean and variance of unobserved expenditures to depend on a linear function of quartic age, gender, and income quintile.

To give some intuition for the role of ξ, 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:

$$\begin{aligned} SSB_i &= \alpha_0 + \alpha_1 Wind_i + \upsilon_i^{SSB} \\ Beq_i &= \pi_0 + \pi_1 SSB_i + \pi_2 \widehat{\upsilon_i^{SSB}} + \nu_i \end{aligned}$$

Then π_1 is identical to ω_1^{beq} 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 ξ_t (in the model) takes on the role of $\widehat{\upsilon_i^{SSB}}$ in the instrumental variable regression. Indeed, it is ξ_t that will allow our model's simulated data to replicate the instrumental variable estimates in the true data.

Recursive Formulation – Denote the vector of state variables as $\boldsymbol{X}_t = \{A_t, \psi_t, y, Fem, SSB\}$ which consists of assets (A_t), the persistent component of expenditure shocks (ψ_t), gender (Fem), permanent income (y), and Social Security benefits (SSB). For each period t, the optimization problem is as follows:

$$\begin{aligned} V_t(\boldsymbol{X}_t) = \max_{c_t} \Big\{ u(c_t) + \beta \Big(& \delta_t(y, Fem, SSB) \cdot E_t[V_{t+1}(\boldsymbol{X}_{t+1} | \boldsymbol{X}_t)] \\ & + \big(1 - \delta_t(y, Fem, SSB)\big) \cdot v(A_{t+1}) \Big) \Big\} \end{aligned} \tag{14}$$

[20]This specification is based on French and Jones (2004), who show that it is able to fit medical costs well.

subject to the constraints (9), (11), and (10). The probability of surviving to the next period is denoted by $\delta_t(y, Fem, SSB)$ which is a function of age, permanent income, gender, and Social Security benefits.

There are two key points to note. First, retirees are not allowed to borrow against future Social Security benefits, an important institutional feature that ensure the annuity-nature of the benefits. This is key for the intuition behind the Notch instrument in its usefulness to distinguish between precautionary savings and bequest motives.

Second, our approach differs from prior attempts to separate bequest motives from precautionary savings by explicitly modeling 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 modeling 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.

5 Estimation

We estimate the model in two stages. In the first stage, certain parameters that we assume to be exogenous in the model are either calibrated or estimated without explicitly using the model. Given the vector of first stage parameters $\hat{\theta_f}$, the second stage uses indirect inference to recover the rest of the parameters in the model. This is done by first, numerically solving the model by starting from the terminal period $T = 110$ and iterating backwards to obtain the value functions and decision rules for each period.[21] Next, we generate a sample of 25,000 simulated retirees and simulate forward using our model solution and the first stage parameters to obtain simulated asset profiles and bequests.[22] We obtain initial state variables (assets, Social Security benefits, income quintile, and gender) directly from our HRS AHEAD sample. We then generate a set of data moments $(\hat{M})$ using the simulated data and compare

[21] See Appendix B for more detail on the model solution.

[22] When computing the value functions and decision rules, we rely on the estimated mortality probabilities δ_t. However, in our simulations, we impose our simulated retirees to have the same death age as observed in the data. If we do not observe the respondent's death date either due to missing data or the respondent being alive at last observation of the data, we use our estimated mortality probabilities to assign mortality shocks. This is similar to the approach taken by De Nardi et al. (2010) and Lockwood (2018).

them with their counterparts (M) in the true data from the HRS AHEAD sample. The final estimate $\hat{\theta}_s$ is chosen such that it 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]:

$$\hat{\theta}_s \;=\; \text{argmin}_{\theta_s}(M - \hat{M}(\hat{\theta}_f, \theta_s))' \; W \; (M - \hat{M}(\hat{\theta}_f, \theta_s)) \tag{15}$$

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 reported death dates to estimate mortality risk.

5.2 First Stage Parameters

Rate of return and discount factor – Real interest rate for assets is set as $r = 0.03$ and discount factor is set as $\beta = 0.97$. These are commonly assumed values as they fall into the range of parameter values estimated by representative works in the literature (Brown and Finkelstein (2008), Gourinchas and Parker (2002), Cagetti (2003)).

Mortality rates – 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 control for gender and Social Security benefits. The predicted mortality rates fit the data well, as shown in Figure D.1 of the Appendix.

[23]Following Pischke (1995), we use a "diagonal" weight matrix W where the diagonal elements are the inverse of the variances of each data moments and the off-diagonal elements are zero. This is because although the inverse of the variance-covariance matrix of the data moments is asymptotically efficient, in practice it can be severely biased in small samples as shown in Altonji and Segal (1996). Therefore, the diagonal weighting matrix is a common weighting matrix used in empirical papers using indirect inference.

5.3 Second Stage: Indirect Inference

The remaining 27 parameters are estimated via indirect inference. These include two bequest preference parameters (ϕ, c_b), the coefficient of relative risk aversion (σ), minimum consumption floor ($\underline{c}$), standard deviation of the white noise and autoregressive components of expenditure risk (σ_η, σ_ϵ), the first order autoregressive coefficient (ρ), and the mean and variance coefficients for expenditure risk (m_t depends on 10 parameters varying by quartic age, gender, and income quintiles).

Indirect inference is suitable since the OLS and IV estimates from Section 3 can be included in the set of data moments that we choose to match in a natural way. While the model's parameters jointly play a role in all of the moments, the following section describes which moments are especially informative of our key model parameters.

5.3.1 Data Moments

One of the most important moments in our estimation procedure is the IV estimates from Section 3 since it helps us recover ϕ and c_b, the key preference parameters that govern bequest motives. To see how the instrument helps with the estimation 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 equations (7) and (8)), and substituting in the budget constraint (equation 9):

$$u'(c) = v'(b)$$
$$(A_1 + SSB - b)^{-\sigma} = \left(c_b + \frac{1-\phi}{\phi}b\right)^{-\sigma}$$

we obtain:

$$b^* = \max\left\{0, \phi(SSB + A_1 - c_b)\right\}$$

Note that if $SSB + A_1 < c_b$, no bequests are left behind. Therefore, c_b has a natural interpretation as the minimum consumption needed, under no uncertainty, for non-zero bequests. This implies that for retirees whose initial assets are low, an increase in SSB means higher consumption but no increase in savings since the entire increase is consumed. 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 ϕ 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 ϕ, 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:

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

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 (i.e., 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 (i.e., 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 (i.e., 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,

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

even when $A_2 = 0$. Here, the 'risk' is mortality risk but we can also incorporate other types of risks such as large medical shocks. Our retiree is unable to insure herself against mortality risk 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 improving the precision of estimating bequest motives (i.e., pinning down the role of bequest motives): first, by dealing with unobserved heterogeneity and second, by providing variation in the incentive to save for precautionary reasons.

In addition to the Notch-related moments, we also match median asset profiles by age and permanent income quintile. Since the intertemporal elasticity σ governs the speed in which assets are decumulated over the life-cycle, median asset profiles by age are especially informative of this parameter. The variation across income quintiles is informative of $\underline{c}$, affecting mainly the lowest quintile.

We also match median and variances of assets by age, permanent income quintile, and gender, in order to pin down the parameters that govern expenditure shocks, ξ.[24] Note that in our model, unobserved heterogeneity comes in the form of unobserved expenditure risks ξ. Therefore, in addition to the asset moments, we match the OLS estimates of the effect of benefits on bequests since the parameters that govern ξ are reflected in the wedge between the OLS and IV estimates. In total, 81 moments are matched in the estimation procedure.

Table 4: Estimated Model Parameters

Parameter	Estimate	90% CI*
σ: relative risk aversion coefficient	2.71	(2.66, 2.75)
ϕ: bequest motive	0.90	(0.81, 0.91)
c_b: bequests motive (\$)‡	14,098	(12,374, 14,599)
$\underline{c}$: consumption floor (\$)‡	6,290	(2,606, 6,685)
Expenditure shocks		
$m_t(Fem, y)$: mean†		
Age	-0.009	(-0.020, 0.004)
$(\text{Age}/10)^2$	0.067	(0.064, 0.071)
$(\text{Age}/10)^3$	0.060	(0.055, 0.064)
$(\text{Age}/10)^4$	-0.225	(-0.234, 0.151)
Female	-59.44	(-73.86, -38.44)
Income Quintile 1 (bottom)	17.09	(9.04, 24.34)
Income Quintile 2	-47.65	(-67.43, -32.81)
Income Quintile 3	22.31	(16.13, 30.37)
Income Quintile 4	-42.08	(-57.39, -27.10)
Income Quintile 5 (top)	144.53	(140.32, 148.85)
$\sigma_{\xi_t}(Fem, y)$: variance†		
Age	-0.018	(-0.030, -0.006)
$(\text{Age}/10)^2$	0.089	(0.088, 0.090)
$(\text{Age}/10)^3$	0.013	(0.002, 0.024)
$(\text{Age}/10)^4$	-0.009	(-0.012, -0.005)
Female	-64.07	(-81.18, -45.50)
Income Quintile 1 (bottom)	13.37	(5.75, 29.57)
Income Quintile 2	-16.30	(-33.08, -4.55)
Income Quintile 3	1.18	(-97.03, 12.20)
Income Quintile 4	126.23	(122.77, 128.43)
Income Quintile 5 (top)	183.34	(173.37, 197.68)
ρ: autocorrelation of persistent shock	0.994	(0.976, 0.998)
σ_ϵ: variance of innovation to persistent shock	54.27	(32.68, 104.05)
σ_η: variance of white noise	210.24	(176.77, 255.07)

* 90% confidence intervals in parentheses computed by bootstrap. Refer to Appendix C for details on how the confidence intervals were computed.

† The mean and variance function of the expenditure shock is a linear function of age quartic, gender, and income quintile dummies.

‡ Dollar values in 1993 dollars.

Utility Functions: $u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$, $v(b) = \left(\frac{\phi}{1-\phi}\right)^{\sigma} \frac{\left(\frac{\phi}{1-\phi}c_b+b\right)^{1-\sigma}}{1-\sigma}$

6 Results

The estimated parameters are shown in Table 4. 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 ($14,098). Further, we find that ϕ is large (note that ϕ 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 ϕ would have been lower.

Our estimated parameters produce an acceptable fit of the asset moments. The data moments and the simulated moments are shown in Figure 4. In Appendix D, we present the model fit for median asset profiles by birth cohort and income quintile, which are untargeted moments (Figure D.2).

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

6.1 Bequest Motives and the Notch

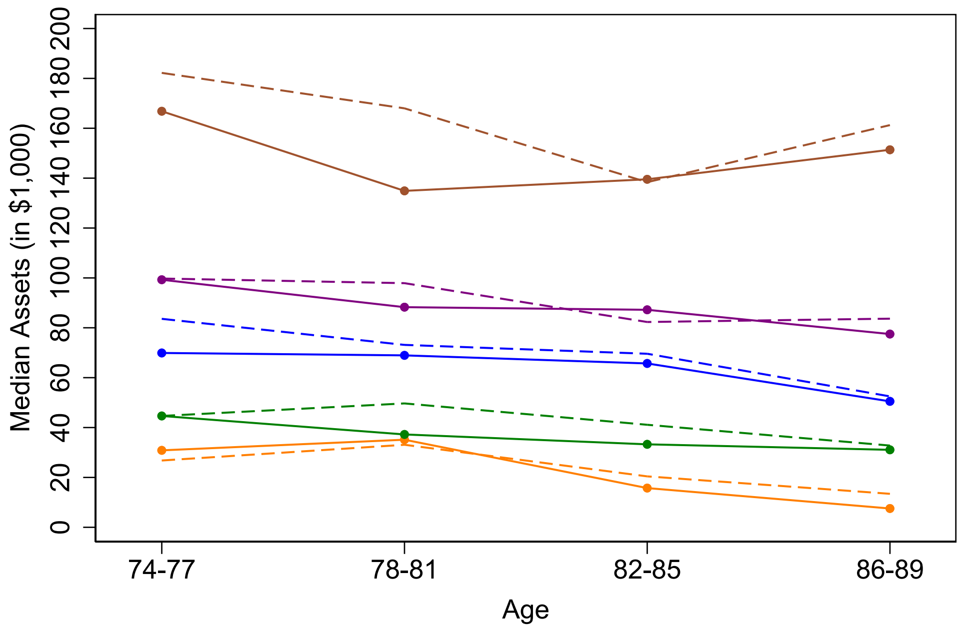
We present estimates for two additional versions of our model that demonstrate the role of the Notch and the role of bequest motives in our model. In the first version (labelled "no IV"), we do not match the IV estimates but only the OLS estimates. Our results in Table 5 show that without exploiting the instrument, bequest motives are underestimated, with $\phi = 0.76$ and c_b close to $24,000. As such, risk aversion has to compensate to explain high levels of savings and is estimated to be $\sigma = 5.53$. Perhaps more importantly, the confidence intervals when estimating without the IV moments increase dramatically, underscoring the importance of the Notch instrument in pinning down bequest motives and risk preferences.

The second version of the model is similar to the baseline, except that ϕ 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 $\sigma = 7.28$. Our results are in line with Lockwood (2018) who finds that bequest motives are important for explaining annuity choices as well as asset profiles.

[24] Recall that the mean and variance of these shocks depend on income, gender, and age.

[25] See for example, Ameriks et al. (2015a,b, 2011); De Nardi et al. (2010, 2016a); Lockwood (2018).

Figure 4: Median Asset Profiles by Income Quintile



Notes: Data moments (dashed lines) and simulated moments (solid lines) by permanent income quintile. Median asset profiles in thousands of 1993 dollars, discounted to 1993 (3% interest rate).

Table 5: Comparing Parameter Estimates and Moment Fit - "No IV"

Parameter	σ	ϕ	c_b	$\underline{c}$
Baseline	2.71	0.90	14,098	6,290
	(2.66, 2.75)	(0.81, 0.91)	(12,374, 14,599)	(2,606, 6,685)
No "IV"	5.53	0.76	23,682	6,214
	(2.68, 5.67)	(0.74, 0.91)	(10,962, 26,188)	(5,601, 6,956)
IV Moment Fit	Bequests ($1,000)		Any bequests	
Data moment	17.90		0.063	
	(8.26)		(0.029)	
Baseline	13.07		0.018	
No "IV"	9.51		0.016	

Notes: "No IV" estimates and fit indicate model parameter estimates and moment fit when the model is estimated without matching the IV moments. 90% confidence intervals in parentheses computed via bootstrap. Standard errors in parentheses for the IV data moment. "Any bequests" refers to an indicator for leaving positive bequests.

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 ξ_t is zero ($\sigma_\eta^2 = \sigma_\epsilon^2 = 0$). 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 35% of bequests are voluntary ($1 - \frac{47.38}{72.84}$), about \$30,000 per retiree. 15% can be explained by precautionary savings against expenditure risks ($\frac{47.36-36.49}{72.84}$). The remainder is due to mortality risk. The proportion of retirees who leave non-zero bequests also declines from 58% to 53% and 38%.

We also document that bequest motives explains roughly 35% 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.

Another way to see the role of bequest motives is to examine median asset profiles. Under the counterfactual model of no bequest motives, the median asset profiles show an even more dramatic decline for the 2nd and 4th income quintiles as seen in Figure 7.

An important caveat in our sample is that it does not include significant numbers of the wealthiest retirees since the HRS is underrepresented at the top of the wealth distribution, for whom the role of voluntary bequests may be different. However, this indicates that even among more moderately wealthy retirees, bequest motives are important.

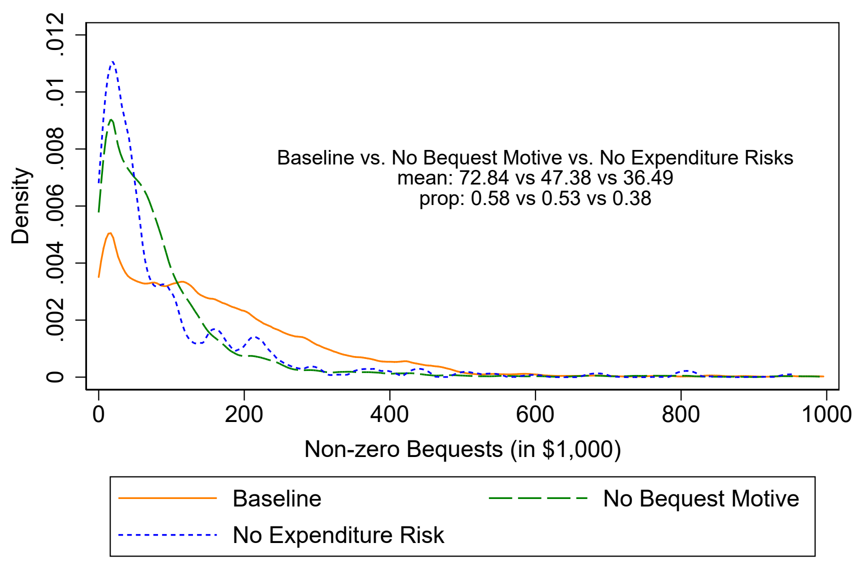
6.3 Policy Counterfactual: Benefit Cuts

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

Table 6: Comparing Parameter Estimates: No Bequest Motives

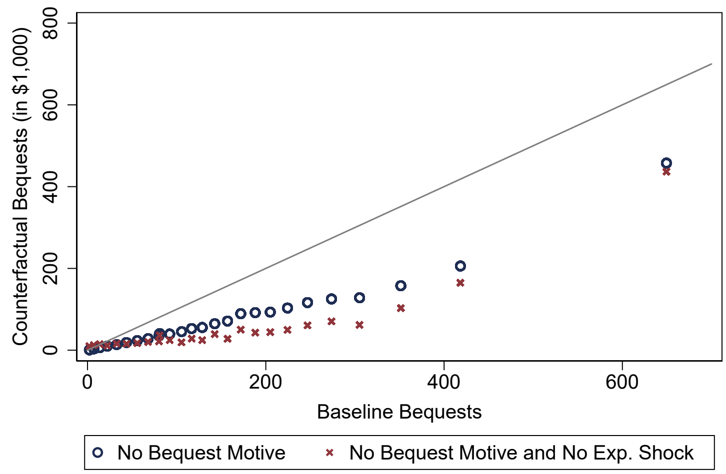
Preferences	σ	ϕ	c_b	$\underline{c}$
Baseline model	2.71	0.90	14,098	6,290
	(2.66, 2.75)	(0.81, 0.91)	(12,374, 14,599)	(2,606, 6,685)
No bequest motives ($\phi = 0$)	7.28	-	-	6,733
	(6.80, 7.34)			(6,415, 7,142)

Figure 5: Decomposing Bequests - Bequest Motives vs. Precautionary Savings



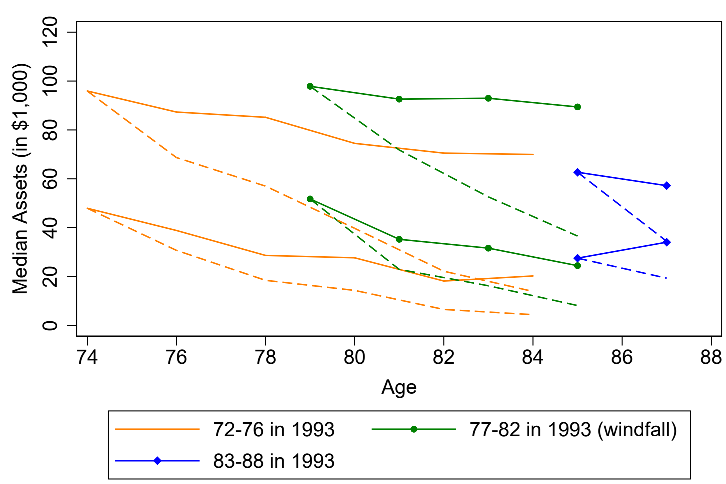
Notes: Densities of bequests under 1) the baseline model and the counterfactual model of 2) no bequest motives and 3) neither bequest motives nor expenditure shocks. Densities are conditional on non-zero bequests. The Epanechnikov kernal is used.

Figure 6: Counterfactual Bequests versus Non-zero Baseline Bequests



Notes: Bequests under the two counterfactuals of 1) no bequest motives and 2) neither bequest motives nor expenditure shocks are plotted against non-zero baseline bequests. Each point is the average counterfactual bequest within a 4 percent quantile of baseline bequests.

Figure 7: Median Asset Profiles Under No Bequest Motives



Notes: Median asset profiles for the baseline model (solid lines) and the counterfactual model of no bequest motives (dashed lines) by birth cohort and permanent income quintile (second and forth).

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 suitable for exploring the effects of policies that reduce benefits for current retirees.[26]

Instead of replicating particular policies proposed, we summarize potential policies for 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 would likely be progressive in nature.[27] 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.

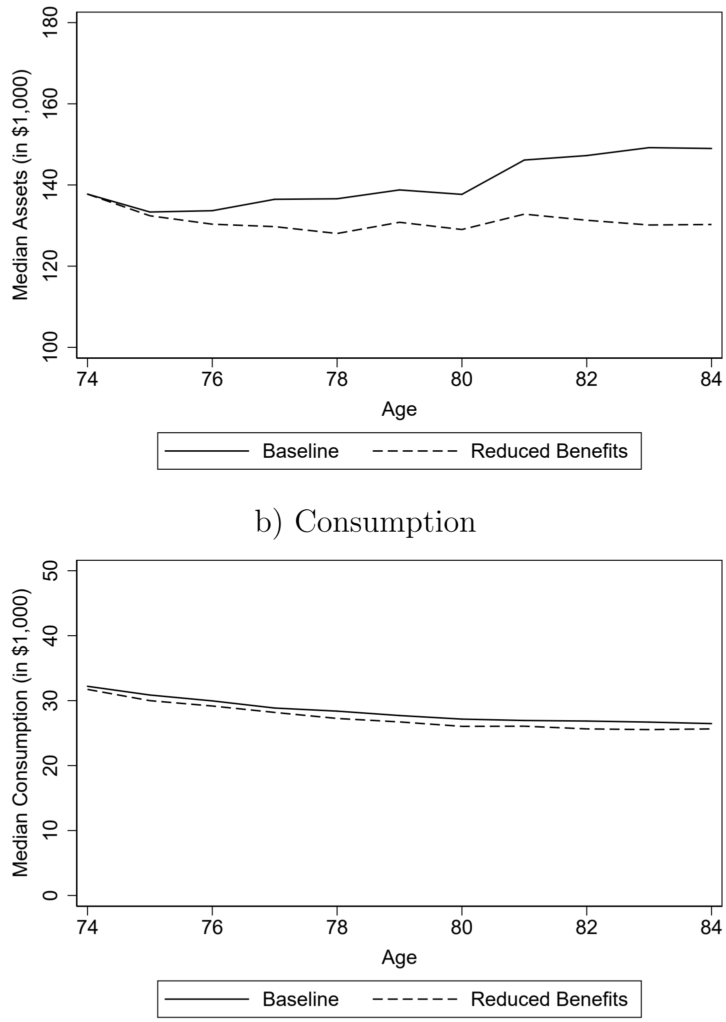
[26] Changes in retirement age and wage caps for taxes could induce large changes in savings and labor force participation before retirees claim benefits (see Scholz et al. (2006), for example), and our model is silent on those choices.

[27] Refer to Social Security Administration (2017) for the SSA's summary of possible program changes and their financial impact on the Social Security Trust Funds. Many of these provisions are progressive in nature including changes in PIA computation formula adjusting for inflation, longevity, etc.

Figure 8: Counterfactual Behavior under Benefits Cap

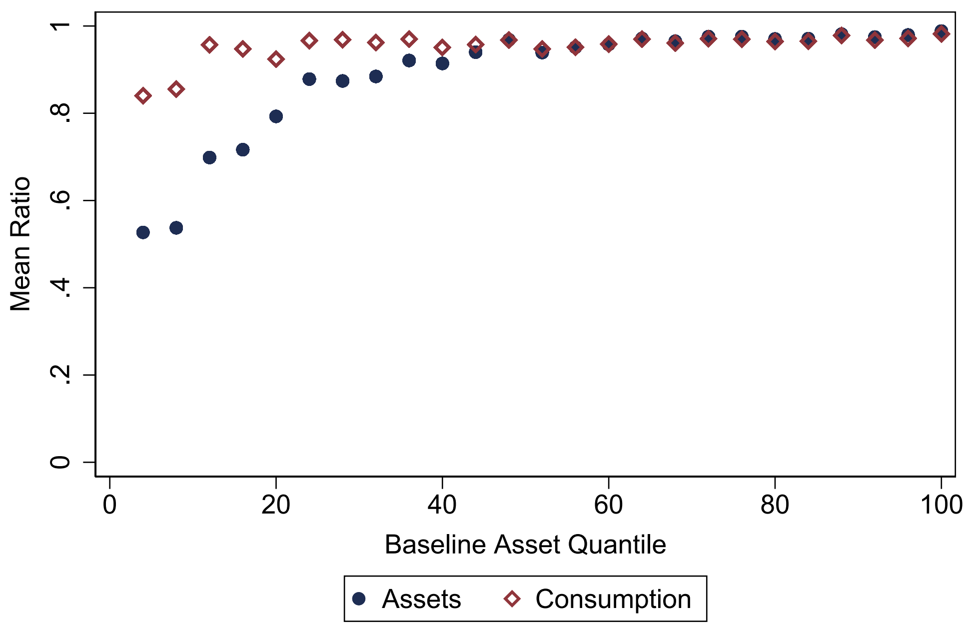
a) Assets

b) Consumption



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. Dollar values in 1993 dollars.

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.

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 and that boost in Social Security payouts is passed through to bequest recipients at a rate of roughly 50%.

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 and less precise. We use the model to decompose savings into precautionary versus bequest motives and find that bequest motives explain 35% of left bequests, consistent with the evidence from the IV regressions that bequest motives are economically significant.

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 alleviate the costs faced by Social Security without significantly compromising retiree consumption. It also highlights the nontrivial potential effects of changes to Social Security on bequest beneficiaries, a feature that deserves a closer look when evaluating policies surrounding Social Security benefits.

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.[28] However, our approach can pave the way for future work to address these issues if the model is suitably enriched.

[28] See De Nardi et al. (2015) for a working paper studying retiree savings for couples.

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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 (Table A.1).

Tables A.2 and A.3 report results for our other robustness checks. Table A.2 shows that the estimates are qualitatively similar conditional on pre-retirement characteristics, including education, an indicator for having children, and an indicator for being born during World War I ("Full controls"). Next, Panel A of Table A.3 shows that our results are robust to using an alternate definition of the Windfall cohort, namely the 1913-1916 birth cohort instead of the 1911-1916 birth cohort. This is motivated by the fact that the 1913 cohort is the earliest cohort of retirees who were definitely affected by the 1972 amendments. In Panel B of Table A.3, we show results for our placebo tests where the Windfall cohort is defined as 1906-1911 instead of the true Windfall cohort. The estimated coefficient is both small and statistically insignificant and this remains true when we restrict the sample to the 1900-1911 cohorts. Lastly, Panel C of Table A.3 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.4). In particular, we show that the interaction between initial observed assets and benefits is statistically significant.

Table A.1: The Effect of Annual Social Security Benefits by Different Discount Rates

	Bequests ($1,000)	Any bequests†
Baseline (3%)	**18.199**	**0.061**
	(8.369)	(0.029)
6% discount rate	**14.767**	**0.061**
	(6.782)	(0.029)
9% discount rate	**12.419**	**0.061**
	(5.763)	(0.029)

Notes: This table reports IV regression results based on our sample of the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in thousands of 1993 dollars. Bequests are discounted to 1993. Standard errors in parentheses.
† "Any bequests" refers to an indicator for leaving positive bequests.

Table A.2: The Effect of Annual Social Security Benefits (Robustness Checks)

		Bequests ($1,000)	Any bequests†
Additional controls‡	coef.	**21.677**	0.064
	s.e.	(12.149)	(0.041)
	p-value	0.074	0.119
Retirement Year	coef.	14.001	**0.075**
	s.e.	(9.398)	(0.036)
	p-value	0.136	0.039
Lifespan	coef.	**18.595**	**0.062**
	s.e.	(8.454)	(0.028)
	p-value	0.028	0.028

Notes: This table reports IV regression results based on our sample of the HRS AHEAD data. Sample consists of single, white, male and female retirees. Benefits and bequests are measured in thousands of 1993 dollars. Bequests are discounted to 1993 (3% discount rate).
† "Any bequests" refers to an indicator for leaving positive bequests.
‡ Additional controls include education, an indicator for having children, and an indicator for being born during World War I.

Table A.3: The Effect of Annual Social Security Benefits (Robustness Checks)

		Bequests ($1,000)	Any bequests
Panel A: Alternative definition of Windfall cohort			
Windfall 1913-1916†	coef.	**16.256**	**0.056**
	s.e.	(9.596)	(0.034)
	p-value	0.090	0.099
Panel B: Placebo tests defining "Windfall" as 1906-1911 cohort			
Full Sample	coef.	-0.613	-0.158
	s.e.	(32.550)	(0.222)
	p-value	0.985	0.476
Sample 1900-1911‡	coef.	1.731	-0.018
	s.e.	(18.053)	(0.066)
	p-value	0.924	0.786
Panel C: Sample restrictions			
Sample 1911-1921*	coef.	**19.259**	0.031
	s.e.	(11.199)	(0.034)
	p-value	0.085	0.366

Notes: This table reports IV coefficients from regressing bequest amounts and the probability of leaving any bequests on annual Social Security benefits. Sample consists of single, white, male and female retirees from the HRS AHEAD data. Benefits and bequests are measured in thousands of 1993 dollars. Bequests are discounted to 1993 (3% discount rate).

† Defining the Windfall cohort as those born from 1913 to 1916 instead of 1911 to 1916.

‡ Restricts the estimation sample to the 1900-1911 birth cohort.

* Restricts the estimation sample to respondents born from 1911 to 1921.

Table A.4: The Effect of Social Security Payouts Interacted with Assets

Dependent variable: Bequests ($1,000)			
		"Social Security payouts" defined as:	
		(a) Annual benefits	(b) Lifetime wealth
Social Security payouts	coef.	3.837	0.145
	s.e.	(8.987)	(0.322)
	p-val.	0.669	0.653
Social Security payouts × Assets	coef.	**0.018**	**0.001**
	s.e.	(0.003)	(0.000)
	p-val.	0.000	0.000
Weak identification test	F stat.	4.892	4.060
Stock-Yogo maximal IV size		15%	20%
Observations		1,436	1,436

Notes: This table reports IV estimates from regressing bequest amounts on Social Security payouts and the interaction of Social Security payouts and assets (as measured at first observation). Sample consists of single, white, male and female retirees in the HRS AHEAD data.. Benefits and bequests are measured in thousands of 1993 dollars. Bequests are discounted to 1993 (3% discount rate).

B Model Solution

In this section we provide further detail on how we solve our model. Since the model does not have an analytical solution, it is solved numerically. We compute the value function and decision rules at each value of the state vector starting from the terminal period T and work backwards until the starting period t_1. We set the value of the terminal period for a given state vector $\mathbf{\Theta}_T$ as the value of the bequest utility $V_T(\mathbf{\Theta}_T) = v(b_T)$ since all individuals die with certainty at T and leave all remaining assets as bequests. This allows us to compute the decision rules for period $T-1$ and V_{T-1}. This process is iterated for period $T-1,\ T-2,\ T-3,\ ...,\ t_1$. The state vector $\mathbf{\Theta}$ is discretized to finite points and linear interpolation is used to compute state vector values that do not correspond to the discretized grid values that we directly compute.

In order to reduce the dimensionality of our state space, we redefine the problem in terms of cash-on-hand x_t, where

$$x_t = A_t + \xi_t + SSB$$

This yields the following constraints:

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

$$\underline{c} \leq c_t \leq x_t \tag{B.17}$$

Then for each value of the state vector $\mathbf{\Theta}_t = (x_t, \psi_t, SSB, y, Fem)$, the value function is defined as follows:

$$\begin{aligned} V_t(\mathbf{\Theta}_t) = \max_{c_t} \Big\{ & u(c_t) + \beta\Big(\delta_t(SSB, y, Fem) \cdot E_t[V_{t+1}(\mathbf{\Theta}_{t+1})|\mathbf{\Theta}_t] \\ & + \big(1 - \delta_t(SSB, y, Fem)\big) \cdot v(x_t - c_t)\Big)\Big\} \end{aligned} \tag{B.18}$$

subject to constraints (B.16) and (B.17).

We take expectation over both the persistent and transitory components of unobserved expenditure risk ψ_{t+1} and η_{t+1} in order to compute the continuation value $E_t[V_{t+1}(\boldsymbol{\Theta}_{t+1})|\boldsymbol{\Theta}_t]$. First, we discretize the process for the persistent expenditure risk shock ψ_t using the Rouwenhorst method (Rouwenhorst, 1995). The transitory process η_t is also discretized using the Gaussian quadrature method. Given $\boldsymbol{\Theta_t}$ and c_t, each combination of ψ_{t+1} and η_{t+1} will give the value of x_{t+1}. Therefore, summing the next period value $V_{t+1}(\boldsymbol{\Theta_{t+1}})$ weighed by the realization probability for each grid point (ψ_{t+1}, η_{t+1}) yields the expected continuation value $E_t[V_{t+1}(\boldsymbol{\Theta_{t+1}})|\boldsymbol{\Theta}_t]$. Linear interpolation is used if x_{t+1} does not directly correspond to the x_t grid that we discretized.

C Bootstrap

Confidence intervals for our estimates are obtained by bootstrap. For each bootstrap replication s, we construct a bootstrap sample from the true data by sampling with replacement and generate initial state variables, moments (M_s) and weights (W_s) from this bootstrap sample. The parameter estimates from each bootstrap sample is denoted as $\hat{\theta}_s$. We perform 100 bootstrap replications and take the 5th and 95th percentiles of the $\hat{\theta}_s$ distribution as our 90% confidence intervals.

D Supplemental Tables and Figures

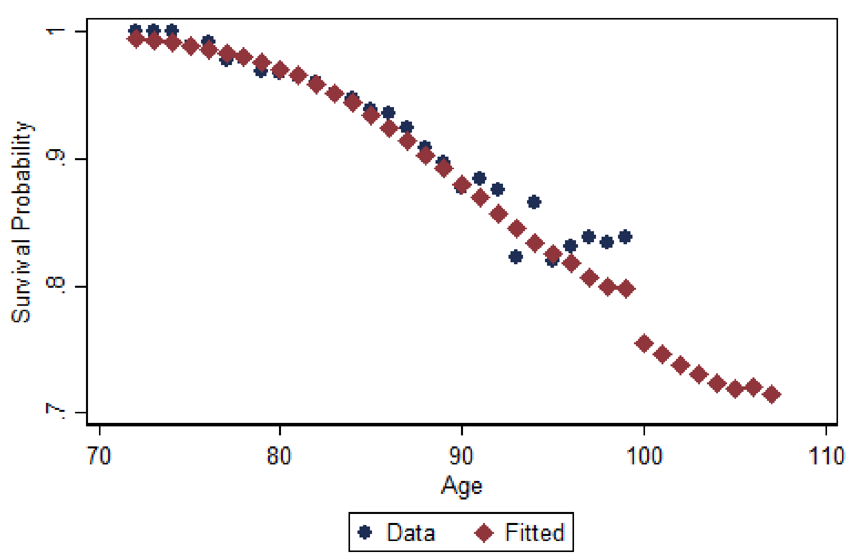
This section contains additional tables and figures.

Table D.5: Other Effects of the Notch

Outcome	Effect	Authors
Labor force participation	-	Krueger and Pischke (1992)
Last year of positive earnings†	0.16 years	Gelber et al. (2016)
Out-of-pocket medical expenses (quarterly)	$83	Tsai (2018)
Number of prescriptions (annual)	0.55	Moran and Simon (2006)
Home care use	3 p.p.	Goda et al. (2011)
Nursing home use	-2 p.p.	Goda et al. (2011)
Mortality	-2%	Snyder and Evans (2006)
Cohabitation	-2 p.p.	Engelhardt et al. (2005)

Notes: This table reports statistically significant effects from the Notch literature. Health expenses are estimated to increase with higher benefits, while cohabitation rates decrease. Despite the fact that higher benefits encourage higher health expenditure, they do not seem to be large enough to erode the bequest effects. Also, some of these reported effects are concentrated among the less educated (Engelhardt et al., 2005; Moran and Simon, 2006; Tsai, 2018) whereas our estimates are concentrated among the wealthy.
† While "retirement" is referred as the first year of Social Security benefit receipt in this paper, Gelber et al. (2016) define it as the last calendar year that an individual earned a positive amount.

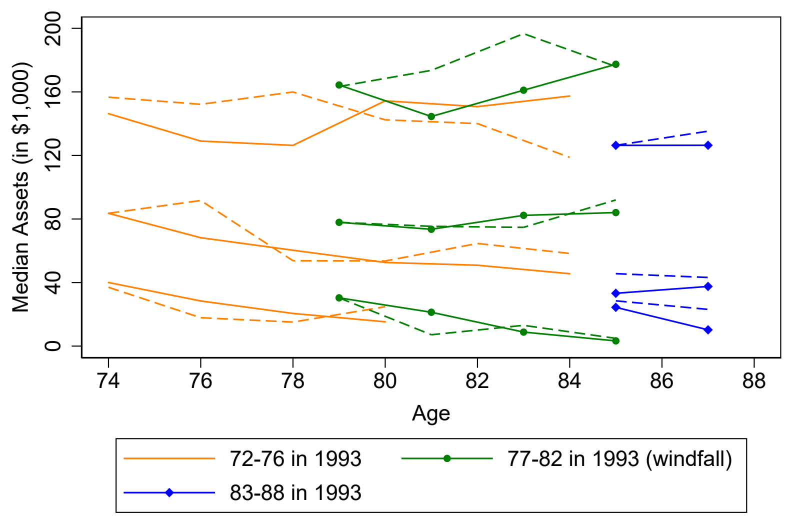
Figure D.1: Survival Probabilities by Age



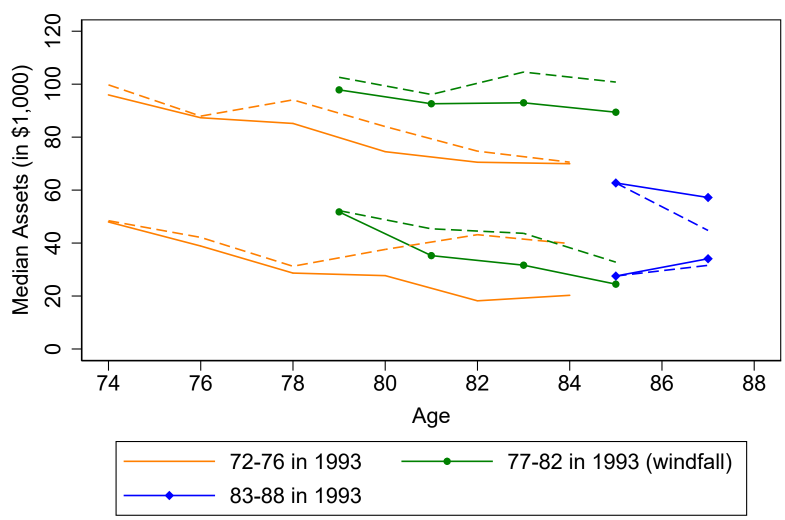
Notes: Fitted survival probabilites are based on a logistic regression controlling for quadratic in age, income quintile, interaction of age and income quintile, gender, and Social Security benefits. Sample consists of single, white, male and female retirees in the HRS AHEAD data.

Figure D.2: Median Asset Profiles by Birth Cohort and Income Quintile

(a) First, Third, and Fifth Income Quintile



(b) Second and Fourth Income Quintile



Notes: Untargeted data moments (dashed lines) and simulated moments (solid lines) by birth cohort and permanent income quintile (second and fourth). Median asset profiles in thousands of 1993 dollars, discounted to 1993 (3% interest rate).